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TÜBA-AR Yazışma Adresi/
Correspondence Address
Sultan Aktaş
TÜBA İstanbul Ofisi
İTÜ Maçka Yerleşkesi
Yabancı Diller Yüksek Okulu
34367, Maçka- İSTANBUL
Tel: 0.212.225 20 66
Faks: 0.212.219 16 60
E-posta: sultan@ist.tuba.gov.tr

Türkiye Bilimler Akademisi
Turkish Academy of Sciences
Piyade Sok. No: 27, 06550
Çankaya- ANKARA
Tel: 0.312.442 29 03
Faks: 0.312.442 23 58
E-posta: tuba@tuba.gov.tr

TÜBA-AR
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TURKISH ACADEMY OF SCIENCES JOURNAL OF ARCHAEOLOGY

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Upon the decision taken by the Editorial Board, a special section of the journal may be reserved on specific entities that are being currently debated in academic media.

Any type of preliminary excavation or survey report that lacks interpretation and perspective cannot be considered. However, original discoveries that bring insights to cultural history can be included in the journal in the “news” section.

Prof. Dr. H.H. Günhan Danışman (1943 -2009)

Bu yıl yitirdiğimiz değerli bilim insanı, arkeolojiye gönül vermiş
Mimar Günhan Danışman'ın anısına sunulur

Dedicated to the memory of distinguished scholar, supporter of archaeology
Architect Günhan Danışman

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İÇİNDEKİLER - *CONTENTS*

SUNU

TÜBA-AR'ın bu sayısı ile birlikte yeni bir uygulamaya başlamaktayız. Çeşitli araştırmacılardan gelen ve farklı açılımları içeren yazıların yanı sıra, belirli bir konu üzerinde yeni veriler ışığında farklı görüşler biraraya getirilecektir. Dosya konuları seçilirken yeni yapılan araştırmalarla ortaya çıkan sonuçların, geleneksel bakış açımızı, bilgimizi değişmeye zorlayan ve aynı zamanda kültür tarihi açısından önem taşıyan konular olmasına özen gösterilmektedir. Bu sayıyla Yakındoğu'da kalay sorunu irdelenmektedir; bilindiği gibi kalay, MÖ 3. binyılda bakır ile karıştırılarak kullanılmaya başlanmıştır. Tunç adını verdiğimiz elde edilen yeni alaşım, yalnızca teknolojik bir aşama değildir; bu aynı zamanda dayanıklı silahların yapılmasına yol açtığı için toplumsal örgütlenmede devrim niteliğinde sonuçlar vermiş, "Tunç Çağı" adını verdiğimiz süreci oluşturmuştur. Bu dönüşüm bir anlamda devlet ve imparatorlukları hazırlayan sürecin de tetikleyicisidir. Geleneksel bilgimiz kalayın Anadolu topraklarında bulunmadığı, bunun Afganistan ya da İngiltere gibi çok uzak bölgelerden ticaretle geldiği şeklindeydi. Ancak dosya yazılarından da görüleceği gibi son yıllarda "Anadolu kalayı" beklenmedik bir şekilde ortaya çıkmış, bunun gerçek olup olmadığı bağlamında uzun süren tartışmaların sonunda kalayın Anadolu'daki varlığı, artık hemen hemen tüm bilim insanları tarafından kabul edilmiştir. Anadolu'nun Yakındoğu kültür tarihi içindeki yerini, maden teknolojisinin gelişimini ve "madencilik arkeolojisi" olarak adlandırılan ve giderek önem kazanan bu alanda farklı bakış açılarını, önde gelen bilim insanlarının yazılarıyla biraraya getiren dosya editörleri Ünsal Yalçın ile Hadi Özbal'a TÜBA-AR yayın kurulu olarak teşekkür borçluyuz.

Kalay konusunun yanı sıra, TÜBA-AR'ın bu sayısında Anadolu'da sürdürülmekte olan çalışmaları yansıtan dört yazı daha eklenmiştir. Bunların arasında arkeozoolojinin önde gelen uzmanlarından Norbert Benecke'nin, Trakya'da Kanlıgeçit kazılarında beklenmedik şekilde ortaya çıkan çok sayıda at kemiğini değerlendiren yazısı bulunmaktadır. Bilindiği gibi geleneksel olarak atın ilk olarak Avrasya steplerinde evcilleştiği ve başka coğrafyalara evcilleşme sürecini tamamladıktan sonra, MÖ 3. binyılın ortalarında geldiği düşünülmekteydi. Son yıllarda yapılan çalışmalar, Anadolu'da Pleistosen'in sonlarında yabani bir at türünün bulunduğunu ve Anadolu Yaylası'nda steplerden ayrı bir at evcilleştirilmesi sürecinin yaşandığını ortaya çıkarmıştır. Bölgeler arası ulaşımda kolaylık sağlayan ve özellikle kervan ticaretinin ortaya çıkmasına yol açan, evcil ata ait sayıca az da olsa izler, yabani atalarının bulunduğu İç Anadolu'daki bazı merkezlerden, MÖ 3. binyılda kesin olarak kanıtlanmış durumdaydı. Trakya'da, Kanlıgeçit kazı yerinde MÖ 2600 yıllarından itibaren tam olarak evcilleşmiş atlara ait çok sayıda kemiğin bulunmuş olması, kervan ticaretinin önceden düşünüldüğü gibi MÖ 2. binyılda değil MÖ 3. binyılda başlamış olduğunu kesin olarak göstermiştir. Kanlıgeçit atlarının ortaya çıkmasıyla bilim dünyasında bu atların Avrasya, Ural ya da Anadolu kökenli olup olmadıkları üzerine yoğun bir tartışma başlamış, ancak yeni veriler söz konusu at türünün Anadolu atı olduğunu kesin olarak ortaya koymuştur. Ayrıca Kanlıgeçit'te bulunan arkeolojik veriler de, Trakya ile İç Anadolu arasında o dönemde ticaretin yoğun bir şekilde sürdüğünü göstermektedir. Bu sayıda ayrıca Tuba Ökse'nin Güneydoğu Anadolu'da Ilısu Baraj Alanı'nda yapılan çalışmaları kapsamlı olarak değerlendirdiği bir yazısı bulunmaktadır. Dicle Nehri üzerinde yapılması planlanan Ilısu Baraj Gölü nedeniyle daha önceleri arkeolojik açıdan hemen hemen hiç araştırılmamış olan bu bölgede son yıllarda çok sayıda ekip gerek yüzey araştırması, gerekse kazı olarak çalışmakta ve yoğun bir veri akışı sağlanmaktadır. Mezopotamya kültürleri ile Anadolu Yaylası arasındaki bağlantıyı sağlayan ve dolayısıyla kültür tarihi açısından kritik bir öneme sahip olan bu bölgeden gelen bilgiyi değerlendiren bu yazı kanımızca, ileride yapılacak birçok çalışma için bir altlık oluşturacaktır. Gene bu sayıda bulunan Engin Akdeniz'in Yortan kültürüyle ilgili çalışması, 20. yüzyılın başlarında, daha 1901 yılında M. Paul Gauguin tarafından bulunan ve daha sonraki yıllarda üzerinde yoğun olarak tartışıldıktan sonra, son yarım yüzyıl içinde büyük ölçüde göz ardı edilen bu kültürü yeniden gündeme taşımış olması açısından önemli bir çalışmadır. Bu çalışmanın bir diğer önemi de, Yortan kültürünün çekirdeğini oluşturan ve son yıllarda hemen hemen hiçbir arkeolojik çalışmanın yapılmadığı Balıkesir-Manisa bölgesinde çok yoğun bir tahribatın sürmekte olması ve antika piyasasına her yıl yüzlerce Yortan kabının girdiğinin bilinmesidir. Umarız ki bu yazı, Güney Marmara MÖ 3. binyılını simgeleyen bu kültürü yeniden gündeme taşıyacak ve yeni çalışmaları tetikleyecektir. Nurettin Arslan'ın Çanakkale bölgesinin Klasik Çağı ile ilgili yazısı, gene Güney Marmara Bölgesi'ni farklı bir açı ve dönemiyle ele almakta, bölgeyle ilgili bilgilerimizin ne kadar eksik olduğunu göstermektedir. Anadolu ile ilgili bu dört yazının yanı sıra John Ryan ve ekibinin höyük oluşumunu toprak bilim yöntemleriyle ele aldığı yazı, hızla gelişmekte olan jeoarkeolojiye önemli bir katkıdır. Bu bölümün son yazısını oluşturan Felix Pirson'ın İstanbul Alman Arkeoloji Enstitüsü'nün geleceği ile ilgili öngörülerini ortaya koyduğu yazı kanımızca, zaman zaman gündeme farklı şekillerde taşınan "yabancı arkeologlar ve bilim kurumları" konusunu irdelemesi açısından çok yararlı bir çalışma olmuştur. Bu bağlamda çağdaş yaklaşımın geçmişin tüm insanlığın ortak kültürel mirası olduğu ve bunu doğru bir şekilde algılamanın bilim dünyasının ortak çabası ile gerçekleşebileceği düşüncesini yansıtan, bilimde geçmişe seçici ya da tekelci olarak değil, yansız olarak tüm bilim kurumlarının ortaklığı ile ele almanın gereği bir kez daha bu yazıyla vurgulanmaktadır.

Bu sayıya katkıda bulunan tüm meslektaşlarımıza ve özellikle kalay dosyası ile seçkin bilim insanlarını biraraya getirerek TÜBA-AR'a kazandıran Ünsal Yalçın ile Hadi Özbal'a içtenlikle teşekkür ederiz.

YAYIN KURULU

PROF. DR. GÜNHAN DANIŞMAN'IN ANISINA

Hadi ÖZBAL

Prof. Dr. Günhan Danışman 1943 yılında doğdu. Orta ve Lise tahsilini 1954-61 yılları arasında Tarsus Amerikan Koleji'nde tamamladı. Lisans diplomasını ODTÜ Mimarlık Bölümü'nden 1965 yılında aldıktan sonra lisans üstü eğitimini İngiltere'de sürdürdü. Buna göre sırasıyla 1968'de University of London, Arkeoloji Bölümü'nden Yüksek Lisans, 1976 yılında, aynı üniversitenin Arkeoloji Enstitüsü'nden Tarihi Anıtların Konservasyonu diploması ve 1977 yılında da Teknoloji Tarihi konusunda doktora derecesini aldı. 1977 yılında Boğaziçi Üniversitesi Fen-Edebiyat Fakültesi Tarih Bölümü'ne katılarak mimarlık ve teknoloji tarihi konularında dersler vermeye başladı. Prof. Danışman 1982-1992 yılları arasnda akademik çalışmalarına ara vererek mimarlık alanında çalışmalar yaptı. 1992-1998 yılları arasında Sağlık ve Eğitim Vakfı'nın Genel Koordinatörlük görevini yürüttü. Bu arada yarı zamanlı olarak Boğaziçi Üniversitesi Tarih Bölümü'nde dersler vermeye başladı. 1995 yılında doçent ünvanını aldıktan sonra 1998 yılında tam zamanlı olarak tekrar Boğaziçi Üniversitesi'ndeki görevine döndü ve 2007 yılında Profesör ünvanını aldı.

Günhan Danışman her şeyden önce iyi bir eğitmendi. Öğrencilerine ders vermekten, herkesle her firsatta belleğindeki bilgi birikimini paylaşmaktan büyük keyif alırdı. Mimarlık tarihi ile ilgili olarak öğrencilerine, ülkemizi ve Üniversitemize gelen konuklara heyecanla İstanbul ve yakın çevresindeki mimari anıtları gezdirir, hatırlardan çıkmayacak ilginç yorumları ile hem eğlendirir hem de eğitirdi. Boğaziçi Üniversitesi'nde hocalığım sırasında, Prof. Danışman'ın Osmanlı mimarisi ve Teknoloji Tarihi konularında vermekte olduğu derslere dinleyici olarak katılmam belki de beni, bugün sürdürmekte olduğum Arkeometri alanına taşımıştır.

Prof. Danışman yoğun akademik çalışmalarının yanı sıra TMMOB'nın İstanbul Büyükkent Şubesi kapsamında mimarlık mesleği ile ilgili birçok ulusal ve uluslararası kuruluşlarda kurucu üyelik ve üst düzey yöneticilik görevleri yürüttü. 2002-2009 yılları arasında TMMOB İstanbul Büyükkent Şubesi 2. Başkanlığı, Mimarlık Müzesi Yönetim Kurulu Başkanı, Mimarlık Vakfı Kurucu Üyesi, Avrupa Mimarlık Konseyi'nin (AEC) Türkiye Temsilcisi, Uluslararası Mimarlar Birliği'nin Konsey Üyeliği görevlerini yürüttü. Ayrıca International Oral History Association üyeliği, Türkiye Ekonomik ve Toplumsal Tarih Vakfı kurucu üyesi, Türk Bilim Tarihi Kurumu kurucusu ve Yönetim Kurulu üyesiydi. Prof. Danışman üyesi olduğu bu kuruluşların yönetisi olarak sayısız ulusal ve uluslararası projeler ve bilimsel toplantıların gerçekleştirilmesinde öncü olmuştur.

Prof. Danışman'nın arkeoloji alanındaki bilimsel çalışmaları 1977-1981 yıllarında Prof. Dr. Bahadır Alkım başkanlığındaki İkiztepe Kazılarında başlar. Bu dönemde İkiztepe kazılarının tüm mimari çizimleri ve gün ışığına çıkarılan nekropolün belgelenmesinde uyguladığı yöntemler arkeolojik kazılara yenilikler katmıştır. Aynı uygulamaları 1979-81 yıllar arasında katıldığı Köşkerbaba Höyüğü kurtarma kazılarında da uygulamıştır. Prof. Danışman'nın daha etkin ve kapsamlı arkeolojik çalışmaları Boğaziçi Üniversitesi, Tarih Bölümu oğretim üyesi Doç. Dr. Aslı Özyar ile birlikte 2001 yılında başlattığı Tarsus Gözlükule çalışmalarıdır. Orta ve lise öğrenciliği süresinda özdeşleştiği Tarsus kentindeki Gözlükule çalışmaları Günhan'ın arkeolojik yeteneklerinin yanı sıra idari deneyimleri ve etkin girişimciliği sayesinde kısa bir sürede kazı deposu, kazı evi gibi tüm alt yapı gereksinimlerini sağlamıştır.

2002 yılında Kırklareli, Demirköy'de başlayan çok değişik disiplinlerden bilim insanlarının katıldığı ve birçok kurumun işbirliğini gerektiren çalışma onun bilinçli ve etkin katkıları ile ülkemizin ilk Endüstri Arkeolojisi Projesine dönüşmüştür. Osmanlı demir dökümhanesinde sürdürülen çalışmalar, onu heyecanlandıran arkeoloji, teknoloji tarihi, sözlü tarih, restorasyon ve arşiv çalışmaları gibi tüm ilgi alanlarını kapsamaktaydı. Demirköy projesinin hedefi, ülkemizde Osmanlı Dönemi'nden kalma tek endüstri merkezinin özgün bir şekilde restorasyonu gerçekleştirerek burasını bir açık hava müzesine döndürmekti.

Prof. Günhan Danışman çok yönlülüğü ve bitmez tükenmez enerjisi ile yaşamı boyunca özveri, heyecan ve tutkuyla yürüttüğü tüm çalışmalarında kendisine özgü inceliği, güzellikleri, verimliliği ve başarıyı yansıtmıştır. Onunla birlikte çalışma olanağına sahip olmuş bir kişi olarak yerinin doldurulamayacağının bilincinde, Demirköy Projesindeki hedeflerine ulaşmak gayreti içinde olacağız.

DR. GÜNHAN DANIŞMAN'IN YAYIN LİSTESİ:

Danışman, H.H. Günhan
1968 *Development of Architectural Settlements in Anatolia from its Beginnings to 100 B.C.,* M. Phil. Thesis in Arts, Presented to University of London, June.

1972 "The Architectural Developments of Settlements in Anatolia", PJ. Ucko, R. Tringham ve G.W. Dimbleby (yay.) *Man, Settlement and Urbanism*: 505-511. G.W. Duckworth, London.

1976 "History of Timber Building Technology and Its Conservation Techniques", PhD Thesis, submitted to University of London.

1977a "An Operational Fulling Mill at Kırha-Divan in Central Anatolian Plateau, Turkey", *Post-Medieval Archaeology* 11: 80-86.

1977b "A Survey of Turbine Type Water Mills in the Bolu Region of the Central Anatolian Plateau", *O.D.T.Ü. Mimarlık Fakültesi Dergisi* 3/1: 17-37.

1977c "Yayla Settlements of the Bolu Regions as Examples of Indigineous Developments of Rural Vernacular Architecture", *Boğaziçi Üniversitesi Dergisi* 4-5: 15-37.

1978 "Kentleşme Sürecinde Anadolu Uygarlıklarının Yeri (I. Kısım)", *Boğaziçi Üniversitesi Dergisi* 6: 75-96.

1979a "Kentleşme Sürecinde Anadolu Uygarlıklarının Yeri (II. Kısım)", *Boğaziçi Üniversitesi Dergisi* 7: 35-59.
1979b "Teknoloji Tarihi Dalında Son Gelişmeler", *B.Ü. Haber Bülteni 17*: 16-17.

1981 *Hassas Ölçü Aletlerinin Teknolojik Evrimlerinin Bilimsel Devrime Katkısı*. Üniversiteler Arası Kurula Sunulan Doçentlik Tezi, Boğaziçi Üniversitesi, İstanbul.

1980-81 "Anadolu'nun Teknoloji Tarihinin Hazırlanmasında Yöntem ve Sorular", *Boğaziçi Üniversitesi Dergisi* 8-9: 27-36.

1981 "Ölçü Aletleri Hassas Aletlerin Teknolojik Evrimlerinin Bilimsel Devrime Katkısı ve Anadolu Uygarlıklarının Bu Katkıdaki Payının Belirlenmesi", *I. Uluslararası Türk-İslam Bilim ve Teknoloji Tarihi Kongresi*, Cilt I (Temel Bilimler Tarihi): 121 vd. İstanbul İ.T.Ü., Mimarlık Fakültesi.

1986a "Samsun Yöresi Ahşap Mimarisinin Gelenekselliği – Bafra İkiztepe Arkeolojik Verilerinin Işığında Çarşamba Camiinin İncelenmesi", *Türk Tarih Kongresi Bildirileri* IX/I: 135-144, Levha 87-95.

1986b "Emirza Bey Türbesi, Bafra*", Anadolu Araştırmaları Dergisi* (Prof. Dr. Bahadır Alkım anısına): 543-45, Levha I-V.

1996 "Designation of Conservation Areas in Cities", *Architectural Heritage Today*, (İstanbul-Süleymaniye and Mostar Workshop): 248. IRSICA, İstanbul.

1997 "Ottoman Early Stage and Its Impact on Rural and Urban Tourism Planning", N. Günsenin ve Ş. Yarcan (yay) *MED Campus, Seminar on Urban, Rural, Cultural Tourism*: 129. Boğaziçi University Press, İstanbul.

1999 "Karakavak Sokak No. 4, Arnavutköy: A Late 19th Century Townhouse Within the Historical Background of a Bosphorus Village", Ç. Kafescioğlu ve L. This-Şenocak (yay.) *Essays in Honour of Abdullah Kuran*: 503-518. Yapı Kredi Yayınları, İstanbul.

2000 "Mimar Sinan'ın Süleymaniye Camii ve Mişelanjelo'nun Roma San Piedro Katedrali: XVI Yüzyılda Klasik Mimari Tarzının Merkezi Planlı İki Önemli Yapısının Karşılaştırılması", *700 Yılı Sempozyumu, Bildiriler*. Osmangazi Universitesi Yayınları, Eskişehir.

2001a "Arnavutköy 1900-2000: Transformacion urbana un barrio meltietnico de Estambul", *Historia Antropologia y Fuentes Orales* 25: 127-132.

2001b "Yerel Tarihin Gücü: Arnavutköy Semt Girişimi'nin Boğaz Köprüsüne Yerel Tarih ile Karşı Koyuşu", *3. Uluslararası Tarih Kongresi: Tarih Yazımı ve Müzecilikte Yeni Yaklaşımlar, Küreselleşme ve Yerelleşme:* 115-124. Türkiye, Ekonomik ve Toplumsal Tarih Vakfı, İstanbul.

2002a (Yay.) *Bir Kurucu Rektörün Anıları: Robert Kolej Yüksek Okulu'ndan Boğaziçi Üniversitesine*, (Anı sahibi) Abdullah Kuran, Boğaziçi Üniversitesi Yayınları, İstanbul.

2002b "The Oral History of a History Department", P. Denis ve J. Worthington (yay.) *The Power of Oral History: Memory, Healing and Development, XIIth International Oral History Conference Proceedings* 3: 1477-1492. University of Natal, Pietermaritzburg.

2003a "Anadolu Enerji Teknolojileri Tarihçesi ve 18. Yüzyıl Sonunda Osmanlı Yönetiminin Sanayileşmede Kaçırdığı Fırsatın Yeniden Değerlendirilmesi", E. Dölen ve M. Kaçar (yay.) *Türk Teknoloji Tarihi* (1. Türk Bilim ve Teknoloji Tarihi Kongresi Bildirileri, 15-17 Kasım 2001): 95-113. Türk Bilim Tarihi Kurumu, İstanbul.

2003b "Ulusal Mimarimizde Kimlik Sorunu: Mimar Vedat Tek ve Araştırıcı Afife Batur", *Mimar.ist* 8: 10-12.

2003c "Çatalhöyük: Anadolu'da bir Neolitik Kent", *Mimar.ist* 10: 9-10. (James Mellaart, Çatalhöyük: *Anadolu'da bir Neolitik Kent*, çeviri Gökçe Bike Yazıcıoğlu, Yapı Kredi Yayınları, İstanbul, 2003)

2004a "Anadolu'da Demir Çağı Kentleri", *Mimar.ist* 11: 10-11. (S. Aktüre, *Anadolu'da Demir Çağı Kentleri*, Tarih Vakfı Yurt Yayınları, İstanbul, 2003).

2004b "Traditional Mediterranean Architecture / Geleneksel Akdeniz Mimarisi", *Mimar.ist*: 12: 8. (G. Nourissierm *et.al*. (eds.), *Traditional Mediterranean Architecture*, Corpus, Barcelona, 2002).

2004c "Globalization and the Predicament of the Artisan/Technologist", *Memory and Globalization*. 23-26 June 2004. XIIIth International Oral History Conference, jointly organized by the Comune di Roma and I.O.H.A. – International Oral History Association.

2004d "Osmanlı Dönemine Yeni Bir Bakış Açısı: Tarihsel Arkeoloji", *Mimar.ist*: 15: 9-10. (U. Baram ve L. Carroll (eds.), *Osmanlı Arkeolojisi*, Kitap Yayınevi, İstanbul, 2004).

2004e "Yazıları ve Röleveleri ile Sedat Çetintaş", *Mimar.ist*, 4/13: 8. (A. Ödekan, *Yazıları ve Röleveleri ile Sedat Çetintaş*, İ.T.Ü. Yayını, İstanbul, 2004).

2004f "Geçmişten Günümüze Beyoğlu", *Mimar.ist*, 4/14: 9. (*Geçmişten Günümüze Beyoğlu*, TAÇ Vakfı ve Beyoğlu Belediyesi ortak yayını, İstanbul, 2004).

2005a "C.A.T.'s Long Courtship of A.C.E./Mimarlar Odası'nın Avrupa Mimarlar Konseyi ile Uzun Süren Sevdası", *Mimar.ist* 5/16: 67-69.

2005b "Çağdaş Kentin Kısa Tarihçesi ve Kentsel Yenileştirme Kavramının Yeniden İrdelenmesi", D. İncedayı (yay.) *Yaşanılır Kentler/Yaşanılır İstanbul* (Teknik Kongre Bildirileri): 15-32. TMMOB, Mimarlar Odası, İstanbul Büyükkent Şubesi, İstanbul.

2005c "Duatepe Türbe: An Ottoman Funerary Monument on the Gözlükule Mound", A. Özyar (yay.) *Interdisiplinary Research at Tarsus-Gözlükule: Results of 2001-2003 Seasons*: 207-217. Ege Yayınları, İstanbul.

2005d "Küreselleşme ve Zanaatçı/Teknoloji Ustalarının Çaresizliği", F. Günergun (yay.) *Osmanlı Bilimi Araştırmaları* (Emre Dölen Armağanı Özel Sayı) 6/2: 235-245.

2005e Çeviren, *Dördüncü Dünya: Baltimore Öyküleri, 1990/The Fourth World: Baltimore Narratives*, 1990, M. Villanova, Boğaziçi Üniversitesi Yayınevi, İstanbul.

2005f "Enterdisipliner Tarsus-Gözlükule Araştırma Projesi'nin Tarsus Kent Mimarisi ve Doğal Çevresine Katkıları", *Tarih İçinde Mersin (Kollokyum II)*: 2-5. Mersin Üniversitesi Yayını, Mersin.

2005g "Ütopya, Mimarlar, Anti-Ütopya", *Mimar.ist* 5/18: 66-67.

2005h "Demirköy'de İkinci Dökümhane Bulundu", *Mimarlara Mektup* 11: 81.

2006a "Korunması Gerekli 20. Yüzyıl Mimari Restorasyon ve Restitüsyon Sorunları", *Mimar.ist* 6/19: 96-100.

2006b "Antalya Kalesi Duvarlarındaki Selçuklu Fetihnamesi", *Mimar.ist* 6/20: 6.

2006c "Siyasetin Sanatı, Sanattaki Siyaset", *Mimar.ist* 22: 8-9.

2006d "15.-17. Yüzyıllarda Balkanlarda Osmanlı Madencilik ve Metal İşletmeciliğinin Güneydoğu Avrupa'daki Ateşli Silahlar Teknolojisi Üzerindeki Etkileri", H. Çalıkuşu (yay.) *Yıldız Dağları ve Yakın Çevresi Tarih Araştırmaları*: 92-103. Arkeoloji ve Sanat Yayınları, İstanbul.

2006e "The Introduction of American Surgical Technology in the Ottoman Empire in the 19th Century", M. Kaçar ve Z. Durukal (yay.) *Essays in Honour of Ekmalettin İhsanoğlu* I: 597-631. IRSICA Yayınları, İstanbul.

2006f *Anadolu Teknoloji Tarih: İlk Aletten M.Ö. 1000'e*. Türk Bilim Tarihi Kurumu Yayını, İstanbul.

2006g "Reha Günay'ın Mimar Sinanı", *Mimar.ist* 6/19: 9, (R. Günay, *Mimar Sinan*, Y.E.M. Yayınları, Istanbul, 2005).

2006h "Atmeydanı – Bizans Araba Yarışlarından Osmanlı Şenliklerine", *Mimar.ist* 6/19: 6 (Seza Sinanlar, *Atmeydanı, Bizans Araba Yarışlarından Osmanlı Şenliklerine*, Kitap Yayınevi, İstanbul, 2005).

2006i "Soframız Nur, Hanemiz Mamur", *Mimar.ist* 6/20: 10, (S. Faroqhi ve C.Neumann (yay.), *Soframız Nur, Hanemiz Mamur*, Kitap Yayınevi, İstanbul, 2006).

2007a "Ottoman Mining, Metal Working and Fire Arms Technology", M. El-Gomati (yay). *1001 Inventions – Discover the Muslim Heritage in our World*: 2-11. Foundation for Science and Technology and Civilization Publication, Manchester.

2007b (Çeviren) *İslam Teknolojisi: Tasvirli bir Tarih.* A.Y. al-Hassan ve D.R. Hill (UNESCO Yayını). TÜBİTAK, Popüler Bilimsel Yayınlar, Ankara.

İkili Yazılar

Danışman, G.H.H. ve B. Çeçener
"Kültür Değeri Olan Yapı Koruması ve İlgili Mevzuatı", *Mimarlık* 10/ 118: 18-23.

Danışman, G.H.H. ve İ. Üstün
2000 "Arnavutköy 1900-2000: Urban Transformation at a Multi-Ethnic Neighbourhood of İstanbul Evidenced Through the Narratives of its Senior Citizens", *Crossroads of History: Experience, Memory, Orality, XIth International Oral History Conference Proceedings* II: 507-513. Boğaziçi Üniversitesi Yayınları, İstanbul.

Danışman, G.H.H., G. Gürbüz, H. Özener ve A. Özyar
2003 "Tarsus Gözlükule 2001 Yılı Enterdisipliner Araştırmaları", *Araştırma Sonuçları Toplantısı* 20/I: 273-282.

Danışman, G.H.H., G. Karabulut, H. Özener ve A. Özyar
2004a "Tarsus-Gözlükule 2002 Yılı Enterdisipliner Araştırmaları", *Araştırma Sonuçları Toplantısı* 21/2: 235-244.

Danışman, G.H.H. ve O.R. Bahadır
2005 "Late Ottoman and Early Republican Science Periodicals: Center and Periphery Relationship in Dissemination of Knowledge", G. Irzık ve G. Güzeldere (yay.) *Turkish Studies in the History and Philosophy of Science*: 271-296. Kluver Academic Publications, Netherlands.

Danışman, G.H.H., H. Özbal ve A. Özyar
2005 "Field Seasons 2001-2003 of the Tarsus Gözlükule Interdisiplinary Research", A. Özyar (yay.) *Interdisiplinary Research at Tarsus-Gözlükule: Results of 2001-2003 Seasons*: 8-47. Ege Yayınları, İstanbul.

Danışman, G.H.H., A. Özyar ve H. Özbal
2005 "Tarsus-Gözlükule 2003 Yılı Enterdisipliner Araştırmaları", *Araştırma Sonuçları Toplantısı* 22/2: 87-92.

Danışman, G.H.H. ve G. Tanyeli
2005a "An Industrial Archaeology Project: An Iron Foundry of Ottoman Period at Kırklareli-Demirköy (Samakocuk)", *Mimar.ist* 5/16 (Special Issue of Trimonthly Journal of the Chamber of Architects of Turkey, İstanbul Metropolitan Branch): 96-98.

2005b "Demirköy-M.Samakov: An Industrial Archaeology Project at Turkish Thrace for an Ottoman Iron Foundry and Its Metal Working Region", *International Symposium on Metallurgy in Southeast Europe from Ancient Times until the end of 19th Century*: 139-144. (26-30 September 2005, Technical University of Sofia, Recreation House), Sozopol.

Danışman, G.H.H., H. Özbal ve A. Özyar
2006 "Tarsus –Gözlükule 2004 Yılı Disiplinlerarası Araştırmaları", *Araştırma Sonuçları Toplantısı* 23/2: 155-162.

Danışman, G.H.H. ve G. Tanyeli
2006 "Trakya'da Bir Endüstri Araştırması Projesi: Kırklareli-Demirköy Demir Dökümhanesi 2004 Yılı Yüzey Araştırması", *Araştırma Sonuçları Toplantısı* 23/2: 389-393.

Danışman, G.H.H. ve İ. Üstün
2006 "Contentious Politics at a Bosphorus Neigborhood: Perspectives on Conflict and Solidarity during the 20th Century", M. Kousis ve T. Selwyn (yay.) *Mediterranean Contention*. Casell-Pinter Publications, N.Y.

Danışman, G.H.H. vd.
2007 "Demirköy-Samakocuk Iron Foundry: An Industrial Archaeology Project at an Ottoman Metal Work-Shop Complex in Thrace", *TÜBA-AR* 10: 91-110.

Danışman, G.H.H. ve H. Özbal
2007 "Southeast Balkans and Turkish Thrace as a Bridge of Diffusion for Metallurgical Technology Between Anatolia and Europe", *Adoption and Adoptation: The Travel of Methods, Techniques and Technologies Between Asia Europe*, Boston Studies in the Philosophy of Science, Kluver Publications.

Danışman, G.H.H. ve A. Özyar
2009 "Tarsus-Gözlükule 2005-2006 Yılı Disiplinlerarası Araştırmaları", *Araştırma Sonuçları Toplantısı* 26/I: 383-398.

Danışman, G.H.H., A. Özyar, E. Kuruçayırlı ve E. Ünlü 2009 "Tarsus-Gözlükule 2007 Yılı Kazısı", *Kazı Sonuçları Toplantısı* 30/2: 47-60.

Danışman, G.H.H. ve H. Özbal
Baskıda "Kırklareli, Demirköy Fatih Dökümhanesi 2008 Yılı Kazıları", *Kazı Sonuçları Toplantısı* 31.

Danışman, G.H.H.
Baskıda "Preliminary Results from an Industrial Archaeology Site in Turkish Thrace: An Ottoman Iron Foundry in Demirköy-Samakocuk", *2nd International Conference on Science and Technology in Archaeology Conservation*. 7-11 December 2003. Queen Raina's Institute of Tourism and Heritage, The Hashemite University, Amman, Jordan (To be published jointly by the Hashemite University and Granada University in Spain).

Kırklareli-Demirköy kazı evi, 2005 yılı Dr. Guntram Gassmann, Günhan Danışman ve Hadi Özbal

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ON THE BEGINNING OF HORSE HUSBANDRY IN THE SOUTHERN BALKAN PENINSULA – THE HORSES FROM KIRKLARELİ-KANLIGEÇİT (TURKISH THRACE)

BALKAN YARIMADASININ GÜNEY KESİMİNDE AT YETİŞTİRİCİLİĞİNİN BAŞLANGICI – KIRKLARELİ (TRAKYA TÜRKİYE KESİMİ) – KANLIGEÇİT ATLARI

N. BENECKE

Keywords: Turkish Thrace, Early Bronze Age, horse husbandry, archaeozoology

Anahtar Sözcükler: Trakya (Türkiye kesimi), İlk Tunç Çağ, at yetiştiriciliği, arkeozooloji

ABSTRACT

The paper presents archaeozoological data on horse remains from the Early Bronze Age site Kırklareli-Kanlıgeçit (Turkish Thrace). Because of the absence of wild horses in Thrace in the Mid-Holocene the bone finds from Kırklareli-Kanlıgeçit can safely be assigned to domestic horses. According to radiocarbon dates on five of the horse bones, they date to the centuries between 2600 and 2300 cal BC. This is one of the earliest records of domestic horses in the southern Balkans. In comparison to other domestic mammals horses only represent a small part of the bone collection. Age determinations show that most horses were adult when they were slaughtered with animals seven to ten years old predominating. This seems to indicate that horses were primarily exploited as work animals, i.e., for riding, as pack animals, for traction, etc. The osteometric data point to quite a large and strongly built animals as the usual type of horse at this place and time. As local domestication can be ruled out, the Early Bronze Age horses from Kırklareli-Kanlıgeçit must have been imported to Thrace from areas outside of this region. Metrical comparisons seem to favour Anatolia as a possible region of origin.

ÖZET

Bu yazıda, Kırklareli'nde, (Trakya) bir İlk Tunç Çağ yerleşmesi olan Kanlıgeçit kazılarında bulunan at kemikleri ile ilgili arkeozoolojik veriler sunulmaktadır. Orta Holosen'deTrakya'da vahşi at bulunmadığı bilinmektedir; dolayısı ile, Kırklareli-Kanlıgeçit'te bulunan at kemiklerinin tümü evcil türlere aittir. At kemiklerinden elde edilen radiokarbon tarihlemeleri bunların, uyarlanmış ^{14}C olarak MÖ 2600 – 2300 yılları arasına ait olduklarını göstermektedir. Bu tarihler güney Balkan'lardaki evcilleştirilmiş at türü için elde edilen en eski yaşlardır. Diğer memeli hayvan kemiklerine göre at kemikleri, kemik buluntu topluluğunun küçük bir bölümünü oluşturur. Yaş saptaması ise atların çoğunun erişkin hayvanlar olduklarını ve daha çok 7-10 yaşındaki hayvanların kesildik-

lerini göstermektedir. Bu durum da bize Kanlıgeçit'deki atların öncelikle iş hayvanı olarak, örneğin binmek, yük taşımak ya da çekme işlerinde kullanılmış olduklarını, ancak yaşlandıktan sonra kesilmiş olduklarını göstermektedir. Atların kemik ölçüm verileri, iri ve kuvvetli yapıya sahip hayvanlar olduklarını ortaya koymaktadır. Atın evcilleştirilme sürecinin Trakya'da gerçekleşmediği kesin olarak bilindiğinden, Kırklareli – Kanlıgeçit İlk Tunç Çağ atlarının Trakya'ya başka bir yerden, evcilleşmelerini tamamladıktan sonra getirildikleri kesin olarak söylenebilir.. Kemik ölçümlerinden elde edilen sayısal verilere dayanarak yapılan karşılaştırmalar Kanlıgeçit atlarının Anadolu kökenli olduklarını göstermektedir.

INTRODUCTION

Even though the economic importance of the domestic horse today is quite limited, still public and scientific interest in horses is high. The main reason for the broad interest in horse domestication and the beginning of horse husbandry are the cultural importance and implications of the domestication of this animal. The domestication of the horse opened up wide possibilities for the use of animals for traction and transport. Here was an animal that could be exploited for its speed and staying power as a riding mount and which could also be used as a strong, versatile draught animal. Above all, the use of horses in this way completely revolutionized the transportation of people and goods in the prehistoric cultures of the Old World — just as the railway and the automobile did in the 19th and early 20th centuries (Clutton-Brock 1992). In addition, the availability of horses was linked to military innovations. Pictorial sources from the ancient Near East that are dated to the second millennium BC show that the horse was used from early times as a draught animal to pull chariots and as a mount for armed warriors (Azzaroli 1985: Fig. 22). Later, many ethnic communities established their power on the strength of their mounted armies. Historically documented invasions of Europe by mounted nomad warriors, such as the Scythians, the Avars, and lastly the Mongols in the 13th century under Jenghis Khan, are well known (Zimmer 1994: 35).

In recent years, there has been considerable progress in research on the origins of horse husbandry in the Old World. On the basis of newly excavated, well dated bone assemblages, the chronology of early horse keeping could already be fixed more precisely for some regions, including among others Western Europe (Uerpmann 1990; Uerpmann 1995), Central Europe (Benecke 1999, 2002), and the eastern Urals (Benecke and von den Driesch 2003; Outram *et al.* 2009). As the various studies show, the horse was lastingly established as a domestic animal in those regions during the course of the third millennium BC. More recent palaeogenetic studies on horse bones from Eastern Europe and Western Siberia have demonstrated that horse domestication was accompanied by a rapid increase in coat color variation. Eight different coat colours have been found in Early Bronze Age horses from these areas (Ludwig *et al.* 2009). In contrast, there are still areas in Eurasia where the beginning of horse husbandry is still insufficiently documented. This is also true for the southern Balkan Peninsula, i.e., the area south of the Balkan mountains.

THE SOUTHERN BALKAN PENINSULA – STATE OF RESEARCH

The archaeozoological record known from Bulgaria so far does not provide clear information about when horses began to be used there as domestic animals. An early occurrence of domestic horses is assumed for the Ezero Culture (Early Bronze Age). This assumption is based on horse remains found at sites like Ezero (Bökönyi 1978: 52), Karanovo (Bökönyi and Bartosiewicz 1997: 399), and Michaliç (Ivanov 1950: 347). In all three cases, they are single bone finds, and whether they originate from wild or domestic horses is problematic as is also the dating. So far only bone finds from the Late Bronze Age document without doubt the presence of domestic horses in Bulgaria (Manhart 1998: 100). As for Greece, there still exist uncertainties about the chronology of early horse keeping. An extensive collection of horse remains has been reported from the mound of Kastanas (Macedonia), which comprises a long sequence of layers of the Bronze and Iron Ages (Becker 1986). At this site, horse remains begin to occur in the lower Early Bronze Age layers 25 and 22. On the basis of ceramics, these deposits can be correlated with layer I of the Ezero mound in Bulgaria (Aslanis 1985: Fig. 123), which according to several radiocarbon dates chronologically belongs to the middle of the 3rd millennium cal BC (Görsdorf and Bojadžiev 1996: 137 pp.). Due to the postglacial absence of wild horses in Macedonia, the finds from Kastanas must represent remains of domestic horses. However, it has to be pointed out that the Early and Middle Bronze Age sequence of layers at Kastanas (layers 28-20) is disturbed by a ditch of the Late Bronze Age (Aslanis 1985: 24 pp.). Thus there is the possibility that the horse bones are intrusive from later deposits. Unfortunately, the questionable bones are no longer available for direct radiocarbon dating (C. Becker, personal communication); therefore their stratigraphy and / or chronology remain doubtful. Two other sites in Macedonia where horse remains have been reported from deposits of the Early Bronze Age are Vardaroftsa (Hančar 1955: 28) and Servia (Watson 1979: 229). Due to insufficient documentation of both assemblages, these finds cannot be used as evidence for the presence of domestic horses at this period.

From the late Early and Middle Bronze Age of Greece, horses are documented by bone finds from Tiryns (Early Helladic III; von den Driesch and Boessneck 1990), Lerna (Phase V, Middle Helladic; Gejvall 1969), Nichoria (Middle Helladic I; Sloan and Duncan 1978) as well as from Argissa-Magula (Boessneck 1962) and Pevkakia Magula (Hinz 1979). Some of these finds are regarded as possible later intrusions (Argissa-Magula, Pevkakia Magula). In deposits of the Late Bronze Age horse remains generally occur more frequently, e.g., in Kastanas, Tiryns and Lerna. In those times the horse was obviously already firmly established as a domestic animal.

Ar egion of the southern Balkan Peninsula that has seen considerable archaeological research in recent years and hence from where large collections of animal remains from different prehistoric periods (Neolithic, Chalcolithic, Bronze Age) have been excavated and analyzed is Thrace and especially its central part (Benecke 2001). Among these newly excavated assemblages is an extensive collection of horse bones from sites near Kırklareli in the Turkish part of Thrace. Due to their early dating to the middle of the 3rd millenium BC, these materials are of great interest in relation to questions on the beginning of horse keeping in Thrace and, in addition to that, in the whole area of the southern Balkan Peninsula. The present article presents this material in more detail.

THE HORSE BONE ASSEMBLAGE FROM KIRKLARELİ

ORIGIN AND CHRONOLOGY

Since 1993 archaeological excavations – until 1998 as a joint German-Turkish project – have taken place on various sites on the southern outskirts of the provincial town Kırklareli in Turkish Thrace (Parzinger *et al.* 1999; Karul *et al.* 2003; Parzinger and Schwarzberg 2005). Research has focused and is still focusing here on the Neolithic mound site Aşağı Pınar. In addition, excavations were carried out in an area close to the Neolithic mound called Kanlıgeçit.

The site Kırklareli-Kanlıgeçit is a settlement mound of about 1,5 m height with an original extent of approximately 50 by 50 meters. Here, settlement remains of different periods were uncovered in an area of more than 1300 m^2. By far the greatest number of features and materials originate from the massive Early Bronze Age layers (1,2 to 1,4 m thick), where four settlement periods (Phase 1 – Phase 4) can be differentiated. Remarkably, remains of stone architecture (megarons, fortification) were found on the site (Fig. 1 and 2). They point to a special significance for the place at that time (e.g., an Acropolis). Large collections of animal remains were recovered from features of the Early Bronze Age, among them numerous horse remains. Concerning later periods, only the Iron Age is represented on the mound. Pits with Hellenistic and later ceramics that were dug into the deposits of the Early Bronze Age, belong to this period. Some of them also contained animal bones. Through single ceramic remains, earlier periods (Chalcolithic, Late Neolthic) could be verified on the site as well. However, distinctive settlement layers of those periods were not identified.

Since bone finds themselves give no clear indications regarding their chronology, the dating of the horse remains from Kırklareli-Kanlıgeçit must rely first of all on the accompanying ceramics. For this study only bones from such features were used that could be reliably assigned to the Early Bronze Age on the basis of the ceramics. As previously mentioned, structures of the Iron Age are present on both sites of Kanlıgeçit. The animal bones from pits of this period are characterized by a bright coloring and can usually be clearly differentiated on the basis of this character from those of the Early Bronze Age. Some bone assemblages with obviously mixed materials were eliminated from consideration. Therefore, the possibility of an admixture of Iron Age horse remains in assemblages of the Early Bronze Age can be confidently excluded.

To check the chronological integrity of the Early Bronze Age horse bone material from Kırklareli-Kanlıgeçit, direct radiocarbon determinations were obtained from some of the specimens. The results are listed in Table 1. The dates confirm the contemporaneity of the horse bones with the ceramic materials and their dating to the Early Bronze Age. Due to a plateau of the ^{14}C-curve at 2550–2450 as well as at 2450–2300 years BC, the calibrated dates unfortunately show a wide range. The date for measurement KIA16209 is about 100 years younger than the others. This can be explained by an incomplete removal of contaminates from the collagen of the bone (P.M. Grootes, personal communication). If one transfers the five dates to the entire Early Bronze Age horse bone material, then the probable time period of its deposition is between 2600 and 2300 cal BC. Radiocarbon dates measured on charred plant remains from the mound confirm the centuries of the middle 3rd millennium cal BC as the period during which the settlement layers of this Early Bronze Age site were deposited (J. Görsdorf, personal communication).

THE HORSES OF KIRKLARELI-KANLIGEÇIT – WILD HORSES OR DOMESTIC HORSES?

Horse bones from Holocene deposits on sites of the southern Balkan Peninsula, i.e., from areas south of the Balkan mountains, are generally regarded as remains of domestic horses. This is based on the assumption that this part of Southeast Europe did not belong to the postglacial range of the wild horse (*Equus ferus*). In fact, for some regions of this area, e.g., Thessaly and Macedonia, the available archaeozoological record confirms the undoubted absence of wild horses during the Early and Mid-Holocene. The question arises here whether this is also true for Thrace.

Due to the lack of faunal remains from the Epipalaeolithic and Mesolithic, we have no information concerning the occurrence of wild horses in Thrace during the early Postglacial. Only for the subsequent period, the Mid-Holocene, are collections of animal bones available in larger numbers. For the Neolithic, 11 sites in Thrace can be cited from which archaeozoological analysis is published (Benecke and Ninov 2002). In none of the examined assemblages have horse remains been identified. In the Chalcolithic bone collections from Thrace, the presence of horses also could not be established. For evaluating the status of the horses from Kırklareli-Kanlıgeçit – wild or domestic – observations on the extensive bone samples of the neighbouring Neolithic tell mound site Aşağı Pınar are of special importance. These materials, which also include numerous bone finds of wild mammals, provide no evidence for the occurrence of *Equus ferus* (Benecke 1998a: Table 2). Based on this situation, wild horses seem not to have occurred during the Mid-Holocene in the vicinity of the site, i.e., in the southern foothills of the Istrandža-mountains. In the large Late Neolithic and Chalcolithic bone collections from sites at Drama (Thrace, Bulgaria), northwest of the Istrandža-mountains, evidence for wild horse is also missing, as recent studies show (Benecke 2001: 32).

The complete absence of horse bones in Neolithic and Chalcolithic faunal assemblages from Thrace either indicates that wild horses did not occur at all in this region during the mid-Holocene or that their numbers were so small that only in very rare cases did they become hunters' prey. The first possiblity appears to be more likely. The Balkan mountains probably marked a natural boundary of distribution for *Equus ferus* in the Postglacial. North of the mountains, in the lower Danube area, wild horse is repeatedly documented by single bone finds in deposits of various Neolithic sites (e.g. Necrasov *et al.* 1967: Fig. 2).

From the above observations one can conclude that the Early Bronze Age horse remains from Kırklareli-Kanlıgeçit probably belonged exclusively to domestic horses. The material of this site can be regarded as the oldest stratigraphically and chronologically unambiguous evidence for the presence and keeping of domestic horses in the southern Balkan Peninsula.

FREQUENCY OF HORSES AT KIRKLARELI-KANLIGEÇIT

Table 2 presents the species composition of the mammal remains excavated from Kırklareli-Kanlıgeçit.

The faunal assemblage of this site is dominated by remains of the "classic" domestic mammals, i.e., cattle, sheep, goat and pig. Wild mammals are represented by 12 species, but their proportion in the assemblage is relatively small representing only 8%. Altogether 306 teeth and bones could be assigned to horses. With the exception of the oldest phases 5 and 6 (Chalcolithic, Late Neolithic), horse is present in all phases of occupation dating to the Early Bronze Age. Based on the number of identified specimens, its proportion in the assemblage is only 3,5% of all domestic species. This corresponds to expectations, since one can assume that horses were primarily exploited as work animals, i.e., for riding, as pack animals, for traction, etc., and only secondarily for food purposes. The results of age determination studies seem to corroborate this assumption, since most horses from Kanlıgeçit were adult when they were slaughtered, with animals of seven to ten years of age predominating (Fig. 3 and 4). Sex determination could be carried out on a few skull and pelvic bones. Nine specimens were identified to be from males and four from females, indicating a predominance of males (stallions or geldings) among the adult horses.

OSTEOMETRICAL EVALUATION AND ORIGIN OF THE HORSES FROM KIRKLARELİ-KANLIGEÇİT

Numerous measurements could be taken on the Early Bronze Age horse remains from Kırklareli-Kanlıgeçit (see Benecke 2002, Appendix). Overall the osteometric data reflect strongly built animals. Unfortunately, complete long bones are missing, so body size can only be very roughly estimated from breadth measurements. The majority of the animals will probably have achieved withers heights between 130 and 145 cm.

Figure 5 shows a metrical comparison between the horses from Kırklareli-Kanlıgeçit and those from the different settlement phases of Kastanas on the basis of logarithmic size index (LSI) distributions. The comparison shows that horses from Kanlıgeçit are more strongly built than those of the Late Bronze and Iron Age from Kastanas. The only measurable horse bone from Early Bronze Age layers at Kastanas (layer 25) morphologically resembles the series from Kanlıgeçit. Since its dating is uncertain (see above), this bone gives only tentative evidence that at Kastanas the Early Bronze Age horses were relatively strongly built as well. As has already been pointed out, the presence of wild horses in Thrace during the Mid-Holocene can be excluded and thus also the possibility of local horse domestication. The earliest domestic horses of this region, which may have included the Early Bronze Age horses from Kırklareli-Kanlıgeçit, must therefore descend from horse populations the domestication of which took place outside Thrace. Two regions are primary candidates for consideration as possible areas of origin, i.e., Southeast or East Europe, and within those regions mainly the northwestern and northern Black Sea area, as well as Asia Minor (Anatolia). The horses from Kırklareli-Kanlıgeçit were compared with horses from those areas. Currently however, only a few series from both areas are available for metrical comparison (Table 3 and Fig. 5).

Unfortunately, for the lower Danube, i.e., the closest region to Thrace with an occurrence of wild horses in the Postglacial, metrical data on horse bones from sites dating to the Mid-Holocene (Neolithic, Chalcolithic) have not been published. Thus this area cannot at present be evaluated as a potential area of origin for the Early Bronze Age domestic horses of the southern Balkan Peninsula. To the east, from the neighbouring northwestern Black Sea area, an extensive collection of wild horses from Mirnoe near Odessa dating to the 6th millennium BC is available for metrical comparison (Benecke 1998b). The mean of this series clearly drops below the mean for the horses from Kırklareli-Kanlıgeçit (Fig. 5). Nearly the same applies to the wild horses from the Criş settlement of Sakarovka in Moldova (Table 3), which are roughly contemporaneous with the collection from Mirnoe. In comparison to the Early Bronze Age horses from Thrace, the horses of both sites were more lightly built. Therefore, one may probably exclude the Mid-Holocene wild horses from the regions of the rivers Dnestr and Prut as direct or indirect ancestors of the earliest domestic horses in Thrace. A greater morphological similarity exists with the horses of Dereivka, a site located at the lower Dnepr. Except for some intrusions from later periods, these animals represent wild horses of the northern Black Sea area from the late 5th and early 4th millennium BC (cf. Uerpmann 1990; Levine 1999). The Dereivka horses are, on average, similar in massiveness to the horses from Kırklareli-Kanlıgeçit. Considering the fact that horse domestication was probably accompanied by a reduction in body size and body weight (Nobis 1971: 54 pp.; Bökönyi 1974: 236; Uerpmann 1990: 125 pp.), then these wild horses seem not to have been sufficiently large or strongly built to be considered ancestors of the domestic horses from Thrace.

Morphological similarities seem to exist with horses from settlements of the Bell Beaker - Culture in the Carpathian basin (Fig. 5). The horses of this period, from which extensive collections are known from sites in the area of Budapest (Csepel Háros, Csepel-Hollandi útca, Szigetcsép-Tangazdaság I), are regarded as early domestic horses of that region (cf. Nobis 1971; Bökönyi 1978; Uerpmann 1990). As an example, Figure 5 shows the LSI-distribution for horses from Budapest-Csepel Háros. Compared to the horses from Kırklareli-Kanlıgeçit, there are only small differences in the mean value. This could point to a similar overall body shape. According to radiocarbon dates available from sites like Csepel Háros (Raczky 1992: 42), the Bell Beaker horses of Hungary are only slightly older than the Early Bronze Age horses from Thrace. Perhaps both groups of horses derive from the same area of origin.

From Anatolia two assemblages of domestic horses dating to the Bronze Age, Demircihüyük and Lidar Höyük, were used for a metrical comparison (Fig. 6). As the mean values of the LSI-distributions show, the horses of both sites are, on average, more lightly built than the horses from Kırklareli-Kanlıgeçit. However, since they partially originate from more recent periods of the Bronze Age, those assemblages are only partly comparable with the early domestic horses from Thrace. Another important group of horses for comparison are the Chalcolithic horses from Norşun-Tepe and Tülintepe in eastern Anatolia. According to radiocarbon dates for the Chalcolithic layers at Norşun-Tepe (di Nocera 2000: Table 2), they date to the second half of the 5th millennium and the beginning of the 4th millennium BC. Their status as either wild or domestic horses is differently evaluated; most authors hold these horses to be wild (cf. Boessneck and von den Driesch 1976; Uerpmann 1990). Two facts seem to support the latter claim, namely the early dating and morphological characteristics, particularly the low total variability among those horses. As the statistical parameters in Table 3 demonstrate, the horses from Norşun-Tepe and Tülintepe represent very strongly built animals. The mean value of the LSI-distribution for this group of horses is clearly larger than that for the horses from Kırklareli-Kanlıgeçit. By taking into account a reduction of body size and body mass through domestication, the Anatolian wild horses could be considered as either the direct or indirect predecessors of the Early Bronze Age domestic horses from Thrace. Unfortunately, up to now series of metrical data for Mid-Holocene wild horses from the central and northwestern parts of Anatolia are lacking, so at the moment one cannot check to what extent those regions could have been a place of origin for the earliest domestic horses on the southern Balkan Peninsula as well.

CONCLUSIONS AND SUMMARY

The horse bones from Early Bronze Age layers of the Kırklareli-Kanlıgeçit site represent domestic horses, which were kept and bred in this area between 2600 and 2300 cal BC. Probably, they were predominantly exploited here as working animals; whether for riding, as pack animals or for traction is a question for which the bone finds themselves allow no answer. Pathologies or anatomical alterations resulting from use as working animals have not been observed on the bones. The osteometric data point to quite a large / heavy horse as the usual type of horses in this region.

The horses from Kırklareli-Kanlıgeçit undoubtedly document an early period of the appearance and exploitation of domestic horses on the southern Balkan Peninsula. Other evidence for horse keeping dating to the mid-3rd millennium in this region is both rare and for the most part plagued by uncertain chronology. The origins of horse husbandry in this part of Southeast Europe should chronologically not go back much further. This assumption is implied by bone assemblages from various sites in Thrace (e.g., Karanovo, Drama, Kırklareli) covering nearly all periods from the Early Neolithic until the Iron Age (Benecke 1998a: Table 1; Benecke 2001: 30). According to determinations on large bone collections from Cernavoda III-Culture settlements at Drama-Merdžumekja, horses seem not to have been present in the area during the last centuries of the

4th millennium BC. For the subsequent centuries of the first half of the 3rd millennium BC, bone assemblages, unfortunately, are present neither from Kırklareli nor from Drama, so that this period (Early Ezero Culture) cannot yet be judged regarding the occurrence of horses in Thrace for that period. From the middle of the 3rd millennium BC, the presence of horses is clear from the bone finds from Kırklareli-Kanlıgeçit discussed in this paper.

The earliest domestic horses of the southern Balkan Peninsula can not have originated locally due to the absence of wild horses. They must have derived from the horses of one or more other regions. As comparisons on the basis of LSI-distributions have shown, the origin of the Early Bronze Age horses from Thrace is difficult to ascertain using biometric characters. From the two regions that were considered here as likely possible places of origin, i.e., Southeast / East Europe and Anatolia, the first can apparently be eliminated. So far no wild horses are known from Southeast and East Europe that, according to their morphology (body shape), could be considered as founder ("parental") populations for the strongly built domestic horses of Thrace. Even if the lower Danube area cannot be evaluated in this respect, it is rather unlikely that especially large and/or strongly built wild horses should have lived there. After all, this area represents „merely" a western extension of the Pontic steppes. Therefore it could be expected that the Mid-Holocne wild horses of the lower Danube area would have approximately corresponded in phenotype (size and shape) to the contemporaneous populations of the northwestern and northern Black Sea area (Mirnoe, Dereivka). Future investigations must show whether this ascription is correct. The currently available osteometric data seems to favour an Anatolian origin for the earliest domestic horses from Thrace. From Eastern Anatolia, wild horses are documented at Norşun-Tepe and Tülintepe that combine those morphological characters that must have been present in the founder ("parental") populations of the early domestic horses from Thrace. Whether still other areas in Central or Northwestern Anatolia were potential areas of origin for those horses remains an open question. Probably only future a DNA analysis will provide better information about where the horses originated and how they came to the southern Balkan Peninsula.

The second half of the 3rd millennium BC seems not only to be an early period for horse husbandry on the Balkan Peninsula, but during those centuries the horse also spread within the Near East. As bone finds demonstrate, domestic horses occurred then for the first time both in Mesopotamia and in the Levant (Becker 1994: 159 pp.).

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REFERENCES

Aslanis, I. 1985
Kastanas. Ausgrabungen in einem Siedlungshügel der Bronze- und Eisenzeit Makedoniens 1975-1979. Die frühbronzezeitlichen Funde und Befunde. Prähistorische Archäologie in Südosteuropa 4, Wissenschaftsverlag Volker Spiess, Berlin.

Azzaroli, A. 1985
An Early History of Horsemanship. E.J. Brill/Dr. W. Backhuys, Leiden.

Becker, C. 1986
Kastanas. Ausgrabungen in einem Siedlungshügel der Bronze- und Eisenzeit Makedoniens 1975-1979. Die Tierknochenfunde. Prähistorische Archäologie in Südosteuropa 5, Wissenschaftsverlag Volker Spiess, Berlin.

Becker, C. 1994
"Zur Problematik früher Pferdenachweise im östlichen Mittelmeergebiet", B. Hänsel and St. Zimmer (eds.) *Die Indogermanen und das Pferd*: 145-177. Archaeolingua Foundation, Archaeolingua 4, Budapest.

Benecke, N. 1998a
"Animal remains from the Neolithic and Bronze Age settlements at Kırklareli (Turkish Thrace)", H. Buitenhuis, L. Bartosiewicz and A.M. Choyke (eds.) *Archaeozoology of the Near East* III: 172-179. Arc-Publication 18, Groningen.

Benecke, N. 1998b
"Die Wildpferde aus der mesolithischen Station Mirnoe in der Südwest-Ukraine", P. Anreiter et al. (eds.) *Man and the Animal World. Studies in Archaeozoology, Archaeology, Anthropology and Palaeolinguistics in memoriam Sándor Bökönyi*: 87-107. Archaeolingua Foundation, Archaeolingua 8, Budapest.

Benecke, N. 1999
"Pferdeknochenfunde aus Siedlungen der Bernburger Kultur - ein Beitrag zur Diskussion um die Anfänge der Pferdehaltung in Mitteleuropa", M. Kokabi and E. May (eds.) *Beiträge zur Archäozoologie und Prähistorischen Anthropologie* II: 107-120. Gesellschaft für Archäozoologie und Prähistorische Anthropologie, Konstanz.

Benecke, N. 2001
"Die Tierwelt Thrakiens im Mittelholozän (ca. 6000–2000 v. Chr.) – anthropogene und natürliche Komponenten", E. May and N. Benecke (eds.) *Beiträge zur Archäozoologie und Prähistorischen Anthropologie* III: 31-40. Gesellschaft für Archäozoologie und Prähistorische Anthropologie, Konstanz.

Benecke, N. 2002
"Die frühbronzezeitlichen Pferde von Kırklareli-Kanlıgeçit, Thrakien, Türkei", *Eurasia Antiqua* 8: 39-59.

Benecke, N. and A. Von Den Driesch 2003
"Horse exploitation in the Kazakh steppes during the Eneolithic and Bronze Age", M. Levine, C. Renfrew and K. Boyle (eds.) *Prehistoric Steppe Adaptation and the Horse*: 69-82. Cambridge University Press, McDonald Institute Monographs, Cambridge.

Benecke, N. and L. Ninov 2002
"Zur Nahrungswirtschaft der neolithischen Bevölkerungen im Gebiet des heutigen Bulgariens nach archäozoologischen Befunden", M. Lichardus, J. Lichardus and V. Nikolov (eds.) *Beiträge zu jungsteinzeitlichen Forschungen in Bulgarien*: 555-573. Dr. Rudolf Habelt GmbH, Saarbrücker Beiträge zur Altertumskunde 74, Bonn.

Boessneck, J. 1962
"Die Tierreste aus der Argissa-Magula vom präkeramischen Neolithikum bis zur mittleren Bronzezeit", V. Milojčić, J. Boessneck and M. Hopf (eds.) *Das präkeramische Neolithikum sowie die Tier- und Pflanzenreste*: 27-99. Die deutschen Ausgrabungen auf der Argissa-Magula in Thessalien 1, Rudolf Habelt Verlag, Bonn.

Boessneck, J. and A. Von Den Driesch 1976
"Pferde im 4./3. Jahrtausend v. Chr. in Ostanatolien", *Säugetierkundliche Mitteilungen* 24: 81-87.

Bökönyi, S. 1974
History of Domestic Mammals in Central and Eastern Europe. Akadémiai Kiadó, Budapest.

Bökönyi, S. 1978
"The earliest waves of domestic horses in East Europe", *Journal of Indo-European Studies* 6: 17-76.

Bökönyi, S. and L. Bartosiewicz 1997
"Tierknochenfunde", St. Hiller and V. Nikolov (eds.) *Karanovo. Die Ausgrabungen im Südsektor 1984-1992* (Österreichisch-Bulgarische Ausgrabungen und Forschungen in Karanovo 1): 385-480. Verlag Berger & Söhne, Horn/Wien.

Bronk Ramsey, Ch. 1995
"Radiocarbon calibration and analysis of stratigraphy: the OxCal Program", *Radiocarbon* 37: 425-430.

Clutton-Brock, J. 1992
Horse power: a history of the horse and the donkey in human societies. MA, Harvard University Press, Cambridge.

Driesch, A. and J. Boessneck 1970
"Die Tierreste von der mykenischen Burg Tiryns bei Nauplion/Peloponnes", *Tiryns. Forschungen und Berichte* 11: 87-164.

Gejvall, N.-G. 1969
Lerna. A Preclassical Site in the Argolid I. The Fauna. American School of Classical Studies at Athens, Princeton.

Görsdorf, J. and J. Bojadžiev 1996
"Zur absoluten Chronologie der bulgarischen Urgeschichte", *Eurasia Antiqua* 2: 105-173.

Hančar, F. 1955
Das Pferd in prähistorischer und früher historischer Zeit. Wiener Beiträge zur Kulturgeschichte und Linguistik 11, Verlag Herold, Wien.

Hinz, G. 1979
Neue Tierknochenfunde aus der Magula Pevkakia in Thessalien I. Die Nichtwiederkäuer. Universität München, Dissertation.

Ivanov, St. 1950
"Prinos kăm vyprosa za domašnite životni prez kăsnija neolit i kamenno-mednata epocha u nas", *Godišnik na Selsko-Stopanskata Akademija "Georgi Dimitrov" Sofija, Veterinarno-Medicinski Fakultet* 26: 345-354.

Karul, N., Z. Eres, M. Özdoğan and H. Parzinger 2003
Aşağı Pınar I. Einführung, Forschungsgeschichte, Stratigraphie und Architektur. Archäologie in Eurasien 15, Studien im Thrakien-Marmara-Raum 1, von Zabern, Mainz.

Kussinger, S. 1988
Tierknochenfunde vom Lidar Höyük in Südostanatolien (Grabungen 1979-86). Universität München, Dissertation.

Levine, M. 1999
"The Origins of Horse Husbandry on the Eurasian Steppe", M. Levine et al. (eds.) *Late Prehistoric Exploitation of the Eurasian Steppe*: 5-58. McDonald Institute Monographs, Cambridge University Press, Cambridge.

Manhart, H. 1998
Vorgeschichtliche Fauna Bulgariens. Documenta naturae 116, München.

Necrasov, O., M. Ştirbu and M. Iacob 1967
"Răspîndirea unor mamifere sălbatice la începutul holocenului (neolitic) pe teritoriul României", *Analele ştiinţifice ale Universităţii "Al. I. Cuza" din Iaşi, Secţiunea II (Ştiinţe naturale, a. Biologie)* 13: 311-319.

Nobis, G. 1971
Vom Wildpferd zum Hauspferd. Fundamenta, Reihe B, Band 6, Böhlau Verlag, Köln.

di Nocera, G.-M. 2000
"Radiocarbon Datings from Arslantepe and Norşuntepe: The fourth-third millennium absolute chronology in the Upper Euphrates and Transcaucasion region", C. Marro and H. Hauptmann (eds.) *Chronologies des pays du Caucase et de l'Euphrate aux IV^{e}–III^{e} millenaires*: 73-93. Varia Anatolica XI, Institut Français d'Archéologie, İstanbul.

Outram, A.K. et al. 2009
"The Earliest Horse Harnessing and Milking", *Science* 323: 1332-1335.
Parzinger, H., M. Özdoğan and N. Karul 1999
"An der Schwelle vom Orient zum Okzident", *Antike Welt* 30: 325-336.

Parzinger, H. and H. Schwarzberg 2005
Aşağı Pınar II. Die mittel- und spätneolithische Keramik. Archäologie in Eurasien 18, Studien im Thrakien-Marmara-Raum 2, von Zabern, Mainz.

Raczky, P., E. Hertelendi and F. Horváth 1992
"Zur absoluten Datierung der bronzezeitlichen Tell-Kulturen in Ungarn", *Bronzezeit in Ungarn*: 42-47. Ausstellungskatalog, Pytheas GmbH, Frankfurt/M.

Rauh, H. 1981
Knochenfunde von Säugetieren aus dem Demircihüyük. Universität München, Dissertation.

Sloan, R.E. and M.A. Duncan 1978
"Zooarchaeology of Nichoria", G. Rapp and S.E. Aschenbrenner (eds.) *Excavations at Nichoria in Southwest Greece 1. Site, Environs, and Techniques*: 60-77. Minnesota Press, Minneapolis.

Uerpmann, H.-P. 1990
"Die Domestikation des Pferdes im Chalkolithikum West- und Mitteleuropas", *Madrider Mitteilungen* 31: 109-153.

Uerpmann, H.-P. 1995
"Domestication of the Horse - When, Where, and Why?", L. Bodson (ed.) *Le cheval et les autres équidés: aspects de l'histoire de leur insertion dans les activités humaines*: 15-29. Colloques d'histoire des connaissances zoologiques 6, Université de Liège, Liège.

Watson, J.P.N. 1979
"Faunal remains", *The Annual of the British School at Athens* 74: 228-229.

Zimmer, St. 1994
"Die Indogermanen und das Pferd - Befunde und Probleme", B. Hänsel and St. Zimmer (eds.) *Die Indogermanen und das Pferd*: 29-35. Archaeolingua 4, Archaeolingua Foundation, Budapest.

Lab-Number	Feature (layer)	Date radiocarbon years BP	Date calibrated years BC (1 σ)	Date calibrated years BC (2 σ)
KIA16208	31R/6 (Phase 1a/b-c)	3990±27	2566–2473	2573-2467
KIA16209	29R/16 (Phase 1c)	3858±27	2452–2236	2461-2209
KIA16210	31R/8 (Phase 1c-2a)	3966±38	2569–2458	2576-2346
KIA16211	30R/15 (Phase 1c-2a)	3957±26	2563–2460	2570-2348
KIA10326	31M/30 (Phase 2b)	3972±36	2566–2465	2578-2348

Table 1. Radiocarbon dates on horse bones from Kırklareli-Kanlıgeçit. Calibration was carried out with the help of the program OxCal (Version 4.1, IntCal04, Bronk Ramsey 2001).

Species	1	1–2	2	2–3	3	3–4	4	1–4	5	6
Domestic Mammals										
Cattle	20	143	722	710	620	496	432	3206	13	47
Pig	15	81	263	651	611	360	403	2477	5	34
Sheep/Goat	31	89	300	785	605	395	514	2803	5	52
(Sheep)	(3)	(10)	(39)	(120)	(75)	(55)	(73)	(385)	–	(10)
(Goat)	–	(2)	(5)	(16)	(15)	(5)	(12)	(56)	–	(2)
Horse	5	7	11	40	150	59	28	306	–	–
Dog	2	2	3	17	12	15	17	70	–	–
Wild Mammals										
Red deer (Cervus elaphus)	2	7	40	66	81	132	50	383	1	2
Red deer, antler –	–	7	8	16	5	2	39	–	1	
Fallow deer (Cervus dama)	2	4	5	8	7	5	20	52	1	–
Fallow deer, antler	–	–	1	2	1	–	–	4	–	–
Roe deer (Capreolus capreolus)	–	2	–	5	2	7	6	23	–	–
Wild pig (Sus scrofa)	1	4	21	56	65	90	30	272	4	2
Aurochs (Bos primigenius)	–	–	8	12	8	26	3	57	–	–
Red fox (Vulpes vulpes)	–	2	1	3	3	1	6	16	–	–
Wild cat (Felis silvestris)	–	1	1	–	–	–	–	2	–	–
Brown bear (Ursus arctos)	1	–	6	1	3	2	4	17	–	–
Marten (Martes spec.)	–	–	1	–	1	–	–	2	–	–
Hare (Lepus europaeus)	1	1	–	10	3	–	2	17	–	–
Beaver (Castor fiber)	–	–	–	–	–	–	1	1	–	–
Dolphin (Delphinus delphis)	–	–	–	–	1	–	–	1	–	–

Table 2. Kırklareli-Kanlıgeçit. Species composition of the mammal remains according to phases of occupation (excavations 1994–1998, number of identified specimens).
Phase 1 – Early Bronze Age III/Middle Bronze Age (2200–2000 cal BC), Phase 2 – Early Bronze Age III (2450–2200 cal BC), Phase 3 – Early Bronze Age II (2650–2450 cal BC), Phase 4 – Early Bronze Age I, Phase 5 – Chalcolithic, Phase 6 – Late Neolithic.

Group	Mean	s	Min.	Max.	Med.	1. Qu.	3. Qu.	N
Mirnoe	0,0341	0,0165	-0,0092	0,0751	0,0363	0,0224	0,0452	113
Sakarovka	0,0312	–	-0,0110	0,0553	–	–	–	13
Dereivka	0,0469	0,0200	0,0057	0,0814	0,0526	0,0376	0,0595	50
Budapest, Csepel Háros	0,0479	0,0281	-0,0058	0,1115	0,0432	0,0255	0,0643	61
Kanlıgeçit	0,0506	0,0173	0,0071	0,0889	0,0514	0,0431	0,0619	62
Kastans, EBA	0,0691	–	–	–	–	–	–	1
Kastanas, LBA	0,0137	0,0212	-0,0243	0,0434	0,0153	-0,0014	0,0337	11
Kastanas, Iron Age	-0,0034	0,0165	-0,0349	0,0268	-0,0053	-0,0147	0,0092	30
Norşun-Tepe, Tülintepe	0,0641	0,0135	0,0368	0,0906	0,0663	0,0536	0,0725	16
Demircihüyük, EBA / MBA	0,0431	–	0,0087	0,0871	–	–	–	5
Lidar Höyük, MBA / LBA	0,0341	0,0265	-0,0081	0,0831	0,0302	0,0131	0,0584	22

Table 3. Statistical parameters for logarithmic size index (LSI) distributions in Figure 5. Abbreviations: s - standard deviation, Min. - Minimum, Max. - Maximum, Med. - Median, 1. Qu. - 1. Quartil, 3. Qu. - 3. Quartil, N - Number. Calculation of LSI according to Uerpmann (1990).
References: Mirnoe (Benecke 1998b), Sakarovka (Benecke, unpublished), Dereivka (Uerpmann 1990), Budapest, Csepel Háros (Uerpmann 1990), Kanlıgeçit (Benecke 2002), Kastanas (Becker 1986), Norşun-Tepe and Tülintepe (Boessneck and von den Driesch 1976), Demircihüyük (Rauh 1981), Lidar Höyük (Kussinger 1988).

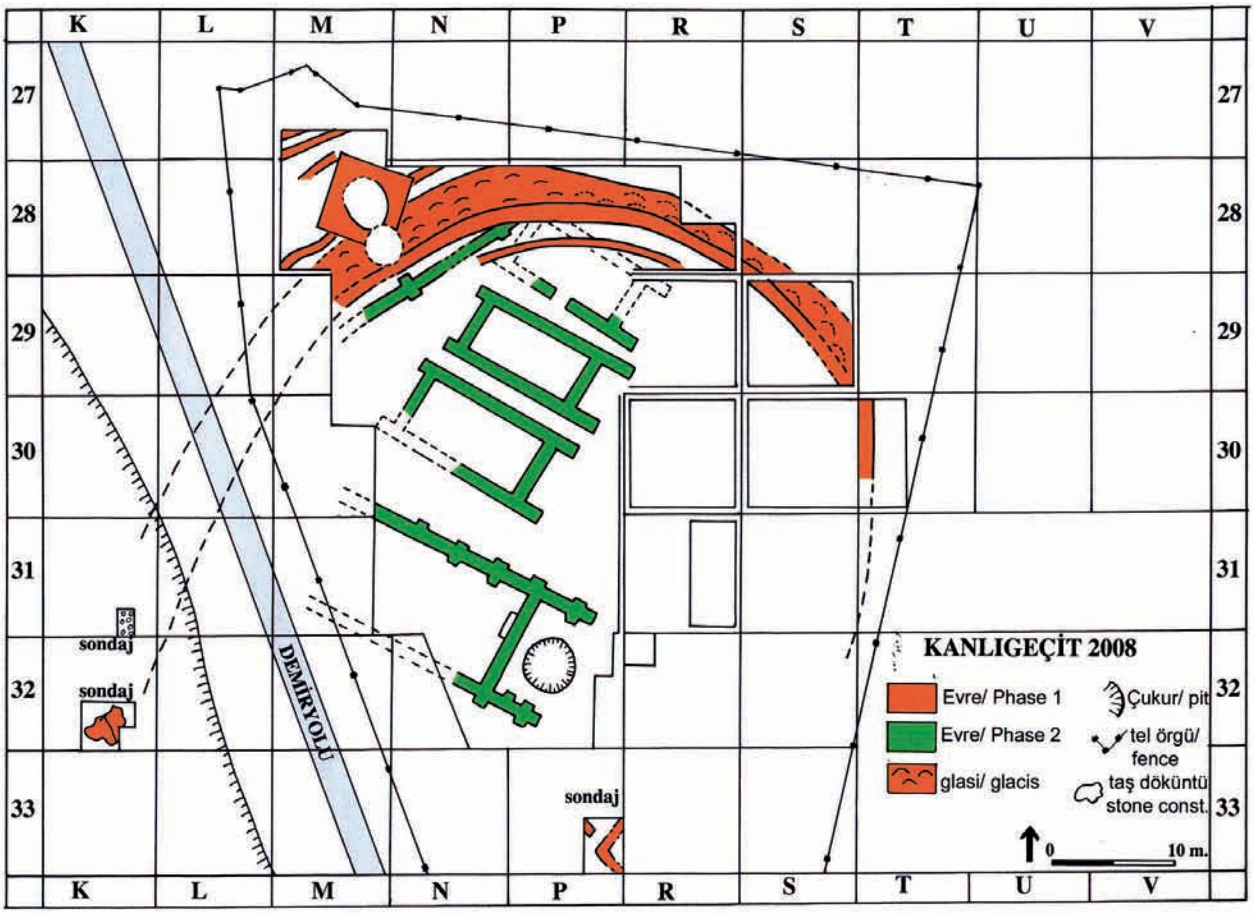


Fig. 1. Kırklareli-Kanlıgeçit. Plan of the excavated area in 2008 (Kırklareli Project Archive).

Fig. 2. Kırklareli-Kanlıgeçit. View of the three megarons from south-east (photo by M. Hochmuth, Berlin).

Fig. 3. Kırklareli-Kanlıgeçit. Left maxilla finds from pit 32P/25. The approximate age of death is ca 9–10, 7–8, 7–8, 4–5, 3–4 years (from left to right; photo by M. Hochmuth, Berlin).

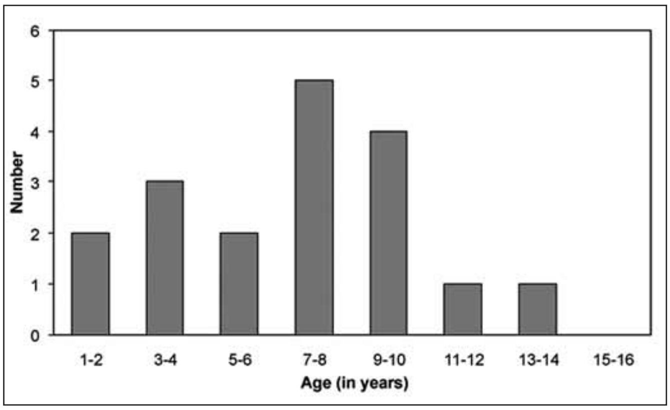


Fig. 4. Kırklareli-Kanlıgeçit. Age structure in horses based on dental eruption and wear

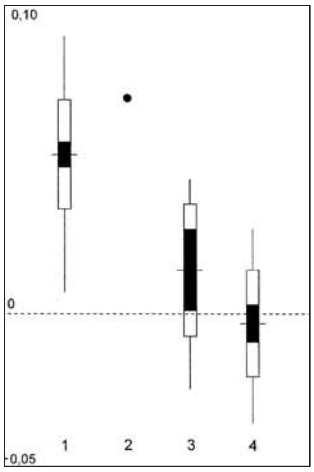


Fig. 5. LSI distributions for the Early Bronze Age horses from Kırklareli-Kanlıgeçit (1) and horses from Kastanas (2 – Early Bronze Age, 3 – Late Bronze Age, 4 – Iron Age). For statistics see Table 3.

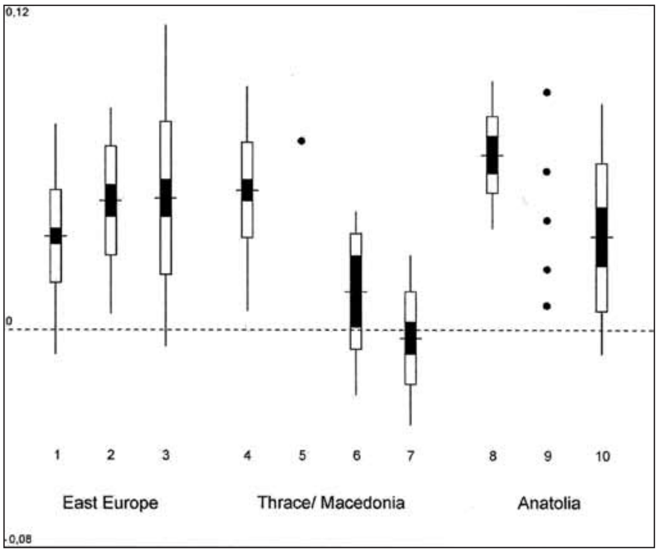


Fig. 6. LSI distributions for horses from East Europe (1 – Mirnoe, 2 – Dereivka, 3 – Csepel Háros), Thrace and Macedonia (4 – Kırklareli-Kanlıgeçit, 5 – Kastanas, Early Bronze Age, 6 – Kastans, Late Bronze Age, 7 – Kastanas, Iron Age) as well as from Anatolia (8 – Norşun-Tepe, Tülintepe, 9 – Demircihüyük, Early and Middle Bronze Age, 10 – Lidar Höyük, Middle and Late Bronze Age). For statistics see Table 3.

ILISU BARAJI İNŞAAT SAHASINA RASTLAYAN DİCLE VADİSİNİN TUNÇ VE DEMİR ÇAĞLARI'NDAKİ YERLEŞİM SİSTEMLERİ VE KÜLTÜR TARİHİ

THE BRONZE AND IRON AGE SETTLEMENT SYSTEMS AND CULTURAL STRUCTURE OF THE TIGRIS REGION WITHIN THE CONSTRUCTION AREA OF THE ILISU DAM

A.Tuba ÖKSE, Erkan ATAY, Murat EROĞLU, Yeliz TAN

Anahtar Sözcükler: Ilısu Barajı, Yukarı Dicle Havzası, Mardin, Tunç Çağları, Demir Çağları, Asur Dönemi
Keywords: Ilısu Dam, Upper Tigris Region, Mardin, Bronze Ages, Iron Ages, Assyrian Period

ÖZET

Ilısu Barajı yapım çalışmaları nedeniyle bölgede yürütülen yüzey araştırmaları, Mardin yükseltisi ile Doğu Toros dağları ve Dicle nehrinin oluşturduğu küçük bir dağarası ovada yapılmış ve Çanak Çömleksiz Neolitik Döneme ait (Ökse vd. 2006) 65 yerleşim yeri ortaya çıkarılmıştır. MÖ 3-1. binyıla tarihlenen yüzey malzemesi 15 ayrı yerleşmeden toplanmıştır. Araştırılan alan nehrin her iki kıyısında olup 1600 ha alana yayılmaktadır.

Erken Tunç Çağ malzemesi nehrin doğu kıyısında kalan üç yerleşmeden toplanmıştır. Birbirilerine yakın konumdaki bu yerleşmelerden biri büyük, diğeri orta, sonuncusu ise küçük boyutludur. Yerleşim yerlerinin seyrek olması Yukarı Habur ve Yukarı Dicle bölgelerindeki yerleşimlerle karşılaştırılabilir. Çanak çömlek, çizi bezemeli ve boyalı Ninive V gibi, portakal rengi mallar, portakal renkli ağzı kara kaseler ve Cezire gri mallarından oluşmaktadır ve MÖ 3. binyıl kuzey Mezopotamya kültürlerine tarihlenir. Erken Transkafkas mal grubuna ait bir çanak parçası, araştırılan bölgede bu binyılın son yüzyıllarında, kuzeydeki dağ kültürlerinin varlığına işaret etmektedir. Orta Tunç Çağ nehrin batı yakasında iki büyük, bir de orta boyutlu, doğu yakasında ise bir büyük, iki orta boyutlu yerleşim yeriyle temsil edilmektedir. Köylerin ve mezra/çiftlik evlerinin yoğun yerleşim düzeni büyük olasılıkla yağışa dayalı kuru tarım yapıldığını göstermektedir. Yüzey buluntuları, yalın düz mallar, kırmızı kahverengi boya astarlı mallar ve Habur boyalı mallarını kapsar. Benzer çanak çömlek topluluğuna sahip ve bu bağlamda karşılaştırılabilecek yerleşim sistemleri, bu yörenin MÖ 19-16. yüzyılda kuzey Dicle ve Yukarı Habur bölgesiyle ilişki içinde olduğunu göstermektedir. Geç Tunç Çağ malzemesi doğu yakasındaki bir büyük ve bir de küçük yerleşmeden toplanan Mitanni ve Orta Asur mallarından oluşmaktadır. Yerleşmelerin azalması, MÖ 15-11. yüzyıllarda Mitanni ve Orta Asur hakimiyeti sırasında, araştırılan bölgede yerleşik toplum nüfusunda belirgin bir azalma olduğunu göstermektedir.

Doğu Anadolu'nun ve Yukarı Dicle'nin el yapımı Erken Demir Çağ çanak çömleği Dicle'nin batı kıyısında iki büyük ve iki orta boyutlu yerleşmeden, doğu kıyısında ise bir büyük, iki orta boyutlu ve iki küçük yerleşim yerinden toplanmıştır. Yerleşmelerin sıklığı ve malzemenin niteliği, Yukarı Dicle bölgesi ile doğu Anadolu'da oldu-

ğu gibi burada da mevsimlik, tarımsal yerleşim birimlerinin olduğunu göstermektedir.. Bu nedenle, Asur krallığının zayıfladığı MÖ 11-9. yüzyıllar arasında, kuzeydeki dağlık bölge göçer-çiftçi toplulukların Mardin bölgesinde de yaşadıkları anlaşılmaktadır. Yeni Asur Devri yalın çanak çömleği ise, nehrin batı kıyısında bir büyük, iki orta boyutlu ve üç küçük yerleşmeden, doğu kıyısında ise iki büyük ve altı küçük yerleşmeden toplanmıştır. Bu yerleşim düzenini, MÖ 9-6. yüzyıllarda kuzey Cezire'den bilinen, çiftlikler ve bunların bileşimi ile oluşan köyler şeklindeki katmanlanmış bir yapıyı yansıtmaktadır. Kırsal yerleşim birimlerinde, Geç Babil ve Pers Dönemi malzemesi arasında belirgin bir farklılık olmadığı için, Geç Demir Çağ'ı yüzey toplamasının değerlendirilmesine tam olarak yansımamıştır.

ABSTRACT

The field surveys carried out at the construction area of the Ilısu Dam, located on a small plain formed by the Tigris River between the Mardin Massive and the Eastern Taurus zone, revealed 65 ancient places used since the Pre-Pottery Neolithic period (Ökse vd 2006). Surface material dating to the 3rd-1st millennia BC is obtained from 15 sites. The surveyed area is 1600 ha in extend, situated on both banks of the river.

The Early Bronze Age material is collected at three sites on the eastern bank – one large, one middle-sized and one small site close to each other. The sparseness of settlements is comparable with the contemporary settlements of the Upper Khabur and Upper Tigris regions. The material is composed by incised and painted Ninevite-V ware, orange ware, Dark Rimmed Orange Bowls and the Jezirah Grey Ware belonging to the Northern Mesopotamian culture dating to the 3rd millennium BC. One shard belonging to the Early Transcaucasian Ware points to the presence of the Northern Highland Culture during the last centuries of the millennium. The Middle Bronze Age material is found on two large and one middle-sized site on the western bank and one large and two middle-sized sites on the eastern bank, pointing to a dense settlement pattern of villages and hamlets/farmsteads, most probably based on rain-fed agriculture. The surface finds include the Monochrome Standard Ware, the Red Brown Wash Ware and the Khabur Painted Ware. Comparable settlement systems with similar ceramic assemblages determine the cultural parallelism of the region with the Upper Tigris and the Upper Khabur regions during the 19th-16th centuries BC. Late Bronze Age is represented by Mitannian and Middle Assyrian wares collected at one large and one small site on the eastern bank. This pattern points to a dramatic decrease in sedentary population within the surveyed region during the Mitannian and Middle Assyrian supremacy in the 15th-11th centuries BC.

The hand-made Early Iron Age Pottery of Eastern Anatolia and the Upper Tigris region is collected on two large and two middle-sized sites on the western bank and on one large, two middle-sized and two small sized sites on the eastern bank. The frequency of sites and characteristics of material culture is comparable with the dense seasonal settlements of pastoralists in the Upper Tigris region as well as in Eastern Anatolia, so, the mobile pastoralists of the Northern Highlands seem to have lived also in the Mardin region during the weak period of the Assyrian Kingdom between the 11th-9th centuries BC. New Assyrian standard pottery is found on one large, two middle-sized and three small sites on the western bank and two large and six small sites on the eastern bank. This pattern points to a dense occupation determining a rural settlement hierarchy of farmsteads belonging to villages, similar to those established in Northern Jezirah during the 9th-6th centuries BC. The Late Iron Age is not represented by surface finds, since the material culture did not change so much in rural sites during the Late Babylonian and Persian Periods.

GİRİŞ

Mardin Eşiği ile Cudi Dağı arasından akan Dicle Nehri Güneydoğu Anadolu bölgesinin yüz yıl öncesine kadar meşe ve palamut ormanlarıyla kaplı kalker kayaçlarında bir kanyon vadi oluşturmuştur. Güneydoğu Anadolu Bölgesinin en engebeli bölümünde bir çanak içinde yer alan cep ovaları ılıman iklime sahiptir. Bu ovalarda yazları kuruyan, kışları ise kar ve yağmur sularıyla beslenen dere ve akarsulardan oluşan su kaynakları bulunur. Bu ovalar zinciri Yukarı Habur Havzası ile Yukarı Dicle Havzası arasında yer alan dar bir doğal geçit oluşturur. Dicle vadisinin bu bölümü yakın zamana kadar arkeolojik bakımdan bir *terra incognita* olarak kalmıştır. Mardin İli Dargeçit ilçesine bağlı Ilısu ve Şırnak ili Güçlükonak ilçesine bağlı Koçköprü ve Koçyurdu köylerine bağlı alanlarda yer alan Ilısu Barajı inşa sahasını kapsayan 1600 hektar büyüklüğündeki kamulaştırma alanında 2008 yılında yürütülen yoğun yüzey araştırmaları ile bölgede 65 buluntu alanı belirlenmiştir (Ökse vd. Baskıda). Bu alanlardan toplanan yüzey buluntularına göre bölgede Çanak Çömleksiz Neolitik dönemden günümüze kadar kesintisiz olarak yerleşilmiştir.

Araştırma alanında MÖ 3.-1. binlere tarihlenen yüzey buluntuları[1] 15 alanda ele geçmiştir (Res. 1-4). Bu alanların çoğunun tarla olarak kullanılmasından dolayı yüzey malzemesi büyük olasılıkla eski yerleşim alanlarından daha büyük bir alana yayılmış olmalıdır. Bu nedenle, bu yerleşimlerin farklı dönemlerde kaplamış oldukları alanı belirlemek mümkün olamamış, dönemlerin yerleşim dokuları yorumlanırken, malzemenin yayılımına göre ölçülen boyutları temel alınmıştır[2].

Yayılım alanı 32,5 hektar ile 119 hektar arasında değişen beş alan, merkezi köyler olarak nitelenen büyük yerleşimlerdir. Bunlar Dicle Nehrinin batı kıyısında Ilısu Köyünün üzerine kurulduğu höyük (119.128 m^2), Zureki Zeri (92.970 m^2) ve Harabe Tepe (69.648 m^2), nehrin doğu kıyısında Zeviya Kavla (32,639 m^2) ve Koçyurdu (32,592 m^2) köyünün üzerine kurulduğu höyüktür.

Dört alanın boyutları 11 hektar ile 21 hektar arasında değişmektedir. Bunlar Dicle Nehrinin batı kıyısında Kilokki Tarlası (20.710 m^2) ve Tivilki Tarlası (12.636 m^2 ve 2300 m^2) ile doğu kıyısındaki Deşta Mira 1 (15,561 m^2) ve Havuz Mevkii (11,934 m^2) adlı alanlardır. Bunlar küçük köyler olarak nitelenmiştir.

Kapladıkları alan bir hektarın altında olan küçük birimler Dicle Nehrinin batı kıyısındaki Şorkey (8241 m^2), Benabahlu (4258 m^2) ve Çelebitepe Tarlası (2178 m^2) ile doğu kıyısındaki Tatıka (5018 m^2), Deşta Mira 2 (2670 m^2) ve Deştika Bzena (2524 m^2) olmak üzere altı alandan oluşmaktadır. Bunlar olasılıkla çiftlik ya da mezra olarak nitelenebilecek, küçük birimlerdir.

ERKEN TUNÇ ÇAĞI (M. Eroğlu)

Erken Tunç Çağı, nehrin doğu yakasında yer alan Zeviya Kavla, Tatıka ve Havuz Mevkiinde ele geçen az sayıda seramik parçası ile temsil edilir (Res. 5-6). Bu alanlardan toplanan MÖ 3. binin ilk yarısına tarihlenen Ninive-V seramiği boyalı, çizi bezeli ve yalın gruplara ait parçalarla temsil edilmiştir. Ninive-V boyalıları çan ayak (Res. 7: 1-2), çanak (Res. 7: 3) ve çömlek (Res. 7: 4) parçaları ile temsil edilir. Bu grup Kuzey Suriye ve Kuzey Mezopotamya'da Yukarı Habur Bölgesinin doğu bölümünde yer alan Tell Leilan IIId tabakasına göre MÖ 3100-2550 yılları arasına tarihlenen Erken Cezire I-II evrelerinde üretilmiştir (Rova 2000: 231, fig.2-3; Lebeau 2000: 168, Tab. IV-V; Akkermans ve Schwartz 2003: 213-215, 255). Dışa açık uzun boyunlu, keskin omuzlu, üzerinde dört ip deliği bulunan, küçük halka dipli ya da çan ayaklı, boyalı küçük kaba ait olmalıdır. Bu biçimdeki kaplar açık renkte, katkısız, temiz hamurlu, boya bezeliler açık zemin üzerine kırmızı geometrik boyalıdır (Rova 2000: 231).

Çizi/kazıma bezekli Ninive-V seramiği çark yapımı ve ince nitelikli, gri ve bej hamurlu olup, çizgisel geometrik düzenlemelerden oluşmaktadır. Bu grup Tatika'da ele geçen dışa çekik dışa kalınlaştırılmış ağızlı, boyunsuz bir çömlek parçası (Res. 7: 7) ile temsil edilmektedir. Orta Fırat, Habur ve Yukarı Dicle havzasında yaygın görülen bu seramik grubunun yakın benzeri Yukarı Habur havzasından bilinmektedir (Oates vd. 2001: 1739-1740). Yalın yüzeyli bir çömlek (Res. 7: 6, 9) ile bir dip parçasından (Res. 7: 10) oluşmaktadır.

Kuzey Suriye'de MÖ 3. binin ikinci yarısında üretilen Cezire Gri Seramiği, Tatıka'da bulunan çizi bezeli amorf parça ile temsil edilmektedir (Res. 7: 8). Aynı merkezde ele geçen ince nitelikli, portakalımsı açık kahverengi kap parçaları da Kuzey Suriye'de MÖ 3. binin ikinci yarısında (Erken Cezire III-IV) yoğunlaşan metalik seramik ile çağdaştır (Akkermans ve Schwartz 2003: 255).

Amuk Bölgesi'nde *Plain Simple Ware* (PSW) olarak adlandırılan (Braidwood ve Braidwood 1960: 25-29) Monokrom Seramik, teknik gelişmeleri ve kap biçimleri dönemlere göre farklılaşmakla birlikte MÖ 3. bin boyunca üretilmiştir. Bu kaplar çarkta üretilmiştir, hamuru mineral katkılıdır ve genellikle orta derecede sertlikte ve özsüz pişmiştir. Bu gruba giren seramikler devetüyü (10 YR 8/4, 10 YR 7/3–4), pembemsi devetüyü (7,5 YR 7/3–4) ve kahverengi (7,5 YR 6/3–4, 10 YR 6/3) tonlarındadır. Genellikle bardaklarla temsil edilen (Özfırat 2005: Lev. XV: 1-7, XVII) bu gruba ait seramikler araştırma alanında 3 basit ağızlı tabak parçası (Res. 7: 11, 12, 13) ile temsil edilmiştir.

Koyu Ağızlı Portakal Rengi Çanaklar (*Dark Rimmed Orange Bowl*: DROB) adı verilen grup genellikle açık kahverengi ve pembe hamurludur ve ağız kenarları dıştan koyu kahverengi ya da siyah boyalıdır. Hamuru renginde astarlı olanların yanı sıra, koyu kahverengi astarlı örnekler de vardır. İnce ve orta kum katkılı, genelde iyi pişirilmiş ve açkılıdır. İnce çeperli bu kaplar daima hızlı dönen çarkta yapılmıştır. Biçim olarak açık ya da hafifçe içe dönük ağızlı ve yuvarlak gövdeli çanaklar çoğunluktadır. Araştırma alanında bu gruba ait parçalar Havuz mevkiinde bulunmuştur (Res. 7: 11- 13). Ağız kısmı koyu, gövde kısmı açık renkte olmakla birlikte ağız kenarı açık renk boyalı olan bir örnek ele geçmiştir (Res. 7: 14). Bir kısmı basit ağız kenarlı bir kısmı da ağzının kenarında yivlere sahiptir (Özfırat 2005: Lev. XXIV, XXXI). Bu kaplar Erken Tunç Çağı III-IV de ortaya çıkmış ve Orta Tunç Çağında devam etmiştir (Ökse ve Görmüş 2006: 140-141; Kozbe vd. 2007: 385).

Doğu Anadolu Erken Tunç Çağı seramiği (*Karaz/Early Transcaucasian/Kura-Araxes/Khirbet Karak Ware*) dışa çekik içe kalınlaştırılmış ağızlı, boyunsuz tek çömlek parçası ile temsil edilir (Res. 7: 16). El yapımı, siyah astarlı ve parlak perdahlı çömlek parçasının yakın benzeri Sos Höyük'te ele geçmiştir (Sagona 2000: fig 9:5, 10:1). Karaz seramiğinin güneye yayılımı MÖ 3. binin son yüzyıllarında başladığından, bu tek örneğin de MÖ 2300 den sonra bölgeye gelen yeni yerleşimcilerin varlığına işaret edebileceği düşünülmektedir.

ORTA TUNÇ ÇAĞI (M. Eroğlu)

Orta Tunç Çağına tarihlenen seramik parçaları yedi alanda toplanmıştır (Res. 8-9). Büyük köyler olarak nitelenen Zuraki Zeri, Kilokki Tarlası, Ilısu Köyü, Harabe Tepe ve Dicle'nin diğer kıyısındaki Zeviya Kavla ve küçük köy niteliğindeki Havuz Mevkiidir. Büyük boyutlu yerleşimler Harabe Tepe ve Zuraki Zeri arasındaki mesafe 5695 metredir.

Kırmızı-kahverengi boya astarlı seramik türü (*Red Brown Wash Ware,* RBWW) çark yapımı seramik parçaları Harabe Tepe, Ilısu Höyüğü ve Zuraki Zeri'de ele geçmiştir. Bu seramik Yukarı Dicle havzasında Kenantepe'de yüzey işlenişleri, biçimleri ve hamurlarına göre gruplandırılmıştır (Parker vd. 2004: 555). Astarın kap yüzeyine uygulanış biçimine göre iki gruba, bunlar da astarın rengine göre alt gruplara ayrılmaktadır.

Kahverengi fırça izli (Kenan Tepe Type 5) grup genelde sert ve özsüz, yoğun olarak kum, orta yoğunlukta kireç, taşçık, bitki ve seyrek olarak da mika katkılıdır. Hamur rengi kızıl kahverengi (5 YR 3/2) olup üzerinde bej (10 YR 7/3) ile kırmızı (2.5 YR 5/8) fırça izli astar bulunmaktadır (Parker vd 2003: 39). Yüzey araştırmasında toplanan bu gruba ait çanak parçası (Res. 10: 1, 2) dışa kalınlaştırılmış ağızlı, dış yüzeyinde gövdeye kadar olan bölümü fırça izli astarla kaplanmış ve alt gövde hamur renginde bırakmıştır. Çömlekler (Res. 10: 3) dışa çekik ağızlı keskin gövdeli ve gövde kısmına kadar fırça izli astarlıdır (Kenan Tepe Type 83). Diğer bir örnek dışa çekik ağızlı, boyunlu çömlektir (Res. 10: 4) (Kenan Tepe Type 111). Bunların dış yüzeyinde boyuna kadar olan kısmında ve birinin ağız kenarı içinde 1-2 cm genişlikte fırça izli astar bulunmaktadır.

Kenantepe'de Type 17 olarak adlandırılan (Parker vd. 2003: 41) kırmızı fırça izli gruba ait iki gövde parçasının dış yüzeyinde astar bulunmakta ve astarın altından sarımsı kırmızı (5YR 6/6) hamur rengi görülebilmektedir. Bu parçalarda pembe (7.5 YR 7/3) astar üzerine fırça ile kırmızı (2.5YR 4/8) astar sürülmüştür.

Krem- yeşil astarlı (*Cream-green Wash*) (Kenan Tepe Type 39) grupta açık kahverengi (10 YR 8/4) astar genellikle kabın tüm yüzünü kaplamaktadır. Araştırma alanında ele geçen iki omurgalı çanak parçası (Res. 10: 22, 23), bu grupta en yoğun görülen tiptedir (Kenantepe Type 83) (Parker ve Swartz-Dodd 2003: 41).

Astarın tüm kap yüzeyini kapladığı ve kalın olması nedeniyle hamur renginin astar altından görünmediği ikinci grup, kahverengi ve kırmızı-kahverengi astarlıdır. Kahverengi astarlı grup (Kenan Tepe Type 4) genelde gri özlü ve perdahlı yoğun olarak kum orta yoğunlukta kuvars, mika ve seyrek olarak kireç, taş ve bitki katkılıdır. Seramiklerin üzerindeki astar kahverengi (7.5 YR 5/4) ile kızıl kahverengi (5 YR 5/4) arasında değişmektedir (Parker vd 2003: 40). Bu gruba ait çömlek parçaları arasında (Res. 10: 5) dışa çekik dışa kalınlaştırılmış ağız kenarı iç ve dıştan şerit halinde astarlı (Res. 10: 6-8), boyunsuz (Kenan Tepe Type 110), dışa çekik, dışa kalınlaştırılmış ağızlı kısa boyunlu (Res. 10: 9-10) ve dışa çekik, dışa kalınlaştırılmış uzun boyunlu tiplere (Res. 10: 11-12) ait parçalar bulunur.

Kırmızı-kahverengi astarlı (Kenan Tepe Type 28) gruba ait parçalar genelde gri özlü ve perdahlı, yoğun olarak kum, orta yoğunlukta kuvars, mika ve seyrek olarak kireç, taşçık ve bitki katkılıdır. Seramiklerin üzerindeki astar açık kahverengi (10 YR 5/6) ile kızıl kahverengi (2.5 YR 5/4) arasında değişmektedir (Parker ve Swartz-Dodd 2003: 41). Kap biçimleri içe çekik, dışa kalınlaştırılmış ağızlı çanaklar (Res. 10: 13-14) ile dışa kalınlaştırılmış ağızlı, boyunsuz çömleklerden (Res. 10: 15-17) oluşmaktadır. Bunların dış yüzeyinde ve birinin ağız kenarı içinde 1-2 cm genişlikte astar bulunmaktadır. Diğer çömleklerden üçü (Res. 10: 18-20) dışa kalınlaştırılmış ağızlı, boyunsuz, kulplu çömleklere aittir. Bir örnek dışa çekik, dışa kalınlaştırılmış ağızlı kısa boyunlu çömleğe aittir.

Kırmızı-Kahverengi boya astarlı seramik türü güneydoğu Anadolu ve kuzey Suriye'de yaygındır: Orta Fırat Havzasında Lidar Höyükte ele geçen boya banyolu seramikler (Kaschau 1999: 111, Taf. 183: 2; 235:1), Orta Dicle havzasında Tell Rijim'de ele geçen olasılıkla fırça ile yapılmış çok ince bir boya tabakası ile kaplı seramikler (Kolinski 2000: 28 fig. 26, Pl. 27B), kuzeybatı Suriye'de Tell Umm el-Marra'da biçim ve yüzey işlenişleri bakımından benzeyen seramikler (Schwartz vd. 2003: fig. 30: 3-4), Yukarı Habur havzasında Tell Brak'ta ele geçen *Red Slip Ware*. Bu gruptaki kaplar dönemin diğer Orta Tunç Çağı seramik gruplarıyla benzerlik gösterir. Bu parçaların biçimsel benzerleri Yukarı Fırat havzası, kuzey Suriye, Habur ve Balikh havzalarını da içine alan geniş bir alana yayılan tek renkli seramik grubuna ait kaplarda da görülür (Nigro 1998: 271-305; Özfırat 2005: 25-29). Bu seramik grubu Yukarı Dicle havzasında yedi kazı alanında açığa çıkartılan görkemli mimari tabakalarda da ele geçmiştir[3].

Kenan Tepe, Salat Tepe, Türbe Höyük, Hirbemerdon kazılarından elde edilen radyokarbon tarihlerine göre RBWW MÖ 19.-16. yüzyıllarda kullanılmıştır (Parker ve Swartz-Dodd 2003: 39 Laneri 2008: 180; Ökse ve Görmüş 2006: 141). Siirt Türbe Höyükten bu mal grubunun ele geçtiği tabakada bulunan tablet MÖ 16. yy Erken Mitanni dönemine tarihlendirilmektedir. (Sağlamtimur ve Ozan 2008: 5). Hirbemerdon kazılarında RBWW kaplarının Erken Tunç Çağı tabakalarında da bulunması (Laneri 2008: 179), bu seramik grubunun MÖ 3. binden itibaren üretildiğini göstermiştir. Yukarı Dicle havzasında Orta Tunç Çağı kontekstlerinde RBWW ile birlikte Erken Tunç Çağına ait DROB ve *Metallic Ware* türünde üretilmiş kapların bulunması (Kozbe vd. 2007: 385; Ökse ve Görmüş 2006: 140-141), bunların kullanımının Orta Tunç Çağında da sürdüğünü göstermiştir.

Ilısu barajı inşaat alanında ele geçen Habur Boyalıları Harabe Tepe (Res. 11: 9, 13) ve Zuraki Zeri'de (Res. 11: 8) ve Dicle'nin diğer kıyısındaki Zeviya Kavla ve Havuz Mevkiinde ele geçmiştir. Sert özsüz pişmiş, yoğun kum taşçık kireç ve bitki katkılıdır. Parçalar yalın yüzeyli, astarlı ve kızıl kahverengi boya bezelidir (5 YR 6/3). Bu seramik parçaları biçim olarak çanak ve çömleğe aittir (Res. 11: 13). Çanaklar dışa kalınlaştırılmış ağızlı, çömlekler (Res. 11: 6-7) dışa çekik ağızlı, kısa boyunludur ve ağız kenarında iç de ve dış yüzeyde boya bant bulunmaktadır. Diğer tipler dışa çekik düz ağızlı, boyunsuz çömlekler (Res. 11: 10-11) ve dışa kalınlaştırılmış boyunsuz çömleklerdir (Res. 11: 1, 4, 9). MÖ 18.-15. yüzyıllarda (Nigro 1998: 287-289; Oguchi 2006: 55) güneydoğu Anadolu ve doğu Akdeniz bölgesinin kuzey kısmından İran'a kadar geniş bir alanda yayılım gösteren Habur Boyalıları[4] çark yapımı, yalın veya devetüyü renkte astarlı kırmızı, siyah ve kahverengi boyalıdır. Kaplar, düz dipli, uzun boyunlu vazolar ile keskin profilli çanaklardan oluşmaktadır (Özfırat 2005: 25-29).

Tek renkli kaplar çark yapımı, taşçık, kum ve saman katkılı, yalın yüzeyli kap parçaları keskin profilli çanaklara, boyunlu boyunsuz çömleklere aittir. Hamurları yoğun olarak kum, orta sıklıkta kireç ve taşçık seyrek olarak da kuvars ve mika katkılıdır. Çark yapımı, genelde yalın veya kendinden astarlıdır. Bu gruba seramik parçaları içe çekik dışa kalınlaştırılmış ağız kenarlı tabaklar (Res. 12: 1-2); keskin gövdeli çanaklar (Res. 12: 3-5); dışa kalınlaştırılmış ağızlı çanaklar (Res. 12: 6-7), dışa çekik ağızlı çanaklar (Res. 12: 8-9) ile boyunsuz (Res. 12: 11-12) ve boyunlu çömleklere (Res. 12: 13-14) ait parçalardan oluşmaktadır. Dışa çekik, dışa kalınlaştırılmış ağızlı (Res. 13: 1-5) ve dışa kalınlaştırılmış ağız kenarı oluklu (Res. 13: 6-9) boyunlu çömlekler Harabe Tepe, Banuva Şengin, Kilokki Tarlası, Zureki Zeri ve Zeviya Kavla'da ele geçmiştir. Bu seramik türü güneydoğu Anadolu ve kuzey Mezopotamya'da yaygın olarak bulunan[5] (Res. 14) *Monokrom Simple Ware* türü içerisinde değerlendirilmektedir (Parayre 1986: Carte 1).

GEÇ TUNÇ ÇAĞI (Y. Tan)

Ilısu baraj gövde inşaatı alanında yapılan yüzey araştırmasında nehrin doğu kıyısında Orta Asur dönemine tarihlenen kap parçaları iki alanda toplanmıştır (Res. 15). Bunlardan Zeviya Kavla Dicle vadisine hakim konumda büyük boyutlu bir yerleşim, Tatıka ise küçük boyutlu bir alandır. Bu iki alan arasında 1 km mesafe bulunması, Tatıka'nın Zeviya Kavla'ya bağlı küçük bir birim olabileceğini düşündürmektedir.

Bu alanlardan toplanan seramiklerin hepsi çark yapımı, iyi pişmiş, kum, mika, kireç, bitki ve nadiren şamot katkılıdır. Dış yüzeyleri koyu kahverengi, açık sarı ve pembemsi kahverengidir. Toplanan parçalar genellikle astarlı, bazıları perdahlıdır. Çanaklar dışa çekik, dıştan kalınlaştırılmış ağızlı ve omurgalıdır (Res. 16: 2, 5-6). Çömlekler dışa çekik, dıştan kalınlaştırılmış ağızlı boyunsuz ve dışa kıvrık ağızlı biçimlerden oluşur (Res. 16: 1, 3-4). Yüzey malzemesi arasında bulunan küp parçaları, burada besin depolanmış olabileceğini düşündürmektedir (Res. 16: 7).

Yukarı Habur havzasında Girnavaz (Erkanal 1991: 280) ve Yukarı Dicle havzasındaki çeşitli boyutlu yerleşimler[6] gibi Zeviya Kavla'nın Dicle kenarındaki konumu, büyüklüğü ve malzemenin yoğunluğu, bu alanın Dicle vadisini kontrol eden bir merkez olabileceğini düşündürmektedir.

ERKEN DEMİR ÇAĞI (E. Atay)

Araştırma alanında Erken Demir Çağı kap parçalarına geniş yerleşim alanlarına sahip Harabe Tepe, Tivilki Tarlası, Kilokki Tarlası, Zureki Zeri, Zeviya Kavla ve küçük alanlar kaplayan Tatika ve Deşta Mira 2 olmak üzere yedi alanda rastlanmıştır (Res. 17). Yerleşim alanları Harabe Tepe ve Zureki Zeri arasındaki mesafe 5695 metredir.

Malzeme el yapımı, kaba bitki, taşçık, kireç ve kum katkılı, düşük ısıda pişirilmiş kaplara ait olup, engebeli ve düzeltme izli yüzeylere sahiptirler (Res. 18). Çark yapımı örnekler dönemin sonlarında ortaya çıkmaya başlar. Seramik dört hamur grubu oluşturur.

Mika katkılı grup çok küçük kum, taşçık, küçük kireç, bitki ve yoğun mika katkılıdır. Parçaların biri çark, diğerleri el yapımıdır. Parçalar gri ve sarımsı kahverengi hamurlu, dış yüzeyleri sarımsı kırmızı ve gri tonlarda, yalın, mat perdahlı ve astarlıdır. Kap yüzeyleri genellikle düz ve düzeltme izlidir, bir tanesinde çizi ve yumru bezeme, birinde yiv bezeme görülmektedir. Çanaklar basit ağız kenarlı, ağız kenarının altında yatay oluklu, basit düz ağızlı, tutamaklı örneklerle temsil edilmiştir (Res. 19: 5, 20: 10, 17). Bir çömlek parçası basit ağız kenarlı ve boyunlu (Res. 20: 6), diğeri yumru ve çizi bezemelidir (Res. 20: 7).

Kireç Katkılı grup küçük taşçık, bitki, kum ve orta büyüklükte kireç katkılıdır. Parçaların bir tanesi çark, diğerleri el yapımıdır. Parçalar genellikle sarımsı kırmızı ve kahverengi hamurlu, dış yüzeyleri sarımsı kırmızı ve açık kahverengi tonlarda, genellikle düz ve düzeltme izli, mat perdahlı, yalın bırakılmış veya astarlanmıştır. Bir örnekte çizi bezeme görülür. Çanaklar yuvarlak ya da düz basit ağız kenarlı olup, ağız kenarları düzensiz biçimlendirilmiştir (Res. 19: 7-8, 20: 11-3, 19). Çömlek biçimleri basit ağız kenarlı ve boyunlu, yuvarlak basit ağız kenarlı ve yiv bezemeli, dışa çekik ağız kenarlı ve kısa boyunlu parçalardan oluşur (Res. 19: 1-4, 20: 1-2, 8). Bitki Katkılı gruba ait parçalar orta boyutta taşçık, küçük kum, kireç ve orta boyutta bitki katkılıdır. Tümü el yapımı olan parçalar gri ve kahverengimsi gri hamurlu, dış yüzeyleri kırmızı sarı ve açık kahverengi tonlarda, yalın veya kendinden astarlıdır. Parçaların yüzeyleri düzeltme izleri taşımakta olup birinin yüzeyi engebelidir. Bu gruba ait çanak parçaları basit yuvarlak ve düzensiz ağız kenarlıdır (Res. 19: 6, 20: 14-15).

İnce Nitelikli gruba ait seramik parçaları çok küçük kum, taşçık, kireç ve bitki katkılıdır. Parçaların biri çark, diğerleri el yapımıdır. Parçalar gri, kırmızımsı sarımsı ve kahverengi hamurlu, dış yüzeyleri açık kahverengi ve gri tonlarda, yalın, kendinden astarlı, mat perdahlı ve düzeltme izlidir. Bu gruba ait çanaklar düz basit ağız kenarlı (Res. 20: 16, 18, 20), boyunsuz çömlekler basit yuvarlak basit düz ağızlı, kısa boyunlu çömlekler dıştan kalınlaştırılmış ağız kenarlıdır (Res. 20: 3-5, 9).

Bu seramik bölgelere göre bazı işleniş ve biçim ve bezeme farklılıkları gösteren, ancak, teknik özellikleri ve kap biçimleri bakımından benzerlik gösteren ürünler olup, doğu ve güneydoğu Anadolu bölgelerinde yaygın olarak bulunmaktadır[7] (Res. 21).

ORTA-GEÇ DEMİR ÇAĞI (Y. Tan)

Yeni Asur dönemine tarihlenen kap parçaları Dicle Nehrinin batı kıyısında yer alan büyük yerleşimler Harabe Tepe, Kilokki Tarlası ve Tivilki Tarlası ile küçük birimler olan Şorkey, Çelebitepe Tarlası ve Benabahlu olmak üzere altı alanda toplanmıştır (Res. 22-23). Nehrin doğu kıyısında Zeviya Kavla ile Koçyurdundaki büyük yerleşimler ile küçük birimler oluşturan Deşta Bzena, Tatıka ve Deşta Mira 1 olmak üzere beş alanda bu döneme ait seramik parçaları toplanmıştır. Yerleşim alanları en geniş olan Harabe Tepe ve Ilısu Köyü arasındaki mesafe 2662 metredir. Yerleşim alanları diğerlerine oranla daha küçük olan Çelebitepe Tarlası ve Benabahlu arasındaki mesafe ise 760 metredir. Nehrin doğu kıyısındaki Zeviya Kavla boyutları ve malzemenin yoğunluğu dikkate alınarak bölgedeki üçüncü büyük yerleşim olarak nitelenmiştir.

Yukarı Dicle Havzasında "Asur Tipi Seramik" olarak adlandırılan, tamamı çark yapımı kap parçaları çok küçük kum, taşçık, mika ve kireç katkılıdır. Hamur renkleri gri, kahverengi tonlardan sarımsı kırmızıya kadar değişmektedir. Dış yüzeyleri genelde sarımsı ve kahverengi tonlarda yalın, mat perdahlı, astarlı, kendinden astarlı ve bezemesizdir. Bu gruba ait çanaklar dışa çekik dışa kalınlaştırılmış, içe çekik ve içe çekik dıştan kalınlaştırılmış ağız kenarlı biçimlerden oluşmaktadır (Res. 25: 5, 7-12). Vazo parçaları dışa çekik ağız kenarlı ve kısa boyunludur (Res. 24: 9-10, 12). Kalın cidarlı büyük boyutlu çömleklere ait bazı gövde parçaları üzerinde bulunan rozet biçimli baskılar (Res. 25: 17-18) bu yerleşimlerin MÖ 6. yüzyılda da kullanıldığını göstermektedir[8].

Asur "saray seramiği" ince nitelikli, teknik ve biçim açısından diğerlerinden ayrılan, özgün bir grup oluşturmaktadır. Bu grubunun en belirgin kap biçimlerini, üzerinde çukur bezekler bulunan kadehler oluşturmaktadır (Oates 1959: 135; Köroğlu 1998: 39, 51, Res. 9:1). Zeviya Kavla da ele geçen parmak baskı bezemeli kadeh gövdesi (Res. 25: 19), olasılıkla bu gruba aittir.

En yoğun rastlanan kaba seramik grubu Üçtepe'de "Asur Dönemi Yerli Seramiği" olarak adlandırılmıştır (Köroğlu 1998: 40-41). Tamamı çark yapımı olan kaplar küçük kum, taşçık, bitki ve orta boyutta kireç katkılıdır. Hamur ve yüzey renkleri genellikle kahverengi ve kırmızımsı sarı, dış yüzeyleri yalın, kendinden astarlı ve astarlıdır. Çanaklar basit ve dışa kalınlaştırılmış ağız kenarlıdır. Basit ağızlı bir çanak parçasının ağız kenarında yiv bezeme görülmektedir (Res. 25: 1-4, 6, 13). Çömlekler dışa çekik veya dıştan kalınlaştırılmış ağızlı ve hafif içe çekik düz ağızlı ya da içe çekik ağızlı kısa boyunlu biçimlere sahiptir (Res. 24: 1-7, 9). Vazo parçaları dışa çekik, dışa kalınlaştırılmış ağız kenarlı ve boyunludur (Res. 24: 8). Bu grupta düz dip ve düğme dip parçaları ele geçmiştir (Res. 25: 14-16). Bu kapların benzerleri kuzey Mezopotamya ve güneydoğu Anadolu'da geniş bir alana yayılmıştır (Res. 26).

YERLEŞİM TARİHİ

Ilısu barajı inşaat alanının bulunduğu bölge kuzeyden Yukarı Dicle havzası, güneyden Yukarı Habur havzası, doğudan doğu Toroslarla Zagrosların kesiştiği dağlık alanla ve batıdan Mardin Eşiği dağları ile çevrelenmiştir. Bölge kuzey Mezopotamya kültürleri ile doğu Anadolu kültürleri arasında kalan bir geçiş alanı özelliği göstermektedir. MÖ 3. ve 2. binde kuzey Mezopotamya ve Yukarı Dicle havzası kültürlerini yansıtan bölge, MÖ 1. bin başlarında doğu Anadolu Erken Demir Çağı kültürünün etkisi altına girmiş, Yeni Asur egemenliğinin başlamasıyla tekrar kuzey Mezopotamya kültürünün bir parçası haline gelmiştir. Araştırılan bölgede çağlar boyunca büyük köy, küçük köy ve mezra/çiftlik olarak nitelenen kırsal yerleşimler bulunması, bir kent oluşumuna olanak vermeyecek biçimde dağlarla sınırlanan küçük bir ova olmasına bağlıdır. Kuzey Cezire'de yapılan yüzey araştırmalarından yola çıkılarak yapılan teorik saptamalara[9] göre, tarım ekonomi sisteminde iki bağımsız yerleşim birimi arasında en az 4 km mesafe bulunması gerekmekte, mesafenin daha yakın olması durumunda bu yerleşim alanları aynı ekonominin birimleri olarak nitelenmektedir. Bu teorik prensiplere göre, araştırılan alanda her dönemde farklı bir yerleşim dokusu ve buna bağlı olarak farklı ekonomik sistemlerin varlığı akla gelmektedir.

Erken Tunç Çağı yerleşimleri Dicle nehrinin doğu yakasındaki bir büyük köy, bir küçük köy ve bir mezradan oluşmaktadır (Res. 5). Bu merkezlerin birbirine olan mesafelerinin 0,5-1 km arasında olması, bunların büyük merkez olan Zeviya Kavla'ya bağlı bir küçük köy (Havuz Mevkii) ile bir mezradan (Tatıka) oluşan hiyerarşik bir yapıya sahip olduğu izlenimini bırakmaktadır. Yerleşimlerin nehrin batı yakasında bulunmayışı, bu bölgenin bu dönemde tercih edilmiş olmasına işaret edebileceği gibi, batı yakasındaki alanlarda Erken Tunç Çağı buluntularının yüzeye çıkmamış olabileceği de düşünülmelidir. Bu döneme tarihlenen çizi bezeli ve boyalı Ninive-V seramikleri, portakal renkli sert pişirilmiş parçalar, DROB parçaları ile Cezire Gri seramiğine ait parçalar (Res. 6), bu bölgede MÖ 3. bin boyunca yerleşildiğine ve yerleşimcilerin Yukarı Habur ve Yukarı Dicle bölgelerinde yaygın olarak belirlenen Kuzey Mezopotamya kültürünün bir parçası olduğunu göstermektedir. Tatıka'da bulunan tek Karaz seramik parçasına dayanarak Doğu Anadolu kökenli grupların bu bölgeyle ilişkilerinin boyutu kesinlik kazanmamıştır.

Kuzey Suriye ve güneydoğu Anadolu'da bir devlet yapısını yansıtan hiyerarşik bir yerleşim şeması MÖ 3. binin ilk yarısında belirlenememiş (Akkermans ve Schwartz 2003: 223-236, 261-262), MÖ 2600-2200 arasında rastlayan dönemde kent ve köylerden oluşan hiyerarşik yerleşim şeması gelişmiştir. Yazılı kaynaklarda MÖ 2300 civarında Akad kralı Naramsin'in Subartu seferlerinden söz edilir (Akkermans ve Schwartz 2003: 278). Yukarı Habur bölgesinin doğu kesiminde yer alan Tell Brak'ta açığa çıkartılan Naramsin sarayı ile Tell Leilan II yerleşimi, Dicle Nehrinin bu kesiminin kontrol altına alınmak istendiğini gösterir niteliktedir. Diyarbakır'ın Silvan ilçesinde bulunan Pir Hüseyin steli, Naramsin'in Yukarı Dicle havzasında egemenliği altına aldığını göstermektedir (Roaf 1996: 97). Yukarı Habur bölgesinde, Mardin Eşiği üzerinden Ergani bakır kaynaklarına giden yol üzerinde yer alan Tell Mozan/Urkesh'de (Kelly-Buccellati 2004: 68) bulunan Akad dönemi tabletlerinde Hurrili kral adlarının geçmesi, bölgenin bu dönemde Hurri krallarınca yönetildiğini de göstermektedir (Akkermans ve Schwartz 2003: 282-288). Bu gelişime karşın, Ilısu Barajı inşaat alanında az sayıda kırsal yerleşim bulunması, bu alanın Akad döneminde önemli bir yol güzergahı oluşturmadığı izlenimini bırakmaktadır. MÖ 2200 sonrasında Habur havzasındaki yerleşim sayısı, olasılıkla kuraklığa bağlı olarak hızla azalmıştır; Tell Leilan'da yerleşim sona ermiş, Tell Brak'ın kentsel boyutları küçülmüştür. Araştırma alanında az sayıda seramik parçası bulunması nedeniyle bölgenin bu değişimden etkilenip etkilenmediği tahmin edilememektedir.

Orta Tunç Çağında RBWW türüne giren parçaların çeşitliliği ve yoğunluğu (Res. 8-9), bölgenin bu dönemde Yukarı Dicle ve Yukarı Habur havzası kültürlerinin bir parçası olduğunu göstermektedir. Bu bölgede kullanılan Monokrom Standart Seramik ve Habur Boyalıları (Res. 14), araştırma alanında Dicle nehrinin her iki yakasında eşit sayıda merkezde belirlenmiştir. Batı yakada yer alan iki büyük köy ve bir küçük köy, aralarındaki mesafe, hiyerarşik bir yerleşim sisteminin varlığını düşündürmektedir. Buna göre doğu yakanın büyük köyü Zeviya Kavla ile küçük köyü Havuz Mevkii arasındaki 500 m mesafe, bunların bağımsız birimler olmadığını göstermektedir. Batı yakadaki büyük köyler Harabe Tepe ile Ilısu Höyüğü arasında 2,5 km üzerinde, Harabe Tepe ile Zuraki Zeri arasında 6 km ye yakın mesafe bulunması, bu büyük köylerin birbirinden bağımsız tarımcı ekonomilere sahip olduklarını düşündürmektedir.

Yukarı Dicle havzasındaki bağımsız ekonomik merkezler[10] arasındaki mesafeler 5-22 km arasında değişmekte, bunların çevresinde birbirinden bağımsız tarım ekonomilerine sahip küçük birimler bulunmaktadır. Büyük merkezlerde açığa çıkartılan anıtsal yapı kompleksleri, bu dönemde kuzey Mezopotamya'da çivi yazılı arşivlerle belgelenen tarım çiftliklerine dayalı ekonomik sistem (*dimtu*-sistemi) ile karşılaştırılmıştır (Radner ve Schachner 2004: 113).

Yukarı Habur havzasının doğu kesiminde yer alan merkezler MÖ 2. binin ilk yüzyıllarında köysel boyutlarını korumuşlardır. MÖ 18. yüzyıldan itibaren yeniden kurulan kentler arasında Eski Assur kralı Şamşi Adad'ın kenti Şubat-Enlil (Tell Leilan I) (Akkermans ve Schwartz 2003: 296-297, 308-309), araştırma alanının bu dönemde Asur kontrolünde olabileceğini düşündürmektedir. Bu dönemde kuzey Suriye ve güneydoğu Anadolu'da üretilen Habur Boyalı kapları, MÖ 16. yüzyıl sonuna kadar kullanılmıştır. Aşağı Habur havzasında saptanan nüfus düşüşü (Wilkinson 2003: 40, 47-49; Martin 1999: 83-84), tarıma dayalı yerleşim sisteminin ortadan kalktığını göstermektedir. Bu düşüş MÖ 16. yüzyıl ortalarında bir kuraklığa (Riehl vd. 2008: 1011; Baillie 1998:111) bağlanmaktadır.

Geç Tunç Çağı'nda Ilısu Barajı inşaat alanında nehrin doğu kıyısındaki büyük köy Zeviya Kavla ve küçük yerleşim birimi Tatıka Mitanni ve Orta Asur kaplarına ait parçaları bulunmuştur. Bu iki alanın birbirine olan mesafesinin 1 km altında olması, bunların bir köy ve mezrasından oluşan bir grup oluşturduğunu düşündürmektedir. Yukarı Habur havzasının doğu bölümünde yer alan Tell Brak ve Tell el-Hamidiya'daki Mitanni sarayları ile Tell Muhammed Diyab'daki yerleşim (Akkermans ve Schwartz 2003: 329-348), araştırma alanının bu dönemde Mitanni Krallığının (MÖ 1500-1350) egemenlik alanına girdiğini göstermektedir.

Yukarı Habur havzasının doğu bölümündeki Tell Amouda, Tell Barri ve Tell el-Hamidiya kentleri, Orta Asur Krallığının (MÖ 1350-1050) yerleşim sisteminin yeniden düzenlenmesiyle ilişkilendirilmektedir (Akkermans ve Schwartz 2003: 350-351). *Tidu* kentinin başkent olduğu Yukarı Dicle bölgesindeki Assur yayılımı I. Adad-Nirari (MÖ 1295-1264) ve I. Salmanasar (MÖ 1263-1234) döneminde başlar. Bu dönemde Yukarı Dicle havzasında kentsel yerleşimler (Ziyarettepe, Gre Dimse, Üçtepe) ve Giricano'da açığa çıkartılan tablet arşivine göre çiftlikler (*dunu*) bulunmaktadır (Radner ve Schachner 2004: 150). Giricano'da ele geçen tabletler Assur belkala'nın (MÖ 1073-1056) *limu*'su Ili-iddina dönemine aittir (MÖ 1069/1068) (Schachner 2003: 158; Radner ve Schachner 2004: 151). Türbe Höyük'ün Geç Tunç Çağ tabakasından alınan radyokarbon tarihleri (MÖ 1300-1030) (Sağlamtimur ve Ozan 2008: 6) bu tarih ile uyumludur. Bu tarihlemelere göre Orta Asur Krallığının Yukarı Dicle havzasına hükmettiği MÖ 13.-11. yüzyıllarda Ilısu Barajı inşaat sahasına rastlayan Dicle vadisinde belirlenen iki köysel yerleşim alanı, bu dönemde bölgede önemli bir tarımsal sistemin kurulmadığını göstermektedir.

Doğu Anadolu ve Yukarı Dicle havzasında Erken Demir Çağı, el yapımı, kısmen yatay oluklarla bezeli seramik gruplarıyla temsil edilir. Bu seramiklerin benzerleri araştırılan alanda dokuz merkezde bulunmuştur (Res. 17). Erken Demir Çağı yerleşim dokusu nehrin batısında iki büyük ve iki küçük köy, doğu yakasında bir büyük, iki küçük köy ve iki küçük mezradan oluşur. Harabe Tepe ve Zeviya Tivilki, doğu yakada Zeviya Kavla ile Deşta Mira 2 ve Tatıka arasındaki mesafe 500-1000 m arasında değişmekte, dolayısıyla, farklı boyutlardaki merkez grupları birbirine bağlı yerleşim alanları olarak nitelenebilir.

Doğu Anadolu Erken Demir Çağının karakteristik yivli çanak çömleği ve basit mimari tarzı, Yukarı Dicle havzasında Orta Asur döneminden sonra görülmeye başlar (Schachner 2003: 158; Roaf ve Schachner 2005: 116). Bu seramik höyüklerin üzerine kazılan çukurlarda ve basit konutlarda ele geçmiştir[11]. Bu özellikleri, Erken Demir Çağı yerleşimlerinin bazılarının tarımcı topluluklarca kullanılmış olmasına karşın, doğu Anadolu'da olduğu gibi, çoğunun çoban topluluklara ait konaklama yerleri olduğunu düşündürmektedir. Bu bağlamda Ilısu Barajı inşaat sahasında belirlenen yerleşim gruplarının kısmen çoban toplulukların konaklama yerleri olabileceği de düşünülmektedir. Van Gölü tabanından alınan polen örneklerine göre MÖ 1260-900 yılları arasında hüküm süren kurak iklim, bu dönemde tarımcı bir sistemin gelişmesini engellemiş görünmektedir (Wilkinson 1995: 151, not 37). Orta Asur krallarının kuzey seferlerini anlatan metinlerden, burada kabile/aşiretler halinde yaşandığı ve hayvancılıkla uğraşıldığı anlaşılmaktadır[12]. Erken Demir Çağı için Yukarı Fırat Havzasında MÖ 1150-950 tarihleri (Bartl 2001: 391, 396), Orta Fırat havzasında MÖ 1100-900 (Müller 1999a: 404) ve MÖ 1000-800 (Blaylock 1999: 267) tarihleri önerilmiştir. Yukarı Dicle havzasında Giricano verilerine göre bu dönem MÖ 1050 den sonraki bir tarihte başlar ve Yeni Asur dönemi içlerine kadar sürer (Roaf ve Schachner 2005: 120). Yeni Asur yerleşimlerinde ve doğu Anadolu'da Urartu kalelerinde ele geçen el ve çark yapımı yivli seramikler, bu geleneğin MÖ 7. yüzyıl ortalarına kadar sürdüğünü kanıtlamaktadır[13]. Buna göre bu seramik geleneği bölgede Orta Asur döneminin son bulduğu MÖ 11. yüzyıldan MÖ 7. yüzyıl başlarına kadar süren zaman dilimine yerleştirilmesi olasıdır.

Araştırma alanında 14 yerleşim biriminde Yeni Asur dönemi seramiği ele geçmiştir (Res. 22). Dicle nehrinin batı yakasında bir büyük ve iki küçük köy ile üç mezra, doğu yakasında 2 büyük köy ile 6 mezradan oluşan yerleşim dokusu, bu dönemde büyük köylere bağlı küçük çiftliklerden oluşan bir hiyerarşik yerleşim sisteminin varlığını ortaya koymaktadır. Harabe Tepe ile Tivilki Tarlası, Şorkey ve Çelebitepe Tarlası arasındaki mesafeler 2 km altındadır. Nehrin doğu kıyısındaki Zeviya Kavla, Havuz ve Tatıka arası da bir km altındadır. Buna karşın büyük köyler Harabe Tepe, Kilokki Tarlası ve Zeviya Kavla arasındaki mesafeler 4 km üzerindedir. Buna göre bu dönemde birden fazla birimden oluşan hiyerarşik grupların bulunduğu ve bu grupların diğerlerinden bağımsız tarım ekonomileri olduğu varsayılabilecektir. Benzeri bir durum, Salat Çayının doğusunda belirlenen, aralarında yaklaşık 4 km mesafeler bulunan küçük yerleşim birimleri için de düşünülebilir.

Yeni Asur metinlerinde söz edilen sık yağmur ve iyi ürünler ile kuzey Suriye'de köy ve çiftlik boyutundaki yerleşim birimlerindeki artış ve bu yerleşimlerin düzenli aralıklarla (2-4 km mesafelerde) dizilmiş olması, bu dönemde bir tarımcı yerleşim sisteminin varlığını düşündürmektedir[14]. Her ne kadar MÖ 2. binde bölgede varlığı bilinen tarım yönetim sistemi (tımar sistemi) bu dönemde belgelenmemiş olsa da, memurların tarım ürünlerinin vergilerini topladıkları (Zablocka 1986; Parpola 2005: 30) ve böylece askeri yapıyı güçlendirmeye ve tarımsal üretimi artırmaya çalıştıkları bilinmektedir (van Driel 1970; Postgate 1974: 231-232, 237-240).

Yeni Asur kralları MÖ 900 den itibaren Yukarı Habur havzasının doğu bölümünde Girnavaz, Tell el-Hamidiya ve Tell Barri sarayları (Akkermans ve Schwartz 2003: 381-385; Erkanal ve Erkanal 1989: 136) ve Yukarı Dicle havzasında Üçtepe ve Ziyarettepe gibi büyük kentler kurmaya başlamışlardır. II. Assurnasirpal'in MÖ 822 yılına tarihlenen Tuşhan ve Kurh stelleri (Grayson 1991: 202, 261; Köroğlu 1998: 76-77) Yukarı Dicle havzasında, Cizre yakınlarındaki Babil Köyü steli ile Cudi Dağı (KUR. Nippur) kabartmaları (Erkanal ve Erkanal 1989: 130, 133-134) da Dicle vadisinin Ilısu Barajı inşaat sahasına rastlayan kesiminde Yeni Asur egemenliğini kanıtlar. Yeni Assur yazıtlarından bilinen ve Mardin Eşiği dağlarını aşarak Midyat üzerinden Diyarbakır'a ulaştığı düşünülen *Kaşşiyari* Dağ Yolunun (Kessler 1980: Karte; Köroğlu 1998: 79, 89, res. 18) kullanılması nedeniyle, Mardin Eşiğinin doğusundaki dar Dicle vadisinin ana geçit olarak kullanılmadığı, bunun yerine bölgede tarımcı toplulukların yaşadığı bir yerleşim sisteminin oluşturulduğu anlaşılmaktadır.

Kuzey Mezopotamya Yeni Asur imparatorluğunun MÖ 612 de yıkılmasından sonra Yeni Babil, MÖ 550 yıllarında Pers İmparatorluğunun egemenliğine girmiştir. Yüzey araştırmaları ile yaklaşık MÖ 330 yıllarına kadar süren bu dönemde maddi kültürün fazla değişmemesi nedeniyle, bu dönemlere ilişkin arkeolojik bulgulara ulaşılamamaktadır.

Kısıtlı bir alanda yapılan yüzey araştırmalarından edinilen sonuçlar, Dicle vadisinin oluşturduğu bu küçük cep ovasının Çanak Çömleksiz Neolitik dönemden itibaren tarımcı köy yerleşimlerini besleyebilecek tarım potansiyelinin bulunduğunu göstermiştir. Bölgede yapılmaya başlanan kurtarma kazılarının bu malzemenin stratigrafik bir temele oturtularak net sonuçlar alınabilecek veriler sunması beklenmektedir.

NOTLAR

1 Yüzeyden toplanan seramik parçaları ayrıntılı olarak incelenmiş ve tanımları yapılmıştır. Seramik katalogunda kullanılan hamur, yüzey ve boya renklerinin tanımında *Munsell Soil Color Charts* kullanılmıştır.

2 Yüzey araştırması sırasında alınan GPS noktaları Netcad ortamında hazırlanan harita üzerine Nurol-Cengiz Şirketi topoğrafları Hafız Özel ve Tahir Timur Göktuğ tarafından yerleştirilmiştir. Belirlenen alanların sınırlarının topoğrafik haritaya uyumunun sağlanması ile yüz ölçümleri ve birbirlerine olan mesafelerinin ölçülmesi Autocad programı ile Sanat Tarihçisi Yunus Muluk tarafından gerçekleştirilmiştir.

3 Üçtepe (Özfırat 2005: Lev. LXXXI:6, LX:1, LXI:5, LXXX:3-4), Giricano (Schachner 2004: Şek. 17-18), Botan Vadisi ve Çattepe (Velibeyoğlu vd. 2002: Şek. 17: 11, 40: 1-2, 4), Kavu-

şan Höyük (Kozbe vd. 2004: Şek. 20: 5-6), Kenan Tepe (Parker ve Swartz-Dodd 2003: fig. 7E, 8A-B, 9H-I; Parker vd 2004: Şek. 9: 10), Hirbemerdon Tepe (Laneri vd 2006: fig. 5: 6), Ziyaret Tepe (Matney 1999: 300), Salat tepe (Ökse ve Görmüş 2006: 139-140).

4 Üçtepe (Özfırat 2005: 25, Lev. XXXIX: 5, 8), Kavuşan Höyük (Kozbe vd. 2004: Şek. 20: 1- 4), Giricano (Schachner 2003: Abb. 34-35), Lidar Höyük (Kaschau 1999: Taf. 90, 155), Ebla (Matthiae 1981: fig. 34), Tall Bi'a (Einwag 1998: Tip, 28, 40), Tell Hadidi (Dornemann 1992: fig. 3: 6, 15: 19, 16: 7), Tell Rijim (Kolinski 2000: Pl. 15a), Kuzey Doğu Suriye Yüzey Araştırması (Meijer 1986: fig. 20- 22), Tell Rimah (Postgate vd. 1997: Pl. 45: 278), Hama (Fungmann 1958: fig. 109-110, 143), Hammam et-Turkman'da (Curvers 1988: Pl. 124: 26, 126: 37-46) tespit edilmiştir.

5 Yukarı Dicle Havzasında Üçtepe (Özfırat 2005: Lev. XCIII: 2/2) ve Kenan Tepe (Parker ve Swartz-Dodd 2003: fig. 5/J, 8/N, O), Yukarı Habur havzasında Tell Bia (Einwag 1998: Tip. 50), Chagar Bazar (Mallowan 1947: Pl. LXXXII: 5, 7), Kuzey Cezire'de Tell Rijim (Kolinski 2000: Pl. 50: 5, 7) ve Tell Rimah (Postgate vd. 1997: Pl. 19 a-d).

6 Giricano (Schachner 2004: 507), Kavuşan Höyük (Kozbe vd 2004: 465), Siirt Türbe Höyük (Sağlamtimur ve Ozan 2008: 6) Üçtepe 10. tabaka (Özfırat 2005: 33-38) Ziyarettepe (Matney vd. 2004: 389) Gre Dimse (Karg 2001: 644)

7 Bazı örnekler için bkz. Erzurum'da Büyükardıç (Şenyurt 2006: Fig. 47: 9, 2; Res. 54: 6, 77: 4, 62: 1) ve Sos Höyük (Güneri 2002: Pl. 4: 4, 6: 6, 7: 2, 7: 4), Yukarı Fırat Havzasında İmikuşağı (Sevin 1995: Res. 16: 1), Norşuntepe (Hauptmann 1976: Abb. 54: 2), Korucutepe (Winn 1980: Pl. 15i), Yukarı Dicle Havzasında Salat Tepe (Ökse ve Görmüş 2006: 142, fig. 25-26; Önen 2006: Lev. 2a, 3b, 5d, 6b-c, 8a, 20a, 26d, 38b, 51e, 54c), Kenan Tepe (Parker vd. 2001: fig. 14R), Orta Fırat havzasında Lidar Höyük (Müller 1999a: Abb. 4: AB01, 7: AA04, 10: AA04; 11: BB06; Müller 1999b: Abb. 5: 5), Tille Höyük (Summers 1993: fig. 44: 2; 44: 1), Kilikya'da Porsuk Höyük (Dupré 1983: Pl. 44: 5; 45: 9).

8 Oates 1959: 137; Mallowan 1966: 462, Abb. 378; Curtis vd. 1993: 30, Fig. 27: 4.

9 Kuzey Suriye'de yapılan yoğun yüzey araştırmalarından, yerleşim alanlarında daha büyük parçalar halinde daha çok sayıda seramik toplanmasına karşın, sadece tarla olarak kullanılan alanlarda daha küçük boyutlu ve daha az sayıda parça toplandığından hareket edilerek bir yerleşim alanını çevreleyen tarım alanı hesaplanmıştır (Wilkinson 1993: 560-565; 1994: 493, 497). Buna göre bir yerleşim birimini çevreleyen tarım alanının ortalama 2 km yarıçapında bir alanı kapsadığı, bunu çevreleyen en fazla 5 km yarıçapındaki alanın ise otlak olarak kullanılmış olabileceği önerilmiştir. Bu mesafenin bir saatte yürünebileceği ve bundan daha uzak mesafelerdeki arazinin bu biçimde kullanılamayacağı öne sürülmüştür (Hodder ve Orton 1976: 233, Fig. 7.4; Wagstaff 1985: 52, Fig. 4.2). Buna göre, bağımsız iki tarımcı yerleşim arasındaki mesafe, her ikisinin tarla alanları da hesaplanarak yaklaşık 4 km olarak hesaplanabilir. Eşzamanlı olarak kullanılan iki yerleşim birimi arasında 2 km den az bir mesafe olması ve bunlardan birisinin küçük boyutlu olması durumunda, büyük yerleşime bağlı küçük bir birimin (mezra, çiftlik) bulunduğu hiyerarşik bir yerleşim sisteminin varlığı söz konusu olabilecektir.

10 Üçtepe Level 11 (Özfırat 2005: 19-30); Ziyarettepe (Matney vd. 2002: Fig. 20; 2004: 414-415, Fig. 6-7); Hirbe Merdon Alt Evre A (Laneri vd. 2006: 156-157, 160); Kenantepe Tabaka 1 (Parker vd. 2004: 590; Parker ve Swartz-Dodd 2005: 80; Parker vd. 2006: 79); Giricano Yapı C ve A (Schachner 2002: 560; Radner ve Schachner 2004: 113); Salat Tepe 2. tabaka (Ökse ve Görmüş 2006: 142; Ökse ve Görmüş baskıda). Orta Tunç Çağında kullanılmış anıtsal bir yapı bulunan Salat Tepe çevresinde, Salat Çayı ile Batman Çağı arasındaki bölgenin batı yarısında, Diyarbakır-Batman karayolu ve Dicle vadisi tarafından sınırlanan yaklaşık 3000 hektarlık alanda 2008 yılında yapılan yoğun yüzey araştırmaları, Salat Tepe çevresinde, Salat Çayı boyunca ikişer kilometre ara ile dizilen küçük boyutlu dört yerleşim biriminin (çiftlikler) varlığını ortaya çıkartmıştır.

11 Üçtepe 7-9 (Köroğlu 1998: 41, 37, fig. 16: 2, 13; 2003: 235), Gre Dimse (Karg 1999: 248-258; 2001: fig. 9; Karg 2002: 705, 716, fig. 3d), Giricano (Schachner 2002: 24-26, 550, Abb. 14; 2003: 158; 2004: 506), Ziyarettepe (Matney 1999: 303; Matney vd. 2002: 66-67, fig. 24; Matney vd. 2004: 387), Kenantepe (Parker vd. 2004: 556; Parker ve Swartz-Dodd 2005: 81), Hakemi Use (Tekin 2004: 425, 434), Hirbe Merdon Tepe (Laneri vd. 2006: 155, fig. 4) ve Salat Tepe (Ökse ve Görmüş 2006: 142; a.y. baskıda).

12 I. Salmanasar'ın (MÖ 1274-1245) sekiz Uruatri ülkesine (Yakar 2000: 432; Çilingiroğlu 2001: 373-376), I. Tiglat-Pileser'in (MÖ 1115-1077) beş Muşki kralına (Yakar 2000: 429; Bartl 2001: 384), diğer bir yazıtta 60 Nairi kralına karşı yapılan seferlere ilişkin ganimet listelerinde çok sayıda hayvan yer almaktadır (Roaf ve Schachner 2005: 120).

13 Van Gölü havzası Urartu kale ve mezarlıkları için bkz: Köroğlu ve Konyar 2005: 32-33; Köroğlu ve Konyar 2008; Erdem 2009: 299-307. Bölgede başlatılan kurtarma kazıları kapsamında 2009 yılında kazılmaya başlanan Zeviya Tivilki'de anakaya üzerine inşa edilmiş tek tabakalı taş yapıda Yeni Asur seramikleri ile Erken Demir Çağı'na ait yivli seramikler aynı mekanlarda bir arada ele geçmiştir.

14 Yukarı Dicle havzasındaki Yeni Asur yerleşim şeması (Schachner 2003: 160; Radner ve Schachner 2004: 118) bölgede tarımcı yerleşim sistemlerinin varlığını göstermektedir. Bunun bir örneğini de Salat Çayı ile Batman Çağı arasındaki bölgenin batı yarısında, Diyarbakır-Batman karayolu ve Dicle Vadisi tarafından sınırlanan yaklaşık 3000 hektarlık alanda 2008 yılında yapılan yoğun yüzey araştırmaları ortaya koymuştur. Bu araştırmalar sonucunda Salat Tepe'nin kuzeyinde 2, güneyinde 2, doğusunda 3 küçük yerleşim birimi ile Gre Dimse'nin kuzeyinde bir küçük birim bulunduğunu ortaya çıkartmıştır. Salat Çayı boyunca dörder kilometre ara ile dizilen küçük boyutlu dört yerleşim biriminin bağımsız çiftlikler, Gre Dimse'nin 1,5 km kuzeyindeki birimin de bu merkeze bağlı bir çiftlik olarak değerlendirilmesi olasıdır. Kuzey Cezire'de yapılan yüzey araştırmalarına göre bu bölgede de Yeni Asur yerleşimlerinin Orta Asur dönemine göre iki buçuk kat artarak aradaki boşlukları doldurduğu ve Thissen poligon şemalarına göre küçük çiftliklerden oluşan bir tarımcı yerleşim sistemi oluşturduğu belirlenmiştir (Wilkinson 1995: 143, 145, 151, 157, not 38-39). Bu alan araştırmalarından elde edilen veriler Ilısu barajı inşaat sahasındaki tarımcı çiftliklerden oluşan dokuya benzerlik göstermektedir.

KAYNAKÇA

Abdul-Amir, S.J. 1988
Archaeological Survey of Ancient Settlements and Irrigation Systems in the Middle Euphrates Region of Mesopatamia. PhD, Department of Near Eastern Languages and Civilizations, The University of Chicago Press, Chicago.

Akkermans, P. ve G.M. Schwartz 2003
The Archaeology of Syria. Cambridge University Press, Cambridge.

Anastasio, S. 1999
"Prospection archéologique du Haut-Khabur occidentale (Syrie du N.E.). Preliminary Information on the Pottery of the Iron Age", A. Hausleiter ve A. Reiche (yay.) *Iron Age Pottery in Northern Mesopotamia, Northern Syria and South-Eastern Anatolia*: 173-191. Ugarit-Verlag, Münster.

Baillie, M.G. 1998
"Hints that Cometary Debris Played Some Role in Several Tree-Ring Dated Environmental Downturns in the Bronze Age", B.J. Peiser, T. Palmer ve M.E. Bailey (yay.) *Natural Catastrophes During Bronze Age Civilizations. Archaeological, Geological, Astronomical and Cultural Perspectives*: 109-116. British Archaeological Reports International Series 728, Archaeopress, Oxford.

Bartl, K. 2001
"Eastern Anatolia in the Erlay Iron Age", J. Eichman ve H. Parzinger (yay.) *Migration und Kulturtrasfer. Der Wandel vorder-und zentralasiatischer Kulturen im Umbruch vom 2. Zum 1. Vorchristlichen Jahrtausend*: 383-410. Habelt, Berlin.

Bernbeck, R. 1993
Stepe als Kulturlandschaft. Das Ağiğ Gebiet Ostsyriens vom Neolithikum bis zur Islamischen Zeit. BBVO Ausgraburgen 1. Reimer, Berlin.

Bielinski, P. 2003
"Ninivite V Burials at Tell Rijim", E. Rova ve H. Weiss (yay.) *The Origins of the North Mesapotamian Civilization Ninivite V Chronology, Economy*, *Society*. Subartu IX Brepols, Turnhout.

Blaylock, S. 1999
"Iron Age Pottery from Tille Höyük, South-Eastern Turkey", A. Hausleiter ve A. Reiche (yay.) *Iron Age Pottery in Northern Mesopotamia, Northern Syria and South-Eastern Anatolia*: 263-286. Ugarit-Verlag, Münster.

Braidwood, R.J. ve L.S. Braidwood 1960
Excavations in the Plain of Antioch I: The Early Assemblages. Phases A- J. Oriental Institute Publications LXI, The University of Chicago Press, Chicago.

Curtis, J., D. Collon ve A. Green 1993
"British Museum Excavations at Nimrud and Balawat in 1989", Iraq 55: 1-37.

Curvers, H.H. 1998
"The Period VII Pottery", M.N. van Loon (yay.) *Hammam et Turkman II. Report on the University of Amsterdam's 1981-1984. Excavations in Syria*: 396-456. Nederlands Historisch-Archaeologisch Instituut te Istanbul, Leiden.

Çilingiroğlu, A. 2001
"Migrations in the Lake Van Basin: East Anatolia in the Late 2. Millenium B.C. and the foundation of a kingdom", R. Eichmann ve H. Parzinger (yay.) *Migration und Kulturtransfer. Der Wandel vorder-und zentralasiatischer kulturen im Umbruch vom 2. zum 1. vorchristlichen Jahrtausend*: 371-381. Habelt, Berlin.

Dornemann, R.H. 1992
"Early Second Millenium Ceramic Parallesls between Tell Hadidi-Azu and Mari", G.D. Young (yay.) *Mari in Retrospect, Fifty years of Mari and Mari*: 77-112. Eisenbrauns, Winona Lake.

Dupré, S. 1983
Porsuk I. La céramique de l'age du bronze et de l'age du fer. Éditions Recherché sur les civilizations, mémoire no. 20, Éditions Recherché sur les civilizations, Paris.

Van Driel, G. 1970
"Land and People in Assyria: Some Remarks", *Bibliotheca Orientalis* 27/3-4: 168-175.

Einwag, B. 1998
Die Keramik aus dem Bereich des Palastes A in Tall Bi'a/Tuttul und das Problem der Frühen Mittleren Bronzezeit. Münchener Vorderasiatische Studien 19, Profil Verlag, München.

Erdem, A.Ü. 2009
"Van Gölü Havzasında Bulunan Demir Çağı Yivli Çanak Çömleğinin Urartu Kalelerindeki Varlığı", H. Sağlamtimur vd. (yay.) *Yukarı Denizin Kıyısında Urartu Krallığı'na Adanmış Bir Hayat. Altan Çilingiroğlu'na Armağan*: 299-307. Arkeoloji ve Sanat Yayınları, İstanbul.

Erkanal, H. 1991
"1989 Girnavaz Kazıları", *Kazı Sonuçları Toplantısı* XII/I: 277-293.

Erkanal, H. ve A. Erkanal 1989
"Archaeologischer Überblick über die Provinz Mardin", K. Emre vd. (yay.) *Anatolia and the Near East. Studies in Honor of Tahsin Özgüç*: 129-134. Türk Tarih Kurumu Basımevi, Ankara.

Fugmann, E. 1958
"L'Architecture des Périodes Préhellenistiques", *Hama: Fouilles et Recherhes 1931-38,* 2/1, Copenhagen, Nationalmuseet.

Grayson, K.A. 1991
Assyrian Rulers of the Early First Millennium BC I (1114-859 BC). Royal Inscriptions of Mesopotamia, Assyrian Periods 2, Toronto.

Güneri, S. 2002
"Cultural Connections between Anatolia and Caucasus-Central Anatolia During the Late Bronze Age-Early Iron Age (In the Light of the 1987 Sos Höyük Excavations and North-eastern Turkey Surveys, Carried out Between 1985-1997)", *Anatolia Antiqua* X: 11-77.

Hauptmann, H. 1976
"Norşun Tepe Kazıları, 1972", S. Pekman (yay.) *Orta Doğu Teknik Üniversitesi Keban Projesi 1972 Çalışmaları*: 41-100. Orta Doğu Teknik Üniversitesi, Ankara.

Hodder, I.R. ve C. Orton 1976
Spatial Analysis in Archaeology. Cambridge University Press, Cambridge.

Jamieson, A.S. 1999
"Neo-Assyrian Pottery from Tell Ahmar", A. Hausleiter ve A. Reiche (yay.) *Iron Age Pottery in Northern Mesopotamia, Northern Syria and South-Eastern Anatolia*: 287-308. Ugarit-Verlag, Münster.

Karg, N. 1999
"Gre Dimse 1998: Başlangıç Raporu", N. Tuna ve J. Öztürk (yay.) *Ilısu ve Kargamış Baraj Gölleri Altında Kalacak Arkeolojik ve Kültür Varlıklarını Kurtarma Projesi 1998 Yılı Çalışmaları*: 237-297. Orta Doğu Teknik Üniversitesi, TAÇDAM, Ankara.

Karg, N. 2001
"Gre Dimse 1999, İlk Sonuçlar", N. Tuna vd. (yay.) *Ilısu ve Kargamış Baraj Gölleri Altında Kalacak Arkeolojik ve Kültür Varlıklarını Kurtarma Projesi 1999 Yılı Çalışmaları*: 643-670. Orta Doğu Teknik Üniversitesi, TAÇDAM, Ankara.

Karg, N. 2002
"Gre Dimse (Ilısu) Research in 2000", N. Tuna ve J. Velibeyoğlu (yay.) *Ilısu ve Kargamış Baraj Gölleri Altında Kalacak Arkeolojik ve Kültür Varlıklarını Kurtarma Projesi 2000 Yılı Çalışmaları*: 699-722. Orta Doğu Teknik Üniversitesi, TAÇDAM, Ankara.

Kaschau, G. 1999
Lidar Höyük: Die Keramik der Mittlerin Bronzezeit. Archaeologica Euphratien 3, Zabern, Mainz am Rhein.

Kelly-Buccelati, M. 2004
"Andirons at Urkesh: New Evidence for the Hurrian Identity of Early Trans- Caucasian Culture", A. Sagona (yay.) *A view from the highlands: Archaeogical studies in honour of Charles Burney*: 67-89. Ancient Near Eastern Studies, Supplement 12, Peeters, Begium.

Kessler, K. 1980
Untersuchungen zur historischen Topographie Nordmesopotamiens nach keilschriftlichen Quellen des 1. Jts. V. Chr. Tübinger Atlas des vorderen Orients Beiheft, Reihe B/26, Harrasowitz Verlag, Wiesbaden.

Kolinski, R. 2000
Tell Rijim, Iraq: Middle Bronze Age Layers. British Archaeological Research International Series 837, Archaeopress, Oxford.

Kozbe, G., K. Köroğlu ve H. Sağlamtimur 2004
"Kavuşan Höyük 2001 Yılı Kazısı", N. Tuna vd. (yay.) *Ilısu ve Kargamış Baraj Gölleri Altında Kalacak Arkeolojik ve Kültür Varlıklarını Kurtarma Projesi 2001 Yılı Çalışmaları*: 463-505. Ortadoğu Teknik Üniversitesi, TAÇDAM, Ankara.

Kozbe, G., K.M. Erdalkıran ve S. Ona 2007
"Diyarbakır/Bismil Kavuşan Höyük 2006 Yılı Kazı Raporu", *Kazı Sonuçları Toplantısı* 29/I: 385-398.

Köroğlu, K. 1998
Üçtepe I-Yeni Kazı ve Yüzey Bulguları Işığında Diyarbakır-Üçtepe ve Çevresinin Yeni Assur Dönemi Tarihi Coğrafyası. Türk Tarih Kurumu Yayınları, Ankara.

Köroğlu, K. 2003
"The Transition from Bronze Age to Iron Age in Eastern Anatolia", B. Fischer vd. (yay.) *Identifying Changes: The Transition from Bronze to Iron Ages in Anatolia and its Neighbouring Regions:* 231-244. Türk Eskiçağ Bilimleri Enstitüsü, İstanbul.

Köroğlu, K. ve E. Konyar 2005
"Van Gölü Havzası'nda Erken Demir Çağı Problemi", *Arkeoloji ve Sanat* 119: 25-38.

Köroğlu, K. ve E. Konyar 2008
"A Re-Assessment of Iron Ages Chronology in Anatolia and Neighbouring Regions", *Ancient Near Eastern Studies* XLV: 123-146.

Laneri, N. 2008
"The Hiremerdon Tepe Archaeological Project 2006-2007 A. preliminary report on the Middle Bronze Age 'architectural complex' and the survey of the site catchment area", *Anatolica* 34: 177-241.

Laneri, N. vd. 2006
"A Preliminary Report of the Archaeological Excavations at Hirbemerdon Tepe, Southeastern Turkey, 2005", *Anatolica* 32: 153-189.

Lebeau, M. 2000
Stratified Archaeological Evidence and Compared Periodizations in the Syrian Jezirah During the third Millennium BC", C. Marro ve H. Hauptmann (yay.) *Chronologies des Pays Du Caucase et de L'euphrate Aux IV-III Millenaires*: 167-193. Varia Anatolica XI, de Boccard, Paris.

Mallowan, M.E.L. 1947
"The Excavations at Brak and Tall Chagar Bazar", *Iraq* 9: 1-259.

Mallowan, M.E.L. 1966
Nimrud and its Remains, Vol. I. The British School of Archaeology in Iraq, Collins, London.

Martin, L. 1999
"Natürliche Umweltbedingungen. Faktoren der sozialen und kulturellen Entwicklung", H. Kühne vd. (yay.) *Fluchtpunkt Uruk. Archäologische Einheit aus Methodischer Vielfalt. Schriften für Hans Jörg Nissen*: 81-86. Leidorf, Rahden.

Matney, T. 1999
"Ziyaret Tepe'de, Yüzey Araştırması ve Yüzeyaltı Taraması, Diyarbakır İli, 1997-1998", N. Tuna vd. (yay.) *Ilısu ve Kargamış Baraj Gölleri Altında Kalacak Arkeolojik ve Kültür Varlıklarını Kurtarma Projesi 1999 Yılı Çalışmaları*: 297-333. Ortadoğu Teknik Üniversitesi, TAÇDAM, Ankara.
Matney, T., M. Roaf, J. Mcginnis ve H. McDonald 2002
"Archaeological Investigations at Ziyaret Tepe, 2000 and 2002", *Anatolica* 28: 47-89.
Matney, T., M. Roaf, J. Macginnis ve H. McDonald 2004
"Ziyaret Tepe Kazıları, 2001", N. Tuna vd. (yay.) *Ilısu ve Kargamış Baraj Gölleri Altında Kalacak Arkeolojik ve Kültür Varlıklarını Kurtarma Projesi 2001 Yılı Çalışmaları*: 387-425. Ortadoğu Teknik Üniversitesi, TAÇDAM, Ankara.

Matthiae, P. 1981
Ebla: An Empire Rediscovered. An Exciting Discovery of the Ancient Empire of Ebla by the Director of the Excavations at Tell Mardikh. Doubleday and Company, New York.

Meijer, D.J.W. 1986
A Survey in North-East Syria. Nederlands Historich-Archaeologisch Instituut te Istanbul, Leiden.

Morandi Bonacossi, D. 1999
"Die Eisenzeitliche Keramik der TAVO-Geländebegehung des Unteren Habur-Gebiets", A. Hausleiter ve A. Reiche (yay.) *Iron Age Pottery in Northern Mesopotamia, Northern Syria and South-Eastern Anatolia*: 193-229. Ugarit-Verlag, Münster.

Müller, U. 1999a
"Die Eisenzeitliche Keramik des Lidar Höyük", A. Hausleiter ve A. Reiche (yay.) *Iron Age Pottery in Northern Mesopotamia, Northern Syria and South-Eastern Anatolia*: 403-434. Ugarit-Verlag, Münster.

Müller, U. 1999b
"Die Eisenzeitliche Stratigraphie von Lidar Höyük", A. Çilingiroğlu ve R.J. Matthews (yay.), *Anatolian Studies* 49 (Anatolian Iron Ages 4): 123-132.

Nigro, L. 1998
"Ebla and Ceramic Provinces of Northern Syria in the Middle Bronze Age: Relationships and Interaction with Pottery Horizon of Upper Mesopotamia", M. Lebeau (yay.) *Subartu IV, About Subartu, Studies Devoted to Upper Mesopotamia 1, Landscape, Archaeology, Settlement*: 271-305. Tounhout, Brepols.

Northedge, A. 1988
"The Stratigraphy of the Excavations", A. Northedege vd. (yay.) *The Stratigraphy of the Excavations, Excavations at 'Ana*: 25-53. Iraq Archaeological Reports 1, British School of Archaeology Iraq, Warminster.

Oates, J. 1959
"Late Assyrian Pottery From Fort Shalmaneser", *Iraq* 21: 130-146.

Oates, D., J. Oates ve H. McDonald 2001
Excavations at Tell Brak, vol. 2: Nagar in the Third Millenium. McDonald Institute Monographs, British Schools of Archaelogy in Iraq, University of Cambridge, Cambridge.

Oguchi, H. 2006
"The Date of the Beginning of Khabur Ware Period 3: Evidence from the Palace of Qarni-lim at Tell Leilan", *Al-Rafidan* 27: 45-58.

Ökse, A.T. ve A. Görmüş 2006
"Excavations at Salat Tepe in the Upper Tigris Region: Stratigraphical Sequence and Preliminary Results of the 2005-2006 Seasons", *Akkadica* 127: 119-149.

Ökse, A.T. ve A. Görmüş (Baskıda)
"Nomadic Way of Life in the Early Iron Age: A Study on the Evidence from Salat Tepe in the Upper Tigris Region", H. Oniz (yay.) *SOMA 2008, Proceedings of the XIIth Symposium on Mediterranean Archaeology*. British Archaeological Reports S 1909, Archaeopress, Oxford.

Ökse, A.T., A. Görmüş, E. Atay ve S. Torpil 2008
"Works Aimed at Researching the Archaeological Potential of the Region Affected by the Ilısu Dam in Turkey", *Antiquity* 82/317: http://www.antiquity.ac.uk /ProjGall/okse2/index. html

Ökse, A.T. vd. (Baskıda)
"Ilısu Barajı İnşaat Sahası Yüzey Araştırmasında Belirlenen Arkeolojik Alanlar", *TÜBA-KED* 7.

Önen, T.I. 2006
Salat Tepe Buluntuları Işığı Altında Doğu ve Güneydoğu Anadolu Erken Demir Çağ Kültürel Yapısı. Yüksek Lisans Tezi, Hacettepe Üniversitesi Sosyal Bilimler Enstitüsü, Ankara.

Özfırat, A. 2005
Üçtepe II Tunç Çağları Kazı ve Yüzey Araştırması Işığında. Ege Yayınları, İstanbul.

Parayre, D. 1986
Des Hurrites et des Pots: Questions Ouvertes Â Propose de la Cêramäque du Habur et de la Cêramique Bichrome. Editions Recherche sur les Civilisations, Paris.

Parker, B.J. ve A. Creekmore 2002
"The Upper Tigris Archaeological Research Project: a final report from the 1999 field season", *Anatolian Studies* 52: 19-74.

Parker, B.J. ve L. Swartz-Dodd 2003
"The Early Second Millennium Ceramic Assemblage from Kenan Tepe, Southeastern Turkey. A preliminary assessment", *Anatolian Studies* 53: 33-69.

Parker, B.J. ve L. Swartz-Dodd 2005
"The Upper Tigris Archaeological Research Project, a Preliminary Report from the 2002 Field Season", *Anatolica* 31: 69-110.

Parker, B.J., A. Creekmore ve C. Easton 2001
"Yukarı Dicle Arkeolojik Araştırma Projesi (UTRAP): Boztepe Yüzey Araştırması Kazıları, Talavaş Tepe Yöntemli Yüzey Araştırması, 1999 Ön Rapor", N. Tuna vd. (yay.) *Ilısu ve Kargamış Baraj Gölleri Altında Kalacak Arkeolojik ve Kültür Varlıklarını Kurtarma Projesi 1999 Yılı Çalışmaları*: 565-591. Orta Doğu Teknik Üniversitesi, TAÇDAM, Ankara.

Parker, B.J., A. Creekmore ve L. Swartz-Dodd 2004
"The Upper Tigris Archaeological Research Project (UTARP): A Preliminary Synthesis of the Cultural History of Kenan Tepe", N. Tuna vd. (yay.) *Ilısu ve Kargamış Baraj Gölleri Altında Kalacak Arkeolojik ve Kültür Varlıklarını Kurtarma Projesi 2001 Yılı Çalışmaları*: 547-602. Orta Doğu Teknik Üniversitesi, TAÇDAM, Ankara.

Parker, B.J. vd. 2006
"The Upper Tigris Archaeological Research Project (UTARP). A Preliminary Report from the 2003 and 2004 Field Seasons at Kenan Tepe", *Anatolica* 32: 72-151.

Parpola, S. 2005
"Archaeological Investigations at Ziyaret Tepe, 2003-2004", *Anatolica* 31: 153-188.

Pfälzner, P. 1995
Mitannische und Mittelassyrische Keramik. Eine Chronologisch, Funktionale und Produktionsökonomische Analyse. Tall Sêh Hamad. Dietrich Reimer Verlag, Berlin.

Postgate, N.J. 1974
"Some Remarks on Conditions in the Assyrian Countryside", *Journal of Economic and Social History of the Orient* 17: 225-243.

Postgate, N., D. Oates ve J. Oates 1997
The Excavations at Tell Al-Rimah: The Pottery. Iraq Archaeological Reports 4, British School of Archaeology in Iraq, Warminster.

Radner, K. ve A. Schachner 2004
"Das Mittelassyrische Tontafelarchiv von Girican/Dunnu-sa-Uzibi", *Subartu XIV*. Brepols, Turhout.

Reiche, A. 1999
"Iron Age Pottery from Tell Rad Shaqrah (North-East Syria)", A. Hausleiter ve A. Reiche (yay.) *Iron Age*

Pottery in Northern Mesopotamia, Northern Syria and South-Eastern Anatolia: 231-259. Ugarit-Verlag, Münster.

Riehl, S., R. Bryson ve K. Pustovoytov 2008
"Changing growing conditions for crops during the Near Eastern Bronze Age (3000-1200 BC): The stable carbon isotope evidence", *Journal of Archaeological Science* 35: 1011-1022.

Roaf, M. 1996
Mezopotamya ve Eski Yakındoğu. İletişim Yayınları, İstanbul.

Roaf, M. ve A. Schachner 2005
"The Bronze Age to Iron Age Transition in the Upper Tigris Region: New Information from Ziyarettepe and Giricano", A. Çilingiroğlu ve G. Derbyshire (yay.) *Anatolian Iron Ages* 5: 115-123. British Institute of Archaeology at Ankara, Austin & Hertford, London.

Rova, E. 2000
"Early Third Millenium BC. Painted Pottery Traditions In Jezirah", C. Marro ve H. Hauptmann (yay.) *Chronologies des Pays Du Caucase et de L'euphrate Aux IV-III Millenaires*: 231-255. Varia Anatolica XI, de Boccard, Paris.

Rova, E. 2003
"Tell Karrana 3: Ceramic Evidence for the Late Uruk/Ninive V Transition", E. Rova ve H. Weiss (yay.) *The Origins of the North Mesapotamian Civilization Ninivite V Chronology, Economy*, *Society*: 11-24. Subartu IX, Brepols, Turnhout.

Sagona, A. 2000
"Sos Höyük and the Erzurum Region in The Late Prehistory: A Provisional Chronology for Northest Anatolia", C. Marro ve H. Hauptmann (yay.) *Chronologies des Pays Du Caucase et de L'euphrate Aux IV-III Millenaires*: 329-373. Varia Anatolica XI, de Boccard, Paris.

Sağlamtimur, H. ve A. Ozan 2008
"Siirt-Türbe Höyük Kazısı, Ön Rapor", *Ege Üniversitesi Arkeoloji Dergisi* X/2: 1-32.

Schachner, A. 2002
"2000 Yılı Giricano Kazıları Ön Raporu", N. Tuna vd. (yay.) *Ilısu ve Kargamış Baraj Gölleri Altında Kalacak Arkeolojik ve Kültür Varlıklarını Kurtarma Projesi 2001 Yılı Çalışmaları*: 549-613. Orta Doğu Teknik Üniversitesi, TAÇDAM, Ankara.

Schachner, A. 2003
"From the Bronze to the Iron Age: Identifying Changes in the Upper Tigris Region. The Case of Gricano", B. Fischer vd. (yay.) *Identifying Chages: The Transition from Bronze to Iron Ages in Anatolia and its Neighbouring Regions*: 151-163. Ege Yayınları, İstanbul.

Schachner, A. 2004
"2001 Yılı Giricano Kazıları", N. Tuna vd. (yay.) *Ilısu ve Kargamış Baraj Gölleri Altında Kalacak Arkeolojik ve Kültür Varlıklarını Kurtarma Projesi 2001 Yılı Çalışmaları*: 505-547. Orta Doğu Teknik Üniversitesi, TAÇDAM, Ankara.

Schmidt, A. 1999
"Die Keramik der Areale A-F in Kar-Tukulti- Ninurta", A. Hausleiter ve A. Reiche (yay.) *Iron Age Pottery in Northern Mesopotamia, Northern Syria and South-Eastern Anatolia*: 61-90. Alter Tumskunde des Vorderen Orient 10, Ugarit-Verlag, Münster.

Schneider, E. 1999
"Assyrische Gefobformen aus Tell Sheikh Hassan (Syrien) und ihre Stellung innerhalb der Keramik des assyrischen Einflubgebietes", A. Hausleiter ve A. Reiche (yay.) *Iron Age Pottery in Northern Mesopotamia, Northern Syria and South-Eastern Anatolia*: 347-375. Alter Tumskunde des Vorderen Orient 10, Ugarit-Verlag, Münster.

Schwartz, M.G., H.H. Curvers, S. Dunham ve B. Stuart 2003
"A Third-Millennium B.C. Elite Tomb and Other New Evidence from Tell el-Marra, Syria", *American Journal of Archaeology* 107/3: 325-362.

Sevin, V. 1995
İmikuşağı I. Türk Tarih Kurumu, Ankara.

Summers, G.D. 1993
Tille Höyük 4. The Late Bronze Age and the Iron Age Transition-Geç Bronz Çağ ve Geç Bronz Çağından Demir Çağına Geçiş. The British Institute of Archaeology, Ankara.

Şenyurt, Y. 2006
Büyükardıç, Doğu Anadolu'da Bir Erken Demir Çağı Tepe Yerleşmesi. Bakü-Tiflis-Ceyhan Ham Petrol Boru Hattı Projesi Arkeolojik Kurtarma Kazıları Yayınları 2, Gazi Üniversitesi Arkeolojik Çevre Değerleri Araştırma Merkezi, Ankara.
Tekin, H. 2004
"Hakemi Use 2001 Yılı Kazısı İlk Sonuçları", N. Tuna vd. (yay.) *Ilısu ve Kargamış Baraj Gölleri Altında Kalacak*

Arkeolojik ve Kültür Varlıklarını Kurtarma Projesi 2001 Yılı Çalışmaları: 425-462. Orta Doğu Teknik Üniversitesi, TAÇDAM, Ankara.

Uysal, B. 2006
"Kertvin, Nusaybin Bölgesi'nde Bulunan Önemli Bir Ninive 5 Merkezi", A. Erkanal vd. (yay.) *Hayat Erkanal'a Armağan Kültürlerin Yansıması*: 746-758. Homer, İstanbul.

Velibeyoğlu, J., A. Schaner ve Ş. Schaner 2002
"Botan Vadisi ve Çattepe (Tilli) Yüzey Araştırmalarının İlk Sonuçları", N. Tuna ve J. Velibeyoğlu (yay.) *Ilısu ve Kargamış Baraj Gölleri Altında Kalacak Arkeolojik ve Kültür Varlıklarını Kurtarma Projesi 2000 Yılı Çalışmaları*: 783-836. Orta Doğu Teknik Üniversitesi, TAÇDAM, Ankara.

Wagstaff, J.M. 1985
The Evolution of Middle Eastern Landscapes: An Outline to A.D. 1840. Croom Helm, London.

Wilhelm, G. 1989
The Hurrians. Aris & Phillips Ltd., Wiltshire.

Wilkinson, T.J. 1993
"Linear Hollows in the Jazira, Upper Mesopotamia", *Antiquity* 67: 548-562.

Wilkinson, T.J. 1994
"The Structure and Dynamics of Dry-Farming States in Upper Mesopotamia", *Current Anthropology* 35/5: 483-520.

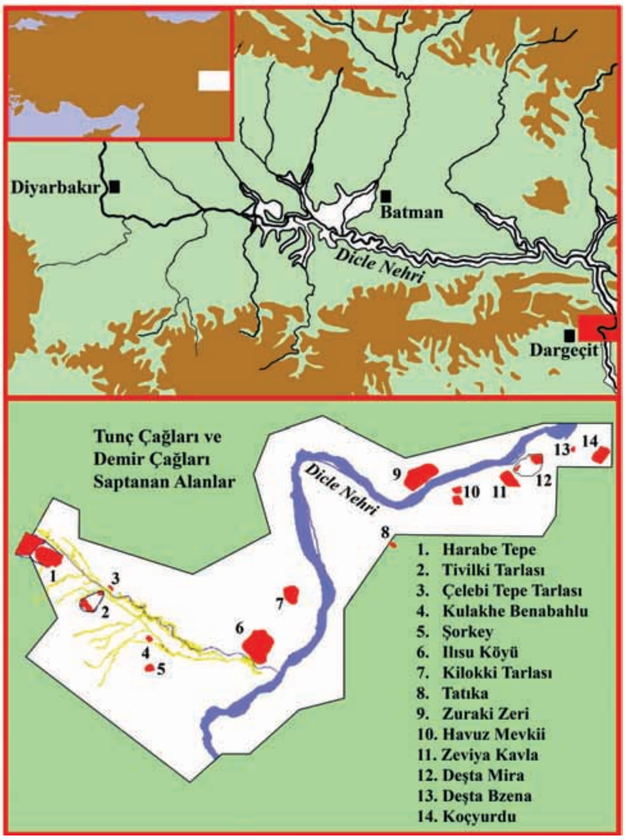
Wilkinson, T.J. 1995
"Late Assyrian Settlement Geography in Upper Mesopotamia", M. Liverani (yay.) *Neo-Assyrian Geography*: 139-160. Università di Roma "La Sapienza", Quaderni di Geografia Storica 5, Università di Roma, Roma.

Wilkinson, T.J. 2003
"Archaeological Survey and Long-Term Population Trends in Upper Mesopotamia and Iran", N.F. Miller ve K. Abdi (yay.) *Yekibud Yekinabud. Essays on the Archaeology of Iran in Honor of William M. Sumner*: 39-59. University of California Press, Los Angeles.

Winn, M.M. 1980
"The Early Iron Age Pottery", M.N. Van Loon (yay.) *Korucutepe 3, Studies in Ancient Civilisations*: 155-175. North-Holland Publishing Company, Amsterdam.

Yakar, J. 2000
Ethnoarchaeology of Anatolia. Rural Socio-Economy in the Bronze and Iron Ages. Graphit Press, Jerusalem.

Zablocka, J. 1986
"Der Haushalt der Neuassyrischen Familie", *Oikumene* 5: 43-49.



Res. 1. Ilısu Barajı inşaat sahasındaki araştırma alanının konumu
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Res. 3. Ilısu Höyüğü. Güneybatıdan görünüm (Bkz. Res. 1, No. 6)
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Res. 4. Zuraki Zeri. Doğudan görünüm (Bkz. Res. 1, No. 9)
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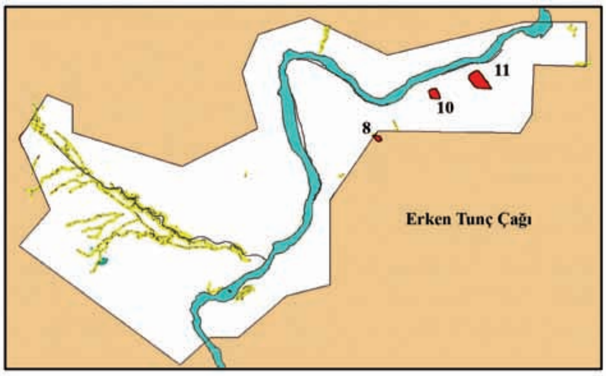

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Res. 6. Erken Tunç Çağı seramiği: Tatıka yüzey buluntuları
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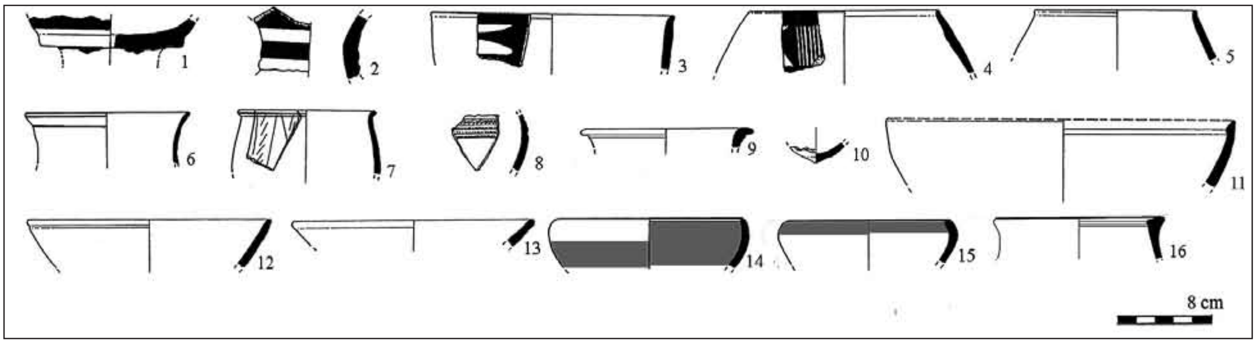

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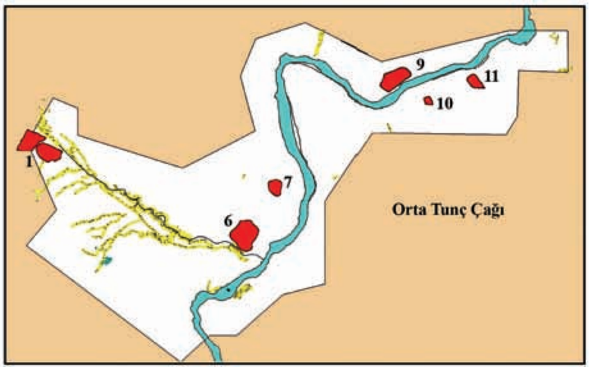

Res. 8. Araştırma alanında Orta Tunç Çağı merkezleri
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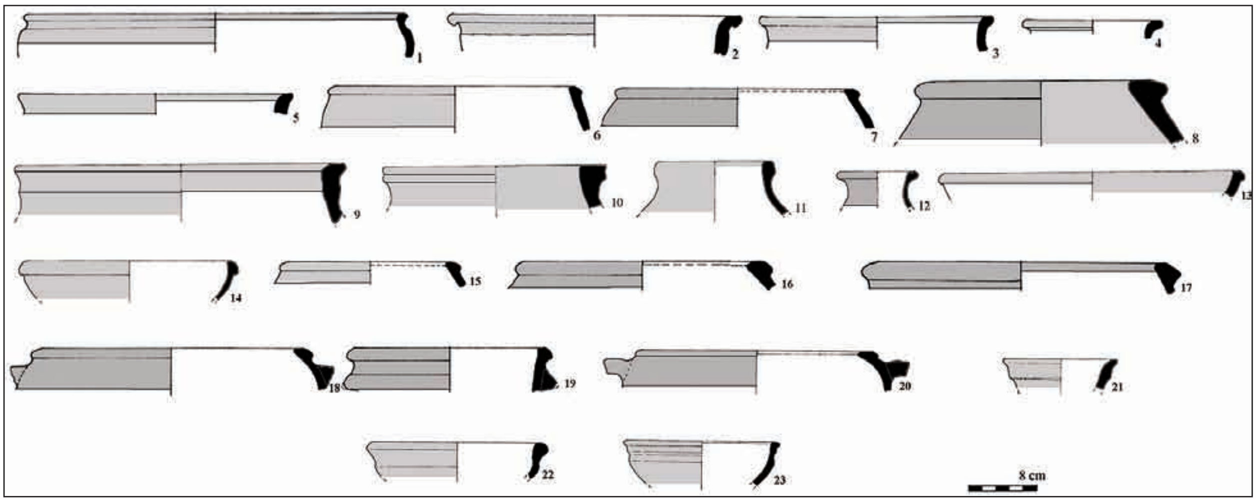
Res. 9. Orta Tunç Çağı seramiği
Fig. 9. Middle Bronze Age pottery



Res. 10 Orta Tunç Çağı seramiği: kırmızı-kahverengi astarlı grup
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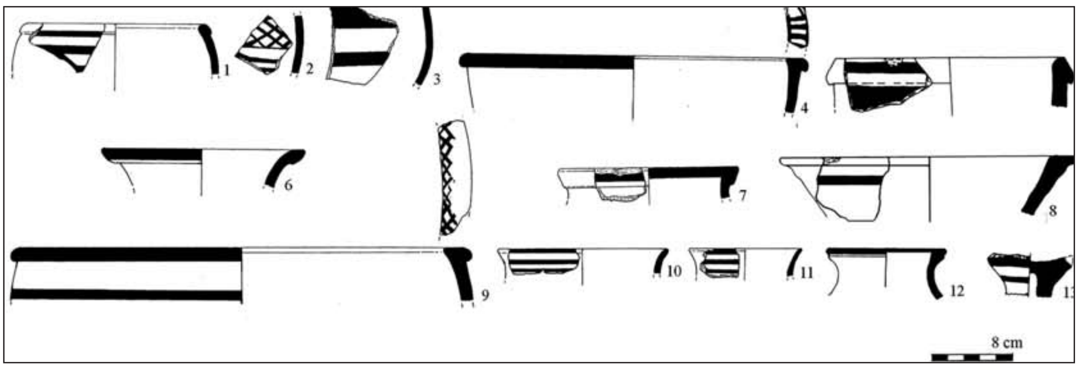

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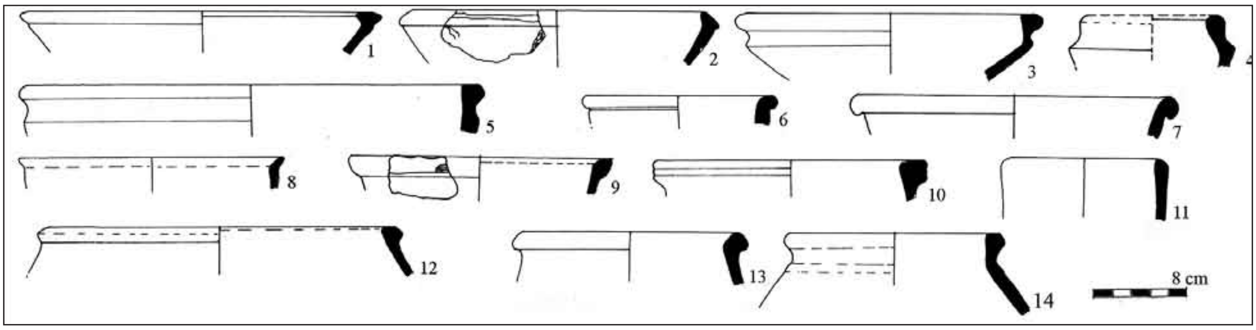
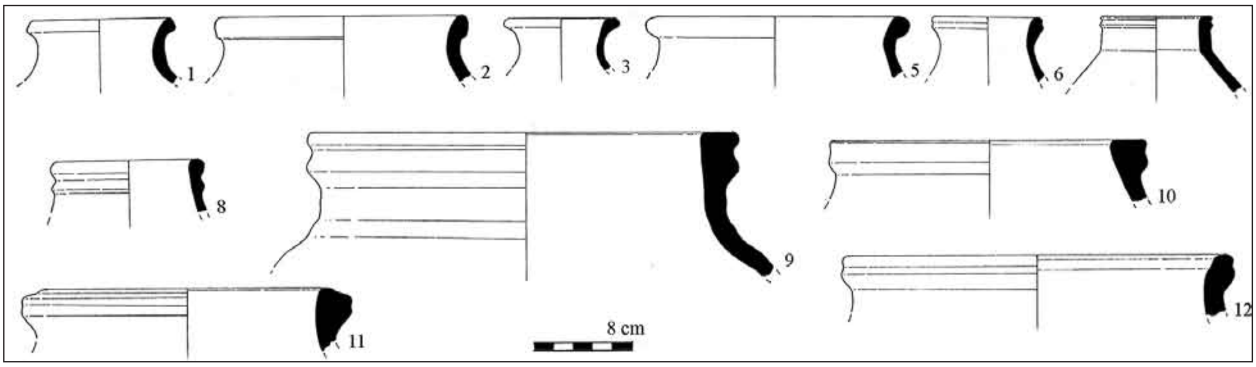
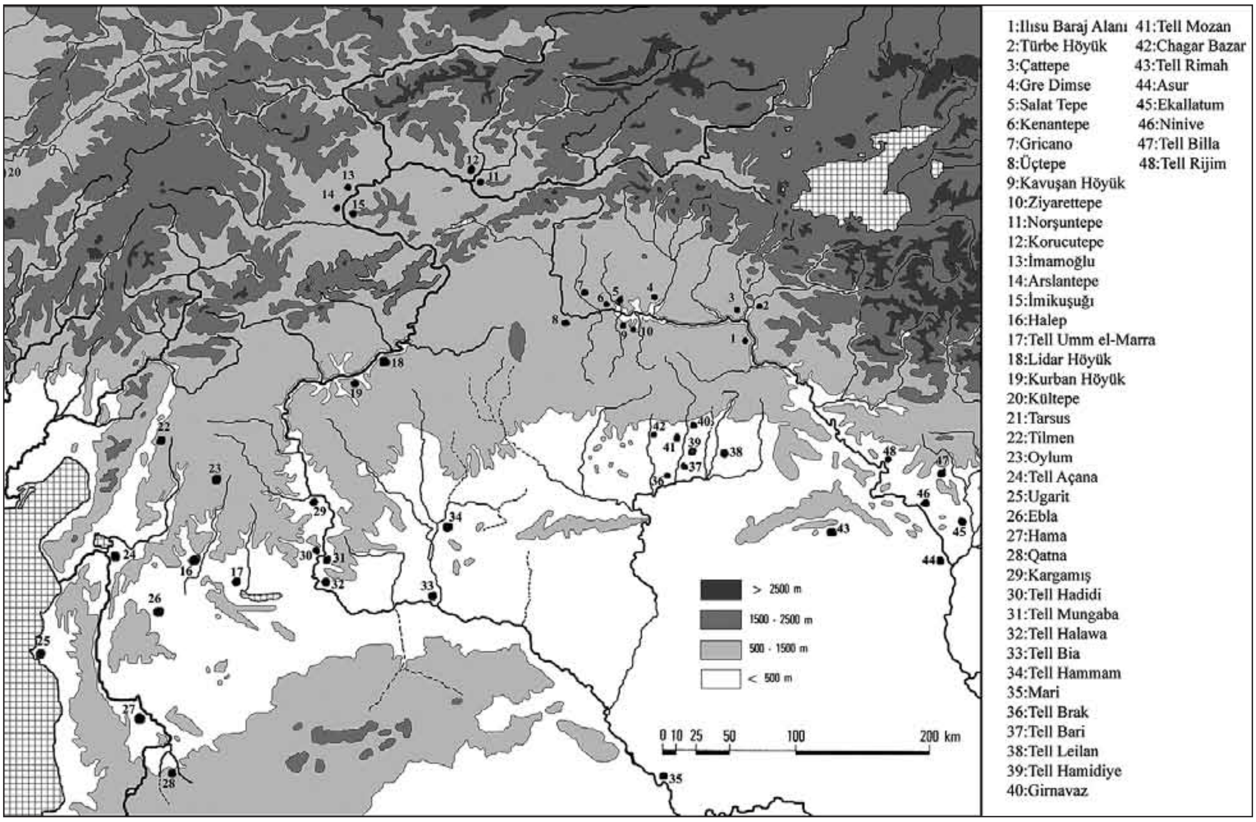


Res. 12. Orta Tunç Çağı seramiği: monokrom seramik
Fig. 12. Middle Bronze Age pottery: monochrome ware



Res. 13. Orta Tunç Çağı seramiği: monokrom seramik
Fig. 13. Middle Bronze Age pottery: Monochrome Ware



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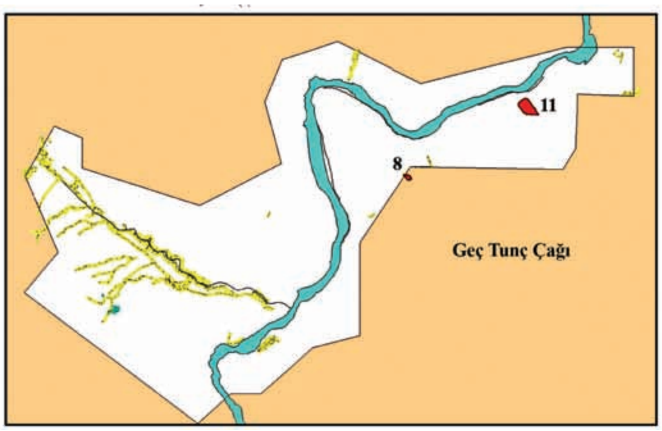

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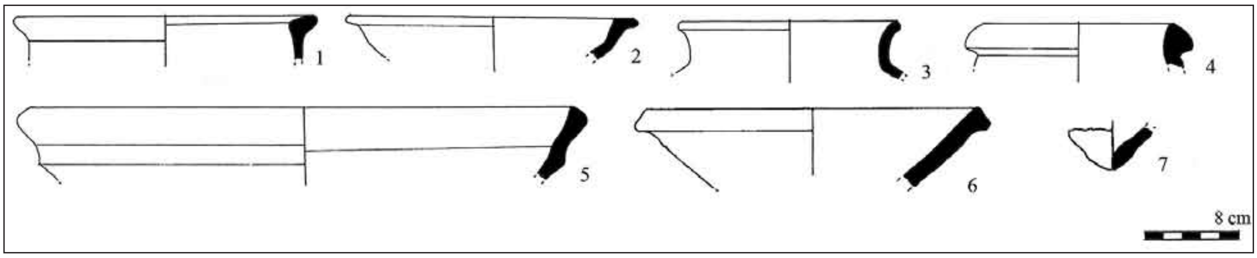
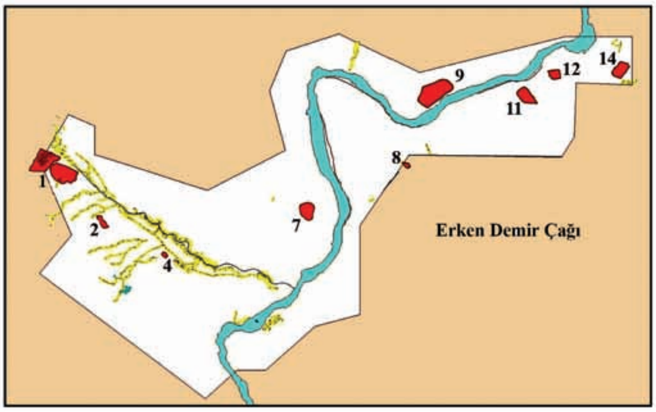


Res. 16. Geç Tunç Çağı seramiği
Fig. 16. Late Bronze Age pottery



Res. 17. Araştırma alanında Erken Demir Çağı merkezleri
Fig. 17. Early Iron Age sites in the survey area

Res. 18. Erken Demir Çağı seramiği
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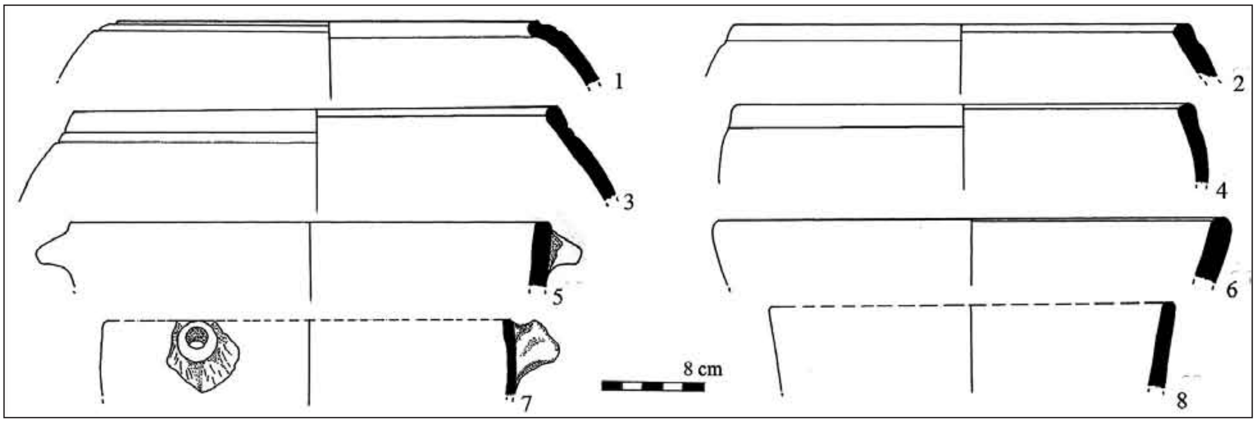
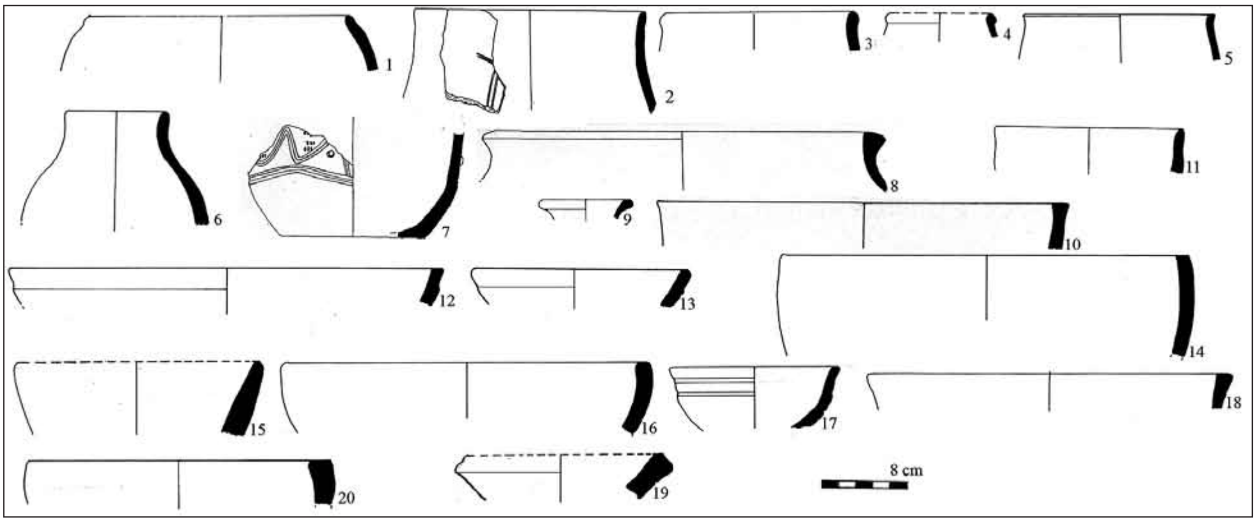
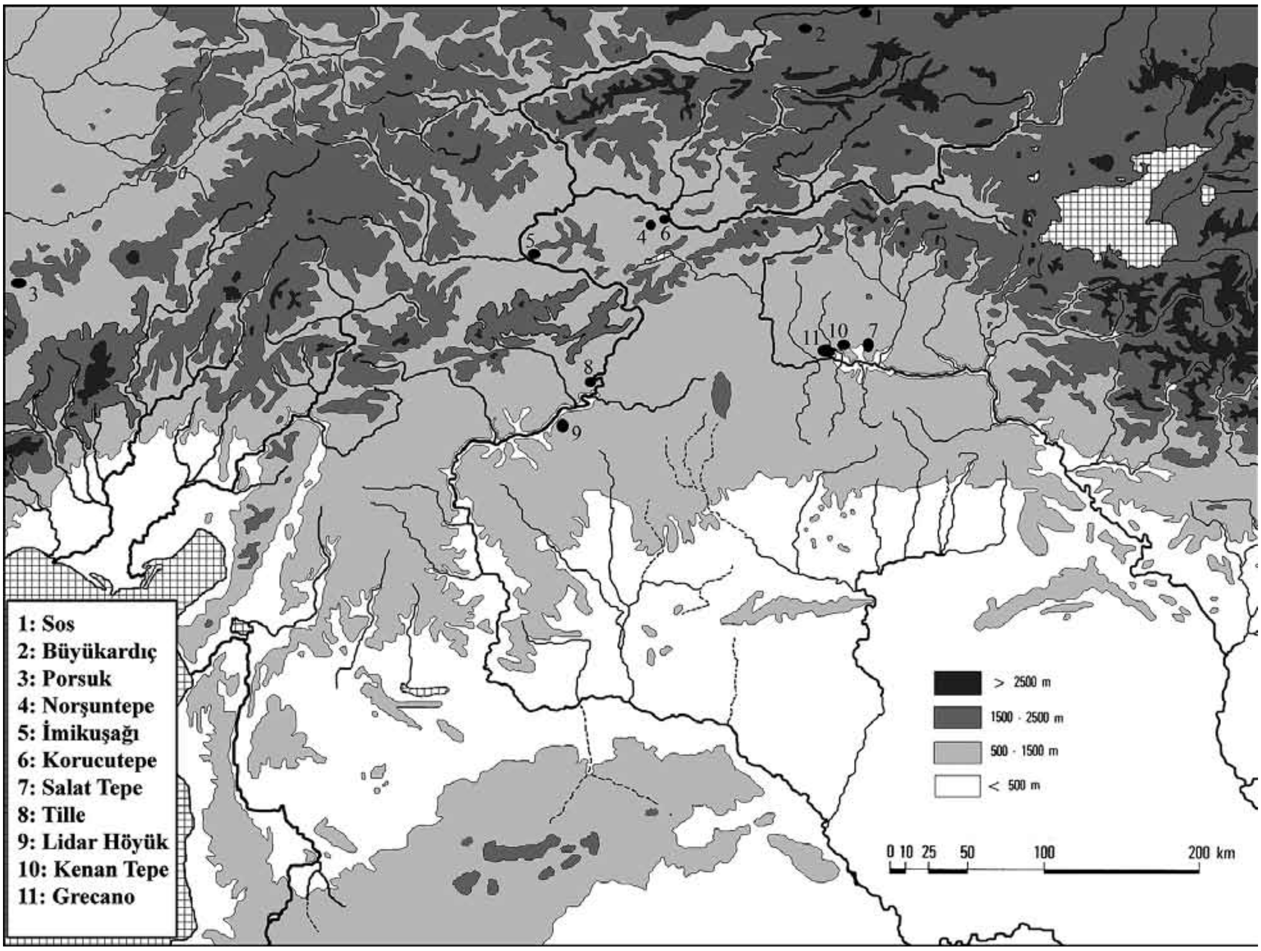


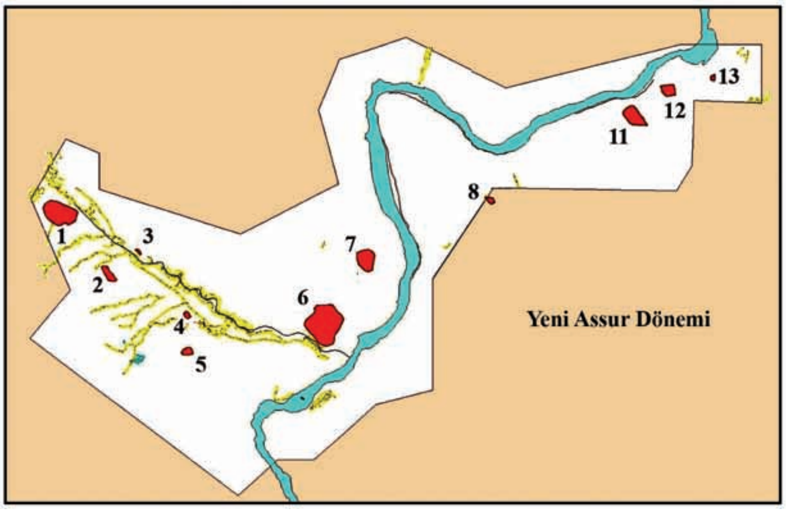
Res. 19. Erken Demir Çağı seramiği
Fig. 19. Early Iron Age pottery



Res. 20 Erken Demir Çağı seramiği
Fig. 20. Early Iron Age pottery



Res. 21. Erken Demir Çağı seramiğinin yayılım alanı
Fig. 21. Distribution of the Early Iron Age pottery



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Res. 23. Orta Demir Çağı (Yeni Asur) seramiği
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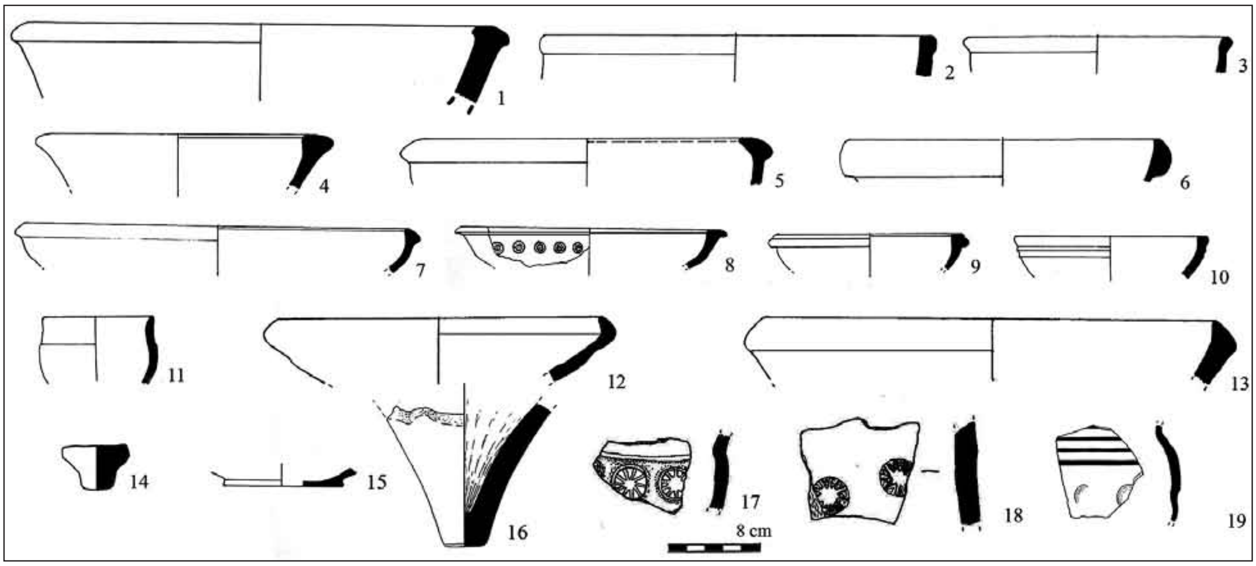
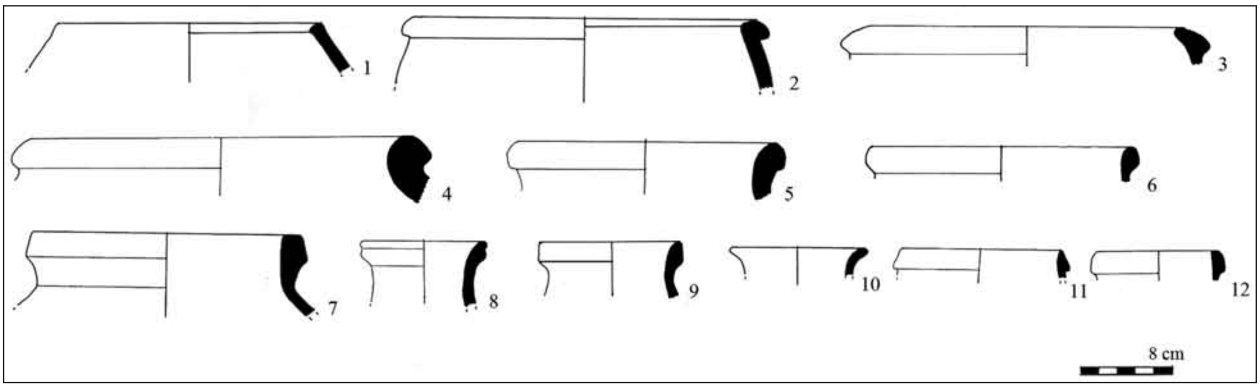
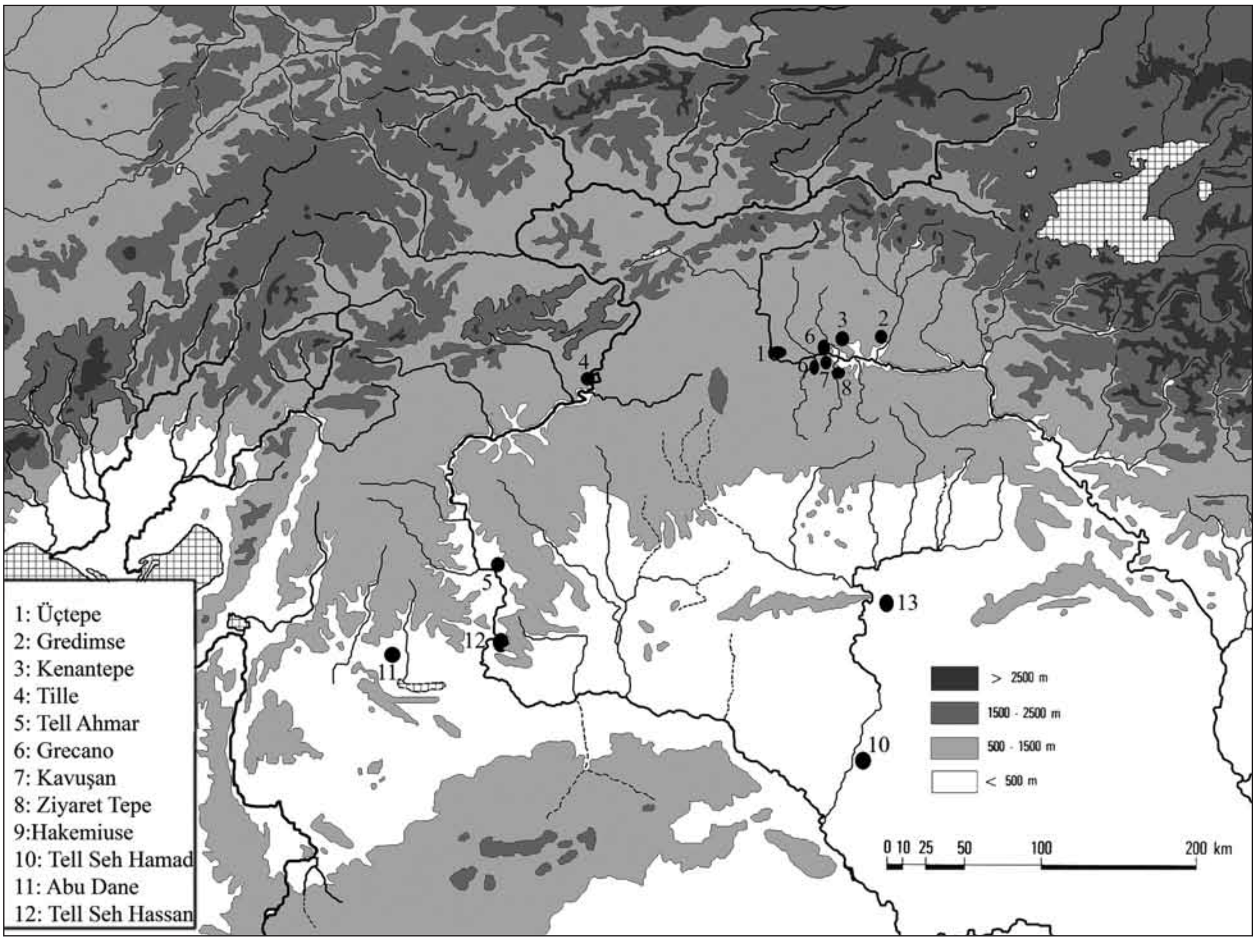


Res. 24. Orta Demir Çağı (Yeni Asur) seramiği
Fig. 24. Middle Iron Age (New Assyrian) pottery



Res. 25. Orta Demir (Yeni Asur) Çağı seramiği
Fig. 25. Middle Iron Age (New Assyrian) pottery



Res. 26. Orta Demir Çağı (Yeni Asur) seramiğinin yayılım alanı
Fig. 26. Distribution of the Middle Iron Age (New Assyrian) pottery

YORTAN MEZARLIĞI HAKKINDA YENİ GÖZLEMLER

NEW OBSERVATIONS ABOUT YORTAN CEMETERY

Engin AKDENİZ

Keywords: Early Bronze Age, Western Anatolia, Yortan, cemetery, P.Gaudin.

Anahtar Sözcükler: İlk Tunç Çağı, Batı Anadolu, Yortan, mezarlık, P.Gaudin

ÖZET

Yortan İlk Tunç Çağı mezarlığındaki kazılar 1898 ya da 1900 yılında, bu bölgedeki Osmanlı İmparatorluk demiryolu hattının inşasında çalışan Fransız demiryolu mühendisi P.Gaudin tarafından başlatılmıştır. Gaudin ile Chapot tarafından iki mevsim sürdürülen kazılarda 100'ün üzerinde mezar açığa çıkarılmıştır. Ancak bu önemli mezarlığın yeriyle ilgili arazi çalışması bugüne kadar yapılmamıştır. 2007 yılında Adnan Menderes Universitesi Arkeoloji Bölümü, Batı Anadolu'da Manisa ilinde bu konuda yeni bir TUBİTAK projesine başlamıştır. Proje kapsamında 2008 yılı yüzey araştırmaları sırasında Yortan mezarlığının yeri saptanmıştır. Yortan mezarlığının yerinin belirlenmesinde en önemli gösterge Gaudin'in haritasında gösterdiği, mezarlığın kenarından geçen eski-Kırkağaç-Gelen(m)be karayolunun kalıntılarının bulunması olmuştur. Gaudin'in raporlarında Tabak Tepe olarak adlandırdığı Yortan, günümüzde Taban Tepe adıyla bilinmektedir. Taban Tepe ile Tabak Tepe arasındaki benzerlik de oldukça önemlidir. Gaudin ve Chapot yerleşimi bulmak amacıyla mezarlığın yakınındaki Çavdar Tepe'de kazılar yapmışlarsa da herhangi bir kanıta ulaşamamışlardır. Bu bölgede gerçekleştirdiğimiz yüzey araştırmalarında araştırma ekibimiz Taban Tepe'nin 200 m. kuzeyindeki Çavdar Tepe'yi (günümüzde Değirmen Tepe adıyla anılmaktadır) de tespit etmiştir. Hem Taban hem de Değirmen Tepe tıpkı Gaudin'in raporlarında belirttiği gibi Bakırçay'ın (Kaikos) yakınında yer almaktadır. Gaudin'in kazı raporlarında tepenin batı kısmında bir değirmenin varlığından söz edilmektedir. Gaudin'in bahsettiği bu değirmenin kalıntılarına yüzey araştırmalarımız sırasında ulaşılmıştır. Değirmen Tepe'den toplanan İlk Tunç Çağı çanak çömleğinin çoğu tepenin gerisindeki tarlalarda bulunmuştur. Taban Tepe ve Değirmen Tepe çevresi tarım yapılması nedeni ile tahrip olmaktadır. Ancak bu iki tepenin de üst kısımları kayalık olduğundan korunmaktadır. Bu kısımlar geç dönemde Frigler tarafından dinsel amaçlarla kullanılmıştır. Yortan mezarlığı hakkındaki cevaplanması gereken en önemli sorun bu mezarlığa gömüt yapan insanların nerede yaşamış olduklarıdır.

ABSTRACT

Excavations at the Early Bronze Age Cemetery of the Yortan excavations were began in 1898 or 1900 by P. Gaudin, a French engineer of the Otoman Empire railway. Even though over 100 graves were cleared during their two-season-long campaign, the site has not been researched since. In 2007 Adnan Menderes University, Department of Archaeology started a new TUBİTAK project in Manisa Province in Western Ana-

tolia. During the 2008 survey the project team discovered the location of the forgotten Yortan cemetery. The biggest clue in this quest was the realization that the Kırkağaç ruins and the Gelen(m)be motorway were indicated on Gaudin's map of the Yortan cemetery. Today the site is called Taban Tepe. In his notes, Gaudin refers to Yortan by a similar name: Tabak Tepe. A sounding at nearby Çavdar Tepe, presumably the associated settlement with the abovementioned cemetery yielded no results. Surveys in following seasons made it clear that Çavdar Tepe was in fact the mound located 200 m north of Taban Tepe, known today as Değirmen Tepe. This means that both Taban and Değirmentepe are located near the Bakırçay (Kaikos) stream as reported by Gaudin. Interestingly, Gaudin's report states that there was a mill located west of the hill. The ruins of this mill (in Turkish "Değirmen") mentioned by Gaudin were found during our final survey season in the vicinity of Değirmen. Most of the Early Bronze Age pottery sherds collected from Değirmen Tepe were found in the part that is under cultivation. The surroundings of both Taban and Değirmen Tepe are damaged due to modern agricultural activities. But the tops of both mounds, used by the Phyrgians as a cemetery, remain intact because the deposits overlie rocky outcrops. The most important question that remains to be answered is where the occupation associated with the settlement may be.

GİRİŞ

Yortan mezarlığı, buluntuları hakkında çok yayın hazırlanan ancak arazi çalışmaları bununla karşılaştırılamayacak derecede ihmal edilen önemli bir buluntu merkezidir. Bu mezarlığın adının ilk defa duyulması, yani keşfedilmesi Fransız demiryolu mühendisi Paul Gaudin'in bölgeye gelmesine dayanır. Bu noktada Paul Gaudin'in kısa hayat hikayesinin anlatılması yerinde olacaktır. Paul Gaudin, maddi durumu iyi bir ailenin üç çocuğundan biri olarak 1 Nisan 1858'de Paris'te doğmuştur. 1880'de mühendislik eğitimini tamamlamasının ardından Fransa'da demiryollarıyla ilişkili değişik pek çok görevde bulunmuştur (Kamil 1982: 1; Charloux 2001: 24).

İlk defa 1892 yılında Osmanlı İmparatorluğu topraklarına gelen Paul Gaudin, 1905 yılına kadar on üç yıl imparatorluk sınırları içerisindeki değişik coğrafyalarda çalışır. İlk zamanlar, Paul Gaudin, o tarihlerde yabancıların *Brousse-Mondania* şeklinde adlandırdıkları Bursa'yı Mudanya'ya bağlayan demiryolu hattında, daha sonra ise 1898'de "işletme şefi" sıfatıyla terfi ettiği, batılıların *Smyrna-Cassaba* dedikleri İzmir-Turgutlu arası ve bağlı hatlarda görevlendirilmiştir. Aynı yılın sonuna doğru bu sefer yabancıların *Soma Panderma* dedikleri Soma-Bandırma hattının inşaatında göreve başlar (Charloux 2001: 24). Gaudin'in bu demiryolu inşası sırasında Soma çevresindeki çalışmaları, Batı Anadolu'nun en meşhur İlk Tunç Çağı mezarlığını bulmasıyla ayrı bir boyuta ulaşır.

Gaudin'in Yortan mezarlığını bulmasında en büyük pay şüphesiz mesleğidir. Çünkü inşaatı devam eden ve kendisinin de görev aldığı bu demiryolu inşaatı olmasaydı olasılıkla Gaudin bölgeye gelmeyecekti. Gaudin'in Yortan'daki çalışmaların başlangıcıyla ilişkili iki farklı tarih öneri vardır. Yortan buluntuları hakkında kapsamlı bir kitap hazırlayan T. Kamil Gaudin'in Yortan'da 1900'de çalışmaya başladığını ileri sürerken (Kamil 1982: 1) son yıllarda konuyla ilişkili ciddi bir çalışma yapan G. Charloux, Gaudin'e verilen Osmanlı fermanının tarihinin Ekim 1898 olduğunu ve kazılara o yıl başlanıldığını belirtir (Charloux 2001:24,26,dipnot IX).

İlk kazısının ardından daha geniş kapsamlı ikinci kazı sezonu *Académie des Inscriptions et Belles-Lettres*'in yardımıyla 1901 yılı Ekim ayında düzenlenir. Bu kampanyaya o zamanlarda da önemli bir araştırma kurumu olan Atina Fransız Okulu da destek verir. Atina Fransız Okulu üyesi V. Chapot çalışmaları izlemek üzere bölgeye gönderilir. Aydın İl Milli Eğitim müdürü İsmail Nail Bey Osmanlı imparatorluk hükümetini temsil eden "hükümet temsilcisi" sıfatıyla çalışmalara katılır (Kamil 1982: 1; Charloux 2001: 24).

Sanılanın aksine Yortan, Gaudin'in Anadolu topraklarındaki tek kazısı değildir. Gaudin, Aydın'ın Karacasu İlçesi yakınlarındaki görkemli Karia kenti Aphrodisias'da da 1904 ve 1905 yıllarında kazılar yapmıştır. Ancak 1905 yılı Osmanlı İmparatorluğu için stratejik öneme sahip olan Hicaz demiryolunun inşasında görevlendirilir. Bu sırada hayatını da tehlikeye atacak bazı olumsuzluklarla karşılaşır. 18 Şubat 1921'de Versailles'de (Versay) ölür (Charloux 2001: 25).

Gaudin'in kazısı döneminin bir özentisi şeklinde gelişse de mühendis olmasından dolayı yaptığı çizimler çağdaşları arasında onu farklı bir konuma getirir. Bu çizimler, Yortan mezarlığındaki pek çok mezar hakkında az sayılamayacak derecede bilgi sahibi olmamızı sağlamıştır. Ancak çizimlerdeki bazı sorunların kimi noktalarda anlaşılmayı güçleştirdiğini de belirtmek gerekmektedir. Gaudin, hemen her mezarı armağanları ve iskelet-kafatası kalıntılarıyla birlikte çizmeye gayret etmiştir (Res. 5,6). Elimizdeki bilgiler Gaudin'in kazılarında o zamanki Kırkağaç-Gelenbe yoluna paralel arazide 100'den fazla küp (pithos) ve çömlek mezarın bulunduğudur. Bazı yayınlarda 110 rakamı geçse de bu sayı genellikle 107 kabul edilmektedir (Kamil 1982: 7). Ayrıca bir adet taş sanduka mezardan (?) söz edilmektedir (Kamil 1982: Fig.9). Yortan mezarlığında küp mezarlar 1 ila 1,5 m. derinlikte saptanmış olup mezarların çoğunun ağız kesimi güneydoğuya bir kısmı ise doğu ve kuzeydoğuya bakmaktadır (Kamil 1982: 8). Diğer merkezlerde de gözlenen bu durum küplerin yerleştirilişindeki doğu-batı doğrultusundaki genel yön birlikteliğinin mevsimlere göre güneşin doğuşu ve batışı arasındaki açı farklılığından kaynaklanmış olmalıdır. Küpler hafif yan yatırılmıştır. Büyük çömleklerin çocuk veya bebekler için kullanıldığı düşünülmektedir (Kamil 1982: 7). Küplerin ağızları büyük yassı taşlarla kapatılmıştır. Küp mezarlar genellikle ikili gömüt içerir. Bir örnekte ise altı ceset bir küp içinde bulunmuştur.

YORTAN MEZARLIĞININ ÖNEMİ

Yortan mezarlığı niçin önemlidir? Bu mezarlık Batı Anadolu'da kıyıya çok uzak olmayan bir noktada, Bakırçay'ın doğduğu topraklarda, ılıman Ege iklimi ile karasal iklimin kesiştiği bir coğrafyada kazısı yapılan en büyük İlk Tunç Çağı mezarlığıdır. Hem ölü gömme adetleri, hem de bu mezarlardan çıkarılan buluntular dolayısıyla önem taşımaktadır. Ölü gömme şekilleri -Gaudin'in raporlarından edindiğimiz bilgilere- göre genel özellikleriyle Batı Anadolu'daki pek çok merkezle benzerlik göstermesine karşın mezar armağanları olarak bırakılan özellikle çanak çömlekler başlı başına "Yortan türü seramik" değerlendirmesini yapma imkanı sağlamaktadır. Bu eserler, Batı Anadolu'nun iç kesimlerine kadar uzanan yayılımı belgelenen çok önemli buluntu topluluklarıdır. 1936'de Alman Arkeoloji Enstitüsü adına K. Bittel ile Cambridge Üniversitesi'nden J.Stewart'ın Yortan'ın kuzeyinde Balıkesir ili sınırları içerisindeki Babaköy'deki çalışmaları (Bittel 1941: 1 vd.) ve devamında 1949 yılında K.Kökten'in araştırmaları (Kökten 1949: 811-814; Res. 2-8), E. Akurgal tarafından 1956 yılında yürütülmüş olan Ovabayındır kazısı (Akurgal 1958: 156-162), D.G.Mitten ve G.Yüğrüm tarafından Ahlatlı Tepecik ve Eski Balıkhane'de yapılan sınırlı kazılar (Mitten-Yüğrüm 1968: 126, 127, 129, 130; 1971: 192-195; 1974: 22-29), R.Dinç'in Erdelli Höyük araştırmaları (Dinç 1991: 27-28, 36), Yortan'ın yakın çevresi de olsa yayılımın belgelenmesi açısından önem taşımaktadır. (Kamil 1982: 1).

Daha 1930'lu yıllarda Yortan'ın bir tek buluntu merkezinden ibaret olmadığı, sanılandan çok daha geniş bir alana yayılan bir "kültür" olduğu anlaşılmıştır. Böylece "Yortan Kültürü" ifadesi kullanılmaya başlanmıştır. Bu kültür, yukarıda da belirttiğimiz üzere ölü gömme adetleri açısından taşıdığı önemin ötesinde asıl önemini mezar armağanlarıyla, özellikle de seramiğiyle göstermekteydi. Mezar armağanı olarak yoğun çanak çömlek dışında ağırşaklar, madeni eserler ve mermer idoller bulunmuştur. Yortan'ın İlk Tunç Çağı sonuna tarihlenen eserlerinde açık renk malların görülmesine karşın ilk dönemlere yani İlk Tunç Çağı I ve II'ye ait eserlerde koyu renk yüzeyli mat beyaz boya bezemeli ya da çizi bezemeli / beyaz dolgu bezemeli mallar hakimdir. Form açısından ise ayaklı ve kapaklı pek çok örneğin görüldüğü kase, çanak, çömlek, testi gibi formlar yaygındır (Kamil 1982, 13-19). Madeni eserlerde kalay içeren bir mızrak ucu dışında bütün eserler arsenik katkılı bakırdan yapılmıştır (Kamil 1982, 19-20). Mermer idoller, Beycesultan tipi keman biçimli Troia tipi yassı-oval formlu ve Kilia tipi penguen formlu olmak üzere üç gruptan oluşmaktadır (Kamil 1982, 21-22).

T.Özgüç'ün Ankara Üniversitesi, Dil ve Tarih Coğrafya Fakültesi Arkeoloji Enstitüsü'ndeki, R.W. Hutchinson'un Louvre Müzesi'ndeki, W.Orthmann'ın ise Berlin Charlottenburg Müzesi'ndeki, Hockmann'ın Essen'deki Altenessener Müzesi'ndeki, G.Wolfgang'ın Wüzburg'daki Martin von Wagner Müzesi'ndeki, Ç.Anlağan'ın İstanbul Sadberk Hanım Müzesi'ndeki, H.Hüryılmaz'ın Uşak Arkeoloji Müzesi'ndeki, T.Sipahi'nin Ankara Anadolu Medeniyetleri Müzesi'ndeki diğer eserlerle birlikte Yortan buluntularını ele alan incelemelerinin dışında (Özgüç 1944, 61 vd.; Hutchinson 1935, 211 vd.; Orthmann 1966, 2 vd.; Hockmann 1984, 97 vd.; Wolfgang 1990, 479 vd.; Anlağan 1990, 65 vd.; Hüryılmaz 1998, 499 vd.; Sipahi 2000, 93 vd.) Yortan buluntularını belli bir kronolojiye yerleştirmeye çalışan T.Kamil, Avrupa'da pek çok müzeye dağılan Yortan mezarlığına ait mezar armağanlarını incelemiş, bunları gruplara ayırmış ve tarihleme önerileri getirmiştir. Kamil'in çalışması çok farklı müzelerde korunmakta olan Yortan buluntularının ilk defa birlikte ele alınması açısından önemlidir. Ancak Kamil, mezarlığın kesin olarak bulunduğu yere dair arazi çalışması yapmamıştır. Kamil, Yortan mezar buluntularını A, B ve C olmak üzere üç grupta incelemiş ve genel olarak İTÇ I-III arasına yerleştirmiştir (Kamil 1982: 14 vd.). Buna göre en yoğun grubu oluşturan A grubu seramikleri İlk Tunç Çağı I'in geç evreleri İlk Tunç Çağı II, B grubu seramikleri İlk Tunç Çağı II'nin geç evreleri ve İlk Tunç Çağı III'e, C grubu ise İlk Tunç Çağı IIIa'ya tarihlendirilmiştir (Kamil 1982: 7, 16, 18, 19, 49, 52, 54, 67 Tablo 2). Bu tarihlemeler dışında farklı öneriler de yapılmıştır (Bittel 1941: 20-22; French 1968: 72; 1969: 56, 57; Hüryılmaz 1997: 502, 504, 505, 506, 508-513; Lloyd-Mellaart 1962: 132, 181, 183, 243, 251; Mellaart 1955: 81-83; 1958: 15; 1966: 128-132; 1971: 120-126, 131, 133; Mellink 1992: 216; Orthmann 1966: 26; Özgüç 1944: 69, 70; Podzuweit 1979: 70-74; Sipahi 2000: 102; Yakar 1979: 60).

YORTAN MEZARLIĞI'NIN YERİ

Çeşitli yayınlarda Yortan mezarlığının yeriyle ilişkili olarak genel bilgiler verilmektedir. Bu bilgilere göre Yortan mezarlığı, Manisa'nın Kırkağaç İlçesine bağlı Gelen(m)be Belediyesi'nin Bostancı Köyü yakınlarındadır[1]. Bostancı Köyü'ne farklı yönlerde ve farklı uzaklıklarda değişik mevkiiler önerilmiştir (Kamil 1982: 1; Özgüç 1944: 55; Dinç 1995: 92; Dinç 1997: 255, dipnot 2; Hockmann 1984: 97; Sipahi 2000: 94; Umar 2006: 122, 123)[2]. Bostancı Köyü'nün eski adının Yortan olması da mezarlığın daha çok bu köyün yakın çevresinde düşünülmesine yol açmıştır. Ancak bu bilgiler arazi incelemesine değil, Gaudin'in kazı raporlarına dayanmaktadır.

Ekibimizin "Prehistorik-Protohistorik Çağlarda Manisa ve Çevresi" Başlıklı TÜBİTAK Araştırma Projesi kapsamında, T.C. Kültür ve Turizm Bakanlığı'ndan aldığı izinle Manisa ili ve ilçelerinde yürütmekte olduğu yüzey araştırmaları sırasında incelenen konulardan birisi de bu mezarlığın yerinin tam saptanması olmuştur (Res. 1, 2).

Bu amaçla özellikle Gaudin zamanında çizilmiş harita ve planlar günümüz arazisine uyarlanmaya çalışılmıştır. Ön çalışmaların ardından, günümüzde SİT alanı kapsamında korunmakta olan Taban Tepe'ye gidilmiştir (Res. 1, 2, 5, 7, 9)[3]. Taban Tepe, Akhisar'ın 24 km. kuzeyinde, Kırkağaç'ın 14 km. doğukuzeydoğusunda, Karakurt Beldesi'nin 3 km. kuzeydoğusunda, hemen her yayında Yortan mezarlığının yer aldığı öne sürülen Bostancı köyünün (Eski adı Yortan) ise 2,5 km. kuzeybatısında yer almaktadır[4]. Yaklaşık 350x120 m. boyutlarında ve deniz seviyesinden 214, ovadan ise 10 m. yüksekliktedir.

Gaudin'in çizimlerini incelerken gözden kaçırılmaması gereken husus günümüzde kullanılan İzmir-İstanbul karayolunun o dönemde aynı güzergahtan geçmediği gerçeğidir. Zaten Gaudin'in çiziminde belirttiği, söz konusu dönemlerde çok işlek olan Kırkağaç-Gelenbe karayolu yeni yolun açılmasıyla birlikte günümüzde neredeyse kaybolmuştur (Res. 12). Gaudin'in kazı raporlarında bu karayolunun hemen bitişiğindeki Tabak Tepe'nin eteklerinin ve özellikle doğusunun Yortan mezarlığı olduğu belirtilmektedir. Ancak arazide günümüzde bu adla anılan bir tepe yoktur. Bölgenin topoğrafya haritaları dikkatlice incelendiğinde Taban Tepe adıyla anılan tepenin varlığı görülür. Bu tepede ve tepenin doğu kısmında incelemelerimiz sırasında tespit ettiğimiz küp parçaları mezarlık alanının yoğunlaştığını göstermektedir (Res. 10).

Günümüzde Taban Tepe adıyla anılan tepenin Gaudin'in kazı yaptığı dönemde Tabak Tepe adıyla anılması ya da Gaudin'in yanlışlıkla Taban Tepe'yi Tabak Tepe şeklinde aktarması mümkündür ve bu durum çok ciddi bir farklılık değildir. Yukarıda da belirtildiği gibi, Gaudin'in planlarında gösterdiği eski Kırkağaç-Gelenbe yolu da çalışmalarımız sırasında kesin olarak tespit edilmiştir. Dolayısıyla gerek haritanın araziye uyarlanması, gerek eski Kırkağaç-Gelenbe yolunun saptanması, gerekse yüzey buluntuları, günümüzde Tabak Tepe adıyla anılan tepenin Gaudin'in doğu eteğinde kazılar yaptığı ve "Yortan mezarlığı" şeklinde adlandırdığı buluntu merkezi olduğunu ispatlamaktadır. Yöre halkıyla yaptığımız görüşmeler sonucunda bu ovalık arazinin önemli bir kısmının Gaudin'in kazı yaptığı dönemlerde de Bostancı (Yortan) Köyü'ne ait olduğu anlaşılmıştır. Taban Tepenin etek ve çevresinde yoğun tarımsal faaliyet gözlemlenmekle birlikte, tepenin üst kısımlarının tarıma müsait olmayan kayalık bir alan olması sebebiyle korunmuş olduğu saptanmıştır. tepenin üst kısmındaki kayalık alanlarda, tıpkı çevresindeki diğer arazilerde olduğu gibi Frig döneminde tapınım ve mezar amaçlı kullanıldığı anlaşılan bazı kalıntılar vardır. Tepenin hemen batısından Bakırçay geçmektedir[5].

ÇAVDAR TEPE SORUNU

Gaudin, Yortan mezarlığında yaptığı kazının ardından bu mezarlığın ait olduğu yerleşimi bulmak amacıyla o dönemde Çavdar Tepe *(Tchavdar Tepe)* adıyla geçen tepede de kazılar kapmıştır. Burada dört açmada kazı gerçekleştirmiştir (Kamil 1982: 5). Ekibimiz tarafından tıpkı Yortan Mezarlığı'nın yerinin saptanmasında olduğu gibi Çavdar Tepe'nin de yerinin saptanmasında benzer yöntemler uygulanmıştır. Öncelikle harita incelemelerinde, uydu görüntülerinde ve yöre halkıyla yapılan görüşmelerde günümüzde arazide bu adla anılan bir tepenin olmadığı anlaşılmıştır. Böylece, Gaudin'in planlarında Tabak Tepe'nin hemen kuzey-kuzeybatısında gösterdiği, güneybatısında bir değirmen (Res. 5'deki Fransızca moulin) bulunan, kuzeybatısından ise Bakırçay'ın *(Kaikos)* bir kolunun geçtiği, yine eski Kırkağaç-Gelenbe yolu kıyısındaki bu tepenin günümüzde başka bir adla anılabilirliği olasılığı gündeme gelmiştir. Ancak yukarıda da vurguladığımız üzere, Gaudin'in Çavdar Tepe dediği tepenin güneybatısında bir değirmenin varlığını belirtmesi araştırmalarımızda büyük fayda sağlamıştır. Gerçekten Taban Tepe'nin yaklaşık 200 m. kuzeyinde günümüzde Değirmen Tepe adıyla anılan tepenin güneybatısında artık kullanılmayan bir değirmenin kalıntıları bulunmakta, kuzeybatısından ise Bakırçay *(Kaikos)* akmaktadır.

Gaudin'in raporlarında Çavdar Tepe adıyla geçen bugünkü adıyla Değirmen Tepe, Akhisar'ın 24,4 km. kuzeyinde, Karakurt'un 3,4 km. kuzeydoğusunda, Kırkağaç'ın 14,4 km. doğu-kuzeydoğusunda Bostancı köyünün (eski adı Yortan) 2,7 km kuzeybatısında, yer almaktadır (Res. 1, 2, 5, 7, 12-15)[6]. Yaklaşık 280x140 m. boyutlarında ve ovadan 12 m. yükseklikte bir tepedir. Tepede yaptığımız incelemelerde Gaudin zamanından kalma açmaların yerleri de tespit edilmiştir (Res. 14). Değirmen Tepe'den toplanan malzemenin büyük kısmı tepenin batı eteklerinde bulunan tarlada ele geçmiştir. Taban Tepe ve Değirmen Tepe'nin bulunduğu arazi sonraki dönemlerde Frig kültürü tarafından da kullanılmıştır (Res. 28). Ancak araştırmacılar daha çok kaya anıtları üzerinde durmuşlardır. Yörede Gaudin'in Yortan mezarlığının yerleşimi olarak düşündüğü Değirmen Tepe'de (Çavdar Tepe) Gaudin'in kazılarında hiç bir yapı kalıntısının bulunmamış olması dikkat çekici bir husustur. Ancak bununla birlikte aşağıda sıraladığımız birkaç olasılığı göz ardı etmemek gelmektedir;

DEĞERLENDİRME

Batı Anadolu'da kazısı yapılmış en büyük İlk Tunç Çağı mezarlığı olan Yortan'ın yerinin tam olarak saptanması bölgede gerçekleştirdiğimiz yüzey araştırmaları sayesinde mümkün olmuştur. Böylece 1930'lu yıllardan itibaren bir "kültür" olarak tanınan Yortan'ın kesin yer tanımı yapılmış, bu boşluk doldurulmuştur. Ancak Yortan mezarlığının yerinin tespiti var olan soruların tümünü çözmediği gibi bazı yeni soruları da akla getirmektedir. Batı Anadolu arkeolojisinde normal şartlarda yerleşim dışı *(extramural)* mezarlıklar höyüklerin hemen yakınında yer alırken Yortan'da durum biraz farklıdır. Elimizdeki bilgilere göre Yortan mezarlığının hemen yakınında höyük tarzında bir yerleşim saptanamamıştır. Zaten bu soruyu Gaudin'in de çözmeye gayret etmiş, bu amaçla Çavdar Tepe'de (Değirmen Tepe) kazı yaptıysa da cevaplaması mümkün olmamıştır.

Yortan mezarlığını kullanan toplumların yaşadıkları olası höyük tarzı yerleşimleri bulmak maksadıyla gerçekleştirdiğimiz yüzey araştırmaları Karakurt Ovası ile Gelenbe Ovası'nın tamamında devam etmiştir. Eski göl yataklarının gözlendiği arazide Karakurt ve Bostancı Köyü çevresinde toplam 3 adet höyük yerleşimi tespit edilmiştir. Akkuştepe I[7] (Res. 1, 3, 18-21), Akkuştepe II[8] (Res. 1, 3, 22-24) ve Azizkuyusu[9] (Res.1, 4, 25-27) adlarıyla anılan höyük yerleşimlerinin Yortan mezarlığına en yakını kuş uçumu yaklaşık 2 km. mesafededir. Bu üç höyük yerleşiminde de Yortan ile çağdaş genellikle koyu renk yüzeyli çanak çömlek parçaları ve taş eserler ele geçmiştir. Buna karşın Yortan mezarlığında sıklıkla karşımıza çıkan beyaz boya ya da çizi bezemeli-macun doldurmalı mallar çok nadirdir. Ancak Yortan'ın bir mezarlık, dolayısıyla buluntularının da "mezar armağanı" olduğunu unutmamak gerekmektedir. Çevredeki höyüklerden özellikle Akkuştepe I, Yortan kültürüyle benzer daha yoğun buluntulara sahiptir. Buna göre ilk olasılık, Karakurt Ovası'nda (Res. 8) yerleşik düzende yaşayan, İlk Tunç Çağı insanlarının belki de Yortan'ı ortak bir mezarlık şeklinde kullandıklarıdır. Çünkü bu mezarların hiçbirisi Yortan'daki yoğun gömütü (ki Gaudin mezarlığın her tarafını kazmamıştır) tek başına açıklayabilecek boyutta yerleşimler değildir. Örneğin yoğun alüvyal dolguyu dikkate almazsak Akkuştepe I, 3 m. yüksekliğinde, yaklaşık 70 x 70 m. boyutlarında, Akkuştepe II yaklaşık 2 m. yüksekliğinde, 95x40 m. boyutlarında, Azizkuyusu ise 11 m. yüksekliğinde ve 85x70 m. boyutlarındadır.

Yortan mezarlığının ortak bir mezarlık şeklinde kullanıldığına ilişkin düşünülebilecek bir başka olasılık göçebe topluluklardır. Acaba özellikle kuzey güney rotasında çok önemli bir noktada yer alan bu arazi (ki antik çağlarda da Lydia ile Mysia arasında sınır oluşturmaktadır), aynı zamanda İlk Tunç Çağı'nda konar göçerlerin göç yolu üzerinde miydi? Anadolu'da yol güzergahlarında uzun süreli devamlılık bilinmektedir. Modern Balıkesir yolu açılmadan önce mezarlığın hemen bitişiğindeki Kırkağaç-Gelen(m)be yolunun kullanıldığı daha önce belirtilmiştir. Bu insanlar ölen bireylerini bir süre yanlarında taşıdıktan sonra burada, kendileri için bilmediğimiz önemdeki bu merkezi mezarlığa mı gömüyorlardı?

Beklediğimiz şekilde bir höyük yerleşimi bulamadığımız için, Yortan mezarlığını kullananların bu ovalık arazide kısa süreli ya da düz yerleşimlerde yaşamış insanlar olabileceği düşünülebilir mi? Çevrede varlığı bilinen göllerin kıyısında ve Bakırçay'da tatlı su balıkçılığını da içeren ya da tamamen ona dayanan ya da göl çevresindeki bataklık alanların çamurundan faydalanılan bir yaşam modeli mümkün müdür? Bu soruları cevaplamak oldukça zordur. Çünkü yörede inceleme yaparken alüvyal dolgunun ve yamaç erozyonunun yoğunluğu dikkat çekmektedir. Nitekim proje aşamasındaki Karakurt Barajının çanak şeklindeki bu çöküntü ovasına yapılması planlanmaktadır. Dolayısıyla, mühendislik bilimleri yardımı olmadan sadece çıplak gözle bu konular hakkında yorum yapmak doğru değildir.

Karakurt Ovası ile Gelenbe çevresindeki en etkileyici arkeolojik kalıntılar, neredeyse Balıkesir-İzmir karayolu kenarına sıralanmış durumdaki Frig eserleridir. Bölge aynı zamanda Frig kültürünün güneybatı sınırlarını oluşturmaktadır. Burada üzerinde durulması gereken bir konu Frig uygarlığının dinsel amaçlarla kullandığı kayalık arazilerin ilk kullanımının daha erken tarihlerde başlamış olabileceği ihtimalidir. Ayrıca bu etkileyici kayalık arazilerin, çevrelerindeki küçük göllerle birlikte İlk Tunç Çağı insanları üzerindeki dinsel etkisi bilinmemektedir. Unutmamak gerekir ki Yortan mezarlığının saptandığı alan benzer özellikteki kayalık bir tepenin hemen eteğindedir. Yani Yortan mezarlığını kullananlar geniş Karakurt Ovası ve Gelenbe çevresinde bir başka noktaya değil, bilinçli olarak bu kayalık arazinin eteğindeki alana gömüt yapmışlardır. Gaudin'in Yortan'ın yerleşimini bulmak amacıyla kazdığı Değirmen Tepe (Çavdar Tepe) jeolojik oluşumlu bir tepe, yani doğal bir tepedir. Buna karşın yüzeyinde sınırlı, eteklerinde ve çevresindeki tarlalarda ise yoğun miktarda İlk Tunç Çağı çanak çömlek parçaları vardır. Dolayısıyla, özellikle Değirmen Tepe yüzeyi ve çevresindeki çanak çömlek buluntuları dikkatle ele alındığında mezarlığa 200 m. mesafedeki bu alanın höyük şeklinde değil fakat tepe üstü yerleşim olduğu önerilebilir. Gaudin'in Değirmen Tepe'de gerçekleştirdiği kazılar o dönem koşullarında ve sınırlı alanlarda yürütülmüştür. Bu çalışmalar yeterli değildir. Tepenin kazılmayan kesimlerinde beklenmedik bir sonuçla da karşılaşılabilinir. Bu durumun bilimsel açıklaması için yörede sistemli kazılara ihtiyaç vardır. Değirmen Tepe'nin yanı sıra Karakurt Ovası'ndaki ve Gelenbe yöresindeki benzeri diğer kayalık arazilerin, tepelerin yerleşim yeri olarak seçiminde bölge için üzerinde pek durulmayan ahşap mimarinin rolünün de göz ardı edilmemesi gerekmektedir. Ancak bu çalışmalar sonucunda kesin yerini tespit ettiğimiz bu mezarlığa gömüt yapan halkların nerelerde yaşadıkları açıklığa kavuşacaktır. Benzer sorun yöredeki etkileyici Frig anıtlarının sahipleri için de geçerlidir. Onların yaşadıkları alanlar da tıpkı Yortan Mezarlığını kullanan halklar gibi cevaplanması gereken bir sorudur.

KATKI BELİRTME

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BULUNTU KATALOĞU

TABAN TEPE

1) İçe eğik duruşlu yuvarlatılmış çanak ağız kenarı parçası. Gri hamurlu, hamuru kum, mika, taşçık katkılı, hamur renginde astarlı, iyi derecede pişirilmiş, el yapımı (Res.10-1; Res.11-1).

2) Gövde parçası. Gri hamurlu, hamuru bol miktarda kum, mika, kuvars ve taşçık katkılı, kırmızımsı kahverengi renkte astarlı, orta derecede pişirilmiş, el yapımı (Res.10-2).

3) Gövde parçası. Gri hamurlu, hamuru bol miktarda kum, mika, kuvars ve taşçık katkılı, kırmızımsı-vişne renkte astarlı ve perdahlı, orta derecede pişirilmiş, el yapımı (Res. 10-3).

4) Gövde parçası. Gri hamurlu, hamuru bol miktarda kum, mika, kuvars ve taşçık katkılı, portakal renkte astarlı ve perdahlı, orta derecede pişirilmiş, çark yapımıdır (Res.10-4).

5) Gövde parçası. Gri hamurlu, hamuru kum, mika, kuvars katkılı, hamur renginde astarlı, orta derecede pişirilmiş, el yapımı (Res.10-5).

6) Boyun parçası. Sarı hamurlu, hamuru kum, mika katkılı, kırmızı astarlı ve perdahlı, çok iyi derecede pişirilmiş, el yapımı (Res.10-6; Res.11-2).

7) Gövde parçası. Koyu gri renkte hamurlu, hamuru kum, mika, kuvars katkılı, hamur renginde astarlı ve perdahlı, iyi derecede pişirilmiş, el yapımı (Res.10-7).

8) Küp (pithos) parçası. Kırmızı renkte hamurlu, hamuru bol miktarda kum, mika kuvars ve taşçık katkılı, kazıma bezemeli, el yapımı (Res.10-8).

9) Küp (pithos) parçası. Grimsi-kahverengi renkte hamurlu, hamuru bol miktarda kum, mika kuvars ve taşçık katkılı, el yapımı (Res.10-9).

10) Küp (pithos) parçası. Grimsi-kahverengi renkte hamurlu, hamuru bol miktarda kum, mika kuvars ve taşçık katkılı, el yapımı (Res.10-10).

11) Küp (pithos) parçası. Kırmızımsı-kahverengi renkte hamurlu, hamuru bol miktarda kum, mika kuvars ve taşçık katkılı, el yapımı (Res.10-11).

12) Küp (pithos) parçası. Kırmızı renkte hamurlu, hamuru bol miktarda kum, mika kuvars ve taşçık katkılı, el yapımı (Res.10-12).

13) Küp (pithos) parçası. Kırmızı renkte hamurlu, hamuru bol miktarda kum, mika kuvars ve taşçık katkılı, el yapımı, yüzeyi yoğun bir şekilde patina kaplı (Res.10-13).

14) Küp (pithos) parçası. Kırmızı renkte hamurlu, hamuru bol miktarda kum, mika kuvars ve taşçık katkılı, el yapımı, yüzeyde yer yer patina tabakası izleri görülmekte (Res.10-14).

DEĞİRMEN TEPE

1) Omurgalı çanak ağız kenarı parçası. Gri hamurlu, hamuru kum, mika, kuvars katkılı, siyah renkte astarlı ve perdahlıdır. Orta-iyi derecede pişirilmiş, el yapımı (Res.16-1; Res.17-1).

2) Omurgalı çanak omuz parçası. Hamuru kum, mika, kuvars katkılı, siyahımsı-kahverengi renkte astarlı ve perdahlı, dış yüzeyinde boya bezeme yer almakta. Orta derecede pişirilmiş, el yapımı (Res.16-2; Res.17-2).

3) Omurgalı çanak ağız kenarı parçası. Kırmızı hamurlu, hamuru kum, mika, kuvars katkılı, hamur renginde astarlı, orta derecede pişirilmiş, el yapımı (Res.16-3; Res.17-3).

4) Hafif içe eğik duruşlu çanak ağız kenarı parçası. Devetüyü renkte hamurlu, hamuru kum, mika, kuvars katkılı, hamur renginde astarlı ve perdahlı, iyi derecede pişirilmiş, el yapımı (Res.16-4; Res.17-4).

5) Kulp. Kahverengimsi-gri renkte hamurlu, hamuru kum, mika, kuvars katkılı, kırmızımsı-kahverengi renkte astarlı ve perdahlı, orta-iyi derecede pişirilmiş (Res.16-5; Res.17-5).

6) Kulp. Kahverengi renkte hamurlu, hamuru kum, mika, kuvars katkılı, hamur renginde astarlı, orta derecede pişirilmiş (Res.16-6; Res.17-6).

7) Kulplu gövde parçası. Gri hamurlu, kum, mika, kuvars katkılı, hamur renginde astarlı, orta derecede pişirilmiş (Res.16-7; Res.17-7).

8) Gövde parçası. Grimsi-siyah renkte hamurlu, hamuru kum, mika, kuvars katkılı, hamur renginde astarlı, iyi derecede pişirilmiş, el yapımı (Res.16-8).

9) Gövde parçası. Grimsi-siyah renkte hamurlu, hamuru kum, mika, kuvars katkılı, siyah astarlı, orta-iyi derecede pişirilmiş, el yapımı (Res.16-9).

10) Dip. Kırmızı renkte hamurlu, hamuru kum, mika, kuvars ve taşçık katkılı, orta derecede pişirilmiş, el yapımı, yüzeyi patina tabakası kaplı (Res.16-10; Res.17-8).

11) Dip. Grimsi-siyah renkte hamurlu, hamuru kum, mika, kuvars ve taşçık katkılı, orta derecede pişirilmiş, el yapımı (Res.16-11; Res.17-9).

12) Ayak. Gri-siyah renkte hamurlu, hamuru kum, mika, kuvars ve taşçık katkılı, orta derecede pişirilmiş, el yapımı (Res.16-12; Res.17-10).

AKKUŞ TEPE I

1) Omurgalı çanak ağız kenarı parçası. Devetüyü hamurlu, hamuru kum, mika, kuvars ve taşçık katkılı, dışta kahverengimsi-kırmızı renkte astarlı, içte açık kırmızı-vişneçürüğü renkte alacalı astarlı ve perdahlı, orta-iyi derecede pişirilmiş, el yapımı (Res.19-1; Res.21-1).

2) Omurgalı çanak ağız kenarı parçası. Gri renkte hamurlu, hamuru kum, mika, kuvars katkılı, içte ve dışta siyah renkte astarlı ve perdahlı, orta-iyi derecede pişirilmiş, el yapımı (Res.19-2; Res.21-2).

3) Omurgalı çanak ağız kenarı parçası. Grimsi-siyah renkte hamurlu, hamuru kum, mika, kuvars ve taşçık katkılı, grimsi-siyah renkte astarlı, orta-iyi derecede pişirilmiş (Res. 19-3; Res.21-3).

4) Tutamaklı gövde parçası. Gri hamurlu, hamuru kum, mika, kuvars ve taşçık katkılı, siyah astarlı ve perdahlı, iyi derecede pişirilmiş, el yapımı (Res.19-4; Res.21-4).

5) Kulp. Gri hamurlu, hamuru kum, mika, kuvars ve taşçık katkılı, grimsi-siyah renkte astarlı ve perdahlı, iyi derecede pişirilmiş (Res.19-5; Res.21-5).

6) Kulp: Grimsi-kahverengi renkte hamurlu, hamuru kum, mika, kuvars katkılı, devetüyü renkte astarlı ve perdahlı, orta-iyi derecede pişirilmiş, el yapımı (Res.19-6; Res.21-6).

7) Kulplu-gövde parçası: Devetüyü renkte hamurlu, hamuru kum, mika katkılı, hamur renginde astarlı, iyi derecede pişirilmiş, çark yapımı (Res.19-7; Res.21-7).

8) Gövde parçası. Gri hamurlu, hamuru kum, mika, kuvars katkılı, siyah renkte astarlı ve perdahlı, iyi derecede pişirilmiş, el yapımı (Res. 19-8).

9) Gövde parçası. Gri hamurlu, hamuru kum, mika, kuvars katkılı, siyah renkte astarlı ve perdahlı, iyi derecede pişirilmiş, el yapımı, beyaz boya bezemeli (Res.19-9; Res.21-8).

10) Gövde parçası. Kiremit kırmızısı hamurlu, kum, mika, kuvars katkılı, kırmızı renkte astarlı ve perdahlı, el yapımı (Res.19-10).

11) Gövde parçası. Devetüyü-gri renkte hamurlu, hamuru kum, mika ve az taşçık katkılı, dışta devetüyümsü-kırmızı renkte astarlı ve perdahlı. Orta derecede pişirilmiş (Res. 19-11).

12) Ayak. Siyahımsı-gri renkte hamurlu, hamuru kum, mika, kuvars ve taşçık katkılı, devetüyü-gri renkte astarlı, orta-iyi derecede pişirilmiş (Res.19-12; Res.21-9).

13) Ayak. Grimsi-siyah renkte hamurlu, hamuru kum, mika, kuvars ve taşçık katkılı, kırmızımsı-kahverengi renkte astarlı ve perdahlı, orta-iyi derecede pişirilmiş (Res. 19-13; Res.21-10).

14) Taş balta parçası (Res. 19-14; Res.21-11)

15) Taş alet parçası (Res.19-15; Res. 21-12)

16) Taş alet parçası (Res.19-16; Res. 21-13)

17) Taş alet parçası (Res.19-17; Res. 21-14)

18) Küp (pithos) parçası: Grimsi-kahverengi renkte hamurlu, hamuru kum, mika, kuvars ve taşçık katkılı, orta-iyi derecede pişirilmiş, çark yapımı. Yüzeyi yoğun miktarda patina kaplı (Res.20-18).

19) Küp (pithos) parçası: Grimsi-kahverengi renkte hamurlu, hamuru kum, mika, kuvars ve taşçık katkılı, orta-iyi derecede pişirilmiş, çark yapımı. Yüzeyi yoğun miktarda patina kaplı (Res. 20-19).

20) Küp (pithos) parçası: Grimsi-kahverengi renkte hamurlu, hamuru kum, mika, kuvars ve taşçık katkılı, orta-iyi derecede pişirilmiş, çark yapımı. Yüzeyi yoğun miktarda patina kaplı (Res.20-20)

AKKUŞTEPE II

1) İçe dönük profilli kase ağız kenarı. Gri hamurlu, hamuru kum, mika, kuvars ve taşçık katkılı, gri astarlı, iyi derecede pişirilmiş, el yapımı (Res. 23-1; Res.24-1)

2) Gövde parçası. Gri hamurlu, hamuru kum, mika, kuvars ve taşçık katkılı, gri astarlı, iyi derecede pişirilmiş, el yapımı (Res. 23-2; Res.24-2).

3) Gövde parçası. Gri hamurlu, hamuru kum, mika, kuvars ve taşçık katkılı, gri astarlı, iyi derecede pişirilmiş, el yapımı (Res. 23-3).

4) Gövde parçası. Kahverengi hamurlu, hamuru kum, mika, kuvars katkılı, gri-siyah alacalı yüzeyli, orta derecede pişirilmiş, el yapımı (Res. 23-4).

5) Gövde parçası. Gri hamurlu, hamuru kum, mika, kuvars ve taşçık katkılı, gri astarlı, iyi derecede pişirilmiş, el yapımı (Res. 23-5).

6) Çakmaktaşı alet (Res. 23-6; Res. 24-3).

7) Taş alet (Res. 23-7; Res. 24-4).

AZİZKUYUSU

1) Hafif dışa yuvarlatılmış profilli çanak ağız kenarı parçası. Kahverengi hamurlu, hamuru bol miktarda kum, mika, kuvars ve taşçık katkılı, kiremit kırmızısı-kahverengi yüzeyli, orta derecede pişirilmiş, el yapımı (Res.26-1; Res.27-1).

2) İçe dönük ağızlı çanak ağız kenarı parçası. Gri hamurlu, hamuru bol miktarda kum, mika, kuvars ve taşçık katkılı, dış yüzeyi gri-siyah astarlı ve perdahlı, orta derecede pişirilmiş, el yapımı (Res. 26-2; Res.27-2).

3) Düzleştirilmiş ağızlı çömlek ağız kenarı parçası. Kahverengi hamurlu, bol miktarda kum, mika, kuars ve taşçık katkılı, aynı renk astarlı, orta derecede pişirilmiş, el yapımı (Res. 26-3).

4) Gövde parçası. Gri hamurlu, hamuru bol miktarda kum, mika, kuvars ve taşçık katkılı, dış yüzeyi gri-siyah astarlı ve perdahlı, orta derecede pişirilmiş, el yapımı (Res. 26-4).

5) Gövde parçası. Kahverengi hamurlu, hamuru bol miktarda kum, mika, kuvars ve taşçık katkılı, kahverengi astarlı ve perdahlı, orta derecede pişirilmiş, el yapımı (Res. 26-5).

6) Düzleştirilmiş dip. Kahverengi hamurlu, hamuru bol miktarda kum, mika, kuvars ve taşçık katkılı, kahverengi astarlı ve perdahlı, orta derecede pişirilmiş, el yapımı, yüzeyi patina tabakası kaplı (Res. 26-6; Res.27-3).

7) Düzleştirilmiş dip. Kahverengi hamurlu, hamuru bol miktarda kum, mika, kuvars ve taşçık katkılı, kahverengi astarlı ve perdahlı, orta derecede pişirilmiş, el yapımı, yüzeyi kısmen patina tabakası kaplı (Res. 26-7; Res.27-4).

NOTLAR

[1]Gaudin zamanında özellikle Fransızlar, Gelenbe'ye Kelmbo/Kelembo, Kırkağaç'a ise Kırcagatch demekteydiler.

[2] Hockmann 1984: 97; Sipahi 2000: 94-95. Burada ilginç bir bilgiyi aktarmak gerekmektedir. Hockmann'ın çalışmasında satın alma yoluyla müzeye kazandırılan eserlerin geliş yeri olarak Karakurt'un belirtildiği anlatılmakta, ancak burada sözü geçen ve araştırma yaptığımız arazide yer alan Karakurt Belediyesi yerine Balıkesir'in Sındırgı İlçesi yakınlarındaki Karagur Köyü üzerinde durulmaktadır. Bu duruma Sipahi de dikkat çekmektedir. Sipahi 2000, 95.

http://www.tayproject.org/TAYmaster.fm$Retrieve?YerlesmeNo=2934&html=masterdetail.html&layout=web

[3] http://www.cedgm.gov.tr/icd_raporlari/manisaicd2004.pdf sayfa 236, 266.

[4]Taban Tepe'den alınan GPS koordinatları; 1- 35571929 D 4332484 K; 2- 35571852 D 4332514 K; 3- 35571905 D 4332599 K; 4- 35571994 D 4332631 K; 5- 35571961 D 4332624 K; 6- 35571938 D 4332538 K; 7- 35571949 D 4332598 K; 8- 35571953 D 4332571 K.

[5] Bakırçay'ın ilk doğduğu bu bölümüne Gelenbe-Gelembe Çayı da denilmektedir.

[6]Değirmen Tepe'den alınan GPS koordinatları; 1-35571967 D 4333000 K ; 2-35571952 D 4332978 K; 3- 35571926 D 4332911 K; 4- 35571898 D 4332881 K.

[7]Akkuştepe I'den alınan GPS koordinatları; 1-35570292 D 4330945 K; 2-35570316 D 4330920 K; 3- 35570296 D 4330920 K; 4- 35570276 D 4330924 K; 5- 35570317 D 4330897 K.

[8]Akkuştepe II'den alınan GPS koordinatları; 1-35570312 D 4331119 K; 2-35570290 D 4331126 K; 3- 35570312 D 4331130 K.

[9]Azizkuyusu'ndan alınan GPS koordinatları; 1-35573658 D 4329399 K; 2-35573776 D 4329506 K.; 3- 35573766 D 4329558 K; 4- 35573736 D 4329474 K ; 5- 35573714 D 4329499 K.

KAYNAKÇA

Akurgal, E. 1958
"Yortankultur-Siedlung in Ovabayındır bei Balıkesir", *Anatolia* III: 156-164.

Bittel, K. 1941
"Ein graberfeld der Yortankultur bei Babaköy", *Archiv für Orientforschung* 13: 1-28.

Charloux, G. 2001
"Paul Gaudin et les premières campagnes de fouilles à Yortan et à Aphrodisias", *Orient Express* 2001/1: 24-26.

Dinç, R. 1991
"Erdelli Höyük und die Bedeutung seiner Funde für die frühbronzezeitliche Geschichte des Manisa-Akhisar Gebietes", *Istanbuler Mitteilungen* 41: 25-38.

Dinç, R. 1995
"Yortan'da Bulunan Kilia Tipi İki Mermer Heykelcik Başı", A. Erkanal vd. (yay.) *İ.Metin Akyurt -Bahattin Devam Anı Kitabı*: 85-89. Arkeoloji ve Sanat Yayınları, İstanbul.

Dinç, R. 1997
"Kulaksızlar Mermer İdol Atölyesi ve Çevre Araştırmaları", *Araştırma Sonuçları Toplantısı* XIV: 255-282.

French, D.H. 1961
"Late Chalcolithic pottery from North-west Turkey and the Aegean", *Anatolian Studies* 11: 99-141.

French, D.H. 1965
"Early Pottery Sites from Western Anatolia", *Bulletin of*

the Institute Archaeology at London 5: 15-23.

French, D.H. 1968
Anatolia and the Aegean in Third Millennium B.C. University of Cambridge, Yayımlanmamış Doktora Tezi, Cambridge.

French, D.H. 1969
"Prehistoric Sites in Northwest Anatolia II. The Balıkesir and Akhisar/Manisa Areas", *Anatolian Studies* 19: 41-98.

Hockmann, O. 1984
"Frühe Funde aus Anatolien im Museum Altenessen Essen und in privatbesitz", *Jahrbuch Des Römisch-Germanischen Zentralmuseums* 31: 97-136.

Hutchinson, R.W. 1935
"Uruk and Yortan", *Iraq* 2: 211-222.

Hüryılmaz, H. 1997
"İçbatı Anadolu Bölgesi'nde Bulunan Yortan Mezarlık Kültürüne Ait Üç Kap", *Belleten* LXI/232: 499-522.

Kamil, T. 1982
Yortan Cemetery in the Early Bronze Age of Western Anatolia. British Archaeological Reports, BAR 145, Oxford.

Kökten, K. 1949
"1949 Yılı Tarih Öncesi Araştırmalar Hakkında Kısa Rapor," *Belleten* XIII: 811-829.

Lloyd, S. ve J. Mellaart 1962
Beycesultan I, The Chalcolithic and Early Bronze Age Levels. British Institute of Archaeology at Ankara, Londra.

Mellaart, J. 1955
"Some Prehistoric Sites in North-Western Anatolia", *Istanbuler Mitteilungen* 6: 53-88.

Mellaart, J. 1958
"The End of Early Bronze Age in Anatolia and the Aegean", *American Journal of Archaeology* 62: 9-34.

Mellaart, J. 1966
The Chalcolithic and Early Bronze Age in the Near East and Anatolia. Khayats, Beyrut.

Mellaart, J. 1971
"Prehistory of Anatolia and its Relations with Balkans", *Studia Balcanica* 5: 119-137.

Mellink, M. 1992
"Anatolia Chronology", R.W. Ehrich (yay.) *Chronologies in Old World Archaeology* I: 207-220. The University of Chicago Press, Chicago.

Mitten, D.G. ve G. Yüğrüm 1968
"Excavation at Ahlatlı Tepecik The Gygean Lake, 1968", *Türk Arkeoloji Dergisi* XVII-1: 125-131.

Mitten, D.G. ve G. Yüğrüm 1971
"The Gygean Lake, 1969: Eski Balıkhane, Preliminary Report", *Harvard Studies in Classical Philology* 75: 191-195.

Mitten, D.G. ve G. Yüğrüm 1974
"Ahlatlı Tepecik, Beside the Gygean Lake", *Archaeology* 27/1: 22-29.

Orhmann, W. 1966
"Keramik der Yortankultur in den Berliner Museen", *Istanbuler Mitteilungen* 16: 1-26.

Özgüç, T. 1944
"Yortan Mezarlık Kültürü'ne Ait Yeni Buluntular", *Belleten* 29: 53-70.

Podzuweit, C. 1979
Trojanische Gefasformen der Frühbronzezeit in Anatolien, der Agais und angrenzenden Gebieten. Philipp von Zabern, Mainz.

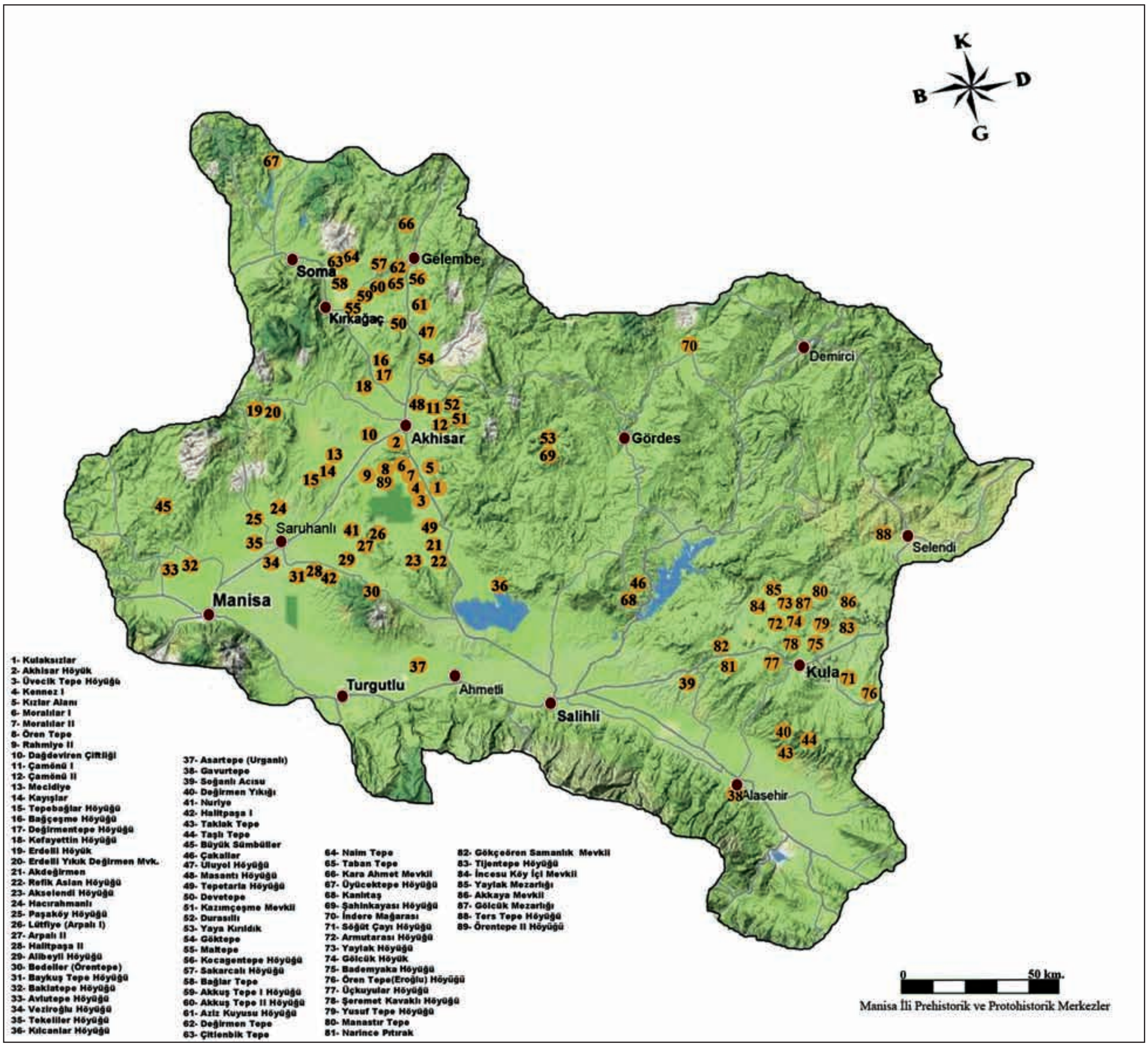
Sipahi, T. 2000
"Babaköy Mezarlığından Bir Grup Yortan Seramiği", *Anadolu Medeniyetleri Müzesi 1999 Yıllığı*: 93-110.

Umar, B. 2006
Mysia, Bir Tarihsel Coğrafya Araştırması ve Gezi Rehberi. İnkılap Kitabevi, İstanbul.

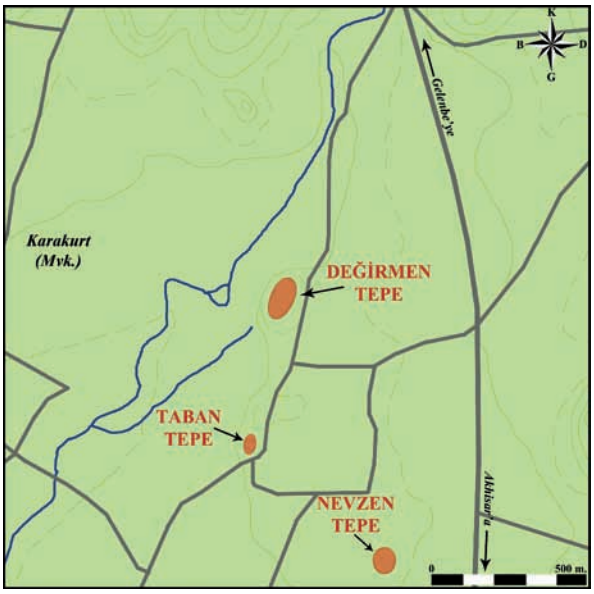
Wolfgang, G. 1990
"Eine Gruppe von Yortan-GefaBen", *Archaeologischer Anzeiger* 4: 479-487.

Yakar, J. 1979
"Troy and Anatolian Early Bronze Age Chronology", *Anatolian Studies* 29: 51-67.

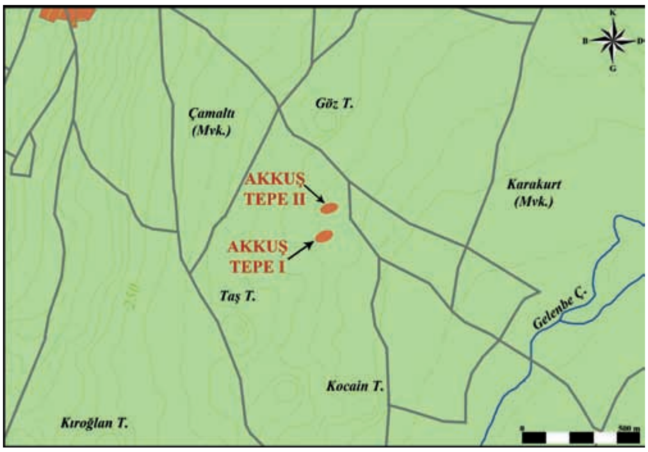
İnternet sitesi
www.tayproject.org Yortan/Gelembe maddesi (19 Haziran 2009 tarihi, saat 13.51 itibariyle)



Res. 1 Manisa'daki tarih öncesi merkezleri gösterir harita (numara 62 Değirmen Tepe, 65 Taban Tepe).
Fig.1 Map of Prehistoric sites in Manisa (number 62 Değirmen Tepe, 65 Taban Tepe) .

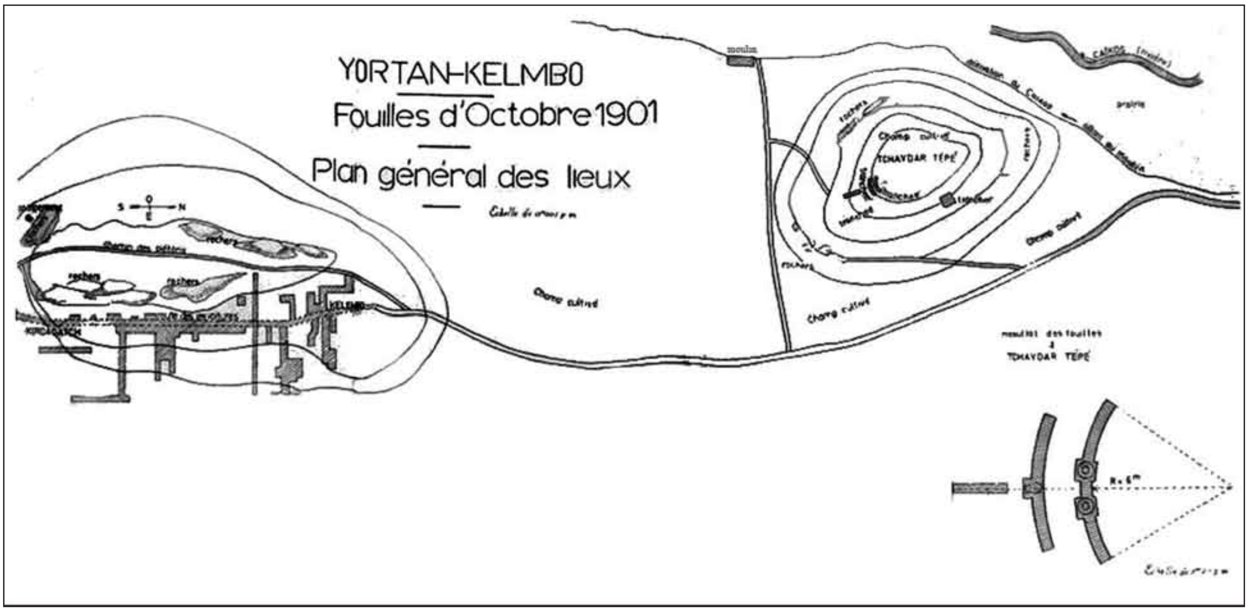


Res. 2 Yortan Mezarlığı ve yakın çevresinin haritası.
Fig. 2 Map of Yortan cemetery and surrounding area.

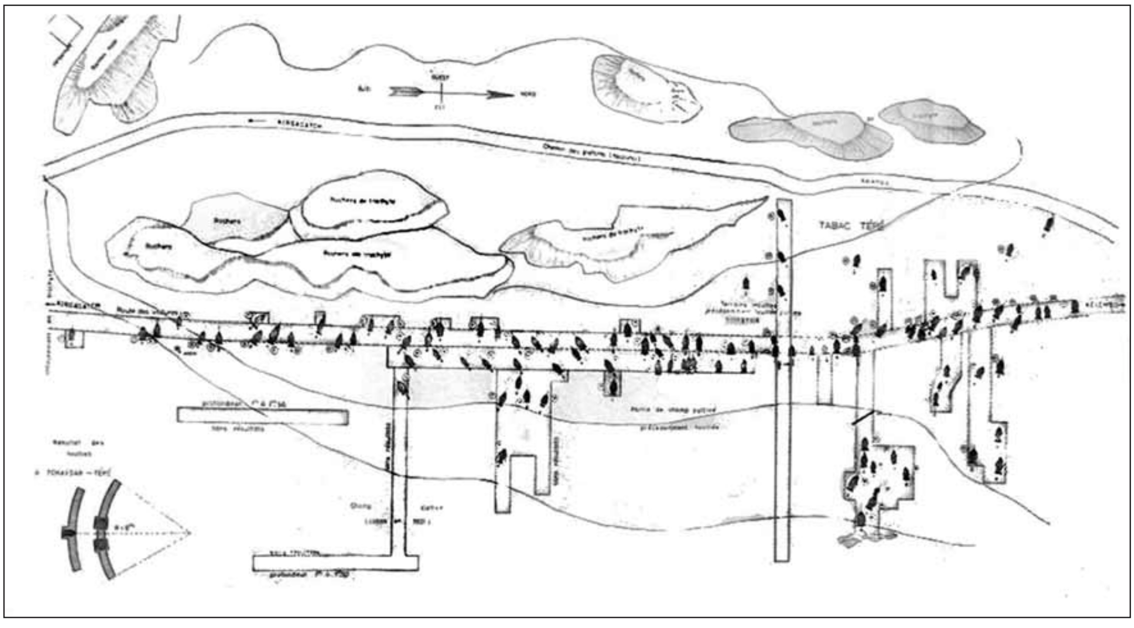


Res.3 Karakurt ovasında İlk Tunç Çağı'na ait iki höyük Akkuş Tepe I ve II.
Fig. 3 Two mound in the Karakurt plain Akkuş Tepe I and II.

Res. 4 Alifakılı Köyü yakınlarındaki Azizkuyusu Höyüğü.
Fig. 4 Azizkuyusu mound near Alifakılı village.



Res. 5 Taban Tepe ve Değirmen Tepe, Gaudin'den.
Fig. 5 Taban Tepe and Değirmen Tepe, from Gaudin (Kamil 1982, plan I).



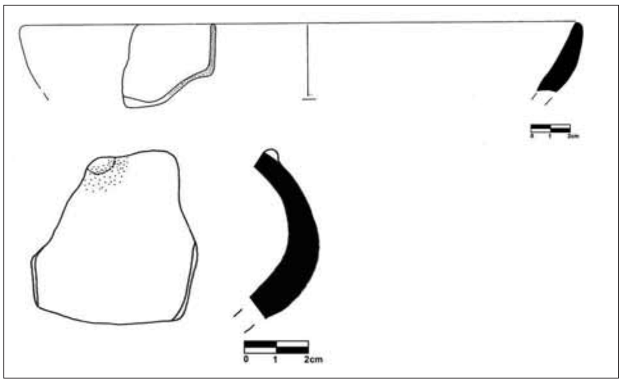
Res. 6 Yortan mezarlığı pithos (küp) mezar örnekleri
Fig.6 Yortan cemetery and examples of pithoi (Kamil 1982, Fig.12).

Res. 7 Taban Tepe ve Değirmen Tepe'nin uydu görüntüleri, (http://earth.google.com/dan alınmıştır).
Fig. 7 Satellite wiev of Taban Tepe and Değirmen Tepe (from http://earth.google.com/)

Res. 8 Karakurt Ovası.
Fig. 8 Karakurt Plain.

Res. 9 Yortan mezarlığı, 2008.
Fig.9 Yortan cemetery in 2008.

Res. 10 Taban Tepe çanak çömleği.
Fig. 10 Pottery sherds from Taban Tepe.



Res.11Taban Tepe çanak çömleği.
Fig.11 Profile drawings of Taban Tepe pottery sherds.

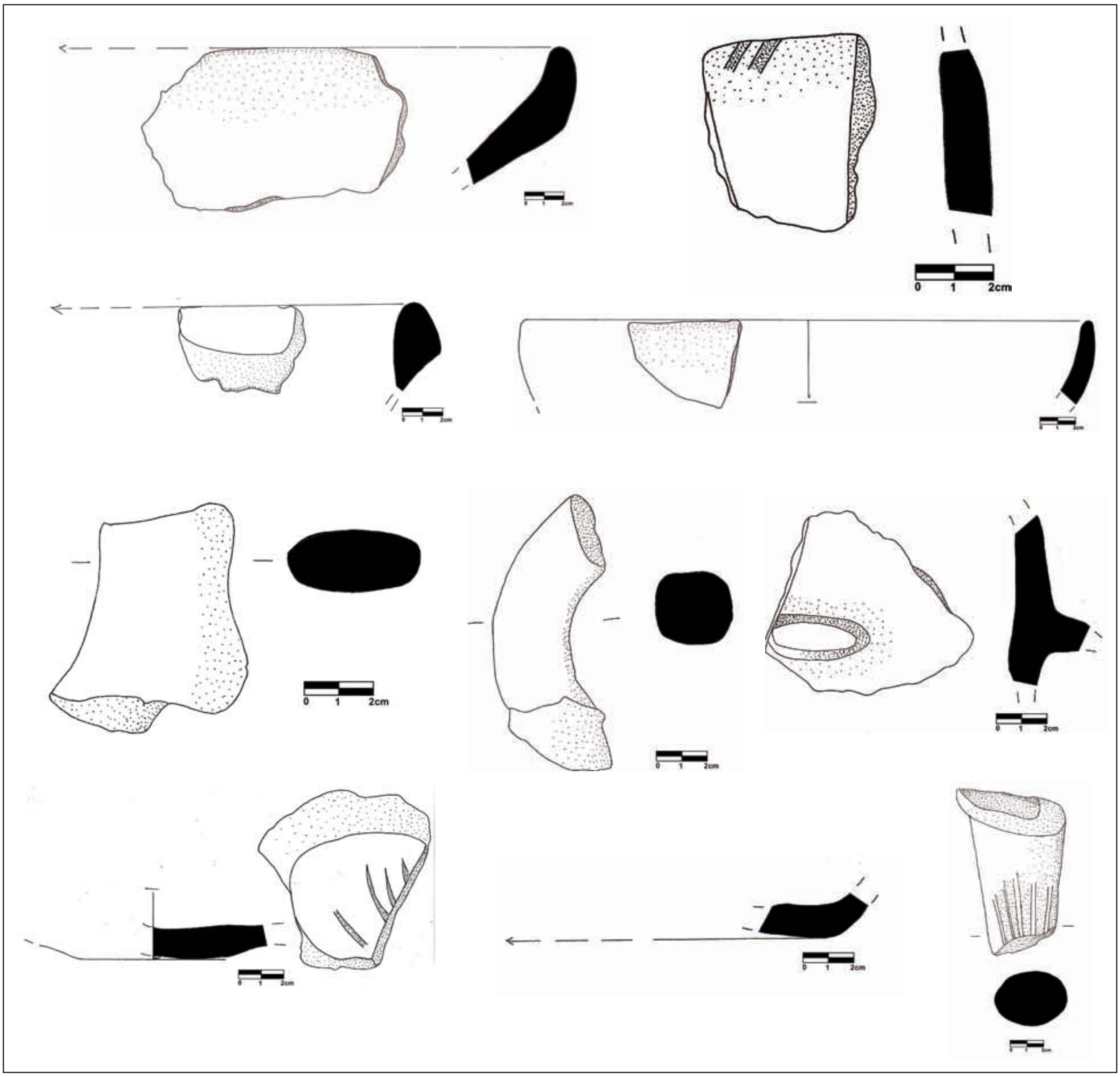
Res. 12 Eski Kırkağaç-Gelenbe Yolu.
Fig.12 Kırkağaç-Gelenbe old motorway.

Res. 13 Değirmen Tepe.
Fig. 13 Değirmen Tepe.

Res. 14 Değirmen Tepe'de Gaudin'in açmalarından biri.
Fig. 14 One of the Gaudin's trench in Değirmen Tepe.

Res. 15 Değirmen Tepe'deki değirmen kalıntısı.
Fig. 15 Değirmen Tepe, ruins of old mill.

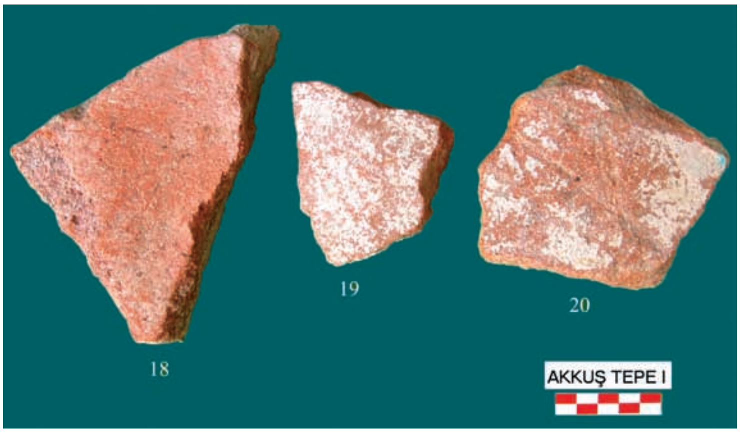
Res.16 Değirmen Tepe'den toplanan çanak çömlek parçaları
Fig. 16 Pottery sherds from Değirmen Tepe.



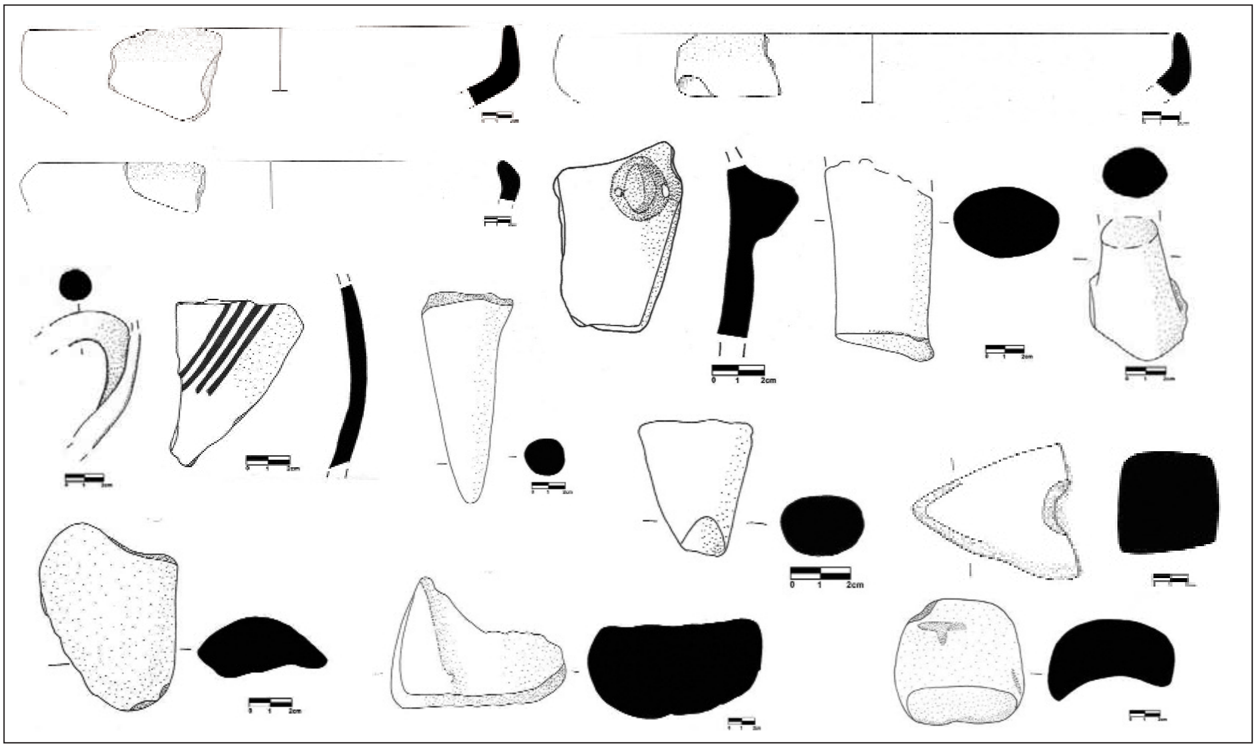
Res. 17 Değirmen Tepe çanak çömlek çizimleri.
Res. 17 Profile drawings of Değirmen Tepe pottery sherds.

Res. 18 Akkuş Tepe I Höyüğü.
Fig. 18 Akkuş Tepe I mound.

Res. 19 Akkuş Tepe I buluntuları.
Fig. 19 Finds from Akkuş Tepe I.



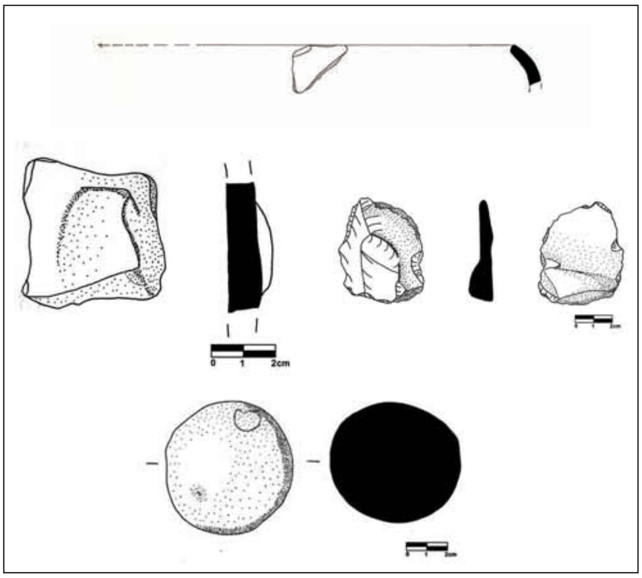
Res.20 Akkuş Tepe I buluntuları
Fig. 20 Finds from Akkuş Tepe I.



Res. 21 Akkuş Tepe I seramik parçalarının profil çizimleri
Res. 21 Profile drawings of Akkuş Tepe I pottery sherds.

Res. 22 Akkuş Tepe II Höyüğü.
Fig. 22 Akkuş Tepe II mound.

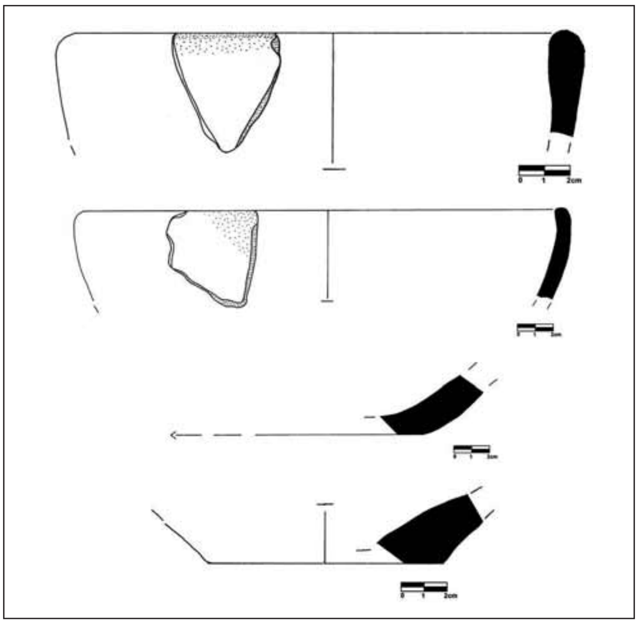
Res. 23 Akkuş Tepe II Höyüğü buluntuları.
Fig. 23 Finds from Akkuş Tepe II mound.



Res.24 Akkuş Tepe II çanak çömleği.
Fig.24 Profile drawings of Akkuş Tepe II pottery sherds.

Res. 25 Azizkuyusu Höyüğü.
Fig. 25 Azizkuyusu mound.

Res. 26 Azizkuyusu Höyüğü buluntuları.
Fig. 26 Finds from Azizkuyusu mound.



Res.27 Azizkuyusu Höyüğü çanak çömleği.
Fig.27 Profile drawings of Azizkuyusu pottery sherds.

Res.28 Karakurt Ovasında Frig dönemine ait bir anıt.
Fig. 28 A Phrygian monument from Karakurt Plain.

APPLICATION OF SOIL ANALYSES AS MARKERS TO CHARACTERIZE A MIDDLE EASTERN CHALCOLITHIC - LATE BRONZE AGE MOUNDS

YAKIN DOĞU'DA KALKOLİTİK – SON TUNÇ ÇAĞ HÖYÜKLERİNİ NİTELEYİCİ TOPRAK ANALİZLERİNE DAİR BİR UYGULAMA

John Ryan - Selim Kapur - Erhan Akça

Key words: Lebanon, Middle East, Chalcolithic, Late Bronze Age, soil analysis, phosphorus, organic matter, weathering, human activity, stratigraphy

Anahtar sözcükler: Lübnan, Orta Doğu, Kalkolitik, Son Tunç Çağ, toprak analizleri, fosfor, organik madde, ayrışma, insan etkinlikleri, tabakalanma

ÖZET

Lübnan'da Bekaa Vadisindeki El-Ghassil Höyüğü Suriye, Türkiye ve Irak'taki tipik höyüklerden biridir. Bu gibi alanlarda değerlendirme yapılırken çalışmaların ağırlığı daha çok tabakalanma ve çeşitli arkeolojik buluntulara verilmekte ve toprak analiz yöntemleri çoğu kez göz ardı edilmektedir. Bu çalışma yüzeyden yaklaşık 6 ile 7 m derinliklere kadar alınan örneklerle, höyük yakınlarından alınan örnekleri içermektedir. Böylece sağlanan organik madde, toplam ve alınabilir fosfor ve demir oksitlerin oranları gibi parametrik verilerden alandaki toprak oluşumunu ve yerleşmenin yoğunlaştığı veya höyüğün terk edildiği dönemleri, dolayısıyla höyükteki insan yaşamının gelişimini aydınlatmak için yararlanılabilir. Ayrıca bir höyüğün ayırt edilmesi zor ve karışık arkeolojik tabakaları -höyük stratigrafisi de, toprak analizleri kullanılarak aydınlatılabilir.

ABSTRACT

Tell El-Ghassil in Lebanon's Beka'a Valley is typical of mounds, in Syria, Turkey, and Iraq. While stratigraphy and human artefacts are used in archaeological investigations of such sites, soil analysis is a less frequently used. This study involved sampling to a depth of about 6 to 7 meters on exposed surfaces of a vertical transect, as well as away from the mound. The data show that parameters such as organic matter, total and available phosphorus, and the proportion of iron oxides are potentially useful indicators of soil weathering and the intensity of human occupation of the site, as well as periods of abandonment, and thus in charting the human evolution of the mound. The diffuse archaeological layers, i.e., the stratigraphy of the mound, which is difficult to distinguish, may also be elucidated with soil analysis.

INTRODUCTION

Archaeologists have long-relied upon artifacts associated with human activity to document the patterns, chronologies and pottery technologies of past civilizations (Henderson 1989: 311, Tite 1989: 116-118, Paynter et al. 2004: 422-425) as well as the soils these materials were extracted from (Kapur et. al. 1998: 183-184, Tite 2008: 220-222). Ample attention was also given to the study of the soils to include micromorphology as a powerful tool. Relatively recent work undertaken at excavations dealing with the characterisation and dating of soil horizons developed in archaeological sections has contributed to the significance of soil development and weathering/decomposition of soils at well known excavation sites of man-made mounds (Eidt 1984: 150). The Middle Eastern region has been the context for examining the civilizations since the beginning of history, with studies conducted in North Mesopotamia-Iraq and Turkey (Stoops and Nijs 1986: 331-333, Weiss et al. 1993: 997-999), the eastern Khabour Basin- Syria (Courty et al. 2008: 215-219), the Madaba-Dhiban Plateau-Jordan (Cordova et al. 2005: 36-40), and the Tigris and Euphrates river basin (Morozova 2005: 41-45).

The approach for this study of an abandoned mound in the Middle East is based on the premise that soil analysis, especially phosphorus (P) as a chemical marker, can complement the conventional archaeological investigations in order to unravel the history of human habitation. The awareness that soil science can add to the archaeologist's endeavors has developed in comparatively recent times (Eidt 1984: 150, Sanchez et al. 1996: 156-160, 1998: 345-350). Recent studies further elucidate phosphorous as a marker in determining degraded archaeological sites with their diffuse stratigraphy/layers incorporated in presently cultivated historical land (Terry et al. 2000: 153-156, Akça et al. 2008: 87). The foregoing study sought to examine an archaeological site in the Middle East using conventional soil analysis with special significance on the phosphorous status of the excavation soils without the use of thin sections regarding the difficulties encountered during the collection of the soils and preparation of the thin sections. These difficulties primarily concern the sampling of the undisturbed soils, that might cause undesired damage at the sampling surface of the selected profile, followed by the tedious thin section preparation methodology that is closely related to the ever-changing composition of the resins used effecting the period and quality of the thin section. Moreover, the cutting (excavation pit) subsequent to sampling has been filled in, thus the mound is no longer available for sampling. The co-author Prof. S. Kapur from the University of Çukurova and the principle author Dr. John Ryan have collaborated in this paper in an attempt to point out the benefit of simple soil chemical analysis in revealing the soil-bound stratigraphy, that would also serve as a preliminary study in the beginning of a mound excavation that should be followed by the ultimate tool of micromorphology. Ultimately, this paper calls for a greater synergy between Soil Scientist and Archaeologist.

ARCHAEOLOGICAL BACKGROUND

Mound represent an example of such former settlement peculiar to the Middle East/Western Asian region (Wilkinson 1976: 280). Some of the major tells in the region are depicted in Fig. 1. The well known fact, that mound are created by the accumulation and weathering of successive levels of human occupation using alluvial clays to construct the walls and roofs of buildings and stables and to enclose courtyards, neighborhoods, and settlements, by the archaeologists is highly intriguing for Earth and Soil Scientists in terms of soil formation. When mud-brick structures reach the end of their usefulness for humans and livestock and/or collapse and are abandoned by their inhabitants, they are often stripped of scarce wood and stone and exposed to weathering (Bullard 1985: 111) or filled in and used as well-drained compact foundations for the next level of structures, all being of strong interest as soil bound natural materials to Soil Scientists, as also exposed to climatic changes in their course of abandonment.

As the build-up of organic materials on site from human and animal waste can make the underlying clay debris unsuitable as a construction material, fresh supplies of well weathered alluvial clays from outside the site tend to be brought in for further building. After several hundreds or thousands of years, a mound is formed from successive phases of building, rebuilding, abandonment and re-occupation superimposed on the rubble of earlier settlements on the same site (Davidson 1976: 261-263). This build-up of sealed deposits provides an opportunity to investigate the development of soils within a closely dated chronological sequence (Haidouti and Yassoglou 1982: 1049).

SOIL INVESTIGATIONS

Soil studies of archaeological sites range from potential and actual erosion (Thornes and Gilman 1983: 93-107), morphology and horizon identification (Haidouti and Yassoglou, 1982: 1048), and chemical analysis (Eidt 1985: 158, Beach and Beach 2008: 420). Analyses that reflect weathering intensity and nutrient accumulation can augment evidence from other approaches. Iron (Fe) solubility in solutions of ammonium oxalate (amorphous) and citrate-dithionite-bicarbonate ("free" or crystalline) reflects weathering intensity in soils, and, by inference, the duration of exposure of a particular surface to the elements of weathering. The ratio of these fractions has been used to indicate relative weathering intensity as a supplement to other criteria (Alexander 1974: 122, Ahmad et al. 1977: 1164).

While "available" phosphorus (P) can build up due to decomposition of plant materials, all of which contain P, as well as ash which is a rich source of P, this fraction tends to "revert" over time to a less soluble fraction. As P is immobile in soils, unless subject to surface erosion, total soil P values reflect accumulation due to plant debris, human and animal excreta, ash, bones, etc (Eidt 1984: 150, 1985: 162-163). Organic carbon (C) and nitrogen (N), as components of organic matter (OM) or material of plant origin, are possible indices of soil change, but are less reliable than P. These elements may disappear from the soil by oxidation, and subsequent volatile loss as carbon dioxide in aerobic and as methane (CH_4) in anaerobic conditions in the case of carbon and ammonia and nitrous oxide in the case of nitrogen, and mineralization to mobile nitrate which may be leached or lost in surface runoff. The rate as well as the extent of these chemical transformations depends on the environment (though ^{14}C dating has been used to establish approximate age of plant remains in soil layers, the presence of known artifacts, i.e., coins and pottery of known historical period, can also be used to define soil age alongside an interpretation of the processes such as bioturbation that may affect any residual soil stratigraphy). Similarly, soluble salts may be ephemeral. Major changes associated with weathering and organic matter accumulation should be reflected in variation in soil color with depth of the accumulated soil (Fitz Patrick 1993: 255-260).

MATERIALS AND METHODS

TELL EL-GHASSIL

Tell El-Ghassil, a mound of approximately 12m in height (Plate 1) above the surrounding ground level, or an elevation of 88 to 100 meters above sea level and one square hectare in area and a slope of up to 35%, is located in the Bekaa Valley, Lebanon, 50 km east of Beirut (Fig. 2). The mound is on the boundary of 100-ha farm of the American University of Beirut's Agricultural Research and Education Center and adjacent private property—the latter half of the mound is off limits to examination and excavation. The climate of the area is typical of the semi-arid Mediterranean agro-ecological zone (Kassem 1981: 11-13), with cold wet winters (mean annual rainfall of 400-500 mm and mean winter temperature of about 5ºC) and hot (30ºC) dry summers. The mound has been cultivated since it was abandoned as an occupation site many centuries ago.

The site was included as a separate "soil unit" in the map prepared by Sarsam (1975: 24). The predominant soil type is a very fine clayey, mixed, mesic, Vertic Xerochrept, developed on alluvium derived from limestone. Nutrient distribution for the farm soil was described by Ryan et al. (1980: 22-30). The adjacent soils exhibited considerable physical and chemical spatial variation consistent with alluvial/colluvial deposition.

The mound owes its existence to human settlement attracted to the perennial spring, 'Ain El-Ghassil' at the foot of the mound at the south side (Fig. 2). The archaeological sequence of the site has been established during excavations between 1956 and 1974 (Baramki 1961: 91, Badre 1982: 126-128). The earliest occupation, during the Bronze Age, extended from about 1200 BC, and lasted until about 600 BC, when the site was finally abandoned. Although clearly stratified deposits from the earliest phases of occupation at the site have not been reached, significant Middle and Late Bronze Age burials (1750-1325 BC ca) and several phases of Iron Age temples have been excavated.

Though the site at Tell El-Ghassil is only partially excavated to a depth of 6-7m (Fig. 2), the purpose of this study was to integrate soil analysis data with previous archaeological observations in order to more accurately establish the site's chronology. A secondary purpose was to evaluate soil chemical data as indices for archaeological work under semi-arid environments. Unfortunately due to logistical constraints in the area, more complete morphological examination was not possible.

PROCEDURE

The 1-ha site was sampled on the surface in each direction of the compass from its center, i.e., north, south, east and west. The samples were taken at the ridge of the tell, the mid and toe slopes, and in the adjacent field or non-tell area on the northern side. In each case, surface debris was cleared away and a composite sample was obtained from 15-20 sub-samples. Samples were also obtained from the vertical sections of the cutting or excavation facing east and west. Samples were taken on systematic basis every 50 cm to a depth of about 6 -7m based on the average depths encountered in the previous mound studies and experience of the authors obtained at field studies on the stratigraphic distributions/depths at relevant conditions. They were obtained by scraping away the exposed/weathered surface layer and taking a core sample at about 10 cm into the excavated pit face.

The samples were then taken to the laboratory, air-dried, and passed through a 2-mm sieve for subsequent chemical and physical analysis, as follows by standard procedures (Black 1965: 1572). Soil pH was conducted by the glass electrode (soil: solution, 1:2.5); electrical conductivity (EC) by a resistance bridge from a similar soil solution extract; total calcium carbonate ($CaCO_3$) equivalent by acid neutralization followed by titration; organic matter by potassium dichromate digestion; total soil nitrogen by the Kjeldahl digestion procedure; total P by perchloric acid digestion followed by colorimetric determination with vanado-molybdate; available phosphorous by extraction with 0.5 M sodium bicarbonate ($NaHCO_3$) and determination with ascorbic acid; soil texture by the Buoyoucos hydrometer; and soil color according to the Munsell colour chart. Soil iron was extracted with acid ammonium oxalate (amorphous) and a solution of citrate-dithionite-bicarbonate ("free Fe - iron"-mainly crystalline) as described by Alexander (1974: 123).

RESULTS

The impact of occupation on the mound can be seen by considering surface soil properties in each direction from the top of the mound to adjacent non-tell fields (Table 1). Differences between the tell and the fields were evident for some parameters, but not for others. There was no difference in soil texture (most samples were clay), pH or soluble salts. With the site's elevation and the moderate rainfall (400-500 mm) any build up of salts was unlikely. As might be expected, pH values were relatively constant due to the solid- phase calcium carbonate. However, while N and organic matter data were variable, calcium carbonate values tended to be higher on the mound than in adjacent fields, but considerable variation in calcium carbonate is a feature of such colluvium/alluvium derived from limestone (Badre 1982: 128). Similarly, most values for both available phosphorous and total phosphorous were higher on the mound.

The inherent variability in the data was reduced by averaging the depth-wise values at both sides of the excavation as well as all surface samples and by comparing them with average field values (Table 2). Thus, more reliable conclusions could be drawn. When surface samples from the tell were compared with depth, the only obvious differences were with organic matter, which were higher, and sodium bicarbonate-phosphorous values which were lower than average values with depth. There were no consistent differences in other properties between surface and depth wise samples on the mound.

Clear differences were evident between average mound and non-mound values. The mound had considerably higher levels of calcium carbonate, both available and total phosphorous, soluble salts, and proportionately more sand and silt. As expected, pH values did not differ between the mound and the field. However, the mound had lower levels of organic matter and consequently lower nitrogen levels. Both forms of iron (i.e. amorphous and "free") were also lower, with proportionally less clay. It is of interest to note that the proportion of amorphous to "free" iron was relatively constant between the tell and adjacent fields, ie at 0.36 to 0.38, indicating similar weathering intensities in the soil of the tell and that of the surrounding field.

In view of these differences in soil enrichment or depletion, the distribution of these parameters with excavation depth was presented. Not only were differences with depth evident (Fig.'s 3 and 4 -broken and solid lines stand for either sides of the Tell) but also depending on the location of the depth-wise probe (ie at opposite sides of the excavation separated by a distance of about 10 m). The fluctuation of some of the contents of the soil attributes with depth, such as the available and total phosphorous, organic matter, nitrogen and the salt as well as the clay contents, around the depths of 1, 3 and 4 m may well be the markers of archaeological stratigraphy/layering.

Consistent with soil having solid-phase calcium carbonate, soil pH showed little depth-wise distribution. Though somewhat erratic, both calcium carbonate and clay values tended on average to be relatively uniform with depth. This is consistent with the notion that the materials used to build the mound came from the same source, with a relatively constant amount of $CaCO_3$ in the clay-sized fraction. Though the distribution of sodium bicarbonate-phosphorous was highly erratic, the average values from both sides of the excavation tended to range from 100 to 150 $mg.kg^{-1}$ with no evident decrease with depth. The two-to three fold increase in available P due to man's activity, eg. ash from burning organic materials- food residues- and bones, both being rich sources of phosphorous, can be seen from a comparison of unfertilized adjacent soil phosphorous values (Ryan et al., 1980: 33-38) and from the ancient bones found in the burials of the mound (Badre 1982: 129-130). Exhibiting a similar erratic distribution, total phosphorous values tended to increase with depth.

However, some parameters showed some consistent changes. Organic matter was uniform with depth, i.e., at about 0.8% at 2.5 to 3.5 m. At lower depths, the organic matter content showed a peak of about 2.75% at 2.5m for one side of the excavation and a similar peak at 4.0 m at the same side. As nitrogen is a relatively constant constituent of organic matter, its distribution followed that of organic matter, with increases from 0.08% to about 0.15% at the 3 and 4-m peaks. Though average salinity values were relatively low, i.e., about 0.2 $ds.m^{-1}$, the distribution showed peaks together with the clay percentage at the 3 to 4-m depth, similar to, but not coinciding exactly, with those for organic matter and nitrogen.

Measurements of soil colour with excavation depth and on the surface showed little variation in this property. Cultivated surface samples were brown (10 YR 5/6) to pale brown (10 YR 6/3). The peaks for organic matter at 3 to 4 m depth showed a slight color change to dark brown (10 YR 3/3) to grayish brown (10 YR 5/2).

DISCUSSION

This study of a partial excavation of a typical mound in the Middle East region indicated that in the absence of apparent physical differentiation in soil properties within the mound, some chemical indices served as indicators of man's activities during the various phases of its evolution. This also yielded clues/markers to the probable diffuse archaeological stratigraphy, i.e., the long-standing layers of human settlement rather than the features of soil development, primarily of soil structure and abrupt changes in color, as observations of the face of the exposure indicated no evidence of pedogenesis or horizon development. Not surprisingly, Eidt (1985: 150) in his overview of such a pre-historic settlement indicated that because of the low weathering intensity, mound in arid/semi-arid areas are unlikely to exhibit features of normal soil development due to the low rainfall; the constant mixing due to human traffic would cause homogenization and prohibit any differentiation to occur, thus, implying to the effect of human activities

causing the formation of the different layers.
The sampling procedure applied in this study is different compared to the well-known drilling method that would need deep augering through the mound causing some destruction, which is unacceptable in archaeological investigations. Moreover, the soil samples were collected simultaneous to the excavation study adding value to archaeological study in need of utmost care in preserving the nature of the mound. On the other hand, the sampling procedure may also help archaeologists, facing difficulties in determining the diffuse stratigraphy of the mound, to start off with some guiding information provided by soil analyses as stated above.

The weak weathering intensity and limited exposure to the elements for a short period of time (from 7000 to 3200 yr BP/ from Early to Late Holocene) in terms of soil development and uniform climate (of that part of the Holocene prevailing at the site) are also reflected in the low ratio of oxalate to citrate-dithionite-bicarbonate iron in the samples. It can be assumed that the chemical and physical composition of the mound is similar to the surrounding soil, since the mound would most probably have been built with local materials. This is in contrast to sites when buildings were made of stone, which often were transported great distances. Examples of such sites are the Greek-Roman site in nearby Baalbek to the north and in Anjar to the east.

Despite this similarity, some physical differences might be expected between mound and the soil of the surrounding area. As the edges of mound are steeply sloping (over 12%), erosion is likely to occur, thus depleting the finer clay fraction and enrich the foot slope with finer depositional material. Despite such expectations, no clear catenary differences in texture were detected. If there were indeed any textural changes with slope position it might have been masked by the mixing effect of cultivation of the surface soil on and around the mound. These probable and expected changes of the surface soil after cultivation, need to be defined as the changing parameters of the habitated areas (Akça 2008: 89-92), whereas it is well known that the ephemeral characteristics such as organic matter, nitrogen and carbon, as well as available phosphorous have been influenced by centuries of human cultivation, especially in the recent decades of fertilizer use.

Of the chemical parameters used to characterize the evolution and build-up of the mound, the most sensitive indicators are phosphorous and organic matter. Much has been written about phosphorous in mound development (Eidt 1985: 150). In this case, it was clear that the available phosphorous levels are derived from ash from burning of fuel wood, as well as from mineralization of organic material and decomposition of bones (Badre 1982: 127-130). The values of 100-250 mg kg^{-1} throughout the 6-7 m transect are 10-20 times higher than in the corresponding soil in the field without any history of fertilization. The high values in the topsoil surrounding the mound were due to over-fertilization with superphosphate for many years at the research station where the mound is located. The phosphorous enrichment in the tell itself obviously came from mans activity.

Due to the dynamics of soil phosphorous in which relatively soluble “available” P gradually reverts to insoluble forms, total phosphorous, which encompasses both soluble and the much larger insoluble fraction, total phosphorous values showed “peaks” and “troughs” at various depths, but a general increase with depth. It might be reasonable to assume that these peaks may reflect periods of extensive human occupation.

Other measurements also showed distinct peaks with depth. For example, there was a threefold increase in organic matter at around 3 to 4 m and the discrepancy between the two samplings was due to the variation at the north and south faces of the excavation. As nitrogen is related to organic matter, the peaks were similar. Those peaks may reflect a time when the site was abandoned and given over to natural vegetation which would enhance the soil organic matter content through root biomass and incorporation of surface biomass. While electrical conductivity did show some peaks, the actual values were low, but could have indicated a dry period when some salts from natural soil weathering or by the input of salt-laden windblown material would accumulate, as has been the case throughout the Eastern part of the Mediterranean Basin and the Middle East since the Early Holocene (Kubilay et al., 1997).

In conclusion, the study shows that some chemical analyses from Middle Eastern mound, or elevated human occupation sites, notably forms of phosphorous, organic matter, and iron can serve as useful indicators of how soils have been historically used by man. The conventional archaeological approaches involving the identification of pottery and other human artifacts, in addition to sophisticated soil micromorphological identification conducted by the use of the polarised and electron microscope, together with these simple chemical analyses can help to elucidate the very complex history of evolution of human habitation over the millennia of man's existence in the Middle East region. The approach is but one piece in the puzzle that enables archaeologists to develop a picture of the chronology of mound. The sampling procedure implemented in thiş study is also recommended together with the type of soil analyses at similar sites for the preservation of the man-made mounds, determination of the human activities and the tentative determination of the archaeological stratigraphy.

NOTE

Prof. S. Kapur in charge of a thin section laboratory and head of the Archaeometry Department of this University and Dr. John Ryan former Professor of Soil Science in the American University of Beirut, presently working in ICARDA, Syria has collaborated extensively with Çukurova University over the past ten years.

REFERENCES

Ahmad, M., J. Ryan and R.J. Paeth 1977
"Soil development as a function of time in the Punjab river plains of Pakistan", *Soil Science Society of America Proceeding* 41: 1162-1166.

Akça, E. et al. 2008
"Differentiating the natural and man-made terraces of Lake Van, Eastern Anatolia, utilising earth science methods", *Lakes & Reservoirs: Research and Management* 13: 83-93.

Alexander, E.B. 1974
"Extractable iron in relation to soil age on terraces along the Truckee River, Nevada", *Soil Science Society of America Proceedings* 38: 121-124.

Badre, L. 1982
"Tell El-Ghassil: Tomb 1", M. Yan (ed.) *Archaeologie du levant*: 123-132. Maison de l'Orient, Lyon.

Baramki, D. 1961
"Preliminary report on the excavation at Tell El-Ghassil", *Bulletin du Musée de* Beyrout 16: 87-97.

Beach, T. and Sh. Beach Luzzadder 2008
"Geoarchaeology and Plain Aggradation around Kinet Höyük, an Archaeological Mound in the Eastern Mediterranean, Turkey", *Geomorphology* 101/3: 416-428.

Black, C.A. 1965
Methods of soil analysis. Agron No. 9, American Society of Agronomy, Madison.

Bullard, R.G. 1985
"Sedimentary environments and lithologic materials at two archaeological sites", G. Rapp and J.A. Gifford (eds.) *Archaeological Geography*: 103-133. Yale University Press, New Haven.

Cordova, C., C. Foley, A. Nowell and M. Bisson 2005
"Landforms, sediments, soil development and prehistoric site settings in the Madaba-Dhiban Plateau, Jordan", *Geoarchaeology* 20: 29-56.

Courty, M.A. et al. 2008
"Regional manifestation of the widespread disruption of soil-landscape by the 4 kyr BP impact-linked dust event using pedo-sedimentary micro-fabrics", S. Kapur, A.R. Mermut and G. Stoops (eds.) *New Trends in Soil Micromorphology*: 211-236. Springer Verlag, Berlin.

Davidson, D.A. 1976
"Processes of tell formation and erosion", D.A. Davidson and M.L. Shockley (eds.) *Geoarchaeology*: 255-265. Duckworth, London.

Eidt, R.C. 1984
Advances in abandoned settlement analysis. Application to prehistoric anthrosols in Colombia, South America. University of Wisconsin, Milwaukee.

Eidt, R.C. 1985
"Theoretical and practical considerations in the analysis of anthrosols", G. Rapp and J.A. Gifford (eds.) *Archeological Geology*: 155-189. Yale University Press, New Haven.

Fitzpatrick, E.A. 1993
Soil Microscopy and micromorphology. John Wiley & Sons, Chichester.

Haidouti, C. and N.J. Yassouglou 1982
"The genesis of certain soil profiles on an archaeological site in southern Greece", *Soil Science Society of America Proceedings* 40: 1047-1051.

Henderson, J. 1989
Scientific Analysis in Archaeology. University of Oxford, Committee for Archaeology, Monograph 19, Oxford.

Kapur, A. et al. 1998
"Mineralogy and Micromorphology of Iznik Ceramics", *Anatolian Studies* 48: 181-189.

Kassem, A. 1981
"Climate, soil and land resources in North Africa and West Asia", *Plant and Soil* 58/1: 28.

Kubilay, N. et al. 1997
"Seasonal chemical and mineralogical variability of atmospheric particles in the coastal region of the Northeastern Mediterranean", *CATENA* 28/3-4: 313-328.

Morozova, G.S. 2005
"A review of Holocene avulsions of the Tigris and Euphrates Rivers and possible effects on the evolution of civilizations in Lower Mesopotamia", *Geoarchaeology* 20: 401-423.

Paynter, S., F. Okyar, S. Wolf and M. Tite 2004
"The Production Technology of Iznik Pottery-A Reassessment", *Archaeometry* 46/3: 421-437.

Ryan, J., G. Musharrafieh and A. Barsumian 1980
Soil fertility characterization at the Agricultural Research and Education Center of the American University of Beirut. Publ. No. 64: 1-47, Faculty of Agriculture and Food Sciences, Beirut.

Sanchez, A.A., M.L. Canabata and R. Lizcano 1996
"Phosphorus analysis in archaeological sites: an optimization of the method and interpretation of the results", *Archaeometry* 38: 151-164.

Sanchez, A.A., M.L. Canabata and R. Lizcano 1998
"Archaeological and chemical research on sediments and ceramics at Polideportivo (Spain): An integrated approach", *Archaeometry* 40: 341-350.

Sarsam, A.A. 1975
Map and characteristics of soils on the Agricultural Research and Education Center of the American University of Beirut. M.Sc. Thesis. American University of Beirut, Beirut.

Stoops, G. and R. Nijs 1986
"Micromorphological characteristics of some tell materials from Mesopotamia", *Pedologie* 36: 329-336.

Terry, R.E. 2000
"Quantitative phosphorous measurement: A field test procedure for archaeological site analysis at Piedras Negras, Guatemala", *Geoarchaeology* 15/2: 151-166.

Thornes, J.B. and A. Gilman 1983
"Potential and actual erosion around archaeological sites in southeast Spain", *Rainfall Simulation, Rain off and Soil Erosion*: 91-113. CATENA Supplement 4, Elsevier, Amsterdam.

Tite, M.S. 1989
"Iznik pottery: An investigation of the methods of production", *Archaeometry* 31/2: 115-132.

Tite, M.S. 2008
"Ceramic production, provenance and use - a review", *Archaeometry* 50/2: 216-231.

Weiss, H. 1993
"The origin and collapse of Third Millennium North Mesopotamian civilization", *Science* 261: 995-1004.

Wilkinson, T.J. 1976
"Soil and sediment structures as an aid to archaeological interpretation: Sediments at Dibsi Faraj, Syria", D.A. Davidson and M.L. Shackley (eds.) *Geoarchaeology*: 275-288. Duckworth, London.

Direction from Tell Center	Location	Soil Properties							
		pH	Electrical Conductivity	Calcium Carbonate	Organic Matter	Nitrogen	Phosphorus Total	NaHCO3	Texture
			dSm-1	%			mg kg-1		
East	Top	8.2	0.16	24	1.8	0.12	0.12	0.27	Clay
	Mid-slope	8.4	0.16	29	1.3	0.10	0.10	0.30	Clay
	Foot-slope	8.1	0.17	29	1.6	0.12	0.14	0.32	Clay
	Field	8.3	0.16	15	1.8	0.14	0.12	0.20	Clay
North	Top	7.9	0.16	29	1.7	0.10	0.33	44	Clay
	Field	8.0	0.30	29	1.7	0.10	0.32	70	Clay loam
	Foot-slope	8.1	0.15	31	1.6	0.12	0.32	52	Clay
	Mid-slope	7.9	0.21	28	2.7	0.19	0.27	49	Clay
South	Top	8.3	0.18	34	1.2	0.07	0.43	163	Clay loam
	Mid-slope	8.1	0.21	29	1.4	0.11	0.34	54	Clay
	Foot-slope	8.2	0.14	28	1.5	0.11	0.30	41	Clay
	Field	8.0	0.18	22	2.0	0.14	0.27	39	Clay
West	Top	8.2	0.15	23	2.4	0.17	0.37	54	Clay
	Field	8.2	0.16	30	2.1	0.13	0.39	88	Clay
	Foot-slope	8.1	0.18	26	2.7	0.19	0.34	44	Clay
	Mid-slope	8.1	0.18	20	1.9	0.14	0.27	29	Clay

Table 1. Selected soil properties of the Tell El-Ghassil site.
Çizelge 1. El-Ghassil Höyüğü alanının seçilmiş toprak özellikleri

Property	Tell Surface	Depth*		Average	Non-Mound	Mound: Non-Mound Ratio
		A	B			
CaCO3, %	28.4	29	28.	28.6	21	1.36
OM, %	1.75	1.39	1.07	1.40	2.1	0.67
Total-P, %	0.34	0.37	0.38	0.36	25	1.44
NaHCO3-P, mg kg-1	2.82	130	130	107	38	62
N, %	0.12	0.08	0.08	0.09	0.15	0.62
pH	8.17	8.1	8.2	8.2	8.0	1.03
E.C. dS m-1	0.18	0.28	0.29	0.25	0.18	1.39
Fe-oxalate	1.37	1.64	1.66	1.56	2.32	0.67
Fe-CDB, mg kg-1	5.36	4.28	4.21	4.62	6.45	0.72
Fe-ox/Fe-CDB	0.25	0.38	0.39	0.38	0.36	
Clay, %	43.3	38.7	42.5	41.5	59.2	0.70
Sand, %	29.4	31.8	30.6	30.6	22.8	1.34
Silt, %	29.3	29.5	27.5	28.8	18.0	1.60

Table 2. Surface and depth-wise soil analysis of Tell El-Ghassil site in relation to adjacent non-mound soil.(from the top of the mound).
Çizelge 2. El-Ghassil Höyüğü alanının yüzey ve derinlikten alınan topraklarının yakından alınan höyük dışı topraklarıyla (höyüğün olan ilişkisi

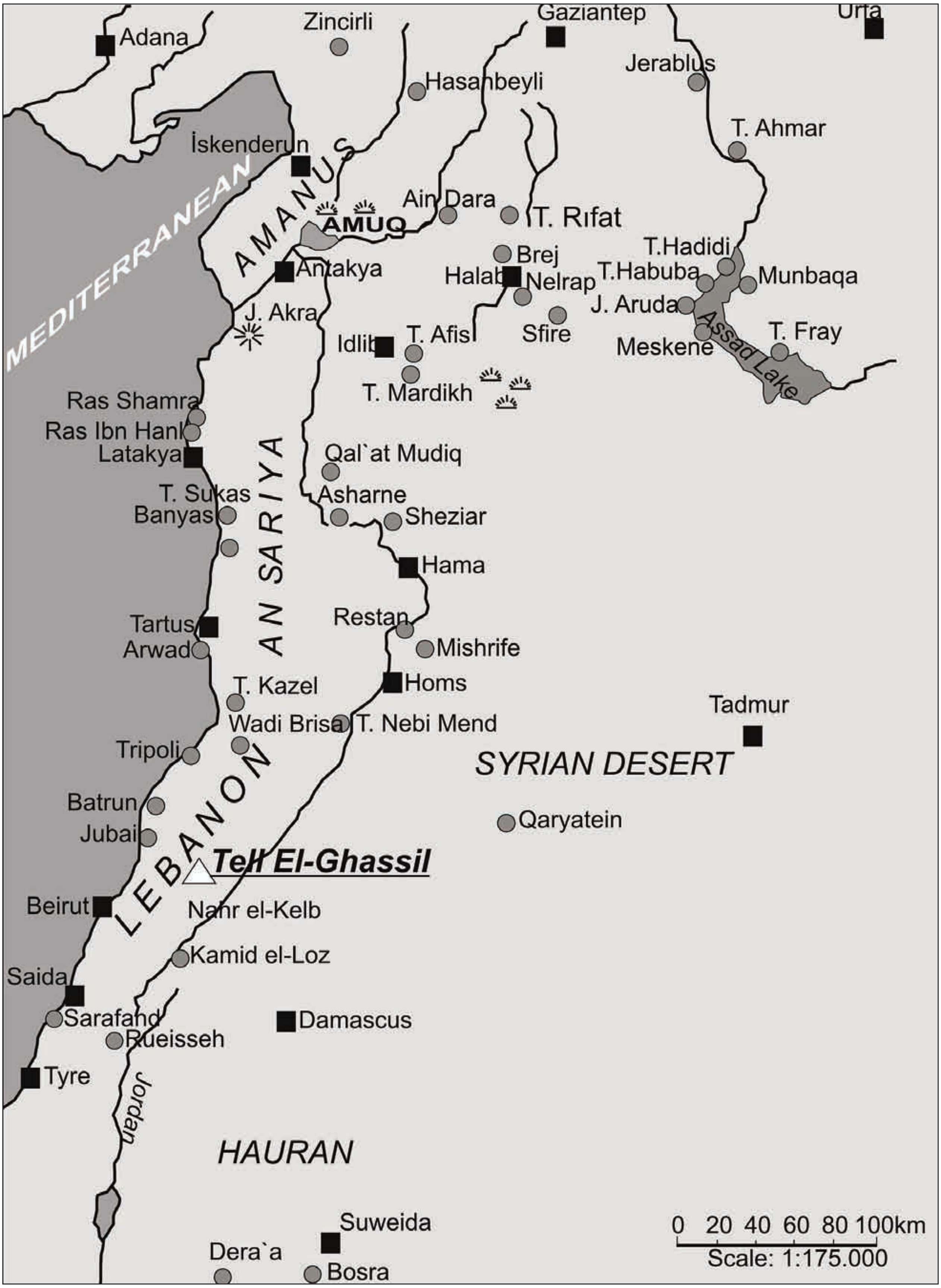


Fig. 1. The major Mound of the Middle East and Location of Mound El-Ghassil.
Res 1. Orta Doğu'daki başlıca Höyükler ve El-Ghassil Höyüğü'nün konumu

Fig. 2. The Tell El-Ghassil and the surrounding cultivated soil
Res 2. El-Ghassil Höyüğü ve çevreleyen işlenen topraklar

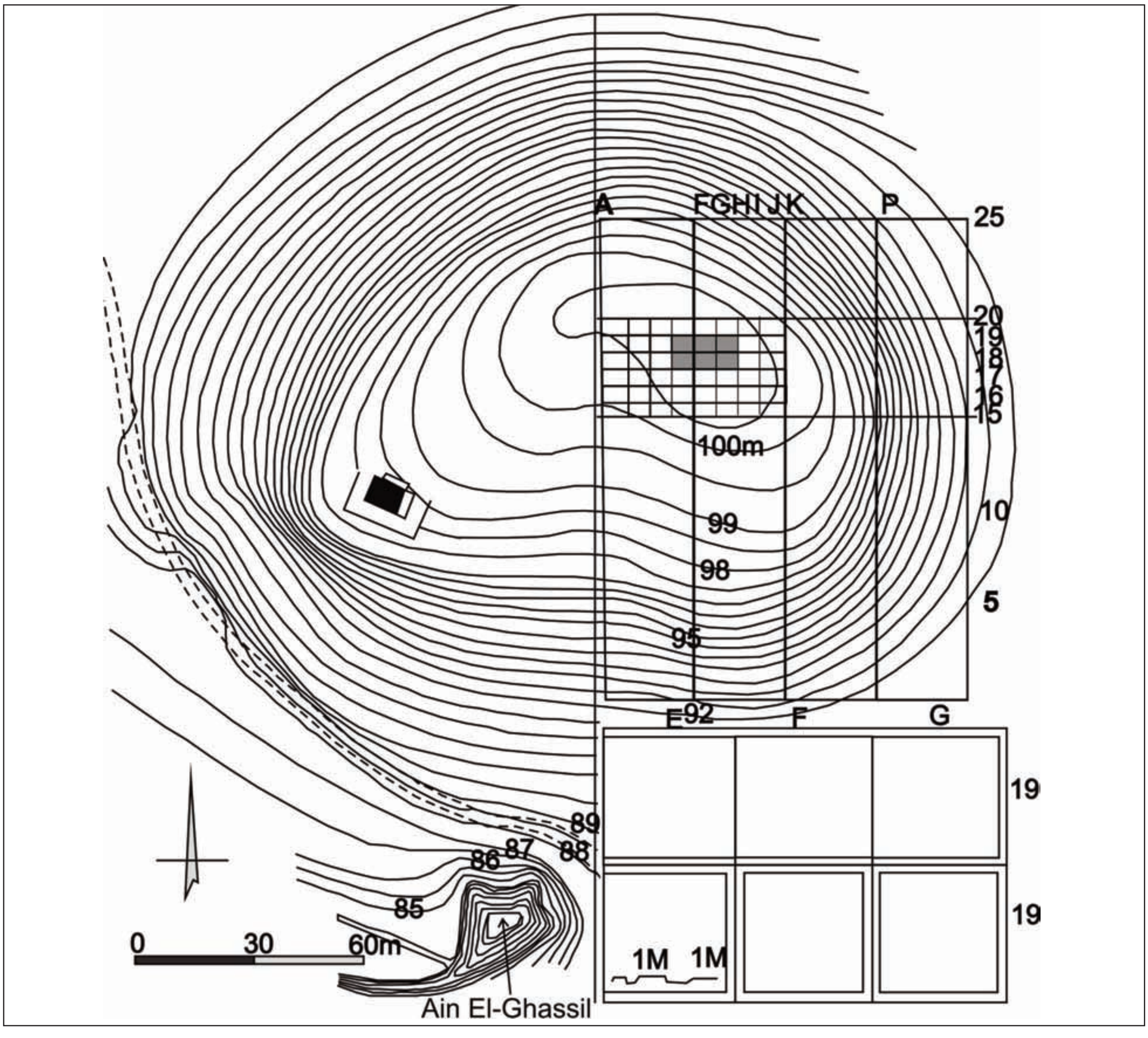


Fig. 3. The topographic setting and excavation of the Tell El-Ghassil.
Res. 3. El-Ghassil Höyüğü'nün topoğrafik konumu ve kazısı.

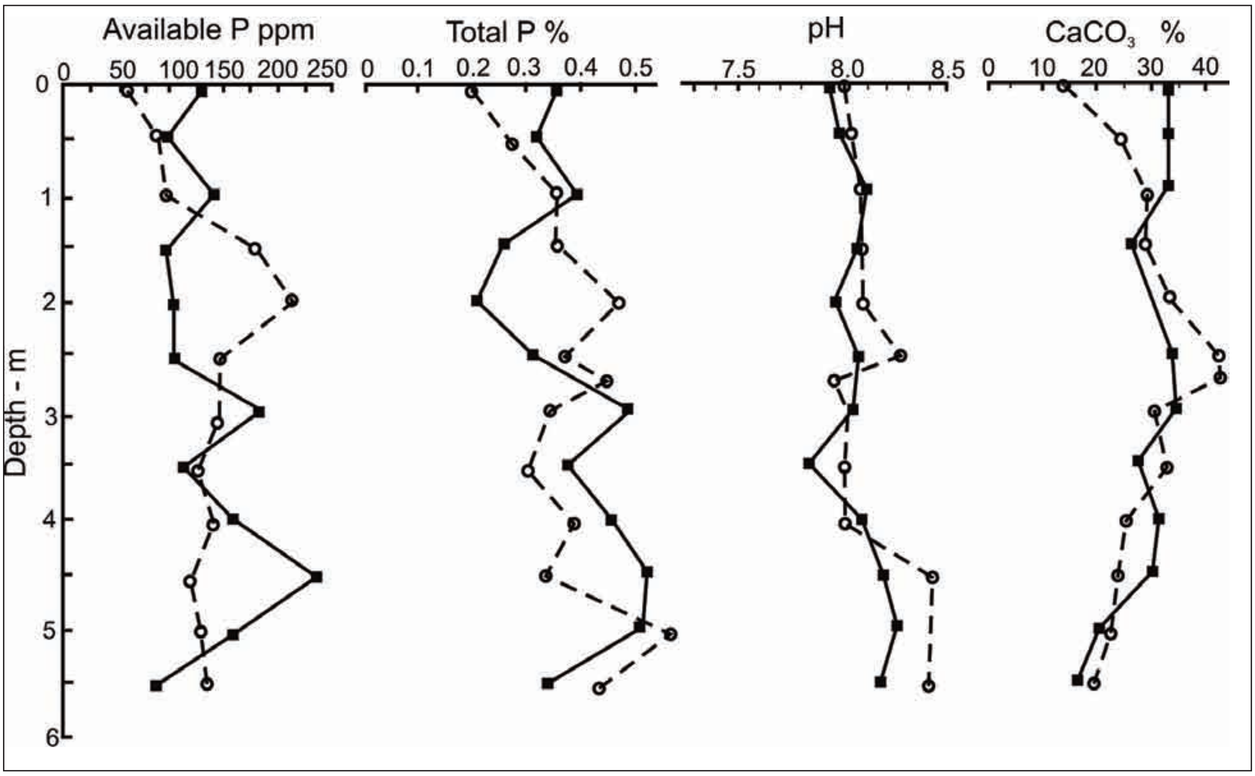


Fig. 4. Some of the depth-wise chemical analyses of the mound soils.
Res. 4. Höyük topraklarının derinliğe bağlı kimi kimyasal analizleri

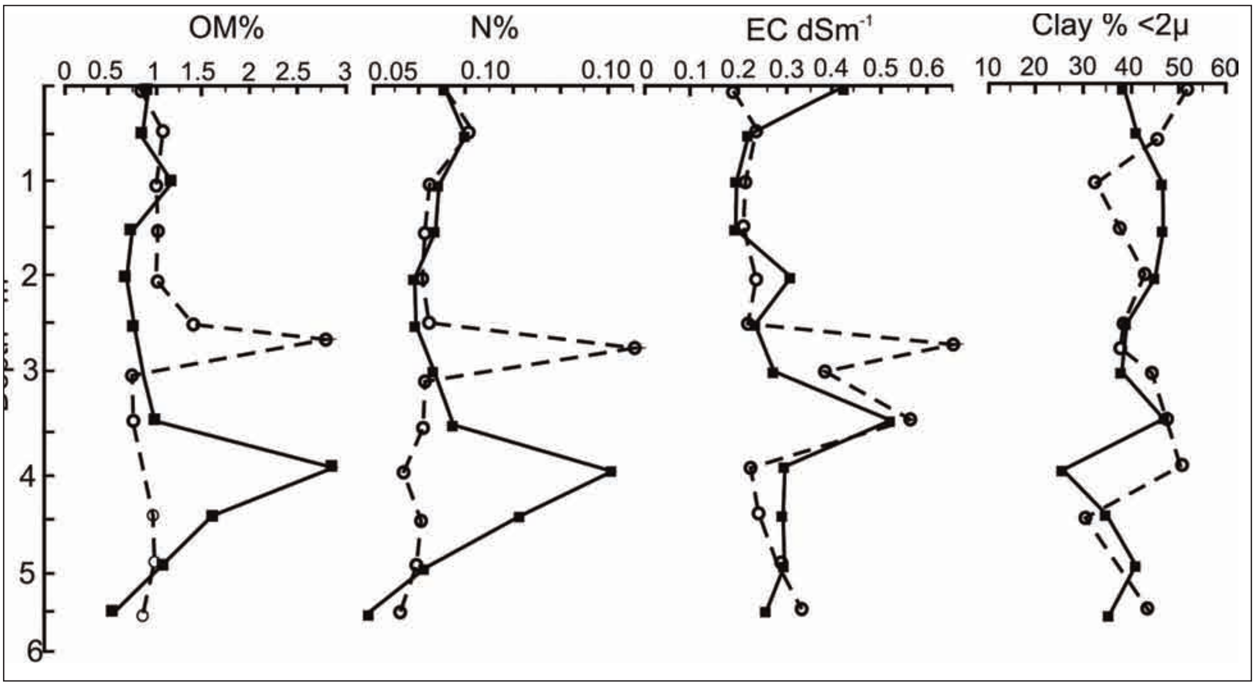


Fig. 5. Some of the depth-wise physical and chemical analyses of the mound soils.
Res. 5. Höyük topraklarının derinliğe bağlı kimi fiziksel ve kimyasal analizleri

KUZEY TROAS BÖLGESİ YÜZEY ARAŞTIRMALARI: PERKOTE VE PALAIPERKOTE'NİN YER BELİRLENMESİNE İLİŞKİN SORUNLAR

SURFACE INVESTIGATIONS IN THE NORTHERN TROAD: PROBLEMS ON THE LOCALIZATIONS OF PERCOTE AND PALAE-PERCOTE

Nurettin ARSLAN

Anahtar sözcükler: Arisbe Arkaik Çağ çanak çömleği, Bergaz, Gri mal, Tunç Çağ, Erdağı, Lampsakos, Palaiperkote, Praktios, Perkote, Troas, Umurbey.

Keywords: Arisbe Archaic pottery, Bergaz, Gray Ware, Bronze Age, Erdağı, Lampsacus, Palae-Percote, Praktios, Percote, the Troad, Umurbey.

ÖZET

Troas bölgesinin kuzey kesiminde yürütülen arkeolojik araştırmalar, bölgedeki antik yerleşimler hakkında bilgi edinmek amacıyla yapılmaktadır. Abydus, Lampsacus, ve Parium gibi büyük yerleşimlerin yanı sıra kuzey Troas'da, Arisbe, Percote ve Paisus gibi daha küçük yerleşim birimleri de bulunmaktadır. Bu yazı, bölgenin küçük yerleşimlerinden biri olan Percote hakkında elimizdeki arkeolojik verileri değerlendirmektedir. Atina kabileler listesinde Percote yerleşmesinin adı Palae- Percote Yeni – Percote) ile beraber anılmaktadır. Bu durum, çoğu kez Percote halkının kurduğu yeni bir şehir için de kullanılmaktadır. Umurbey'in doğusunda yer alan Erdağı bölgesi, uzun süre Palae- Percote şehrinin yeri olarak düşünülmüştür. Yeni Percote şehrinin Umurbey (Bergazi), Narlıçeşme yahut Kemiklialan köylerinden birinde yer alması öngörülmektedir. Yüzey araştırmaları sırasında Erdağı'da, yıkık bir duvar haricinde bir yerleşime ait hiçbir bulgu ele geçmemiştir. Buna karşın, Umurbey'de (Bergaz), Arkaik Devre, hatta daha da eskiye, Tunç Çağ'larına tarihlenebilecek bir yerleşime dair izler bulunmuştur. Son arkeolojik buluntular Palae- Percote'nin yerini Umurbey köyü olarak saptamamızı sağlamıştır. Hellaspontus (Hellas köprüsü) yer alan Kemiklialan köyünün ise Yeni Perkote olabileceği hakkında da hiçbir veri mevcut değildir.

ABSTRACT

Archaeological investigations were carried out in the northern parts of the Troad to reveal information on the ancient settlement patterns. In addition to large cities such as Abydus, Lampsacus, and Parium, there are also small settlements such as Arisbe, Percote, and Paisus in the northern Troad. This essay evaluates the available archaeological evidence regarding Percote, one of the small cities of the region. In the Athenian tribute lists, the name of Percote appears together with Palae-Percote. This is often linked to the establishment of a new city by the people of Percote. The district of Erdağı to the east of Umurbey was long thought to be *the place where the city of Palae-Percote existed. There are proposals that the new Percote should be located at the villages of Umurbey (Bergaz), Narlıçeşme, or Kemiklialan. Besides a fallen wall, no evidence for occupation was detected at Erdağı during the surveys investigations. In contrast, a settlement dating back to as early as the Archaic period and even Bronze Age has been detected at Umurbey (Bergaz). New archaeological finds make it possible to locate Palae-Percote at Umurbey, whereas there is no evidence to locate the new Percote at the village of Kemiklialan located on the Hellespont.*

GİRİŞ

Anadolu'nun kuzeybatısındaki Biga Yarımadası, Antik Çağ'daki adı ile Troas Bölgesi, 16. yüzyıldan itibaren birçok gezgin ve araştırmacı tarafından ziyaret edilmiştir (Cook 1973, 14-44; Cobet 2003, 331-365). Arkeolojinin henüz yeni bir bilim dalı olma yolunda olduğu, 19. yüzyılın sonlarında, bölgenin güneyindeki Assos (Clarke – Bacon – Koldewey 1902-1921), Neandria (Koldwey 1891) ve Troia'da kazılar yapılmıştır (Schliemann 1881). Ayakta kalmış kalıntılar ve İlyada destanı nedeni ile Troas'ın güneyine olan ilgi, daha sonraki yüzyıllarda da devam etmiştir. Bazı kaynaklarda Mysia bölgesine dahil edilen Troas'ın kuzey kesimi araştırmacıların yeterince ilgisini çekmemiştir (Res. 1). Bölgenin kuzeydeki Prehistorik Çağ yerleşmeleri, M. Özdoğan (Özdoğan 1989, 443-457; Özdoğan 1993, 151-163) tarafından araştırılmıştır. C. Başaran, Parion'daki yüzey araştırmasının ardından, 2005 yılında kazılara başlamıştır (Başaran 1999, 349-364; Başaran - Tavukçu 2007 609-628). B. Rose'un 2004 yılında Granikos Vadisi'nde başlayan yüzey araştırması 2008 yılında son bulmuştur (Rose – Körpe 2008, 103-116). Çanakkale Arkeoloji Müzesi tarafından, Biga ve Çan ilçelerinde yapılan kurtarma kazılarında arkeoloji dünyasının özgün eserleri gün yüzüne çıkartılmıştır. Bunlar, Parion'un doğusunda Kızöldün Tepesi'ndeki Polyksena lahdi (Sevinç 1996b; Sevinç 1996a; Sevinç – Rose 1999), Dedetepe'deki boyalı kline (Sevinç vd. 1998) ve Çan, Altıkulaç Köyü, Çingene Tepe'deki boyalı Pers lahdidir (Sevinç vd. 2001) (Res. 2). Bunlar dışında Hellenistik Çağ girlandlı lahitlerin erken örneklerinden biri, yine Parion yakınındaki Bekirli Köy'de bulunmuştur (Berges 1993, 25, 26; Strocka 1996, 458ff. Abb.4-5). Çok sayıda kazı ve araştırmaların yapıldığı Güney Troas'ta, bu tür eselere henüz rastlanmamıştır. Gerek Troas'ın kuzeyindeki özgün buluntular, gerekse şimdiye kadar bu kesimde Klasik Çağ kentleri hakkındaki bilgilerin, daha çok antik kaynaklarla sınırlı olması göz önüne alınarak, 2003 yılında Abydos ve Lampsakos şehirleri çevresinde yüzey araştırmasına başlanmıştır.

Bölgede gerçekleştirilen yüzey araştırmalarında, Abydos ve Lampsakos'un kontrolü altındaki küçük yerleşmeler konusunda önemli bulgular elde edilmiştir. Bu yazıda Lampsakos ve Abydos arasındaki, Palaiperkote ve Perkote kentlerinin lokalizasyon problemleri, antik yazarlar, modern araştırmacıların görüşleri ve arkeolojik veriler ışığında irdelenmektedir.

ANTİK KAYNAKLARDA PERKOTE

Perkote'den ilk söz eden Homeros, İlyada destanında kentin Praktios nehrinin yakınında olduğunu aktarır (İlyada II, 835). Antik yazarlar Perkote'yi Arisbe ile Lampsakos arasında bir kent olarak tanımlarlar (Plinius, V 141; Ps. Skylaks, Periplos, s.v. Φρυγία 94; Apollonios, Rhodios, I 931– 933) (Res. 2). Herodotos, Ionya ayaklamasına katılan Perkote'nin Pers kralı Dareios tarafından, Abydos'tan sonra ele geçirildiğini ifade eder (Herodotos, V 117). Pers kralı Artakserkses, Lampsakos'u şarabı, Perkote'yi ise yatağı ve kıyafeti için Spartalı Themistokles'e vermiştir (Athenaios, Deipnosophistai I, 54). Attik Deniz Birliği vergi listesinde Perkote (M.Ö. 451/50-427/26) ve Palaiperkote (M.Ö. 451/50-421/20) olmak üzere iki kent adına rastlanmaktadır (Meritt- Wade-Grey - McGregor 1950, 56, 200, 201, 206, 207). Antalkidas M.Ö. 387'de, Atinalılara fark edilmeden gemiyle Perkote'ye doğru hareket etmiştir (Ksen. Hell. V 1, 25). Büyük İskender, M.Ö. 334 yılında ordugâhını kurduğu Arisbe'den bir gün sonra Perkote'ye ulaşmıştır (Arrianos, Aleksandri Anabasis I, 12, 6, 7). Argonautlar, Hellespontos'daki yolculukları esnasında Abydos ve sonra Perkote'nin önünden geçmişlerdir. Kyzikos'un karısı Kleite, Perkoteli Merposa'nın kızıdır (Apollonios Rhodios I 932, 975).

Perkote'nin kimler tarafından kolonize edildiği hakkında antik yazarlar bilgi vermezler. Buna rağmen, modern araştırmacılar Perkote'nin Abydos, Arisbe ve Paisos gibi bir Milet kolonisi olduğu görüşündedirler (Rambach 1790, 390; 288; Bilabel 1920, 50-51; Ruge 1937, 683; Ehrhardt 1988, 35). Perkote adın sikke bastırılmamıştır. Yakın çevredeki Arisbe ve Paisos gibi küçük yerleşmelerde de sikke darbı söz konusu değildir.

Palaiperkote ve Perkote'nin nüfusu, Attik Deniz Birliği'ne ödedikleri vergi miktarına göre, tahmini olarak hesaplanmıştır. Bu hesaplamaya göre 1000 drakhme ödeyen Perkote'nin nüfusu 530, 500 drakhme ödeyen Palaiperkote'nin nüfusu 265 kişi olmalıdır (Ruschenbusch, 1983, 141; Tenger, 1995, 154). Her iki kentteki insan yoğunluğu göz önüne alındığında, bunların bir kentten daha ziyade Lampsakos topraklarındaki küçük yerleşmeler olduğu söylenebilir. Palaiperkote ve Perkote'nin geçim kaynaklarının hayvancılık (Homeros, İlyada XX, 548; H. Bernsdorff 2001, 61), yün üretimi (Athenaios, Deipnosophistai I, *549)*, liman gelirleri, tarım ve balıkçılık olduğu tahmin edilmektedir (Tenger, 1995, 154).

Attik Deniz Birliği listesindeki Perkote yanında Palaiperkote adının geçmesi nedeni ile araştırmacılar, bu kentleri Erdağı, Narlıçeşme, Bergaz (Umurbey) ve Kemiklialan gibi farklı yerlere lokalize etmişlerdir. Ancak bu görüşler, arkeolojik verilerle yeterince desteklenmemiştir. Tarafımızdan bölgede yürütülen arkeolojik yüzey araştırmalarında konu ile ilgili bazı bulgular elde edilmiştir.

ERDAĞI

Erdağı, Umurbey'in doğusunda, Praktios nehrinin batı yakasında ve Hellespontos'tan (Çanakkale Boğazı) kuş uçumu 11,5 km., Umurbey'den ise 5,5 km. uzaklıktadır (Res. 1-2). Denizden 373 m. yükseklikteki Erdağı, volkanik bir kayalıktan oluşmaktadır. Güneybatı kuzeydoğu doğrultusunda uzanan dağın, her iki ucundaki küçük yükseltiler dışındaki arazi düzdür. Dağın etrafını yıkık bir duvar kuşatmaktadır. Sur olduğu düşünülen (Judeich, 1898, 546; Schulz, 200, 23) duvar moloz ve doğal kesme taş kullanılarak, kuru duvar tekniğinde inşa edilmiştir (Res. 3-4). Ancak duvarlardan günümüze, temellere ait küçük bir bölüm ulaşmıştır. Yerleşmeye güneydeki uzun bir rampadan ulaşılmaktadır. Rampanın batı yönünde, yola paralel bir duvar örülmüştür. Geniş bir bölgenin gözetlenebildiği Erdağı'nda, binaların inşası için yeterli düz alan ve kuzey yamacında su kaynağı vardır.

Erdağı'nın kuzeydoğu ucunda 3-4 m. yüksekliğinde ve yaklaşık 30 m. çapındaki tepenin etrafında ikinci bir duvar vardır. Bu alan içerisinde, 1,5 m. çapında daire planlı kalıntılar dikkati çekmektedir. Şehrin bir iç sur ile çevrilmesi geleneğine, Troas Bölgesi'ndeki Gargara ve Lamponia kentlerinde de rastlanır. Küçük Asya ve Mezopotamya'da yaygın olan iç surun içerisinde, yönetim binaları ve kutsal alanlar bulunmaktadır (Lang 1991, 21). Erdağı'nda da iç surun böyle bir amaca hizmet ettiği kesin değildir.

Erdağı'nın 500 m. kadar güneyindeki kalıntılar nekropol olarak tanımlanmıştır (Judeich 546). Nekropolde birkaç parça pithos ve düzgün kesilmiş kireç taşı bloklar göze çarpmaktadır (Res. 5-6). Nekropol olarak önerilen yerin yaklaşık 750 m. güneydoğusundaki Kiremitli Tepe'de, Geç Roma Çağı seramikleri bulunmuştur. Az sayıdaki ve kalitesiz seramik örnekleri, bu alanın bir süre çiftlik yeri olarak kullanıldığını ortaya koymaktadır.

Yamaçları ve doruğu kayalarla kaplı olan Erdağı ve çevresindeki engebeli arazi günümüzde ormanlarla kaplıdır. Praktios nehri, Erdağı'nın kuzey kıyısındaki derin bir vadiden akmaktadır. Bu yüzden ırmak boyunda tarıma uygun alanlar mevcut değildir. Yerleşme ve yakın çevresindeki alanların coğrafi yapısı, tarımdan daha çok hayvancılık için uygundur.

NARLIÇEŞME

Umurbey'in 1 km. kuzeyinde, Praktios çayının (Bergaz Çayı) hemen kenarındaki kalıntılar, bazı araştırmacılar tarafından Perkote olarak önerilmiştir (Cuinet 1894, 761; Ruge 1937, 864; Müller 1991, 905). Bu alan, gür akan bir su kaynağı yüzünden Narlıçeşme olarak adlandırılmıştır. Narlıçeşme çevresinde gerçekleştirdiğimiz araştırmalarda, biz de W. Judeich gibi seramik parçaları dışında antik yapı kalıntısına rastlamadık (Judeich 1898, 546). Verimli toprakların hemen kıyısında bulunan Narlıçeşme mevkiinde ele geçen seramik parçaları, Geç Roma ve özellikle Bizans Çağı'na aittir. Seramikler arasında, içe dönük ağızlı ve siyah astarlı Hellenistik Çağ kase parçaları çok azdır.

BERGAZ/UMURBEY, TABAKLAR MAHALLESİ

Eski adı Bergaz, yeni adı Umurbey olan kasaba, Çanakkale'nin 15 km. kuzeyindedir. Umurbey'in merkezindeki pınar, günümüzde zeminin 2 m. aşağısında kalmıştır. Pınarın üzerine inşa edilen şadırvana merdivenle ulaşılmaktadır. Onlarca kurnadan akan gür ve kaliteli su, yıllar önce Bergaz'ı ziyaret eden araştırmacıların da ilgisini çekmiştir (Pococke 1792, 161; Judeich 1848, 128; Leaf 1923, 112).

Bergaz'da 19. yüzyıldaki incelemelerde, Roma Çağı'na tarihlenen iki yazıt (Loling 1884, 68; Legrand 1893, 556) ve birkaç antik mimari blok (Ruge 1937, 864) görülmüştür.

Umurbey'deki araştırmalarda belediyeye ait petrol istasyonunda mermerden yapılmış sütun başlıklarına rastlanmıştır. Kısa süre sonra bunlar, Çanakkale Arkeoloji Müzesi'ne nakledilmiştir. Söz konusu mimari parçaların, Umurbey'de yıkılan eski camide, devşirme yapı elemanı olarak kullanıldığı öğrenilmiştir. Biri Roma Çağı (Korinth tipi, M.S. 2.-3. yy.), diğerleri ise Bizans Çağı'na tarihlenen sütun başlıklarının buluntu yerleri bilinmemektedir (Res. 7).

Umurbey şehir merkezinin batısındaki Tabaklar Mahallesi'nde, antik bir iskân yeri tespit edilmiştir. Güneyden kuzeye doğru uzanan tepenin, güneyi hariç diğer yönleri sarptır. Ovaya ve Hellespontos'a hâkim bir tepe üzerine kurulan yerleşme, Abydos-Arisbe yönünden gelen ve Lampsakos'a uzanan antik karayolu üzerindedir. Günümüzde Tabaklar Mahallesi'nin büyük bir bölümüne konutlar inşa edilmiştir. Boş olan araziler ise bağ ve zeytinliklerle kaplıdır. Ayakta kalmış hiçbir kalıntı olmamasına rağmen, arazideki seramik parçaları, bahçe duvarları içindeki çatı kiremitleri ve öğütme taşları buradaki eski iskânın varlığını açıkça ortaya koymaktadır.

Tabaklar Mahallesi'ndeki az sayıda el yapımı açkılı çanak çömlek İlk Tunç Çağı'na aittir (Res. 8). İlk Tunç Çağı sonrasında iskânın devam ettiğini gösteren bulgulara rastlanmamıştır. Buna karşın M.Ö. 7. yüzyıldan sonrasına ait çanak çömlekte ani bir artış gözlenmiştir. Arkaik Çağ sonrasında, yeniden azalmaya başlayan seramik parçaları, Roma Çağı'na kadar kesintisiz devam eder. Troas Bölgesi'nin yerel üretimi kabul edilen gri seramikler, Perkote'de de vardır. Genellikle kapalı biçimlerden oluşan gri seramikler, diğer kentlerdeki örnekler gibi açkılı, yalın veya kazıma dalga bantlarla süslenmiştir (Blegen 1958, 275, 276, fig.300-301; F. Utili 1999, 70, 74-76, 230, 231, Abb. 315, 526-533) (Res. 9). Tabaklar Mahallesi'ndeki Arkaik Çağ'a ait boyalı seramikler arasında, Yaban keçisi üslubunda boyanmış testi, geometrik ve bitkisel bezeklerle süslenmiş tabaklar, kuşlu kaseler, dinos, Ionya kaseleri (Blegen, 1958, fig. 294, 10; Isler 1978, 150, Beil. 13, 526; Utili 1999, 145-146, 183, 191, Abb. 286, 1-6, Abb. 289, 66, Abb. 299, 249,250) ve siyah figürlü vazo parçaları oldukça yoğundur (Res. 10-12). M.Ö. 7. ve 6. yüzyıla tarihlen Doğu Grek üslubundaki seramik parçaları, Perkote'nin komşuları olan Arisbe ve Paisos'daki örneklere benzemektedir (Arslan 2005, 9-14). Klasik Çağ'a tarihlenen seramikler genelde siyah astarlı kandil (Sparkes – Talcott 1970, 73, pl. 38, 310) (Res. 13) ve kantharos parçalarından oluşmaktadır. Az sayıdaki Hellenistik ve Roma Çağı seramiği, bu alanda çok yoğun olmasa da iskânın devam ettiğini göstermektedir (Res. 14-15).

Tabaklar Mahallesi'nde seramikler yanında boyalı çatı kiremidi ve mimari terrakotta parçaları (Res. 16), burada bir tapınak veya yönetim binasının varlığı ile ilişkilendirilebilir. Troas Bölgesi'ndeki resmi ve kutsal yapıların, pişmiş toprak levhalarla süslendiği bilinmektedir (Akerström 1966, 5-6; Cook 1973, 334-336, Lev. 61, 62,10). Tabaklar Mahallesi'nde Antik Çağ gündelik yaşamının izleri olan öğütme taşları ve iğ ağırlıkları da bulunmuştur. Ele geçen iğ ağırlıkları, Arisbe ve Troia'da olduğu gibi gri seramik parçalarından imal edilmiştir (Blegen 1950, 114, 143, 177, fig. 221, 33.157, 33.160, 33.151, 37.673; Blegen 1951, 269, fig. 32.191, 192) (Res. 17).

Antik kentin nekropolleri, Tabaklar Mahallesi'nin güney ve batı yönlerinde bulunmaktadır. Bunlardan birinci nekropol, Tabaklar Mahallesi'nin batısındaki yamaçlardadır. Bu alanda mezarların izleri halen görülebilmektedir. 19. yüzyılda Lapsekili Sabri Efendi tarafından Perkote'de bulunan, Klasik ve Hellenistik Çağ'lara ait terrakottalar, F. Calvert (Thiersch 1902, 168-170) ve İstanbul Arkeoloji Müzesi'ne (Mendel 1908, 186-187, KtNr. 1890-1894, Taf. XIII, 9) (Res. 18) verilmiştir. Yüzey araştırmasında ele geçen bir kadın başı, müze ve koleksiyondaki terrakottaların bu alanda bulunmuş olmalarını desteklemektedir (Res. 19). Kentin güneyinde, Perkote'yi

Abydos'a bağlayan karayolunun doğusunda, ikinci bir nekropol alanı vardır. Bu nekropolde yapılan tarım faaliyetleri sırasında ortaya çıkan lahitler, yol kenarına atılmıştır. Sandukaları sade olan lahitlerin, kapaklarında köşe akroterleri kabaca işlenmiştir. M.S. 2.-3. yüzyıllara tarihlenen lahitler, yerleşmenin Roma Çağı iskânı için önemlidir (Res. 20).

TARTIŞMA:

Attik Delos Deniz Birliği vergi listelerindeki Perkote ve Palaiperkote'den dolayı, Perkote halkı tarafından kurulmuş, ikinci bir kentin var olduğu kabul edilmektedir. Eski anlamına gelen "Palai" ön takısı, aynı adı taşıyan ikinci bir yerleşmenin kurulmasında kullanılmıştır (Kahrstedt 1955, 296). Palai ön ekini taşıyan kentler, Yunan kolonizasyonu öncesinde, yerel halklar tarafından kurulmuştur (Kahrstedt 1955, 297). Aynı isim ile kurulan yeni kentleri, eski kentlerden ayırmak için Palai ekinin kullanılmasına, Skepsis/Palaiskpesis, Gargara/Palaigargaros, Gambreion/Palaigambreion, Magnesia/Palaimagnesia ve Myndos/Palaimyndos gibi Anadolu'nun batısındaki kentlerde de rastlanır (Kahrstedt 1955, 297).

M.Ö. 5 yüzyıldan sonraki antik kaynaklarda görülen, Perkope ve Perkote şeklindeki farklı yazılım biçimleri de yine iki yerleşmenin varlığına bağlanır. Strabon, eski Perkote'nin bir isim değişikliğine uğradığı ve bu kentin iyi bilinmediğini ifade eder (Strabon XIII, 20).

Yukarıdaki sınırlı verilerden yola çıkan araştırmacılar, Troas Bölgesi'nin kuzeyindeki eski Perkote (Palaiperkote) ve yeni Perkote'nin (Perkote) yerleri konusunda farklı görüşler ileri sürmüşlerdir.

Araştırmacılardan W. Judeich göre, Erdağı'ndaki kalıntılar Palaiperkote kentidir. Palaiperkote halkı, bilinmeyen bir nedenden dolayı M.Ö. 5. yüzyılın ortalarından önce, boğaza yakın bir yere yeni bir kent kurmuştur (Judeich 1898, 546-547). Konuyu daha ayrıntılı ele alan W. Leaf, Homeros'un eserinde sözünü ettiği Perkote'nin daha doğrusu Palaiperkote'nin, Judeich'ın aksine Praktios nehrinin Hellespontos'a döküldüğü kıyı kesiminde olduğu görüşündedir (Leaf 1923, 111). W. Leaf, yerli halkın (Teukroi ve Gergithes) Yunan göçleri sonrasında, tepelere doğru hareket ederek, Erdağı üzerinde yeni bir kent kurduklarını ileri sürer (Leaf 1917, 26). Buna göre Ksenophon'daki Perkope, Palaiperkote olmalıdır. Eski yerleşmede oturan (Palaiperkote) halk, dağda oturanlardan (Perkote) kendilerini ayırmak için Perkope biçimini kullanmıştır (Leaf 1917, 26). Bu açıklamadan Leaf'in Erdağı'nı Perkote'nin yeri olarak belirlediği anlaşılmaktadır.

W. Ruge, saldırılara karşı güvenli olsa da, ağır yaşam şartlarından ötürü halkın, Erdağı'ndan (Palaiperkote) tarım alanlarına yakın Bergaz'a (Perkote) taşınmış olabileceklerini aktarır (Ruge 1937, 863-865). D. Müller de W. Ruge gibi Palaiperkote'nin Erdağı olduğu konusunda hem fikirdir. Kendisi yeni kent (Perkote) için Kemiklialan Köyü'nü önerir (Müller 1991, 905) (Res. 21).

Erdağı, Bergaz/Umurbey ve Kemiklialan dışında Perkote içi önerilen Narlıçeşme Mevkii'ndeki (Cuinet 1894, 761; Ruge 1937, 864; Müller, 1991, 905) buluntular, ağırlıklı olarak Bizans Çağı'na aittir. Narlıçeşme ve çevresindeki antik bulgular, bir yerleşmeden daha ziyade, çiftlik yeri olarak yorumlanmalıdır.

Yukarıda sıralanan görüşler ile arkeolojik verilerin çeliştiği açıkça görülmektedir. Bunlara kısaca değinmekte fayda vardır. Palaiperkote için önerilen Erdağı, Prehistorik bir yerleşme için oldukça büyüktür. Tarihleme için verilerin eksikliğine rağmen, Erdağı'ndaki surlu yerleşme Arkaik Çağ kentlerinin karakteristik özelliklerini yansıtmaktadır. Fakat yıkılmış duvarlar dışında, buradaki yaşamı gösteren başka izler eksiktir. Bu yüzden Hellespontos'tan 11 km. uzaklıktaki Erdağı, ne Judeich'ın önerdiği Palaiperkote ne de Laef'in önerdiği Perkote olmalıdır.

Araştırmacılar tarafından yeni Perkote'nin lokalize edildiği Umurbey/Tabaklar Mahallesi'ndeki arkeolojik kanıtlar, yerleşmenin Tunç Çağı'nda iskân edildiğini açıkça ortaya koymaktadır. Bir boşluk olmasına rağmen, M.Ö. 7. yüzyıldan itibaren Tabaklar Mahallesi'nde güçlü bir iskânının varlığı söz konusudur. Bu alan, Arkaik Çağ sonrasında giderek zayıflasa da Roma Çağı sonuna kadar kesintisiz iskân edilmiştir. Eldeki arkeolojik veriler, Umurbey'i yeni Perkote olarak önermenin yanlışlığını ortaya koymaktadır. M.Ö. 5. yüzyılın başlarında, Pers kralı Dareios'un Perkote'yi ele geçirmesi ve aynı yüzyılın ortasında, halkın bir kısmının başka bir yere taşınması olayı ile yüzeydeki seramikler örtüşmektedir. Çok sayıdaki boyalı Yunan seramiği bulunan Umurbey/Bergaz, diğer araştırmacıların iddialarının aksine Palaiperkote olmalıdır.

Tarafımızdan Palaiperkote olarak önerilen Umurbey, Hellespontos'tan 5,5 km. uzaklıkta, boğaz ve ovaya hâkimdir. B.Tenger, antik kentte yaşayanların Praktios ırmağını kullanarak Hellespontos'a ulaştıklarını düşünmektedir (Tenger 1995,154). Gerçekten de hiçbir antik yazar kentin bir limana sahip olduğundan söz etmez. Antik Çağ'da kıyıya biraz daha yakın olduğu düşünülen Palaiperkote, Praktios ırmağının taşıdığı alüvyonlar yüzünden M.Ö. 5. yüzyılın ortalarında kıyıdan iyice uzaklaşmış olmalıdır. Perkote halkı kentin boğaz ile irtibatının kesilmesi yüzünden, kıyıya daha yakın bir yerde, yeni kenti kurmak zorunda kalmış olabilirler.

Hellespontos kıyısında iskân için iki uygun yer vardır. Bunlar Praktios'un batısındaki alçak bir tepe ile kuzeyindeki Kemiklialan'dır. Batıdaki tepelerde antik iskân izine rastlanmamıştır. Buna karşın uzun bir sahil ve gemilerin demir atması için uygun bir koya sahip Kemiklialan'da, eskiye ait bulgular mevcuttur. D. Müller, Kemiklialan'da konutların inşasında kullanılan antik taşlar ve köyün kuzey yamaçlarındaki seramikler nedeni ile yeni Perkote'yi, bu köye lokalize eder (Müller 1997, 905). Ancak Kemiklialan'daki seramiklerin Roma Çağı öncesine gitmemesi, bu görüşü bir varsayımdan öteye götürmez.

Yakın bir zamana kadar batıklık olan Umurbey Ovası, günümüzde şeftali ve kiraz bahçeleri ile kaplıdır. 20. yüzyılın başlarına kadar Bergaz/Umurbey'de üretilen sebze ve meyveler, Kemiklialan'daki iskeleden İstanbul'a gönderilmiştir. Palaiperkote'den (Umurbey) Hellespontos'a açılmak için en uygun konumdaki Kemiklialan'ın, Antik Çağ'daki rolünün tam olarak anlaşılması için daha fazla arkeolojik veriye ihtiyaç vardır.

KAYNAKÇA

Akerström, A. 1966
Die architektonischen Terrakotten Kleinasiens. Gleerup, Lund.

Arslan, N. 2005
"Die Lokalisation von Paisos", M. Şahin ve İ.H. Mert (yay.) *Ramazan Özgana'a Armağan*: 9-14. Ege Yayınları, İstanbul.

Başaran, C. 1999
"Parion 1997 Araştırmaları", *Araştırma Sonuçları Toplantısı* XVI: 349-364.

Başaran, C. ve A. Tavukçu 2007
"Parion Kazısı 2005", *Kazı Sonuçları Toplantısı* 27: 609-628.

Berges, D. 1993
"Frühe Girlandensarkophage in Kleinasien", G. Koch (yay.) *Grabeskunst der römischen Kaiserzeit*: 23-35. von Zabern, Mainz am Rhein.

Bernsdorff, H. 2001
Hirten in der nicht-bukolischen Dichtung des Hellenismus. Steiner, Stuttgart.

Bilabel, F. 1920
Die ionische Kolonisation; Untersuchungen über die Gründungen der Ioner, deren staatliche und kultliche Organisation und Beziehungen zu den Mautterstädten Dieterich'sche Verlagsbuchandlung m.b. H., Leipzig.

Blegen, C.W. (yay.) 1950
Troy 1. General introduction. The first and second settlements. Princeton University Press, Princeton.

Blegen, C.W. (yay.) 1951
Troy II. The third, fourth, and fifth settlements. Princeton University Press, Princeton.

Blegen, C.W. (yay.) 1958
Troy IV. Settlements VIIa, VIIb and VIII. Princeton University Press, Princeton.

Clarke, J.T., F.H. Bacon ve R. Koldewey 1902
Investigations at Assos: expedition of the Archaeological Institute of America ; drawings and photographs of the buildings and objects discovered during the excavations of 1881, 1882, 1883. Sotheran, London.

Cobet, J. 2003
"Die Troas als historische Landschaft", D. Unverhau (yay.) *Geschichtsdeutung auf alten Karten. Archäologie und Geschichte, Wolfenbütteler Forschungen* 101: 331-377. Harrassowitz Verlag, Wiesbaden.

Cuinet, V. 1894
La Turquie d'Asie: Géographie administrative, statistique, descriptive et raisonnée de chaque province de l'Asie mineure. Leroux, Paris.

Erhrhardt, N. 1988
Milet und seine Kolonien. P. Lang, Frankfurt.

Hertel, D. 2008
Das frühe Ilion: die Besiedlung Troias durch die Griechen (1020-650/25 v. Chr.). C.H. Beck, München.

Isler, H.P. 1978
Das archaische Nordtor und seine Umgebung im Heraion von Samos, Samos IV. Hablet, Bonn.

Judeich, W. 1898
"Bericht über eine Reise im nordwestlichen Kleinasien", *Sitzungsberichte der königlichen preussischen Akademie der Wissenschaften*: 531-555.

Kahrstedt, U. 1955
"Palaiskepsis und werwandte Ortsnamen", *Zeitschrift für Alte Geschichte* 3/3: 292-301.

Koldewey, R. 1891
Neandria. Reimer, Berlin.

Lang, F. 1991
Archaische Siedlungen in Griechenland Struktur und Entwicklung. Akademische Verlag, Berlin.

Lang, F. 1996
Archaische Siedlungen in Griechenland. Struktur und Entwicklung. Akademie Verlag, Berlin.

Leaf, W. 1917
"Notes on the Text of Strabo XIII 1", *The Journal of Hellenic Studies* 37: 19-30.

Leaf, W. 1923
Strabo on the Troad : Book XIII, Cap. I. Univ. Press, Cambridge.
Legrand, P.E. 1893
"Inscriptions de Mysie et de Bithynie", *Bulletin de correspondance hellénique* 17: 534-556.

Loling, L. 1884
"Inschriften aus den Küstenstädten des Hellespontus und der Propontis", *Mitteilungen des Deutschen Archäologischen Instituts, Athenische Abteilung* 9: 58-77.

Mendel, G. 1908
Catalogue des figurines grecques de terre cuite. Musées Impériaux Ottomans, Constantinople.

Meritt, B.D., H.T. Wade-Grey ve M.F. Mcgregor 1950
The Athenian Tribute Lists III. The American school of classical studies at Athens, Princeton.

Meyer, E. 1877
Geschichte von Troas. Verlag von Wilhelm Engelmann, Leipzig.

Müller, D. 1997
Topographischer Bildkomentar zu den Historien Herodots. Ernst Wasmuth Verlag, Tübingen.

Özdoğan, M. 1993
"The second millennium of the Marmara region. The perspective of a prehistorian on a controversial historical issue", *Istanbuler Mitteilungen* 43:151-163.

Özdoğan, M. 1989
"1988 Yılı Trakya ve Marmara Bölgesi Yüzey Araştırması", *Araştırma Sonuçları Toplantısı* VII: 443-457.

Pococke, D.R. 1792
Beschreibung des Morgenlandes III. Wolfgang Walther, Erlangen.

Rambach, F.E. 1790
De Mileto ejusque Coloniis. Gesayer, Halle.

Rose, B.R. ve R. Körpe 2008
"The Granicus River Valley Survey Project, 2006", *Araştırma Sonuçları Toplantısı* XXIV: 103-116.

Ruge, W. 1937
"Perkote", *Paulys Realencyclopädie der classischen Altertumswissenschaft* 19/1: 862-865.

Ruschenbusch, E. 1983
"Tribut und Bürgerzahl im ersten attischen Seebund", *Zeitschrift für Papyrologie und Epigraphik* 53: 125-148.

Schliemann, H. 1881
Ilios. Stadt und Land der Trojaner. F.A. Brochaus, Leipzig.
Schulz, A. 2000
Die Stadtmauern von Neandreeia in der Troas. Dr. Rudolf Habelt GMBN, Bonn.

Sevinç, N. 1996a
"A New Sarcophagus of Polyxena from the Salvage Excavations at Gümüşçay", *Studia Troica* 6: 251-264.

Sevinç, N. 1996b
"Çanakkale-Gümüşçay Tümülüsleri 1994 Yılı Kurtarma Kazıları", *Müze Kurtarma Kazıları Seminerleri* VI: 443-446.

Sevinç, N. ve B. Rose 1999
"A Child's Sarcophagus from the Salvage Excavation at Gümüşçay", *Studia Troica* 9: 489-509.

Sevinç, N. vd. 1998
"Dedetepe Tumulus", *Studia Troica* 8: 305-327.

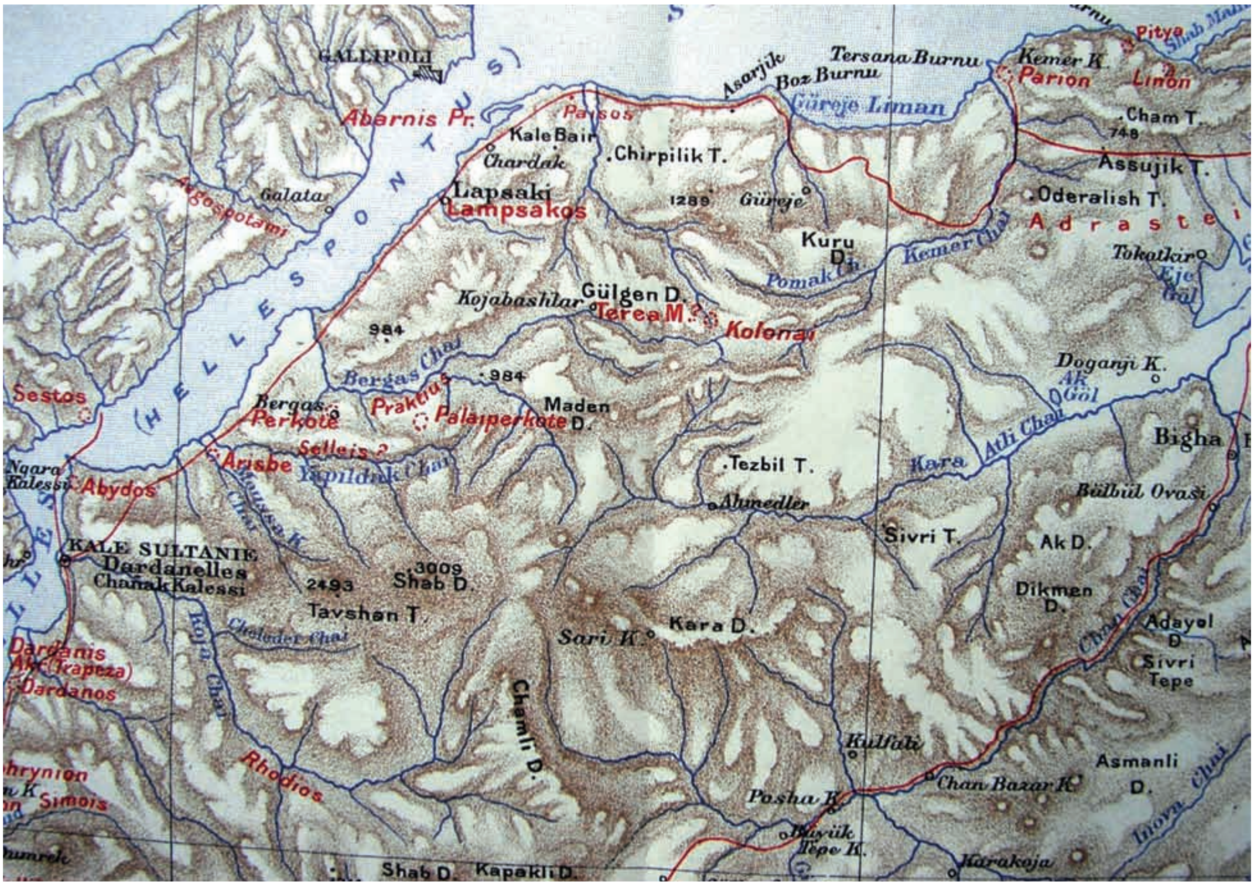
Sevinç, N. vd. 2001
"New Painted Graeco-Persian Sarcophagus from Çan", *Studia Troica* 11: 383-420.
Sparkes, B.A. ve L. Talcott 1970
Black and plain pottery of the 6th, 5th and 4th centuries B. C, Agora XII. NJ, American School of Classical Studies at Athens, Princeton.

Strocka, V.M. 1996
"Datierungskriterien kleinasiatischer Girlanden sarkophage", *Archäologischer Anzeiger*: 455-473.

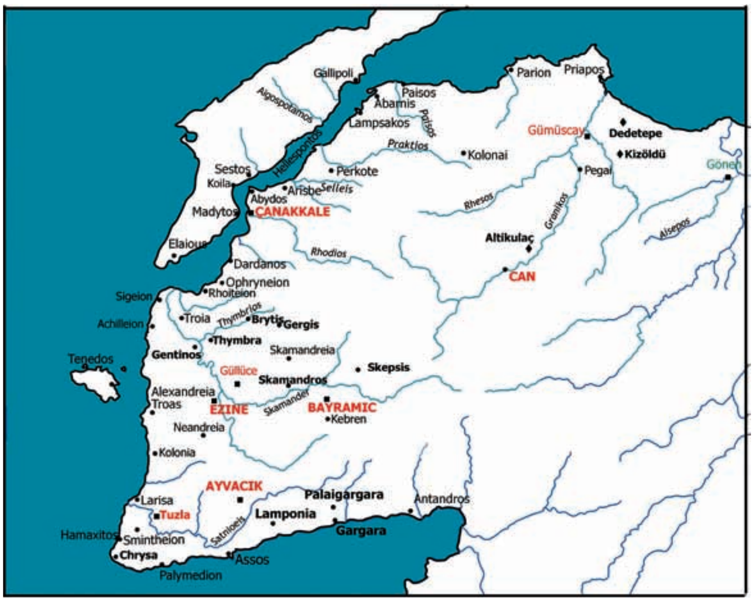
Tenger, B. 1995
"Phoroshöhe und Bevölkerungsgröße. Die Athener Tributlisten als Indikator für die Grö□e der Einwohnerschaft einer Polis?", *Asia Minor Studien* 16: 139-160.

Thiersch, T. 1902
Katalog der Sammlung Calvert in den Dardanellen und in Thymbra. Çanakkale Müzesi, Çanakkale.

Utili, F. 1999
Die archaische Nekropole von Assos. Asia Minor Studien 31, Bonn.



Res. 1: Kuzey Troas bölgesi antik kentleri



Res. 2:Troas Bölgesi

Res. 3-4: Erdağı, yıkılmış sur duvarı ve doğal taş blokları

Res. 5-6: Erdağı'nın güneyindeki nekropol alanındaki pithos parçaları ve taş bloklar

Res. 7: Eski Umurbey camisinde kullanılmış olan sütun başlıkları

Res. 8: Umurbey, Tabaklar Mahallesi'nde ele geçen elde şekillendirilmiş çömlek parçaları

Res. 9: Tabaklar Mahallesi, gri seramik örnekleri

Res. 10: Tabaklar Mahallesi, Arkaik Çağ seramikleri

Res. 12: Tabaklar Mahallesi, Arkaik Çağ seramikleri, Ionya kasesi ve siyah figürlü vazolar

Res. 11: Tabaklar Mahallesi Arkaik Çağ seramikleri

Res. 13-14: Tabaklar Mahallesi, Geç Klasik Çağ kandilleri ve Hellenistik Çağ seramikleri

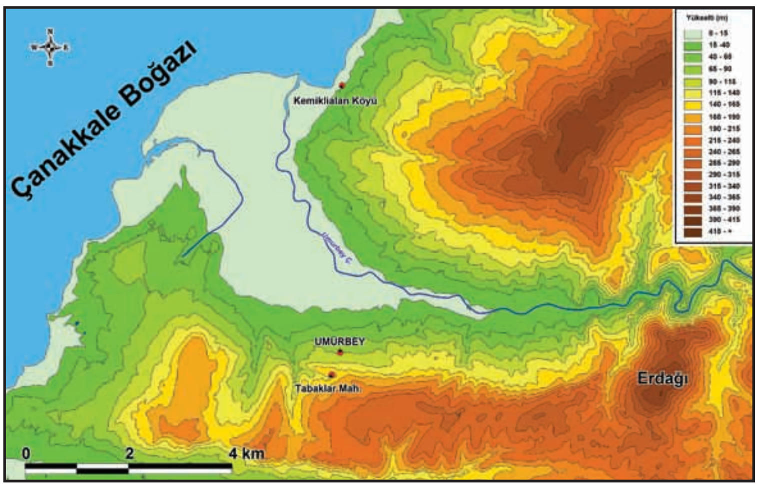
Res. 15: Tabaklar Mahallesi, Roma Çağı seramikleri, terrasigillata

Res. 16-17: Tabaklar Mahallesi, mimari terrakotta ve iğ ağırlığı

Res. 18: Nekropol buluntuları, İstanbul Arkeoloji Müzesi

Res. 19: Tabaklar Mahallesi, terrakota başı

Res. 20: Nekropol, Roma Çağı lahit kapağı



Res. 21: Umurbey ve Çevresi

SOME THOUGHTS CONCERNING THE FUTURE AIMS AND DIRECTIONS OF THE ISTANBUL BRANCH OF THE GERMAN ARCHAEOLOGICAL INSTITUTE[1]

ALMAN ARKEOLOJİ ENSTİTÜLERİ İSTANBUL ŞUBESİNİN İLERİYE YÖNELİK AMAÇLARI İLE İLGİLİ BAZI ÖNGÖRÜLER

Felix PIRSON

Keywords: German Archaeological Institute, research policy, scientific organizations

Anahtar sözcükler: Alman Arkeoloji Enstitüleri, araştırma politikaları, bilim kurumları

ABSTRACT

The İstanbul branch of the German Archaeological Institute is the largest foreign scientific institute in Turkey. Even though it has had a long and successful past, the institute must redefine its goals to meet the needs of the changing Turkish and international academic environment. This article presents research plans and aims ultimately to contribute to continuing archaeological discussions in Turkey. Research should be conducted by endorsing the values of collaboration and partnership and by embracing the joint responsibility towards cultural heritage. Such an approach will ensure that cultural policies are maintained through united efforts and accredited academic research standards

ÖZET

Türkiye'deki yabancı arkeoloji enstitüleri arasında en kapsamlı yapılanmaya sahip olan kurum Alman Arkeoloji Enstitülerinin İstanbul Şubesidir. Her ne kadar Enstitü kurulmuş olduğu yıldan bu yana çok sayıda araştırma projesini başarı ile gerçekleştirmiş ise de, uluslararası ve Türkiye'nin akademik ortamındaki gelişmeler, önümüzdeki yıllarda Enstitünün amaç ve yaklaşımlarının yeniden tanımlamasını gerekli kılmaktadır. Bu yazı ile, Türkiye'de hızla gelişmekte olan bilimsel arkeoloji ortamına, Enstitünün nasıl katkıda bulunabileceği konusunda bazı öngörüleri ve bu doğrultuda tanımlanacak yeni amaçlarını tartışmaya açmaktadır. Enstitünün ileriki yıllarda yapacağı her türlü projenin dayanağı kültürel mirasa ortak sorumluluk ve duyarlılığı olan, yüksek akademik standartlara sahip işbirliği ve ortaklık ilkesi olmalıdır. Akademik ortamın bilimsel standartlarını yerine getiren, işbirliği ve paylaşımı esas alan sürdürülebilir kültür politikaları ancak bu şekilde gerçekleşebilir.

INTRODUCTION

The Istanbul branch of the German Archaeological Institute (DAI) - a public research institution operating under the auspices of the Foreign Office of the Federal Republic of Germany with branches in many countries - is the largest foreign research institute for archaeological disciplines in Turkey (Fig. 1). When it was established in 1929 following the approval of a request by the German government to the Republic of Turkey, its research program differed considerably from the older branches in Rome and Athens. While they were - and still are - characterized by an obvious focus on Greek and roman archaeology, the Istanbul branch (in the following: the Institute) aimed to cover all periods of Turkey's culture and history, "…from the oldest to the most recent times", as Martin Schede, the founding director of the Istanbul branch of the DAI, declared in a policy statement[2].

Despite the loss of one post in the 1990s, assigned to the Ottoman periods, the Institute still attempts to pursue its initial aims. Today, the post-doctoral scholars employed in Istanbul include a prehistorian, a Near-Eastern archaeologist, two Classical and one Byzantine archaeologist, and an architect (*Bauforscher*) working on the architecture of Anatolia from prehistoric to Ottoman times. Two research assistants working on their doctoral thesis are Classical archaeologists, one postdoctoral research fellow is a prehistorian. The assignation of different archaeological disciplines to the various positions (directors, researchers, research-assistants and postdoctoral research fellows) is not fixed but highly flexible. Hence we are able to follow actual trends and developments in the archaeological sciences and combine them with the needs of our long-term research projects such as Hattusha (Fig. 2) or Pergamon (Fig. 3).

Apart from these general outlines, one major aim of our current and future research policy is to maintain and extend research cover over as many periods and materials as possible. This endeavour does not lay claim to any universality, but instead reflects our interest in cross-cultural and comparative approaches. We think that Turkey is particularly appropriate for such approaches, given its long historical tradition, its position as the site of crucial historical evolutions such as the "neolithic revolution" and its function as a bridge between east and west. In order to foster a fruitful academic exchange with visible synergies, we will reinforce our efforts to build academic networks within the Institute and beyond, including colleagues from Germany, Turkey and elsewhere. The first network with the title "Manifestations of Power and Hierarchies in Urban and Rural Landscapes" ran from 2006 to 2008. For 2009-2010, a further network is planned with the title "Changes of Epochs (*Epochenwandel*) and Processes of Historical Transformation in Anatolia". Several projects of the Institute will be involved in a process of academic exchange and discussion with each other and with colleagues from German, Turkish and international universities and research institutions, organized in the framework of seminars and workshops. The academic networks form part of the DAI-wide research-clusters (*Forschungscluster*), covering broader and more general themes such as "Political Spaces", and forging contacts with archaeologists, historians and colleagues from other relevant disciplines outside the DAI.

The material basis of our research – whether inside or outside the networks and clusters – consists in field projects, i.e. excavations, surveys and studies of architecture. Additionally, work on material in museums represents another important source of new archaeological data. This also includes the presentation of unpublished excavations and finds in Web-based archives as highly useful tools for the scientific community. A planned joint-venture between the Archaeological Museum of Istanbul and the Institute raises high expectations with regard to this form of cooperation.

The field projects can be roughly divided into long-term excavations such as Göbekli Tepe, Hattusha, Miletus and Pergamon, and short-term projects (maximum five years) such as Anazarbos or Oinoanda[3]. The long-term excavations with their stable infrastructures should be regarded as research centres in their own right under the direction of the DAI[4]. The focuses of their research have to be (re-)formulated every five years and are evaluated by the *Zentraldirektion*, the scientific governing body of the DAI. According to their respective research programs, they should invite sub-projects from

Turkish, German or international universities to participate. Additionally, they are centres of education for advanced students and platforms for academic discussions in the form of small and informal meetings and seminars during the excavation campaigns. Projects such as Göbekli Tepe, Hattusha, Miletus and Pergamon fulfil an important function as laboratories of new archaeological questions and methods which not only can be applied over an adequate time span, but can also be reviewed and further developed within a long-term perspective. As showcases of the DAI and of German archaeology, they should become points of reference in a fruitful and cooperative academic contest between the various national and international archaeological projects in Turkey. The effort to attain the highest possible standards also applies to the conservation and presentation of archaeological sites, where these projects have particular responsibilities due to their long-term nature.

The short-term projects are much more flexible in terms of organization and scientific focuses. Ideally, they are cooperation projects with Turkish partners or sub-projects within Turkish or international long-term excavations or surveys. Due to the continuous presence of the DAI in Turkey, participation in rescue excavations, which are not limited to the traditional excavation seasons, might be an opportunity for future cooperation. Successful examples from Pergamon/Bergama, where the local Museum and the DAI are carrying out such excavations together, lead in the right direction.

The infrastructure of our work is formed by the Institute in Istanbul and the various excavation houses. The core elements in Istanbul are the library (Fig. 4) and the photo-archive (Fig. 5), both the largest structures of their kind for the archaeological sciences in Turkey. They do not only serve the needs of the Institute‘s projects, but are also crucial tools for all archaeological research in Turkey. Consequently the library, which currently holds 60,000 volumes and two hundred ongoing periodicals, is not only open to scholars, but also to students and the general public. The great importance of our library, which was named one of the 10 best libraries in Turkey in 2007 by the newspaper Hürriyet[5], is reflected by the large number of 4,750 readers in 2008. Among the various libraries of the DAI (for example Berlin, Rome, Athens, Cairo, Madrid) the Istanbul branch is in second place after Rome and equal with Athens in terms of the frequentation of the library. Additionally, the Institute houses accommodation facilities and rooms for public lectures and workshops. It is also the base for various public relations activities, including a website (www.dainst.org/abteilung_266_de.html), a yearly brochure (Fig. 6), public lectures and guided tours to the museums and monuments of Istanbul.

Apart from scientific public relations for a wider audience, the Institute also organizes and hosts specialized conferences, for instance in 2007 on “Bautechnik im antiken und vorantiken Kleinasien” and in 2008 on “Byzantinische Kleinfunde im archäologischen Kontext” (together with the Koç University). The public lectures by Turkish, German and international scholars are directed at laymen as well as colleagues from different archaeological disciplines. Unfortunately, there has been a decline in attendance figures at the lectures over the last couple of years, particularly among students and colleagues from Istanbul. This might be partly due to problems in understanding German, the preferred language of most of the lectures (see below). However, we will continue to offer such lectures since we are convinced that they form an integral part in the international exchange of new results and methods.

On the basis of the Institute‘s research program, its projects and its infrastructure, the following future aims and directions can be formulated:

1) COOPERATION AND PARTNERSHIP

When the Institute was founded in 1929, it was the first foreign research institute with a clear focus on archaeology in Turkey. Against the background of the modernization of the young Turkish Republic, setting up an academic system played a crucial part and was a core element of the ideas of Mustafa Kemal Atatürk. German scholars played an important role in this astonishing process, which was particularly fruitful for the field of archaeology. In this context, Kurt Bittel, director of the Institute between 1938-1944 and 1954-1960, also became the founder of the Institute of Prehistory at the University of Istanbul as well as the academic teacher of many eminent Turkish archaeologists[6]. However, Turkish archaeology – in particular prehistory – also oriented itself in various other directions and created close links with Anglo-American academia. And despite more or less continuous academic teaching by the Institute‘s directors and other members of the staff in Turkey until today, the Institute is not the central point of reference for Turkish archaeologists anymore. In my point of view, the loss of such a monopolist position is a very positive development, reflecting the full integration of Turkish archaeology in the international scientific community. Nowadays, the Institute still holds a very prominent position among other foreign institutes, but we have to adapt our profile to the changing world of archaeology and particularly to the changing environment in Turkey. The latter is characterized by the establishment of several public and private universities and research centres with archaeological departments located all over the country.

In the future, the academic networks mentioned above will become a central tool of scientific cooperation. By discussing specific archaeological problems on an informal and continuous basis, joint projects between Turkish and German scholars can be developed. Thanks to its specific potential - i.e. the coverage of most periods of Anatolian history and their study in a cross-cultural and comparative perspective (see above) - the Institute can offer a platform for exchange beyond the limits of national academic systems and their typical structural shortcomings (concurrence between different national academic ‘schools’, development of exclusive networks etc.), which are to be observed in Germany as well.

Another basis for the development of networks is the knowledge of the German language and/or experience with the German academic world by means of Humboldt, DAI or DAAD scholarships etc. In archaeology and the classics, the knowledge of (at least some) German is still a precondition for serious academic work. Due to the long and close Turkish-German relations, the degree of knowledge of German in Turkey is remarkably high. Having this in mind, we adhere to German as the basic language in our lectures and publications, even if this might reduce our potential audience[7].

A good knowledge of German on the part of Turkish academics is a great potential which led to the establishment of a network for Turkish Germany-alumni by the Institute in cooperation with the German Academic Exchange Service (DAAD) in 2005 (Fig. 7). One of the aims of this network is to build up and strengthen contacts between Turkish and German universities, which might result in joint research projects or student exchanges. In this respect, the Institute intends to play an important role as mediator, particularly in encouraging German students to gain academic experience at Turkish universities. Exchange in this direction has slightly increased in the last few years, but there is still potential to be exploited. This process might be further enhanced by German colleagues who start to discover Turkish universities, particularly the private ones, as an interesting job-market.

Concerning Turkish-German cooperation in archaeological field-projects, it should be possible to carry them out under Turkish, German or joint directorship. The latter form, however, is difficult to realize due to the specific regulations of Turkish law on archaeological excavations and surveys requiring one project director. Beyond the level of project-directorship, the exchange of students from both sides in archaeological field projects should be intensified. This however requires good mutual knowledge of the respective language for communication as well as for the documentation systems.

Cooperation also works by organizing joint conferences or exhibitions. Here the already very good relations of the Institute with, for example, the Istanbul Archaeological Museum, the Research Centre for Anatolian Civilisations of the Koç-University and the Istanbul Araştırma Enstitüsü should be further strengthened (Fig. 8)[8].

2) RESPONSIBILITY

The opportunity to work at very prominent archaeological sites in Turkey is a great courtesy of the Turkish Republic and also a sign of firm trust in German archaeology and the Institute. Such trust implies responsibilities for the Institute, not only in terms of high-standard research and publication, but also in the preservation and presentation of the sites. Therefore, large scale conservation projects and the development of management plans have to be an integral part at least of the long term projects. Responsibility means furthermore that it has to be made clear that the preservation of the cultural heritage is a joint obligation of both the German (or other foreign license holder) and the Turkish side. In particular the development of management plans for archaeological sites offers various possibilities of cooperation between the Institute and Turkish universities, the Ministry of Culture and Tourism and the local administrations. In this context, cooperation between the Municipality of Bergama, the Mimar-Sinan-University, the Koç University and the Institute in developing a management plan for Pergamon/Bergama should be mentioned.

3) STANDARDS

The time when foreign institutes developed archaeological standards in Turkey is clearly over, and it has to be stated that Turkish universities played a leading role in this respect from the very beginning of the Turkish Republic. On the other hand, academia is always a field of fruitful competition, and the Institute firmly declares its will to participate in this competition. Therefore it is our obligation to promote the latest methods, techniques and – above all – approaches of German archaeology in Turkey. In this respect, our field projects, academic networks, conferences etc. still aim to set standards – though clearly not as development workers, but rather as part of an international scientific discourse going on in Turkey. Particularly in specific fields of our disciplines, such as the study of historical buildings (*Bauforschung*), where German scholarship is traditionally very strong, we can still give important stimuli to the Turkish and international colleagues working here. The Institute accordingly attempts to represent such disciplines and fields of research as have a positive and successful tradition in Germany. This is in line with our belief that Anatolia is one of the most important and promising areas of archaeological research and hence an important laboratory for methods and approaches from all over the world. This is reflected by the highly praiseworthy “Kazı Sonuçları Toplantısı” organized every year by the Ministry of Culture and Tourism, which is attended by a great number of German colleagues who not only contribute but also receive important stimuli for their own work.

4) SUPPORT

The Institute‘s infrastructure puts us in the favorable position of being able to contribute in many ways to archaeological research in Turkey. Not only is this sound international academic practice, it is also, in our view, an important aspect of the bilateral cultural policy between Germany and Turkey. As part of the German Foreign Office, the Institute takes this task particularly seriously.

The support includes the library, which is open to everybody and can be used day and night by the colleagues staying in our guest-rooms. In view of the large number of newly founded departments of archaeology at Turkish universities with hardly any books, it is clear how important such support is. And even at the traditional universities in Ankara, Istanbul and Izmir, a general tendency to concentrate books in centralized libraries with limited access stresses the importance of the Institute‘s library for archaeological research in Turkey. Therefore, the Institute will use all efforts to keep the high standard of its library despite rising costs for publications and maintenance.

The photo-collections of the Institute are the biggest of their kind in Turkey and represent valuable cultural archives. Despite the lack of a photographer, we are attempting to build them up further and to make them accessible via internet.

By means of “guest invitations” (*Gasteinladungen*), the Institute offers a non-bureaucratic way for Turkish colleagues to work in other libraries of the DAI such as in Berlin or Athens. We would like to increase this form of support and also to introduce other forms of scholarships for Turkish colleagues.

Our peer-reviewed scientific journals and monographs – such as “Istanbuler Mitteilungen”, “Istanbuler Forschungen” or “BYZAS” (Fig. 9) - contribute significantly to the publication of archaeological material from Turkey and to its discussion by an international academic audience.

CONCLUSION

The Institute believes that its future aims and directions lie in making a significant contribution to the international archaeological discourse going on in Turkey. This contribution will follow the principles of cooperation and partnership, responsibility towards the cultural heritage, high standards in research and finally support as part of good international academic practice and bilateral cultural policy.

NOTES

1 I am very grateful to Prof. Dr. Mehmet Özdoğan for encouraging me to publish these very preliminary thoughts which initially were only intended as a stimulation for discussion with Turkish and international colleagues.

2 On the history of the Istanbul Branch of the DAI see Hauptmann 1991.

3 An overview of recent research projects of the DAI is given on the homepage of the Institute (http://www.dainst.org/abteilung_266_de.html) and in the yearly report of the DAI in the *Archäologischer Anzeiger*; for 2007 see *Archäologischer Anzeiger* 2008/1 Beiheft p. 159-192.

4 For a discussion of the risks and opportunities of traditional long-term projects, particularly Pergamon, see Raeck 2001.

5 Hürriyet 9.3.2007, p. 4.

6 On Kurt Bittel, see Esin 1999.

7 The choice of English for this article – although TÜBA-AR accepts contributions in German – is due to the fact that it was first drafted for a British audience.

8 See most recently the exhibition „Ahşap İstanbul" on Istanbul's wooden houses (İstanbul Araştırma Enstitüsü – DAI 30.10.2008 – 15.3.2009) or the conference "*Tumul* istanbul 2009 - Tumuli as Sema" on burial mounds (Centre for Anatolian Civilisations of the Koç-University – DAI 1.-3.6.2009).

REFERENCES

Esin, U. 1999
"Kurt Bittel (5.7.1907-30.1.1991)", H. Hauptmann (ed.) *Kayıp Zamaların Peşinde - Auf Der Suche Nach Verschwundenen Zeiten. Catalogue Exhibition*: 21-23. Yapı Kredi Kültür Sanat Yayıncılık, İstanbul.

Hauptmann, H. 1991
"Alman Arkeoloji Enstitüsü İstanbul Şubesi", H. Hauptmann (ed.) *Kayıp Zamanların Peşinde - Auf Der Suche Nach Verschwundenen Zeiten. Catalogue Exhibition*: 29-39. Yapı Kredi Kültür Sanat Yayıncılık, İstanbul.

Raeck, W. 2001
"Spaten Und Steuergelder. Deutsche Traditionsgrabungen Im Wandel Der Interessen Von Wissenschaft Und Offentlichkeit", S. Altekamp, R. Hofter and M. Krumme (eds.) *Posthumanistische Klassische Archäologie. Proceedings Colloquium Berlin 1999*: 39-51. Hirmer Verlag, München.

Fig.1. The German Consulate housing the Institute since 1989

Fig.2. Recent excavations at Boğazköy-Hattusha

Fig.3. Recent restoration work at Pergamom

Fig.4. The main reading room of the library

Fig.5. A selection of historic pictures from the photo-archive

Fig.6. Cover of the"Wooden Istanbul" exhibition catalogue

Fig.7. The alumni meeting held in 2005

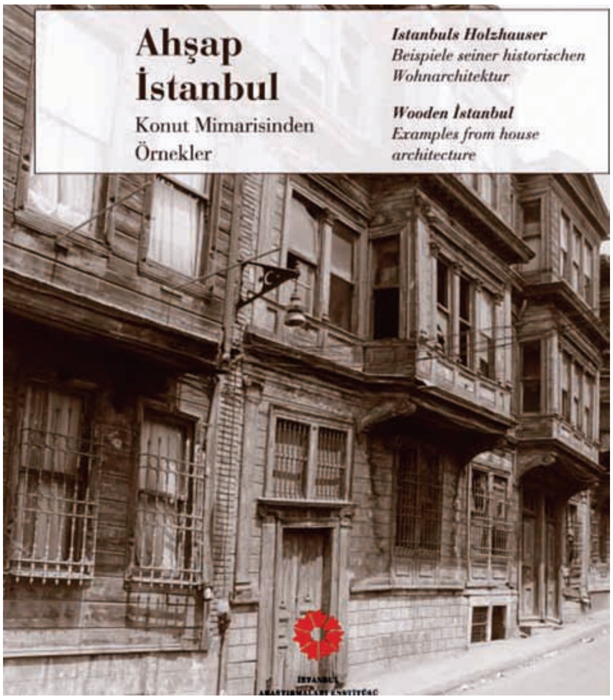


Fig.8. Cover of the yearly booklet of the institute

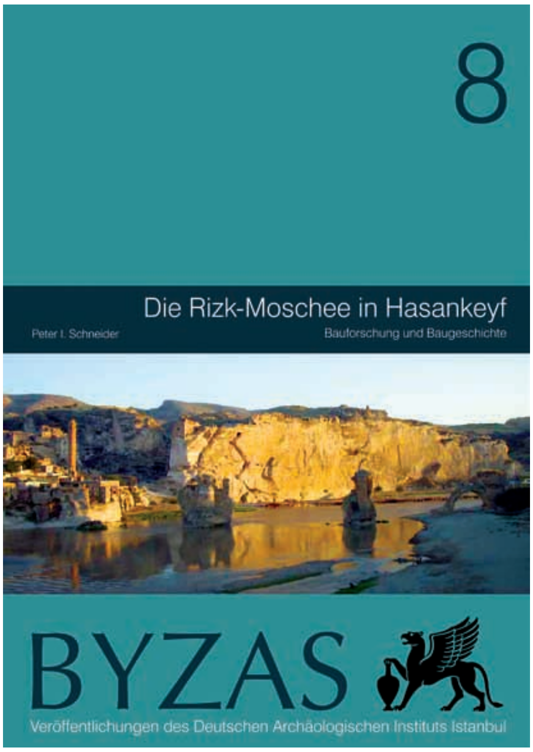


Fig.9. Cover of the Byzas, a new periodical on the proceedings of scientific meetings held by the Institute.

ÖZEL KONU: ARKEOLOJİDE KALAY

Ünsal YALÇIN - Hadi ÖZBAL
Özel Konuyu Yayına Hazırlayanlar

İnsanlık tarihinin en önemli madenleri arasında yer alan kalay kuşkusuz stratejik yönden de büyük bir öneme sahipti. Kalayın Tunç Çağı madenciliğindeki yeri ve kökeni konuları bir süre daha arkeoloji dünyasını uğraştıracak gibi görünmektedir. TÜBA-AR'ın bu özel sayısı yoluyla kalay konusunda süregelen tartışmalara bir katkıda bulunmayı amaçladık. Burada kalay konusunda yapılan araştırma sonuçlarının tümünü yayınlamanın ve tek tek her soruya yanıt bulmanın mümkün olmadığının bilincindeyiz. Ancak erken kalay kullanımıyla ilgili, çok yönlü soru ve sorunlara bir forum oluşturmak bizim açımızdan önemliydi. TÜBA-AR'in bu sayısını hazırladıktan sonra konuyu bütün boyutlarıyla ele alamadığımızın bilincine vardık. Bu nedenle TÜBA-AR'in yakın bir gelecekte konuya yeniden yönelerek tarihöncesi kalay araştırmalarıyla ilgili yeni bir sayı hazırlayacağını ümit etmekteyiz.

Bu sayıdaki kalay dosyasının gerçekleşmesinde emeği geçen tüm yazar ve hakemlere en içten teşekkürü bir borç biliriz.

SPECIAL SECTION: TIN IN ARCHAEOLOGY

Ünsal YALÇIN - Hadi ÖZBAL
Special Section Editors

Considered among the most important metals in human history, tin undoubtedly had strategic significance in Bronze Age archaeology. Trying to locate its provenance is bound to keep archaeologists busy for years to come. With this section we hope to further contribute to the discussions about tin and its origins in the Ancient World. We are conscious that the volume addresses limited issues and is unable to conclusively answer all pressing questions. Yet our intention was to present multifarious issues revolving around early tin. As the volume neared conclusion we realized that many aspects of research concerning tin still remain to be considered. Our hope is that TÜBA-AR returns to these questions in the near future by publishing a second issue of investigations on prehistoric tin.

We cordially thank all authors and surveyors who enabled this publication with their contributions and critiques.

STRATEJİK 'ÖNEMİ OLAN' BİR METAL: KALAY

Ünsal YALÇIN

Kullanılmış olan en eski maden bakırdır; daha MÖ 9. binyılda doğal bakır toplanarak boncuk gibi küçük nesnelerin yapımında kullanılmıştır. MÖ 5. binden itibaren bakır kendi cevherlerinden kazanılmaya başlanır. MÖ 4.binin başlarından, Son Kalkolitik Çağ'dan itibaren altın, gümüş ve kurşun keşfedilmiş, ayrıca polimetalik kompleks cevherler çıkarılarak ergitilmeye başlanmıştır. Böylece arsenli, antimuanlı ya da diğer iz elementleri içeren bakır türleri elde edilmiştir. Bu dönemde insanlar bileşimlerine göre metallerin farklı özellikler gösterdiğini ayırtetmiş ve MÖ 4. binin ikinci yarısından itibaren arsenli ve antimuanlı cevherler bakırın cevherleriyle birlikte izabe edilerek ergitilmesine geçilmiş ve bu bağlamda bakırın % 4-5 oranında arsenik içerdiğinde saf bakırdan daha uygun özelliklere sahip olduğunun ayırdına varılmıştır. Kalay ise Son Kalkolitik Çağ'ın sonlarında keşfedilmiş ve kullanım açısından, bakırın metal özelliklerinin çok daha uygun duruma gelmesini sağlamıştır. Saf bakır yeterince sert olmadığı için silah türü aletlerin yapımına uygun değildir; madenci ustalarının bu sorunu çözmek için arayış içinde olduklarını düşünebiliriz. Olasılıkla arsenli bakırın üretim sürecinde ustalar, bakırın başka madenler ile karıştırıldığı konusunda bir deneyim sahibi olmuş, çeşitli denemelerden sonra MÖ 3.binyılda ustalar kalayı farketmiş ve bakırla alaşmasını sağlayacabilecek teknolojiyi geliştirmişlerdir. Bakır, kalay ile alaştırıldığında sertliğinin belirgin bir şekilde artmasının yanı sıra döküm için çok daha uygun bir duruma geldiği de görülmüştür. Bakırın kalayla karıştırılması ile elde edilen bileşim yeni ve sert bir metaldir; bu keşif insanlık tarihinin akışını değiştirmiştir. Yaklaşık MÖ 3000'lerde maden ustaları söz konusu yeni hammaddeyi kullanmaya başlamış, giderek taş, tahta, kemik ve saf bakırdan üretilen aletler ve silahlar yerlerini tunçtan yapılan benzer örneklere bırakmışlardır. MÖ 3. binin ilk yarısında, İlk Tunç Çağı I ve II dönemleri boyunca, tunç nesneler öncelikli olarak toplumun seçkin üyelerinin kullanımına yönelik olarak üretilmişlerdir. Mezopotamya ve Anadolu'daki seçkin yöneticilerin zengin ölü armağanlı mezarlarında, çoğu altın ve gümüşle bezenmiş birçok tunç nesne bulunmuştur; bunların arasında en iyi bilinenleri Ur ve Alacahöyük kral mezarlarıdır. Zengin mezar armağanları soylu ve seçkin sınıfın altın, gümüş ve tunç nesnelerle, az bulunan değerli ve yarı değerli taşlara verdikleri önemi açık olarak yansıtmaktadır. Bu dönemde Ön Asya'da tuncun daha çok ayrıcalıklı bir yönetici sınıfın var olduğu anlaşılan Kuzeybatı ve Orta Anadolu ile Yukarı Fırat, Dicle havzaları ve Mezopotamya'da yeğlendiği, buna karşılık Anadolu'nun diğer bölgeleriyle Ön Asya'nın geri kalan kesiminde arsenli ve antimuanlı bakır ya da saf bakır kullanımının devam ettiği anlaşılmaktadır. Anadolu'da kazılmış olan merkezlerden tunç buluntuları ile öne çıkan yerler arasında Troya, Alacahöyük, Hasanoğlan, Horoztepe, Eskiyapar ya da Ahlatlıbel'i sayabiliriz. Tunç teknolojisi MÖ 3. binin ikinci yarısından başlayarak yaygınlaşmış, MÖ 2. binyılda ise tümüyle benimsenmiş ve böylelikle bronz ya da yaygın adıyla tunç, Ön Asya ülkelerinin en önemli hammaddesi durumuna gelmiştir. Tunçtan yapılan nitelikli aletler, insanoğlunun büyük ağaçları kesip ahşap barınaklar, köprüler ya da tekneler yapmasını, tunç tarım aletleriyle tarlasını daha derin kazabilmesini sağlamış, böylece artan verimin sağladığı bol ürün, artı değer olarak dönemin sosyo-ekonomik kurgusunu yönlendirmiştir. Tunç silahlara sahip olanlar, düşmanına karşı üstünlük sağlamış, tunç aletlerin yardımıyla diğer maden ve hammadelerin biçimlendirilmesi de kolaylaşmıştır. MÖ 1. binyılda silah ve alet üretiminde tuncun yerini çelik aldıysa da, günümüze dek tunç, insanlık tarihinin en önemli alaşımlarından biri olma özelliğini sürdürmüştür.

Bu bağlamda kısaca kalayı tanımlamakta yarar vardır: Kalay, Latince *stannum*, *plumbum album* ya da *plumbum candidum* olarak adlandırılan, gümüşümsü beyaz bir metal olup kimyasal element çizelgesinde *Sn* ile gösterilir. Kalayı ince levhalar halinde haddelemek olasıdır. Moch Skala'sında 1,8 sertliğe sahip olan kalay yumuşak bir metaldir. En önemli ve sık rastlanan cevheri kasiterittir (SnO_2). Fazla sık görülmemekle birlikte diğer önemli cevherleri arasında frankeit ($Pb_5Sn_3Sb_2S_{14}$, teallit ($PbSnS_2$), stannit (Cu_2FeSnS_4) ve muşistonit ($(Cu,Zn,Fe)Sn(OH)_6$) yer alır. Kompoze cevherler olan stannit ve muşistonit bakır ve kalay içerdiklerinden tuncun keşfedilmesinde büyük bir olasılıkla önemli rol üstlenmişlerdir. Söz konusu kompoze cevherler ergitildiğinde tunç açığa çıkmış olmalıdır.

Kalay yatakları, bakır, demir ya da gümüşe oranla çok daha enderdir. Mineralojide dağ kalay yatakları ve alüvyal kalay yatakları olmak üzere iki tür kalay yatağı ayırt edilmektedir. Dağ kalay yatakları granit kökenli magmatik kayaçlarda bulunur. Bu tür kalay pegmatik-pnömatolik ve hidrotermal yataklarda görülür. Günümüzün önemli kalay yatakları Güneydoğu Asya'da Tayland, Malezya ve Endonezya'da, Afrika'da Güney Afrika Cumhuriyeti'nde, Kongo ve Nijerya'nın yanı sıra Güney Amerika'da Bolivya ve Brezilya'da yer alır. Tarihöncesinde kullanılan kalay yatakları Orta Asya'da Özbekistan, Tacikistan ve Kazakistan'da saptanmıştır. İngiltere'de Conrnwall, İber Yarımadası, Fransa'da Bretanya, Güney Almanya'da Erzgebirge ve Çek Cumhuriyeti'nde bazı yataklar da Avrupa'nın önemli kalay yatakları arasındadır. Ancak söz konusu Avrupa ülkelerinde tarihöncesi dönemlerde kalay çıkarılıp çıkarılmadığı henüz aydınlatılmamış bir konudur. Orta Fransa'da, İtalya'nin Toskana Bölgesi'nde ve Sardunya Adası'nda, Yugoslavya'da ve Romanya'da da küçük çaplı kalay yatakları bulunmaktadır. Önasya arkeolojisi kapsamında ele alınan ve İlk Tunç Çağ, tunç üretiminde kullanılan kalayın kökeninin yukarıda tanımlanan Avrupa kalay yataklarından gelmediğini burada belirtmek gerekir. MÖ 1. binyılda yerel gereksinim için işletilen Avrupa kalay yatakları, Antik Çağ'da daha kapsamlı olarak kullanıldığı anlaşılmaktadır.

Yakın zamana kadar, ne Anadolu, ne de Kafkaslar ya da Kuzeybatı İran'ın maden yatakları bakımından zengin olan bölgeleri, İlk Tunç Çağı boyunca Önasya coğrafyasında kullanılan kalayın olası kaynak alanları olarak düşünülmemiştir. Bu görüşe yol açan iki neden vardır; bunların ilki söz konusu bölgelerde kayda değer önemde kalay yatağının bulunmadığı varsayımı, diğeri ve belki de daha baskın olanı kalay ticareti ile ilgili MÖ 2. binyıla tarihlenen çok sayıdaki yazılı belgede kalay ticaretinin yönü ile ilgili anlatımlardır. Kültepe, Ugarit ve Katna'da bulunmuş olan Eski Asur yazılı belgeleri, tüccarların kalayı Doğu'dan (olasılıkla Orta Asya, Afganistan, İndüs ve İran) getirerek Mezopotamya ve Doğu Akdeniz Bölgesi'ne dağıttıklarından söz etmektedir. Bu dönemde Mezopotamya ve Doğu Akdeniz'de ticaret, saray ekonomisi olarak tanımlanan bir şekilde, yerel yöneticilerin denetimi altındadır. Mezopotamya'dan başlayan ticaret ağı Doğu Akdeniz liman kentleri Ugarit ve Byblos'tan doğuda Mısır'a, batıda ise Ege'ye ulaşacak biçimde düzenlenmiştir. Suriye içlerinde ise, kuzeyde yer alan Halep ile ana yolların kesiştiği kavşak konumununda olan Katna kenti önemli bir rol oynamaktaydı. MÖ 2. binyıl Anadolusunda ise, Kültepe-Kaneş kalay ticaretinin merkezi durumuna gelmişti. Eşek kervanlarına yüklenen kalay, Asur üzerinden Orta Anadolu'ya ulaşır, oradan da satışa sunulduğu yerlerde altın ile gümüş karşılığı alıcı bulurdu.

Son yirmi yılda yapılan araştırmalar MÖ 2. binde ve Son Tunç Çağı'nda kullanılan kalayın Orta Asya ülkelerinden Özbekistan, Kazakistan ve Tacikistan'dan gelmiş olabileceğini göstermektedir. Yapılan araştırmalar bu ülkelerdeki kalay madenlerinin tarihöncesi dönemden beri işletildiğini ortaya çıkartmıştır. Bu bağlamda MÖ 2. binde kullanılan kalayın olasılıkla Orta Asya kökenli olması akla yakındır; 2. binyıldaki bu duruma karşın, MÖ 3. binde kullanılan kalayın kökeni henüz aydınlanmamıştır. 1987 yılında Bolkardağı'ndaki Kestel'in keşfi bu konuya yeni bir bakış açısı getirmiş ve çok yönlü tartışmalara neden olmuştur. Arkeolojik kazılar ve doğabilim araştırmaları ile MÖ 3. binyılın ilk yarısında Kestel'den kalay çıkarıldığı kanısına varılmış, ancak bu yaklaşım bilim dünyasında beklenen onayı görmemiş, Avrupalı bazı bilim insanları Kestel'de kalay çıkarılmış olabileceği konusunda kuşkularını dile getirmişlerdir. Bolkardağı'ndaki hidrotermal çatlakların altın içermesi, burasının altın çıkarmaya daha elverişli olabileceği izlenimini doğurmuştur.

Ancak, yapılan ayrıntılı arkeometalurjik araştırmalarla çok sayıda potanın iç yüzeyinde kalay taneciklerinin saptanmış olmasını gözardı edemeyiz; söz konusu pota artıkları burada sürekli kalay üretiminin olduğunu kanıtlamaktadır. Yine de Kestel'de üretilen kalay Mezopotamya ve Anadolu'yu kapsayan bölgenin tümünde MÖ 3. binlerin kalay gereksinimini karşılamış olmayabilir; bir olasılık olarak burada yalnızca yerel gereksinimi karşılayan sınırlı bir üretimin gerçekleştirildiğini düşünebiliriz. Bütün bunlar göz önüne alındığında Kestel'de kalay üretildiği artık kabul edilmelidir.

Yukarıda değindiğimiz gibi Anadolu'dan elde edilen kalayın erken bir tarihteki kullanımıyla ilgili verileri göz ardı edilmeyecek bir olgudur; ancak bu dönemde gerek Anadolu, gerekse Mezopotamya'da, seçkin soylu kesimin zenginliğinin simgesi olarak görülen tunçtan yapılma buluntuların sayısının çokluğu, bu kadar yoğun bir tüketim için Anadolu kaynaklarının yeterli olamayacağını, dolayısı ile başka kaynakların da aranması gerektiğini düşündürmektedir. Bu da başka nereleri olabileceği sorusunu ortaya koymaktadır. Özbekistan, Kazakistan ve Tacikistan'daki Orta Asya kalay işletme tarihçesi MÖ 2. ve 1. binyıllar için kanıtlanmış olsa da, bölgedeki kalay madenlerinin MÖ 2. binyıldan daha eski bir tarihte işletildiği yolunda bir veriye henüz ulaşılmamıştır. Bu durumda MÖ 4. bin sonlarında Tülintepe'de kullanılan kalayın nasıl ve nereden elde edildiği yanıtsız bir soru olarak durmaktadır. İlk Tunç Çağı toplumlarındaki ayrıcalıklı kesimin biriktirdiği yüzlerce tunç nesnenin üretiminde kullanılan kalay nereden sağlanmıştır? Anadolu, Kafkasya ya da İran'daki bir kalay yatağı bu sorunun yanıtı olabilir. Bu bağlamda kalayın kaynağını Kestel'de de aramak yanlış sayılmaz. Ayrıca Kayseri'de saptanan yeni buluntu yeri akılda tutulmalıdır. Belki de o dönemde Anadolu'da yerel gereksinimi karşılamaya yeterli olacak, henüz bulamadığımız küçük çaplı daha birçok kalay işletmesi vardı. Bu soru henüz yanıtlanmadan durmakta ise de, ortaya çıkan yeni veriler artık Anadolu'da kalay olmadığı yolundaki öngörüyü bir yana bırakmanın zamanı geldiğini göstermektedir.

Kafkasya ve İran'ı da kapsayan bölgelerde de kalay çıkartmaya elverişli jeolojik formasyonlar bulunmaktadır. Kısa bir süre önce MÖ 2. bin ve 1. binyıllarında Batı İran'da kalay madenciliğinin yapıldığı yönünde verilere ulaşılmıştır. Bu durumda gelecekte yapılacak olan madencilik arkeolojisi ve arkeometallurji araştırmalarını beklemek en uygun tutumdur. Tarihöncesi işletme izlerini taşıyan ve henüz bilinmeyen kalay madenlerinin bulunması ısrarla beklenmektedir ve bunların ortaya çıkması kesinlikle sürpriz olmayacaktır.

A 'STRATEGICALLY IMPORTANT' METAL: TIN

Ünsal YALÇIN

Copper was the first metal used by humans, already by the 9^{th} millennium BC being collected as native metal and used for the production of small beads. Copper began to be obtained from ores starting in the 5^{th} millennium BC. By the beginning of the 4^{th} millennium BC gold, silver and lead were also discovered. The Late Chalcholithic Period witnessed the exploitation and extraction of poly-metallic and complex ores. Thus different kinds of copper like arsenical copper, antimony copper and copper with other trace elements began to be produced and it became clear the addition of different metals yields alloys with different properties. By the second half of the 4^{th} millennium BC arsenic and antimony ores began to be extracted and smelted together with copper ores. Arsenical copper (with 4-5% arsenic) had superior (delete better) properties to pure copper. The discovery of tin alloys by the end of the Late Chalcholithic Period is logical; pure copper is not hard enough for the production of weapons. Experimental production with different ores by innumerable metal smiths may have led to the discovery and importance of tin. By the end of the Late Chalcolithic Period (3000 BC), it became clear that when alloyed with copper, tin improved both mechanical strengthened and casting ability of copper. Alloying copper with tin to form a new and firm metal has changed the course of human history. From 3000 BC onwards this became a favored raw material among metal smiths. Tools and weapons made of bronze began to replace those of stone, wood, bone and copper. In the first half of the 3^{rd} millennium BC (in the Early Bronze Age I and II) this precious new allow and the resulting bronze was a prestige good. Bronze objects, mostly decorated with silver and gold, have been recovered from rich elite tombs both in Anatolia and Mesopotamia. Among them one can list the famous finds from Ur and Alacahöyük. Rich finds from graves provides important clues about elite traditions of hoarding and burying precious metals like gold silver and bronze as well as precious and semiprecious stones. Bronze artifacts have been discovered in the residences of these privileged leaders in north-western and western Anatolia, at sites like Troy, Alacahöyük, Hasanoğlan, Horoztepe, Eskiyapar or Ahlatlıbel, and settlements in the Upper Euphrates, Tigris and in Mesopotamia. But in other regions of Anatolia and in the Near East the earlier alloy of arsenical copper and even pure copper was still in use. By the second half of the 3rd and 2nd millennium BC bronze technology gained significance and bronze became an important commodity. Bronze tools enabled people to chop down large trees to build huts, houses, bridges or ships more efficiently. They could plough the fields deeper and get better crops. Bronze weapons gave them the upper hand on the battlefield. Moreover, bronze was used to carve and shape other raw materials. Although even today bronze remains an important alloy, by the 1st millennium BC it was replaced by iron in the production of tools and weapons.

Before going into further details, as a brief introduction to tin, we find it useful to present it basic features. Tin, *stannum, plumbum album* or *plumbum candidum*, is a silvery white metal with the chemical symbol Sn. It is a soft metal (Moh's hardness scale: 1, 8), and highly malleable that allows it to be rolled out into thin sheets. Compared with the other metals like iron, copper and zinc, tin is rare. Cassiterite (tin stone: SnO_2) is the most important and frequently used ore. Other important but less common tin ores include franckite ($Pb_5Sn_3Sb_2S_{14}$), teallite ($PbSnS_2$), stannite (Cu_2FeSnS_4) or mushistonite ($(Cu, Zn, Fe)Sn(OH)_6$). The latter two, stannite and mushistonite, had probably an important part in the discovery of bronze, as they contain both copper and tin and would have been recognized as bronze when smelted.

Compared with copper, iron or silver tin deposits are very rare. Mineralogically one can differentiate two types of tin: mountain tin and alluvial tin. Mountain tin is bounded to the granitic magma bodies. It occurs in pegmatic-pneumatolic and hydrothermal deposits. Today the most important ore deposits are found in South-eastern Asia (Thailand, Malaysia, Indonesia), in Africa (South Africa, Congo, Nigeria) and in South America (Bolivia, Brazil). Prehistoric tin deposits are found in Central Asia (Uzbekistan, Tajikistan and Kazakhstan). In Europe Cornwall in England, the Iberian Peninsula, the Bretagne in France, the Erzgebirge in South Germany and in the Czech Republic bear the most important tin deposits. However, to date no evidence of prehistoric tin mining has been found in these European ore deposits. They appear, in other words, not connected with the Early Bronze Age metallurgy. The only evidence of mining in these deposits comes from the 1st millennium BC (Early Bronze Age of Europe) and Antiquity.

Anatolia, North-western Iran and Caucasus have traditionally not been considered as possible origins of tin. The common belief pointed out for these regions has been that they do not bear noteworthy tin deposits. This idea was supported by several scripts from the 2nd millennium BC. The Old Assyrian cuneiform texts from Kültepe, Ugarit or Qatna, for example, report that merchants delivered tin from the East (Central Asia, Afghanistan, Indus Valley, Iran (?)) to Mesopotamia and to the Levant. We know that the import of this material was regulated through local palace economies through the harbors of Ugarit and Byblos to Egypt and the Aegean ports via the Mediterranean. The North Syrian city Aleppo and Qatna played important roles in the distribution of tin. The latter city was situated at the crossroads of the most important trade routes. In Anatolia Kanesh (Kültepe) was developed to the ultimate trade center for tin in the 2nd millennium BC. Tin reached Central Anatolia via Assur by donkey caravans where it was traded for gold and silver.

Investigations over the last two decades have yielded considerable evidence for early tin mining in Central Asian countries like Uzbekistan, Kazakhstan and Tajikistan. This suggests that the origin of tin in the 2nd millennium BC may in fact be coming from Central Asia. But what was the situation in the 3rd millennium BC? What evidence do we have for tin mining in the Early Bronze Age? The discovery of the Kestel mines near Niğde Çamardı in the early 1990's has caused considerable controversy. Investigations here have determined that tin mining here took place during the 3rd millennium BC over

600 years. The question as to whether Kestel was the origin of Bronze Age tin remains because many scientists have not approached this possibility with approval. Some European scientists have expressed their doubts. The fact that some of the hydrothermal intrusions within the Kestel mine are also rich in gold has led many to believe that the mine is actually much more suitable for the mining of gold. Previous archaeological and archaeometallurgical investigations as well as the latest study on several crucible fragments from Göltepe have yielded pure tin prills in a thin band of tin oxide on the inner surface of the crucibles. This data may be interpreted as possible evidence for the production of "industrial" tin. On the other hand, it is clear that this mine alone probably could not have fulfilled the growing need for tin in both Mesopotamia and Anatolia in the 3rd millennium BC. In any case, the idea that this mine could have produced limited quantities of tin to meet local needs should not be overlooked and needs to be accepted.

If we consider Anatolia to be an origin of the earliest tin for bronze objects for Anatolian and Mesopotamian elites, the Anatolian mines (to the extent that they a known) are undoubtedly insufficient. This raises the question that other regions must clearly have been involved. Let us focus our attention on the central Asiatic tin deposits in Uzbekistan, Kazakhstan and Tajikistan once again. Tin mining during the second millennium has successfully been proven from all across these countries but the region lacks any evidence of earlier use of these ore deposits. Where did the early tin we find at Tülintepe, dating to the end of the 4th millennium BC originate? The most logical answer would be a tin source in Anatolia, Caucasus or Iran. Kestel is one possibility but the new site near Kayseri could be considered an alternative. It is likely that there are many small tin deposits in Anatolia that can be regarded as potential locales of tin extraction. It is now set aside all resignations that Anatolia lacked tin.

The geological formations in other regions like Caucasus and Iran may also support tin extraction. The site of Deh Hosein in western Iran has yielded evidence for tin mining during the 2nd and the 1st millennium BC. For the time being it is best to await upcoming results and new investigations into mining archaeology and archaeometallurgy. New and yet unknown prehistoric tin deposits could undoubtedly yield important results.

METALLOGENIC EVALUATION OF TURKEY: IMPLICATIONS FOR TIN SOURCES OF BRONZE AGE IN ANATOLIA

TÜRKİYE'NİN METALOJENEZ GELİŞİMİ: ANADOLU'NUN İLK TUNÇ ÇAĞ KALAY KAYNAKLARININ İRDELENMESİ

Hüseyin ÖZTÜRK, Nurullah HANİLÇİ

Keywords: Tin deposits, Early Bronze Age, Metallogeny of Turkey

Anahtar Sözcükler: Kalay yatakları, İlk Tunç Çağ, Türkiye Metalojenezi

ÖZET

Tunç yapımında kullanılan kalayın, Tunç Çağ'ında Anadolu' ya nereden ve nasıl sağlandığı sorusu hem arkeologlar, hem de yerbilimciler için önemli bir bilmeceyi oluşturmuştur. Bu soruya cevap olması için Anadolu'nun jeolojik–metalojenik yapısı, Anadolu'daki kalay cevherleşmeleri ve kalay üretimine ait son jeoarkeolojik bulgular bu makalede irdelenmiştir.

Anadolu'nun jeolojik çatısı Pontitler, Anatolidler ve Arap Kıtası olarak tanımlanan üç kıtasal parçadan ve bunların arasında sıkışmış eski okyanus ortamına ait derin deniz çökelleri ve ofiyolitik karmaşıklardan (sütur kuşakları) oluşmaktadır. Bu jeolojik çatı içinde kalay, kuzey batı Anadolu (Batı Pontidler) ve İç Anadolu' daki (Anatolidler) metamorfik kayaçlar içine sokulan magmatik kayaçlar ile çevresinde bulunmaktadır.

Türkiye'de kalay minerali ilk kez Bursa ilinde, tipik bir kalay graniti olan Uludağ granitinin güneyinde saptanmıştır. Madenbelenitepe cevherleşmesi olarak bilinen yatakta kalayın sülfürlü minerali olan stannit (Cu_2FeSnS_4) saptanmıştır. Bu bölgede geçmiş dönemlerde madencilik yapıldığına ait herhangi bir bulgu ise mevcut değildir. Bu kuşakta yer alan Uludağ wolfram yatağı, Gümele Sn belirtisi ve Tahtalıdağ W cevherleşmesi bölgenin bir W-Sn provensi olduğunu göstermektedir. Bu provens Hersiniyen yaşlı çarpışma veya son çalışmalarla Oligosen yaşı verilen kıtasal kabuğunun ergimesiyle oluşan granitlerle ilgili bir provens olup bu kuşakta geçmiş dönemlerde çalışılmış kalay yataklarının bulunması olasıdır.

Kalay için Anadolu'da en önemli yatak, son yıllarda yapılan araştırmalarla jeolojisi, mineralojisi ve geçmiş dönem madenciliği aydınlatılmış olan Celaller (Çamardı-Niğde) kalay yatağıdır. Bu yatağın cevher minerali kassiterittir (SnO_2) ve Niğde masifinin metamorfik kayaçları içine sokulan kalay granitlerine bağlı oluşmuştur. Yatak civarındaki pek çok iki mikalı granit stokları, bir başka ifadeyle kalay graniti (Örn. Üçkapılı S-tipi graniti) bulunmaktadır. Bu granitler kuzey batı Anadolu masiflerinde olduğu gibi, Niğde ve Kırşehir masifinin de kalay yatakları oluşturma potansiyelini gösteren en önemli jeolojik verilerdir. Celaller (Çamardı-Niğde) kalay cevherleşmesinde cevher minerali kasiterit (SnO_2) olup, burada İlk Tunç Çağı'nda bu yatakta yapılan üretim

galerilerinin yanısıra cevherin işlendiği ve ergitildiğini belgeleyen çok sayıda cevher kırma ve öğütme değirmenleri bulunmuştur. Ayrıca, Celaller (Çamardı-Niğde) kalay yatağının yaklaşık 45 km güneybatısında, Bolkardağı mermerleri içine sokulum yapan Horoz Graniti'nin (S-tipi) kuvars porfir dayklarına bağlı oluşmuş Sulucadere Pb-Zn damarlarında da stannit mineralleri bulunmaktadır.

Anadolu'nun kuzeybatısında Bursa civarında görülen Hersiniyen yaşlı kalay granitleri ile Niğde civarındaki Alpin yaşlı kalay granitleri; Anatolid - Pontid - Arap Kıtasının çarpışması ve kabuk kalınlaşmasına bağlı olarak yer derinliklerindeki sedimenter malzemelerin kısmi ergimesine bağlı gelişmiş granitlerdir ve İngiltere, Malezya, Çin gibi çeşitli ülkelerde kalay üretiminin yapıldığı granitlerle benzerlik gösterirler.

Sonuç olarak; gerek Alpin, gerekse Hersiniyen dağ oluşumu kuşağı üzerinde yer alan Anadolu; kalay yataklarının oluşumuna da olanak sağlayan bir jeolojiye sahiptir. Niğde ve Uludağ masifi başta olmak üzere, Anadolu'da kalay cevheri üretimi yapılmış bazı yatakların gelecekte bulunması da sürpriz olmayacaktır.

INTRODUCTION

Tin (Sn) was a very important metal for making bronze tools in the Bronze Age, between 3000 - 1500 BC (as an alloy with copper). The tin content of the earths crust is twenty times lower than copper, and twenty thousands times lower than iron (average crust, Sn: 2.5 ppm, Cu:50 ppm, Fe: 54000 ppm; Krauskopf 1989). In spite of its lower abundance and the difficulties of mineral definition compared to those of copper and iron minerals, early civilizations located many tin deposits. Tin content typically is very low, rarely exceeding 2 % Sn, therefore, finding a tin deposit in the Bronze Age is still a bewildering phenomenon even for today's geologist.

Even though bronze tools were widely used in Anatolia throughout the Bronze Age, the possible sources of tin are not very well understood in Anatolia and its nearby regions. Owing to the unique position of Anatolia, the source of tin is of special geoarcheological interest in understanding the raw material trade in ancient time. In order to contribute to the understanding of this enigmatic problem within this paper, geology, metallogeny and tin mineralizations of Anatolia have been reviewed with regard to its tin potential and/or tin supply capacity for making bronze, in the Bronze Age.

GEOLOGY OF TURKEY

Turkey basically consists of three major tectonic units, being the Pontides, Anatolides and Arabian Plate from north to south, respectively (Şengör and Yılmaz 1981). Pontides belongs to Eurasia, including the Paleo-Tethyan Suture Zone (PTSZ) of Hercinian age, and the Karakaya Suture of Cimmerian age. The underlying rocks of the Pontides are represented by the Kargı and Tokat Massif along with epi-metamorphic rocks of Paleozoic age, cut by the Gümüşhane granite of the Permian age (Çoğulu 1975). The Uludağ granite in the west is defined as a Hercinian granite by Öztunalı (1973) and Oligocene by Okay *et al*. (2008). This peraluminus granite shows tin granite features which are different in mineralogy and metallogeny to those of other granites in northwestern Anatolia. Ophiolitic rocks in the Küre region are generally accepted as remnants of Paleo-tethyan oceanic crust. Karakaya marginal basin was opened within the Pontides in the Early Triassic and closed during the Late Triassic (Okay and Tüysüz 1999; Okay and Göncüoğlu 2004). Rock associations of the Karakaya Complex consist of exotic blocks such as limestone, diabase, serpentine, chert, mudstone etc. in a sedimentary matrix. Although complex geological features occur in the Western Pontides, the Eastern Pontides in contrast show relatively monotonous geological features.

The North Anatolian Suture (NASZ), also called the İzmir-Anakara-Erzincan Suture Zone, consists of ophiolitic mélange (accretionary complex) and serpentinised basic-ultrabasic rocks. These ultrabasics consist of tectonites such as hazburite, dunite, and include podiform-type chromite deposits. The melange consists of tectonically imbricated rocks, namely chert, radiolarian chert, reddish clay, spilite, and diabase. Many manganese or ferromanganese deposits occur in the radiolarian chert series throughout the melange zone (Öztürk 1997). NASZ separates the Pontides from the Anatolides, and melange formations of this suture zone constitute an E - W trending belt from the Aegean coast to the Armenian border (Fig.1).

The Anatolides are located between the Pontide and the Arabian continentes (Fig.1), which consists of high grade metamorphic rocks. Mesozoic and Cenozoic formations unconformably cover the Anatolides; therefore, the E- W continuity of the Anatolian metamorphic massifs is not seen very well. The Menderes Massif, the Kırşehir Massif, the Niğde Massif and the Bitlis Massif from west to east are accepted as the continuation of the same old underlying units of the Anatolides. These massifs are composed of high grade metamorphosed rock associations and represent African Plate fragments, welded to Eurasia throughout the North Anatolian Suture zone in the pre-Eocene Period (Şengör and Yılmaz, 1981).

The Tauride Mountains consists of Paleozoic - Mesozoic autochthonous and allocthonous sedimentary units. These tectono-stratigraphic units mostly consist of passive margin - type platform carbonates from the Early Paleozoic to the Eocene which were deposited on the Anatolian bas. However, Moix *et al*. (2008) concluded that Taurides was accreted to the Anatolides during the Carnian - Norian time span as an independent tectonic unit.

The South Anatolian Suture Zone (SASZ), known also the Bitlis - Zagros Suture, begins from the Mediterranean coast and extends into Iran (Fig.1). This suture zone separates Anatolides from the Arabian continent, including mélange series and basic - ultrabasic rocks as in the North Anatolian Suture Zone. The South Anatolian Suture Zone represents a south branch of the Neo-tethyan ocean, closed by the end of the Miocene in southeastern Turkey (Şengör and Yılmaz 1981).

The Arabian continent occupies the southwestern part of Turkey separated by South Anatolian Suture Zone (Fig.1). The oldest rock of the Arabian continent consists of unmetamorphosed Paleozoic – Mesozoic sediments cropping out in Hakkari province. These Paleozoic and Mesozoic carbonates represent a passive margin sedimentary rock association, which was highly deformed within a N - S directional compressional tectonic regime that lasted to the late Miocene.

METALLOGENIC STRUCTURE OF TURKEY

The development of metallogenic belts of Turkey is related to the Tethyan evolution in Turkey. The Tethyan evolution is associated with two major orogenic events in Turkey. The first is called the Hercinian-Cimmerian orogenesis (mountain building period-process) which is related to the evolution of the Paleo-Tethyan Ocean and the Karakaya Marginal Basin. The second is Alpine orogenesis which is related to the evolution of the Neo-Tethyan Ocean and its branches from the Jurassic to Miocene (Fig.1 and 2).

The mineralizations related to the Hercinian - Cimmerian orogenesis in Turkey are represented by three important deposits, the first is Kiruna-type Avnik iron ore deposit in Bitlis Massif, the second is Uludağ W mineralization, and the third is Cyprus-type Küre Cu deposit. The Madenbeleni Tepe stannite mineralization must also have been formed at this time. The Kiruna - type Avnik iron ore deposit (Fig.1) with high phosphorus, occurs within the gneiss and amphibolites of the Bitlis Massif. The Uludağ skarn- type W deposit was formed by metasomatic reactions between the Uludağ granite and carbonatic country rocks (Kaaden 1958).

Alpine phase mineralizations of Turkey are common and include different types of deposits, some with giant ore reserves. The subduction of the Neo-Tethyan oceanic crust (İzmir-Ankara-Erzincan Ocean) beneath the Pontides continued throughout the Cretaceous. A continental arc magmatism associated with this north polarized subduction resulted in I- type granitoide intrusion and the formation of Kuroko-type Cu-Zn-Pb-Ag±Au deposits. The Çayeli and Murgul massive sulfide deposits were formed in volcanoclastic rock associations which deposited in a back arc rift basin (Pejatovic 1979; Schneider *et al*. 1988). Many vein and skarn-type polymetallic Pb-Zn-Cu sulfide deposits, also formed related to arc magmatism in the Eastern Pontides throughout the Cretaceous (Öztürk *et al.* 2008). Carlin - type Kaletaş Au Deposit (Tüysüz *et al*. 1994; 1995) was also formed close to the arc - trench system in the Eastern Pontides, whereas the tavşan dağı porphyry Mo deposit formed an inner arc in the middle Pontides (Fig. 2).

The Anatolides reveal very composite metallogeny compared to the Pontides. Many bauxite deposits have been developed in karstic depressions on the passive margin carbonates throughout the Tauride Mountains especially during the Cretaceous (Öztürk *et al*. 2002). Black shale hosted the Ulukent manganese deposit that formed in an anoxic sub basin of the southern branch of the Neotethyan Ocean (Öztürk and Hein 1997). Subduction of a southern branch of the Neo-tethyan oceanic crust beneath the Anatolides from the Upper Cretaceous to the Eocene resulted in the formation of a continental magmatic arc on the Anatolides which is known as Baskil Magmatics (Yazgan 1984). This arc magmatism produced the porphyry-type Cu-Mo and pollymetalic Pb-Zn-Cu-Ag±Au mineralization in the Keban Region in the east of Turkey. Western equivalents of these subduction events were represented by volcano-plutonic rock associations in northwestern Anatolia in the Paleocene to the Miocene age span. The most important economic Pb-Zn deposits and/or NW Anatolian Pb-Zn±Cu metallogenic province were formed related to this magmatic activity. The Balya and Arapuçandere skarn-hydrothermal-type Au-bearing Pb-Zn±Cu deposits were formed related to calc-alkaline granites mostly in the Oligocene (Kasapçı *et al*. 2008).

During the syn-to post collisional period between the Pontide and the Anatolide, S, I and A- type graphinites formed in the Anatolides (Boztuğ 2000) and this resulted in tin mineralizations in Central Anatolia. Polycyclic magmatic activity associated with the collision-related crustal melting resulted in granitic batholith formation in Anatolides. Felsic to intermediate intrusives and/or S - type tin granites formed by partial melting of pelitic sedimentary materials. Certain elements such as B, F, and Sn were enriched in roof sections of the granites and deposited within quartz veins both into granites and metamorphosed country rocks (i.e. Celaller tin deposit). At this stage, the Divriği and Hasançelebi skarn-type iron ore deposits were also formed at the limestone-serpentine contact in the Eastern Taurides (Ünlü *et al*. 1995; Öztürk *et al*. 2005).

Post-collisional extensional tectonism throughout Western Anatolia is a feature of the late Cenozoic (Seyitoğlu and Scott 1996). This extension is associated with lithospheric thinning probably related to changes in the geometry of the subducted slab, the dynamics of the mantle wedge, and the beginning of slab rollback along the Hellenic subduction zone (Le Pichon and Angelier 1979; Cemen *et al*. 2007; Burchfiel *et al.* 2008). Basic alkaline intrusives, hyperbysal stocks and related hydrothermal activity from the Paleocene to the end of the Miocene resulted in Au, B, REE-F-Th-Ba, Sr and F deposition from west to east indicating an important mantle contribution into the continental crust. Extensional tectonics in western Anatolia owing to the steepening of the subduction angle from the Miocene to the present resulted in the degassing of the mantle and is associated with the worlds' biggest borate deposits in playa lakes (Helvacı and Alanso 2000). Both epithermal-type Ovacık Au (Yılmaz 2002) and porphyry- type Kışladağ Au deposits have been formed related to the graben structures and hydrothermal activity.

The Kızılcaören REE-F-Ba-Th deposit of the Miocene is related to carbonatites (Özgenç 1993), which formed during the extensional stage related to injection of melts from the mantle into shallow crustal levels through deep seated faults. This mantle signature on the metallogeny of Anatolia from the Paleocene to the Miocene could be accepted as an indicator of a post-collision extensional period. On the other hand, certain siderophile and chalcophile element enrichment (Au, Fe, V, Cu) in mineral deposits, for example in iron ore deposits in Anatolia, can be explained either as direct mantle contribution or remobilizing of these elements from ophiolitic country rocks. The ultimate origin is not well understood.

Mississippi Valley-Type Pb-Zn deposits, namely the Karakaya and Meskan Tepe Zn-Pb deposit in Hakkari region, were formed within passive margin carbonates of the Arabian continent via orogenic and/or deep seated fluids originating from the suture zone during the Miocene (Hanilçi and Öztürk 2008). Similar deposits, such as Delikkaya Pb-Zn deposit also occur within the passive margin sediments of Anatolides, formed by orogenic fluids in Paleocene - Eocene time interval (Hanilçi and Öztürk 2005).

FORMATION TYPES OF TIN DEPOSITS

Tin deposits occur by hydrothermal activity with relatively high P-T conditions, 300- 600^{o}C, associated with both alkali and S-type peraluminus granites (Haapala 1997). Elemental association of the tin consists of W, Mo, Nb, F, P, Be, B, Li, Nb, Ta, and REEs in alkaline magmatic rocks. Low Ba and high Li and Sr have been recommended as a pathfinder for tin deposit. The formation of tin deposits can be divided into four main types related to granite host rocks relationships (Fig.3).

The first and common type of deposit is intraplutonic deposits, occurring in the greisenized roof pendant section of granitoid batholiths. Tin enrichment occurs in greisen – bordered vein swarms within the granite along the roof zone of cupolas related to late stage magmatic crystallization. The second is skarn - type Sn deposit of which there are few worldwide, being relatively unimportant. The third type occurs as irregular replacement bodies in carbonate country rocks or as strata-bound type along bedding of limestone near granite. The fourth type is stockworks or fissure veins regarded as fracture fillings in the country rocks. The tin deposits of Turkey (Celaller deposit) can be accepted as belonging to this group. The most important tin deposits occur in Malaysia, China, Russia, England, Bolivia and Portugual.

TIN MINERALIZATIONS IN ANATOLIA

Although there is some published research on the geology of tin mineralization in Anatolia (Kaptan and Jesus 1974; Kaptan 1992; Pehlivan and Alpan 1986; Çağatay at al. 1979), an important historical tin mining site has recently been found by Yener and Özbal (1987) in Anatolia. Long -term studies of these groups revealed that the Göltepe region (Fig . 5.), close to Niğde in Central Anatolia, was an important mining and metallurgical site for tin metal in the Early Bronze age (Yener *et al*. 1989; Yener 1994).

The geological nature of Turkey, especially within the central metamorphic massifs of Anatolides provides a favorable environment for tin formation. Crystaline massifs of the Anatolides include both S and A-type granites and their silisic hyperbysal stocks, displaying important similarities to the host rocks of known tin mineralization of the word. An important S- type or two mica granite (Yurdagül 2004) occurs to the south of Bursa and is called the Uludağ Granite, studied by many geologists, in terms of its geochemistry and petrography (Öztunalı 1973, Okay *et. al.* 2008). The Uludağ Granite is a tin granite due to its peraluminus composition, alteration features such as greisenization (coexistence of the specific alteration minerals such as beryl-tourmaline-topaz), and having two micas as muscovite and biotite. Tungsten (W) and tin (Sn) occur together in tin granites due to their similar geochemical behaviors in high P-T conditions. The presence of the important skarn-type W deposit (Scheelite) at the contact between the limestone and S- type Uludağ Granite clearly indicates its tin granite nature. The Madenbeleni Tepe tin mineralization occurs south of this granite. The Gümele tin prospect was an important tin deposit located east of Bursa, according to historical notes (Kaptan 1992)

Üçkapılı granite (Göncüoğlu 1986) is also a good example of tin granite in Turkey, located in the Niğde Massif in Central Anatolia. The Celaller tin deposits occur south of this granite. The Üçkapılı granite includes two micas biotite and muscovite, and is intruded into gneiss and marble of the Niğde Massif. Radiometric age determination of the Üçkapılı granite has been made by Göncuoğlu (1986), giving a Cenomanian age (95±11 Ma) from whole rock Rb/ Sr analyses. Despite similar mineralogical nature and metal content, the age of the Üçkapılı granite is different from the Uludağ granite. This phenomenon can be explained by partial melting of the deeper section of the continental crusts of both the Anatolides and the Pontides, and having their available crustal thickness.

THE MADENBELENİ TEPE TIN MINARALIZATION

This mineralization occurs in Western Anatolia, south of Bursa Province, studied by Çağatay *et al*. (1979) in terms of ore and alteration mineralogy. The Madenbeleni Tepe tin mineralization occurs in greisenized granite porphyry stocks at Handere Creek, south of the Uludağ granite (Fig. 4).

The main tin mineral is stannite (Cu_2FeSnS_4). Minor amounts of cassiterite (SnO_2) are associated with other metallic minerals such as arsenopyrite, pyrite, sphalarite, fahlerz (tennantite-tetrahedrite), galena, chalcopyrite, bournonite, boulangerite, rutile and pyrhotite (Çağatay *et al*. 1979). Gangue minerals are quartz, muscovite and minor apatite. The mineralization was defined by Çağatay *et al*. (1979) as hydrothermal quartz greissen – type, formed at relatively high temperature. This mineralization represents a fissure-filling-type vein formation associated with S-type Uludağ granite, lying at shallow depth. There is no indication of ancient mining activity in the field.

THE CELALLER TIN MINERALIZATION

The Celaller tin mineralization occurs west of Celaller Village in southern Niğde Province (Fig.

5). The area has been studied by Oygür *et al*. (1984), associated with an iron ore project, and by Çağatay and Pehlivan (1988) in terms of tin mineralogy. The Celaller tin mineralization occurs as E-W trending veins within the high grade metamorphic rocks of the Niğde Massif, composed of marble, gneiss, quartzite, gabbro and tourmaline–bearing quartz veins (Fig. 5). Pegmatitic dykes of a buried granite resulted in development of a reaction skarn zone around the dykes with hematite. Aplites and tourmaline bearing quartz veins are seen very well in the field, representing a late magmatic hydrothermal system associated with a main body of buried granite. Tin mineralization occurs as cassiterite and hematite–bearing quartz veins in this metasedimentary rock series. Granitic pegmatite dykes display an advanced sericitic and argillic alteration. Tin mineralization occurs at the top of the granitic cupola or greisenized contact zone of the granite (Çağatay and Pehlivan 1988).

The formation sequence of the mineralization is cassiterite, quartz, hematite, carbonates such as calcite, dolomite, siderite, and pyrite. Minor amounts of chalcosine, native bismuth, arsenopyrite, pyrotite, and limonite, psilomelane, malachite, covellite are also defined as supergene minerals. Mean value of the microprobe analyses of eight cassiterite samples from the Celaller region (Çağatay and Pehlivan 1988) indicate that the cassiterite includes minor impurities such as Mn, Fe, Ca , occuring very close to its stochiometric ratio (98.02 % SnO_2 ; 0.47 % CaO; 0.45 % FeO; 0.05 % MnO; 0.04 % TiO_2).

THE SULUCADERE ZN- PB -SN MINARALIZATION

The Sulucadere tin - bearing Pb–Zn deposit occurs 45 km southwest of the Celaller deposit. The tin mineral is stannite (Cu_2FeSnS_4). This location represents the second area of stannite formation in Turkey. The mineralization is related to low grade Pb-Zn formation at the high elevation of the Bolkardağı region.

Rock associations of the mineralization area consist of Mesozoic marble, ophiolitic melange, quartz porphyry dykes, and Eocene clastics (Fig. 6). The highly altered Horoz granite of Paleocene age occurs south of the mineralized area. There is a general consensus on the formation of the mineralization as being related to the S-type Horoz granite and its quartz porphyry dyke emplacement. Quartz porphyry dykes consist of quartz and feldspar phenocrystals, muscovite, pyrite, rutile and titanite.

Stannite-bearing Pb-Zn formation was studied by Çağatay and Arman (1989) especially for its mineralogy. Paragenetic assemblage according to these authors consists of zinc blend, chalcopyrite, galena, pyrite, fahlerz, arsenopyrite, marcasite, stannite, bournonite, phyrotite, siderite, ankerite. Supergene alteration minerals are chalcocite, limonite, azurite, psilomelane etc. Gangue minerals are calcite dolomite, quartz, epidote, muscovite, and chlorite.

Stannite occurs as both inclusion and exsolution patches in sphalerite. Their habits generally are euhedral or subhedral. Most of the coarse cassiterite crystals are 125 x 75 micron in dimension. According to microprobe results, the formula of stannite has been calculated as $Cu_{1.9}Zn_{0.5}Fe_{0.7}Sn_{0.9}S_4$ by Çağatay and Arman (1989). This zinc–rich stannite chemistry is very different to those of Bolivian stannites (Dana 1892).

THE SART RIVER CASSITERITE – BEARING PLACER GOLD DEPOSIT

The Sart River placer - type gold deposit occurs close to Aegean Coast, mined from ancient time to the present by conventional techniques. Gold, electrum (gold and silver mixture), cassiterite, zircon, ilmenite were extracted from coarse grained Pliocene alluvial fan sediments. Both gold and cassiterite originate from the arsenopyrite and tourmaline - rich quartz veins of the high grade metamorphosed Menderes Massif. There is no economic importance of cassiterite.

DISCUSSION and CONCLUSIONS

The Sn deposits occur associated with S-type granite, or two mica (muscovite and biotite) granite, or tin granite. Behavior of W is very similar to Sn and therefore, Sn and W deposits occur together. Sn-W mineralizations were formed mainly by magmatic hydrothermal solutions in relatively high P -T conditions, 500- 300 ^{o}C, defining a metallogenic belt.

Syn and post-collisional S-type granitoids which were intruded into the high grade metamorphic massifs of the Anatolides resulted in vein-skarn-type Sn±W mineralizations. Such Sn±W metallogeny are seen in the Balıkesir-Bursa-Eskişehir region of the northwestern Anatolia related to S - type garnites of Hercinian age (Fig.7). Tin deposits related to S-type granites also occur in the highly metamorphosed rocks of the Central Anatolian Massifs with low W content.

Sn±W province of NW Anatolia and Sn province of Central Anatolia are related to continent-continent collusion of the Anatolides with the Pontides during the Cimmerian - Hercinian and the Alpine orogeny. These collision granites, the so-called tin granites, were generated within the continental crust by partial melting of pelitic metasedimentary rocks (Sn content of the metapelites, clay stone, is higher than the other rock types) which gave rise to the two mica (muscovite and biotite) granites. The Uludağ granite in NW Anatolia and the Üçkapılı granite from Central Anatolia are typical examples of tin granites of Turkey. S-type granite does not occur in the Pontide belt along the Black Sea coast. The granites of the Black Sea regions are mostly I-type arc granitoids which are unfertile for tin formation. Therefore; tin formation is limited in Turkey to the Central Anatolian matamorphic massif and NW Anatolia.

The presence of tin mineralization in the Madenbeleni Tepe of Northwestern Anatolia, Celaller and Sulucadere in Central Anatolia related to S-type granites, indicates their possible tin potentials. A-I-S-type granitoides, of the Kırşehir Massif in Central Anatolia, form big batholiths, which can also be accepted as a potential tin province of secondary importance.

Recent paleoarcheological studies reveal that the region of the Niğde Massif, Central Anatolia served as important tin resource in the early Bronze Age period. The underground galleries (Fig.8a), shafts, refractory crucible fragments, stone mortar for crushing and grinding (Fig. 8b) were found at both Kestel and Göltepe, (Yener and Özbal, 1987) as a unique and very old mining area in Central Anatolia, possibly even in the world. The artifacts from prehistoric mining are dated to the third millennium B.C. According to Yener (1997), crucibles at Kestel could have been used to assay the tin content of ore in order to make strategic decisions during mining that totals 200 tons of tin produced over perhaps a thousand years. However Pernica *et al.* (2003) do not accept such a kind of elemental Sn production in this site. The mining site is under the conservation of the Minister of Culture and Tourism of Turkey.

The geology of the Niğde Massif and its surrounding area indicates that the region has a special importance for tin potential with high a grade around the Üçkapılı granite. Therefore, some abandoned mine sites of tin from ancient times or some undiscovered tin deposits may be found around the Celaller deposit in the near future. NW Anatolia Sn±W belt of Turkey also reveals an important potential area for finding some ancient mining sites.

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REFERENCES

Boztuğ, D. 2000
"S-I-A- type intrusive associations: geodynamic significance of synchronism between metamorphism and magmatism in Central Anatolia, Turkey", E. Bozkurt, J. Winchester and J.A. Piper (eds.) *Tectonics and Magmatism in Turkey and the Surrounding Area*: 173, 407-424. Geological Society of London, Special Publication, London.

Burchfiel, B.C. et al. 2008
"Evolution and dynamics of the Cenozoic tectonics of the South Balkan extensional system", *Geosphere* 4 /6: 919-938.

Cemen, I., E. Catlos and G. Axen 2007
"Continental Extension in Basin and Range, USA and Western Anatolia Extended Terrane (WAET) in western

Turkey", A review: *Eos, Transactions of the American Geophysical Union* 88/52, Fall Meeting Supplement, Abstract T21D-03.

Çağatay, A., Y. Altun and B. Arman 1979
" Madenbelenitepe (Soğukpınar-Bursa) kalay cevherleşmesinin mineralojisi", *Maden Tetkik ve Arama Dergisi* 92: 40-48.

Çağatay, A. and R. Pehlivan 1988
"Celaller (Niğde- Çamardı) Kalay Cevherleşmesinin Mineralojisi", *Geological Engineering* 3: 27-31.

Çağatay, A. and B. Arman 1989
"Bolkardağ Sulucadere (Ulukışla-Niğde) kalay içerikli çinko-kurşun cevherleşmesinin mineralojisi", *Geological Engineering* 32: 15-20.

Çoğulu, E. 1975
Gümüşhane ve Rize granitik plütonlarının mukayeseli petrografik ve jeokronometrik etüdü. Istanbul Technical University Publication, İstanbul.

Dana, E.S. 1892
Descriptive Mineralogy. Dana's System of Mineralogy, 7th edn. 1946.

Göncüoğlu, M.C. 1986
"Orta Anadolu masifinin güney ucundan jeokronolojik yaş bulgulan", *Maden Tetkik ve Arama Dergisi* 105-106: 111-125.

Haapala, I. 1997
"Magmatic and Postmagmatic Proceses in Tin Mineralized Granites: Topaz - bearing Leucogranite in the Eurajoki Rapakivi Granite Stock, Finland", *Journal of Petrology* 38/12: 1645- 1659.

Hanilçi, N. and H. Öztürk 2005
"Aladağlar-Zamantı (Doğu Toroslar) Bölgesinde Mississipi Vadisi Tipi (MVT) Zn-Pb Yatakları: Ayraklı ve Denizovası Zn-Pb Yatakları-Türkiye", *İstanbul Üniv. Müh. Fak. Yerbilimleri Dergisi* 18: 23-43.

Hanilçi, N. and H. Öztürk 2008
"Hakkari Bölgesi Zn-Pb Yatakları: Jeolojisi, Özellikleri ve Oluşumuna Ait İlk Bulgular", H. Öztürk et al. (eds.) *Türkiye Kurşun-Çinko Yataklarının Jeolojisi Madenciliği ve Mevcut Sorunları Sempozyumu Bildiriler Kitabı*: 244-264.

Helvacı, C. and G. Alonso 2000
"Borate deposits of Turkey and Argentina; A summary and geological Comparison", *Turkish Journal of Earth Sciences* 9: 1-27.

Kaaden, G. van der 1958
"Uludağ Bursa Uludağ volfram madeninin jönez ve mineralizasyonu hakkında", *Maden Tetkik ve Arama Dergisi* 50: 36-47.

Kaptan, E. and P.S. de Jesus 1974
Türkiye madencilik tarihi için genel bir araştırma (kalayın kökeni). Maden Tetkik ve Arama Enstitüsü Raporu, 8, 5226 (unpublished), 106, Ankara.

Kaptan, E. 1992
"Anadolu'da Kalay ve Eski Yer altı Kalay Madenciliği", *Jeoloji Mühendisliği* 40: 15-19.

Kasapçı, C., H. Öztürk, N. Hanilçi and N. Aysal 2008
"Jeoloji ve Sıvı Kapanım Bulguları Işığında Arapuçan Dere (Yenice – Çanakkale) Pb-Zn-Cu Yatağının Oluşumu", H. Öztürk et al. (eds.) *Türkiye Kurşun-Çinko Yataklarının Jeolojisi Madenciliği ve Mevcut Sorunları Sempozyumu Bildiriler Kitabı*: 100-118.

Krauskopf, K.B. 1989
Introduction to Geochemistry. McGRAW-HILL International Series in the Earth and Planetary Science, Second Edition, Tokyo.

Moix, P. et al. 2008
"A new Classification of the Turkish Terranes and Structures and its implication for the Paleotectonic History of the Region", *Tectonophysics* 451: 7-39.

Okay, A.I. and O. Tüysüz 1999
"Tethyan sutures of northern Turkey", B. Durand et al. (eds.) *The Mediterranean Basins: Tertiary Extension within the Alpine Orogen*: 475-515. Geological Society of London, Special Publication 156, London.

Okay, A.I. and M.C. Göncüoğlu 2004
"The Karakaya Complex: A review of data and concepts", *Turkish Journal of Earth Sciences* 13: 77-95.

Okay, A.I. et al. 2008
"An Oligocene ductile strike-slip shear zone: The Uludağ Massif, northwest Turkey - Implications for the westward translation of Anatolia", *Geological Society of America Bulletin* 120: 893-911.

Oygür, V., H.E. Erkale, N. Erkan and N. Karabalık 1984
Niğde Masifi Demir Cevherleşmeleri Maden Jeolojisi Raporu. MTA Rapor 7521, Ankara.

Özgenç, İ. 1993
"Kızılcaören (Sivrihisar-Eskişehir) karbotermal bastneazit-fluorit-barit yatağının jeolojisi ve nadirtoprak element jeokimyası", *Türkiye Jeoloji Bülteni* 36: 1-11.

Öztunalı, Ö. 1973
Uludağ (Kuzeybatı Anadolu) ve Eğrigöz (Batı Anadolu)

Masiflerinin Petrolojileri ve Jeokronolojileri. İstanbul Üniv. Fen Fak. Monog., İstanbul.

Öztürk, H. 1997
"Manganese deposits in Turkey: distribution, types and tectonic setting", *Ore Geology Reviews* 12: 187-203.

Öztürk, H. and J.R. Hein 1997
"Mineralogy and Stable Isotopes of Black Shale - Hosted Manganese Ores, Southwestern Taurides, Turkey", *Economic Geology* 92: 733-744.

Öztürk, H., J.R. Hein and N. Hanilçi 2002
"Genesis of the Doğankuzu and Mortaş Bauxite Deposits, Taurides, Turkey: Separation of Al, Fe and Mn and Implications for Passive Margin Metallogeny", *Economic Geology* 97: 1063-1077.

Öztürk, H., N. Hanilçi, C. Kasapçı and S. Altuncu 2005
"Divriği Bölgesi Demir Yataklarının Yan Kaya Özellikleri", *Türkiye Demir Yatakları Jeolojisi, Madenciliği ve Mevcut Sorunları Sempozyumu Bildiriler Kitabı*: 74-84.

Öztürk, H., N. Hanilçi, C. Kasapçı and S. Altuncu 2008
"Orta Karadeniz Bölgesi (Giresun -Ordu) Damar Tipi Zn-Pb± Cu Yataklarının Jeolojik Özellikleri ve Oluşumları", H. Öztürk et al. (eds.) *Türiye Kurşun-Çinko Yataklarının Jeolojisi Madenciliği ve Mevcut Sorunları Sempozyumu Bildiriler Kitabı*: 325-246. İstanbul.

Pehlivan, N. and T. Alpan 1986
Niğde Masifi Altın-Kalay cevherleşmesi ve ağır mineral çalısmaları ön raporu. MTA Genel Müdülüğü, Maden Etüd ve Arama Dairesi, Ankara.

Pejatovic, S. 1979
Pondit tipi masif sülfit yataklarının metalojenisi. Maden Tetkik ve Arama Enstitüsü Yayınları, Ankara.

Pernicka, E., C. Eibner, Ö. Öztunalı and G.A. Wagner 2003
"Early Bronze Age Metallurgy in the Northeast Aegean", G. Wagner, E. Pernicka and H. Uerpmann (eds.) *Troia and the Troad: Scientific Approaches*: 143-172. Springer, Berlin.

Pichon, L. and J. Angelier 1979
"The Hellenic arc and trench system: a key to the neotectonic evolution of the eastern Mediterranean area", *Tectonophysics* 60: 1-42.

Schneider, H.J., N. Özgür and C.M. Palacios 1988
"Relationship between alteration, rare earth element distribution and mineralisation of the Murgul copper deposit, northern Turkey", *Economic Geology* 83: 1238-1246.

Seyitoğlu, G. and B.C. Scott 1996
"The cause of N–S extensional tectonics in western Turkey: tectonic escape vs back-arc spreading vs orogenic collapse", *Journal of Geodynamics* 22: 145-153.

Şengör, A.M.C. and Y. Yılmaz 1981
"Tethyan evolution of Turkey: a plate tectonic approach", *Tectonophysics* 75: 181-241.

Tüysüz, N. et al. 1994
"A Carlin-type gold occurrence in the Pontide island arc: the Kaletas fold occurrence (Gümüşhane, NE Turkey)", *Geological Bulletin of Turkey* 37/1: 41-46.

Tüysüz, N., B. Sadıklar, M. Er and Z. Yılmaz 1995
"An epithermal gold–silver deposit in the Pontide island arc, Mastra, Gumushane, northeast Turkey", *Economic Geology* 90: 1301-1309.

Ünlü, T., H. Stendal, E. Makovicky and I.S. Sayılı 1995
"Divriği demir yatağının kökeni, Orta Anadolu, Türkiye - Bir cevher mikroskobisi *çalışması", Maden Tetkik ve Arama Dergisi* 117: 17-28.

Yazgan, E. 1984
" Geodynamic evolution of eastern Taurus belt", O. Tekeli and M.C. Göncüoğlu (eds.) *Geology of Taurus Belt*: 199-201. Maden Tetkik Arama, Ankara.

Yener, K.A. 1994
Managing Metals: An Early Bronze Age Tin Producing Site at Göltepe, Turkey. The Oriental Institute Annual Report, USA, 31- 40, Chicago.

Yener, K.A. 1997
Excavatıons At Kestel Mıne, Turkey: The Fınal Season: 1996-97 Annual Report. Oriental Ins., Univ. of Chicago. *http://oi.uchicago.edu/OI/AR/96-97/96-97_Goltepe.html*

Yener, K.A. and H. Özbal 1987
"Tin in the Turkish Taurus Mountains: The Bolkardağ mining district", *Antiquity* 61/232: 220-226.

Yener, K.A. et al. 1989
"Kestel: An Early Bronze Age source of tin ore in the Taurus Mountains, Turkey", *Science* 244: 200-203.

Yılmaz, H. 2002
"Ovacık gold deposit: An example of quartz-adularia-type gold mineralization in Turkey", *Economic Geology* 97: 1829-1839.

Yurdagül, A. 2004
Uludağ Granitoyidinin Litojeokimyasal İncelenmesi. İstanbul Üniversitesi, Fen Bilimleri Enstitüsü, Yayımlanmamış Yüksek Lisans Tezi, İstanbul.

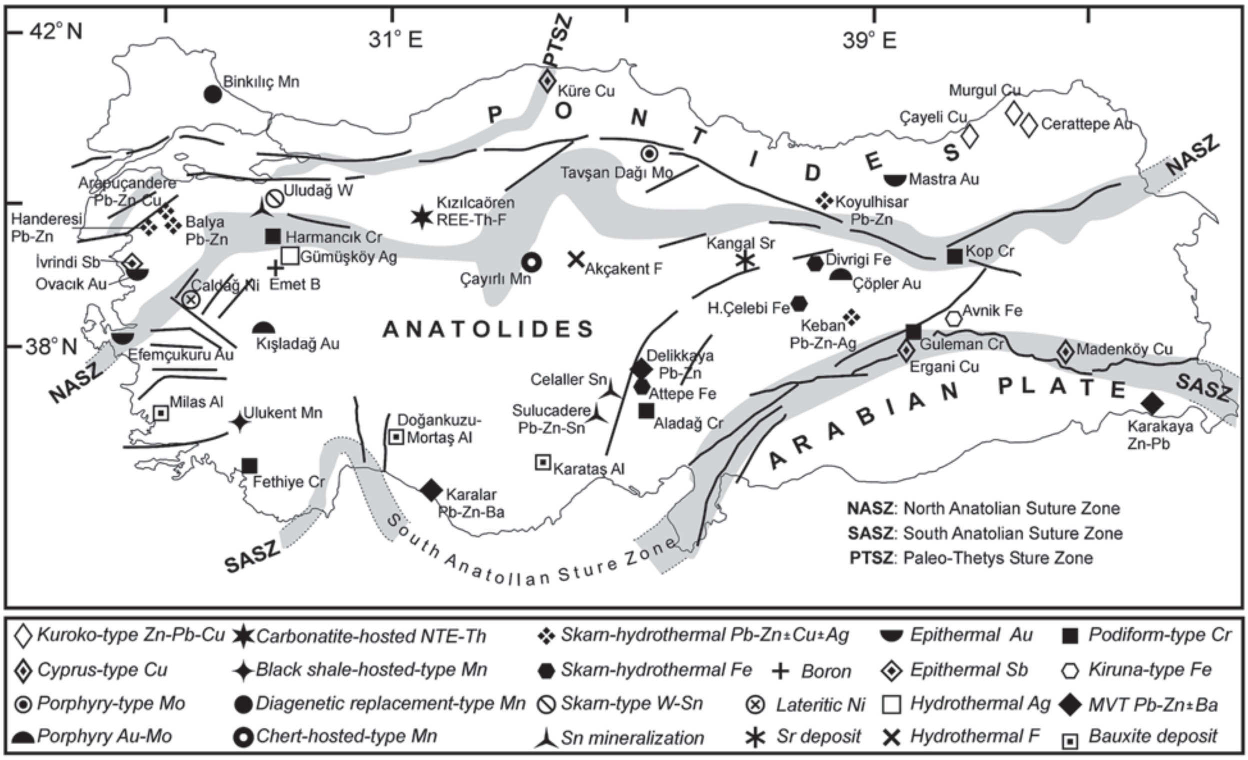
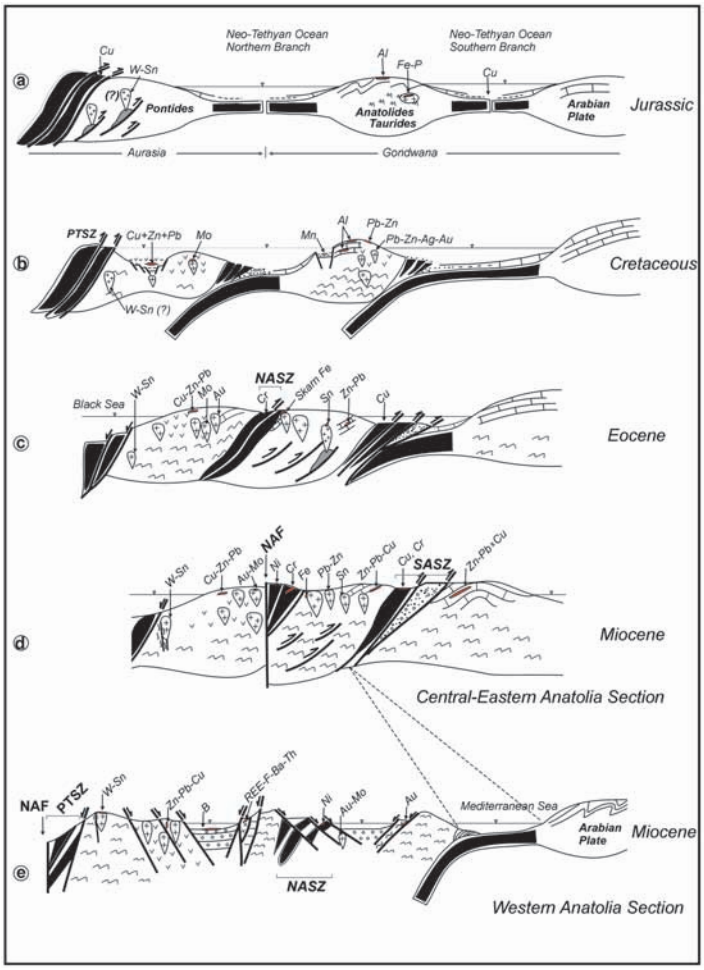


Fig. 1: The important ore deposits and suture zones separating the tectonic units of Turkey.



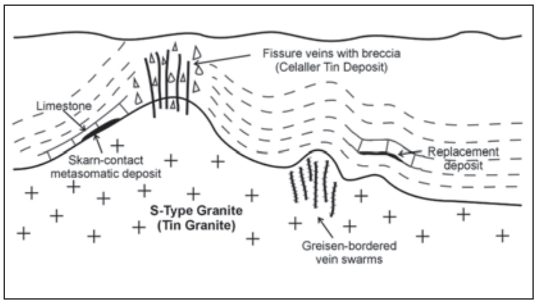


Fig. 3: Figure showing main formation types of Sn deposits related to tin granite.

Fig. 2: Formation history of the different types of ore deposits in Turkey (depicted on the base on the "Tethyan Evolution in Turkey" according to Şengör and Yılmaz 1981).

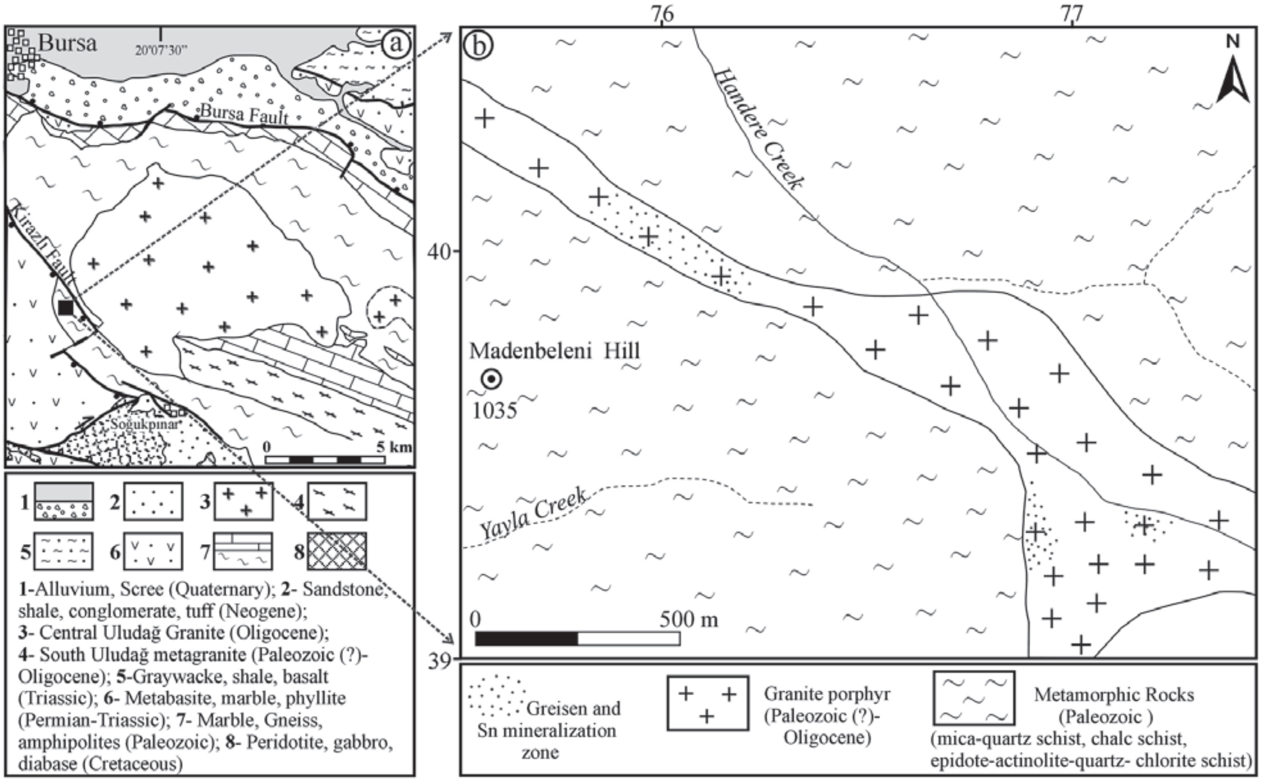


Fig. 4: Geological map of the Uludağ Massif (a) (modified after Okay et al. 2008 and Kaaden 1958) and Madenbeleni Tepe (b) tin mineralization (modified after Çağatay et al. 1979).

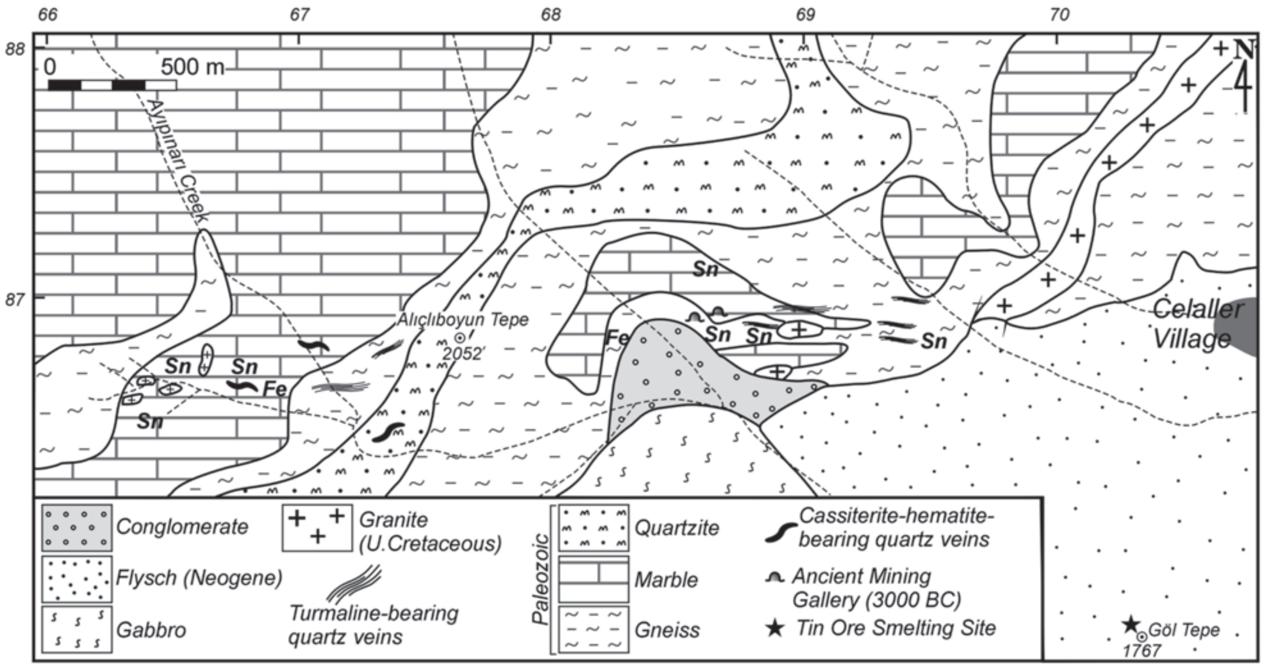


Fig. 5: Geological map of the Celaller tin deposit (modified after Oygür et al. 1984) showing location of the mining galleries and Göl Tepe smelting site in Bronze Age.

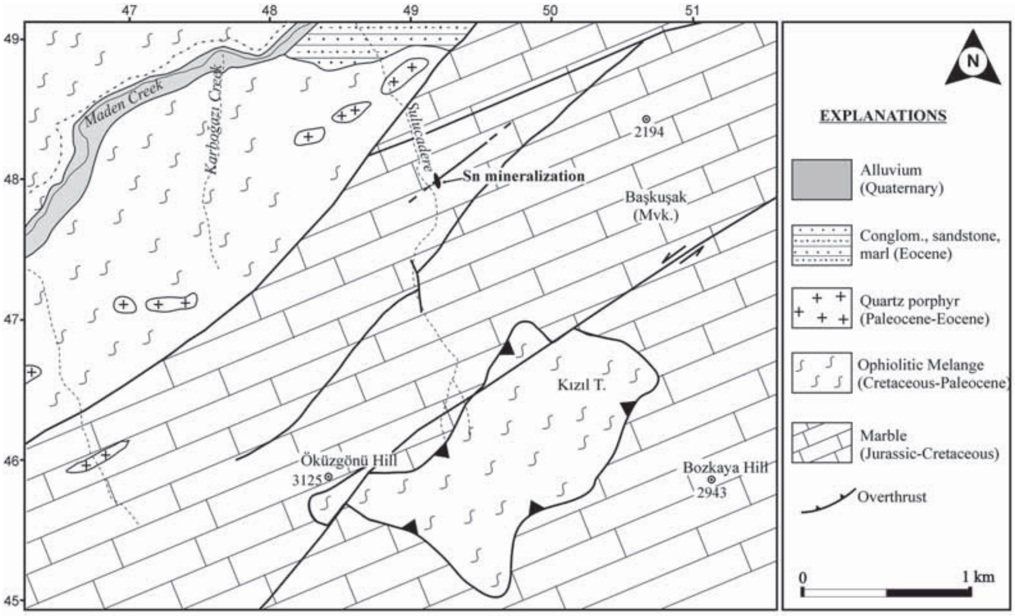


Fig. 6: Geological map of the Sulucadere Pb-Zn-Sn mineralization.

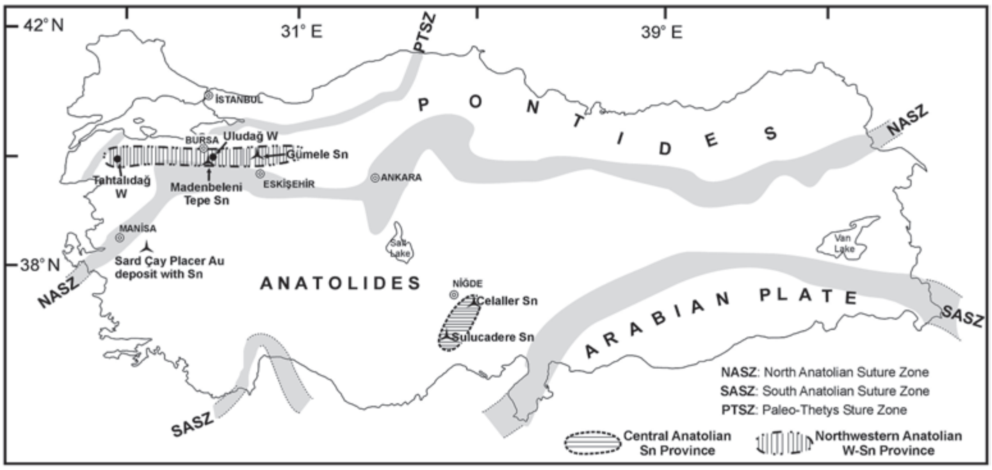


Fig. 7: Central Anatolian Sn and Northwestern Anatolian W-Sn Province of Turkey.

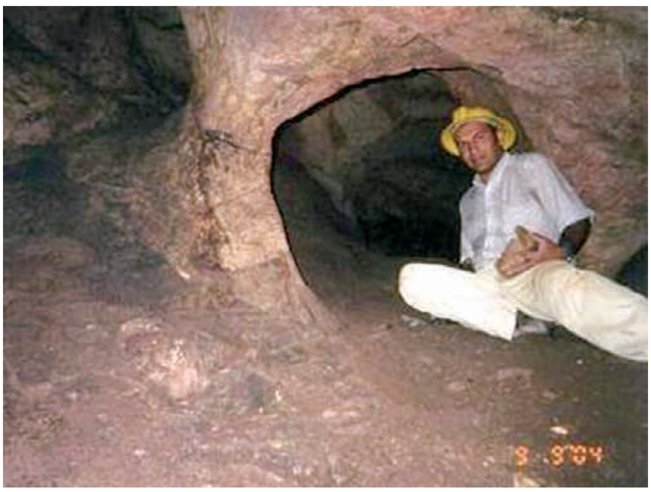


Fig. 8: (a) Rounded and narrow underground galleries of the Celaller tin deposit which were opened in a highly fractured crystalizsed limestone and silicified rocks in Bronze Age.

Fig. 8: (b) Ore crushing stone with concave -shaped which is composed of diorite from the Göltepe tin ore processing - smelting site where 2 km southeast of the Celaller tin deposit.

EIN NEUES ZINNVORKOMMEN IN KAYSERİ-HİSARCIK, ZENTRALANATOLIEN: EIN VORBERICHT

KAYSERİ-HİSARCIK'TA YENİ BİR KALAY YATAĞI: ÖNRAPOR

Ünsal YALÇIN, Hadi ÖZBAL

Schlüsselwörter: Zinn, Alter Bergbau, Kayseri, Anatolien

Anahtar Sözcükler: Kalay, eski madencilik, Kayseri, Anadolu

Key Words: Tin, ancient mining, Kayseri, Anatolia

ÖZET

MÖ 2. binyıl yazılı kaynaklara dayanarak oluşan ve arkeoloji'de bugüne kadar hakim olan görüş, Kestel'de keşfedilen İlk Tunç Çağ'ı kalay işletmelerinin varlığına karşın, Anadolu'da kalay yataklarının olmayışı yönündedir. Bu kapsamda Kayseri-Hisarcık'ta bulunan yeni bir kalay yatağı tarihöncesi kalayın kaynaği açısından önem taşımaktadır. 2003 ve 2004 yıllarında yapılan arazi çalışmalarında, Kayseri'nin kuzeyinde Hisarcık merkez ilçesi Senir Sırtı mevkiinde Andesit'ten oluşan volkanik kayaçların çatlaklarında hematitle birlikte kassiterit cevherine rastlanmıştır. Ayrıca yer yer cepler ve galeriler açılarak tarihöncesi dönemlerde buradan cevher alınmıştır. Böylece Anadolu'da Kestel'in yanısıra yeni bir kalay işletmesinin varolduğu anlaşılmaktadır.

İlerdeki çalışmalar bu yeni bölgenin tarih içindeki önemini aydınlatacaktır. Burada ilk gözlemlerimizi bir ön rapor olarak sunmakla, Anadolu'nun kalay içermediği şeklindeki geleneksel görüşü değiştireceğini düşünmekteyiz.

EINFÜHRUNG

Die Stellung Anatoliens in der Entwicklung der Bronzemetallurgie ist unumstritten (Yalçın and Yalçın 2008, und dieser Band), denn Anatolien befindet sich in einer Region, in der die ältesten Gegenstände aus Bronze zu Tage getreten sind. Trotz dieser führenden Rolle wird aber angenommen, dass Anatolien über kein nennenswertes Zinnvorkommen verfügt (Pernicka 1995; Muhly 1985; 1993).

Entgegen dieser noch vorherrschenden Meinung ergaben die Geländearbeiten in den letzten Jahren, neben fundierten Kenntnissen über die Erzlagerstätten, auch einige überraschende neue Ergebnisse über deren frühe Nutzung. Nachdem der prähistorische Zinnbergbau bei Kestel in den letzten 20 Jahren Zündstoff für kontroverse Diskussionen lieferte (Yener *et al.* 1989; Muhly *et al.* 1991), wird eine neue Beobachtung bei Kayseri die frühe Zinnfrage wieder in den Fokus der archäologischen Forschung rücken.

Zinn, als eines der wichtigsten Legierungsmetalle der Menschheitsgeschichte, wurde seit dem Beginn der Bronzezeit als ein strategisch wichtiges Metall gehandelt. Die Entdeckung des frühbronzezeitlichen Zinnbergbaus in Kestel vor 20 Jahren fand nicht die breite Akzeptanz in der Archäologie, denn die Vorderasiatische Archäologie war noch nicht bereit diesen neuen Befund zu akzeptieren, da die bestehende Lehrmeinung sich auf die historische Überlieferungen beruft: Altassyrische Texte von Kültepe berichten mehrmals über die Herkunft des Zinns aus dem Osten (vgl. Klengel, dieser Band). Die interdisziplinären Forschungen in den letzten zwei Jahrzehnten haben zudem den bronzezeitlichen Zinnbergbau in zentralasiatischen Ländern wie Usbekistan, Tadschikistan und Kasachstan sowie bei Deh Hosein im Iran belegt (Cierny et al. 2005; Weisgerber und Cierny 2002; vergl. ebenfalls Nezafati *et al.*, dieser Band). So konnten aussagekräftige Argumente für eine Zinnherkunft aus den östlich gelegenen Regionen erbracht werden, zumindest für die 2. und 1. Jahrtausende v. Chr.

Andererseits lassen die sehr frühen Belege der Zinnnutzung in Anatolien (vgl. Yalçın and Yalçın 2008, und dieser Band) den Verdacht zu, dass in Anatolien möglicherweise Zinnvorkommen existieren, die noch nicht entdeckt sind (Yalçın 2005; vgl. ebenfalls Öztürk und Hanilçi, dieser Band). In diesem Zusammenhang scheint uns eine neue Beobachtung in Kayseri-Hisarcık nicht unwichtig (Abb. 1).

Die ersten Hinweise für eine Zinnvererzung bei Kayseri lieferten die Prospektionsarbeiten der Staatlichen Anstalt für Geologie und Erzexploration (MTA) in den Jahren 2001 bis 2003 (Pehlivan *et al.* 2003; Sarp and Cerny 2005). Daraufhin wurde das Gebiet im Rahmen eines Gemeinschaftsprojektes des Deutschen Bergbau-Museums Bochum und MTA Ankara in den Jahren 2004 und 2007 besucht und beprobt. Eine intensive Erforschung des Gebiets steht noch aus, soll aber in naher Zukunft realisiert werden. Hier wird über die ersten Geländebeobachtungen und Analysenergebnisse kurz berichtet.

GELÄNDEBEOBACHTUNGEN

Hisarcık befindet sich etwa 10 km südlich von der Provinzhauptstadt Kayseri. Auf dem Hügel „Senir Sırtı", unterhalb der Gemarkung "Şelale Mevkii" befindet sich eine prähistorische Siedlung (Abb. 2a). Die Steinmauer und die Keramikfunde belegen eine Zeitstellung in das 2. Jahrtausend v. Chr. Die Steingeräte, handgefertigte Keramikscherben und Obsidianklingen (Abb. 2b) in der Siedlung lassen aber weitere, ältere Siedlungsphasen (chalkolithisch-frühbronzezeitlich) vermuten.

Der NNE-SSW verlaufende und leicht nach Norden abtauchende Höhenzug „Senir Sırtı" ist aus den vulkanischen Koçdağ-Einheiten aufgebaut. Diese gehören, als Teil des Erciyes Vulkanits, zu „Kappadokischen Vulkanit-Provinz (KVP)" und bestehen aus Andesiten, Tuffen und Ingrimbiten (Toprak *et al*. 1994). Erciyes Dağı, der Namengebende höchste Punkt des Gebiets mit 3917 m befindet sich etwa 40 km südlich von Kayseri. Der Erciyes Komplex ist der größte und einer der jüngsten Stratovulkane des KVP. Nach der geochemischen Analyse liegen kalk-alkalische, basaltische Andesite und Dazite vor. Die vulkanische Aktivität des Erciyes-Komplex wird in eine Zeitspanne von Jung Pleistozän bis Quartär datiert (Toprak *et al*. 1994).

Das Aufeinanderdriften der Eurasischen und Afrikanischen Kontinente prägt das heutige Bild Anatoliens (Okay 2008). Das Gebiet von Kayseri und damit Hisarcık ist infolge dieser großen kontinentalen Depression stark zerklüftet. Nord-Süd verlaufende Hauptstörungslinien werden von zahlreichen kleineren Brüchen begleitet. Gerade diese Bruch- und Kluftspalten sind lagerstättenkundlich interessant, da sie hydrothermal ausgeprägt sind. Auf den Spaltflächen wurde Hämatit ausgeschieden, der in geringen Mengen Kassiterit, Yazganit, Auripigment, Realgar und Tridymit enthält (Sarp and Cerny 2005: 368). Diese Mineralparagenese wird außerdem im naheliegenden Gümüşdere Mevkii in den pyroklastischen Serien beobachtet. Durch die Entwicklung der granitischen Schmelzbildung entstandene heiße Gase müssen entlang der Spalten und Risse nach Oben gestiegen und die mitgeführten Metalle wie Eisen und Zinn unter erhöhter Sauerstofffugazität auf den oberflächennahen Spalten ausgeschieden haben.

Infolge der tektonischen Aktivitäten wurde auch Senir Sırtı stark gestört. Zahlreiche etwa mit 40° NE und 15° NW streichende Störungen weisen Abbauspuren auf, da die Spalten und Klüfte entlang dieser Störungen erzführend sind. Die Hämatitschlieren bzw. –schichen auf den Kluftflächen sind mm bis cm dick ausgebildet (Abb. 4a). Die Abbauspuren befinden sich auf dem Westhang des Höhenzugs (Abb. 3a, b). Die ersten Stolen liegen gleich oberhalb eines Bachlaufs, am alten Schlachthof. Weiter nördlich, am Ende des Höhenzugs entstand beim Hausbau ein neuer Aufschluss, wo auf mehreren parallel zueinander verlaufenden Spaltflächen eine Hämatitschicht liegt, die mit teilweise bis zu 0,5 cm großen Spekularitkristallen auffällt (Abb. 4b). Hier wurden außerdem die höchsten Zinnwerte gemessen (Tab. 1-2).

Bei den Bergbauspuren handelt es sich um kleine Schächte, Such- und Abbaustrecken und durch die Erosion verschüttete Stollenmundlöcher. Einige Kriechstrecken enden in einem größeren Abraum. Die stumpfen Abbauspuren deuten darauf hin, dass hier Steinwerkzeuge im Einsatz waren. Damit kann eine prähistorische Zeitstellung als wahrscheinlich gehalten werden. Die prähistorische Siedlung oberhalb des Hügels würde das vorgeschlagene prähistorische Alter ebenfalls unterstützen. Es bedarf jedoch weitgehender Untersuchungen der Stollen und Taschen, um sicher zu datierendes Material zu finden, etwa wie Holz, Holzkohle, Scherben und Werkzeuge.

ANALYSENERGEBNİSSE

Im Gelände wurden die Hämatitschlieren aus den Kluftflächen in den alten Stollen und Abbautaschen beprobt. Außerdem konnte in einem neuen Steinbruch am Südende des Senirsırtı-Höhenzugs eine frische Probe gewonnen werden. Die beprobten Stücke wurden sowohl mineralogisch (XRD) als auch chemisch (ICP-OES) analysiert. In den XRD-Diffraktogramm konnte neben Hämatit immer etwas Kassiterit nachgewiesn werden (Abb. 4c). Außerdem wurden die Hämatitlagen aus den Spalten heraus präpariert und unter Rasterelektronenmikroskop semiquantitativ (EDX) analysiert. Hier wird die Analyse von vier ausgewählten Proben kurz besprochen:

Die Andesitprobe (Tr-04/1-2b) enthält Spuren von Arsen und Zinn (30 ppm As, 20 ppm Sn), während in einer weiteren Andesitprobe mit dünner Hämatitschicht der Zinngehalt merklich steigt (100 ppm). In den beiden Proben aus der Hämatitschicht sind aber deutliche Mengen Zinn und Arsen enthalten. Der Zinngehalt liegt bei der Probe aus der alten Abbautasche bei 0,12 Gew. %, bei der Probe aus dem neuen Aufschluss sogar bei 0,21 %. Die letzte Probe enthält außerdem 1,34 Gew. % Arsen.

Um das Zinn in Hämatit besser zu erfassen wurde die Hämatitschicht in einer Achatmühle gemahlen und dann zunächst unter dem Binokular und anschließend unter dem Rasterelektronenmikroskop untersucht. Es zeigte sich, dass Zinn in oxidischer Form als Kassiterit vorliegt, mit einer Korngröße unter 100 μm und meist mit Hämatit verwachsen (Abb. 5a, b). Ein Versuch das gemahlene Gut zu trennen, führte zu einer Anreicherung des Kassiterit bis zu 20 %. Dieses Ergebnis ist mit den Beobachtungen in Kestel durchaus vergleichbar. Auch dort konnte der Zinnanteil des Hämatits experimentell erhöht werden (Earl and Özbal 1996).

SCHLUSSWORT

Die ersten Untersuchungen in Hisarcık haben gezeigt, dass in Anatolien durchaus Zinnvorkommen zu erwarten ist. Die bis dahin steril geltende granitische Schmelze des Kappadokischen Vulkanischen Komplexes scheint doch erzführend zu sein, wenn auch sein ökonomisches Ausmaß noch nicht abzuschätzen ist. Neben den bisher viel diskutierten Kestel wird auch in Hisarcık bei Kayseri Zinn nachgewiesen. Über die Größe des Vorkommens und das Ausmaß des frühen Bergbaus und dessen Zeitstellung lässt sich momentan keine Aussage treffen. Weitere Untersuchungen sind notwendig, um offene Fragen zu beantworten. Dabei stehen folgende Punkte im Vordergrund:
Wie Groß ist die Zinnvererzung in Kayseri?
Wann wurde dort Zinn abgebaut?
Spielte dieses Vorkommen in der Frühbronzezeit eine Schlüsselstellung oder wurde es nur für den lokalen Bedarf abgebaut?

Die Geländearbeiten wurden im Rahmen einer Kooperation des Deutschen Bergbau-Museums Bochum mit der MTA Ankara durchgeführt. An den Geländearbeiten waren außerdem A. Kartalkanat und N. Pehlivan (MTA) beteiligt. Die Arbeiten wurden von beiden Institutionen finanziell unterstützt. Allen Beteiligten sei hier ausdrücklich gedankt.

REFERENCES

Cierny, J., Th. Stöllner and G. Weisgerber 2005
"Zinn in und aus Mittelasien", Ü. Yalçın, C. Pulak and R. Slotta (eds.) *Das Schiff von Uluburun – Welthandel vor 3000 Jahren*: 431-448. Deutsches Bergbau Museum, Bochum.

Earl, B. and H. Özbal 1996
"Early Bronze Age Tin Processing at Kestel/Göltepe, Anatolia", *Archaeometry* 38: 289-303.

Muhly, J.D. 1985
"Sources of Tin and the Beginning of Bronze Metallurgy", *American Journal of Archaeology* 89: 275-291.

Muhly, J.D. 1993
"Early Bronze Age Tin and the Taurus", *American Journal of Archaeology* 97/2: 239-253.

Muhly, J.D. et al. 1991
"The Bronze Age Metallurgy of Anatolia and the Question of Local Tin Sources", E. Pernicka and G.A. Wagner (eds.) *Archaeometry* '90: 209-220. Proceedings of the 27th Symposium on Archaeometry held in Heidelberg, Basel.

Okay, A. 2008
"Geology of Turkey: A Synopsis", *Anatolian Metal* IV (Der Anschnitt, Beiheft 21): 19-42.

Pehlivan, N., E. Tufan, O. Tüvar and E. Yiğit 2003
Kayseri (Hisarcık-Kıranardı) Kalay aramaları. Maden Tetkik Araştırma 8524 nolu raporu, Ankara.

Pernicka, E. 1995
"Gewinnung und Verbreitung der Metalle in prähistorischer Zeit", *Jahrbuch d. Römisch Germanischen Zentralmuseums Mainz* 37/1: 21-129.

Sarp, H. and R. Cerny 2005
"Yazganite, NaF2(Mg,Mn)(AsO4)3.H2O, a new mineral: its description and crystal structure", *European Journal of Mineral* 17: 367-373.

Toprak, V., J. Keller and R. Schumacher 1994
"Volcano-Tectonic Features of the Cappadocian Volcanic Province", *IAVCEI Intern. Volc. Congress, Excursion Guide Book*: 1-58. Ankara.

Weisgerber, G. and J. Cierny 2002
"Tin for Ancient Anatolia?", *Anatolian Metal* II (Der Anschnitt, Beiheft 15): 179-187.

Yalçın, Ü. 2008
"Ancient Metallurgy in Anatolia", Ü. Yalçın, H. Özbal and A.G. Paşamehmetoğlu (eds.) *Ancient Mining in Turkey and the Eastern Mediterranean*: 15-42. Atılım Üniversitesi, Ankara.

Yalçın, Ü. and H.G. Yalçın 2008
"Der Hortfund von Tülintepe, Ostanatolien", *Anatolian Metal* IV (Der Anschnitt, Beiheft 21): 101-123.

Yener, K.A. et al. 1989
"Kestel: An Early Bronze Age source of Tin Ore in the Taurus Mountains, Turkey", *Sciences* 144: 200-203.

Tr-04/1-2b:	Andesit, Probe aus der Galerie 1
Tr-04/1-3:	Vererztes Andesitstück aus der prähistorischen Siedlung
Tr-04/1-6:	Neuer Aufschluss, hämatitreiche Probe aus der Kluftfläche
Tr-04/1-11:	Hämatitreiche Probe aus der Abbautasche (Zwillingsgalerie)

Tabelle 1: Untersuchte Proben aus Hisarcık: Probeentnahmestellen.

Probenr.	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O
Tr-04/1-2b	67,3	0,29	21,3	2,45	0,04	0,36	1,14	4,47	3,97
Tr-04/1-3	67,5	0,23	19,7	2,98	0,03	0,11	0,96	4,42	4,30
Tr-04/1-6	32,4	0,09	5,53	56,80	0,34	0,04	0,37	1,41	3,65
Tr-04/1-11	47,8	0,47	14,6	25,60	0,07	1,96	3,55	2,98	2,24

Probenr.	Ni	Cu	Zn	Pb	As	Sb	Bi	Sn	V
Tr-04/1-2b	—	0,002	0,003	—	0,003	—	—	0.002	0.001
Tr-04/1-3	0,001	0,001	0,002	—	0,004	—	—	0,010	0,001
Tr-04/1-6	0,001	—	0,084	0,014	1,340	0,007	0,001	0,210	0,002
Tr-04/1-11	0,004	—	0,003	0,003	0,100	—	0,004	0,120	0,009

Tabelle 2: Chemische Zusammensetzung der Proben aus Hisarcık (Angaben in Gewichst %; —: nicht vorhanden).

Abb. 1: Karte Anatoliens mit den wichtigsten Prähistorischen Bergbaubezirken. Kayseri und Kestel als Zinnvorkommen sind besonders vermerkt.

Abb. 2: Die alte Siedlung (a) auf dem Senirsırtı bei Hisarcık (a) und die Obsidianfunde (b).

Abb. 3: Prähistorischen Abbautaschen und Stollenmundlöcher am Westhang des Höhenzugs Senirsırtı. In den Kluftspalten des Andesitfels befinden sich die Abbautaschen (a). Einige alte Abräume sind durch Erosion frei gelegt und so wieder zugänglich (b).

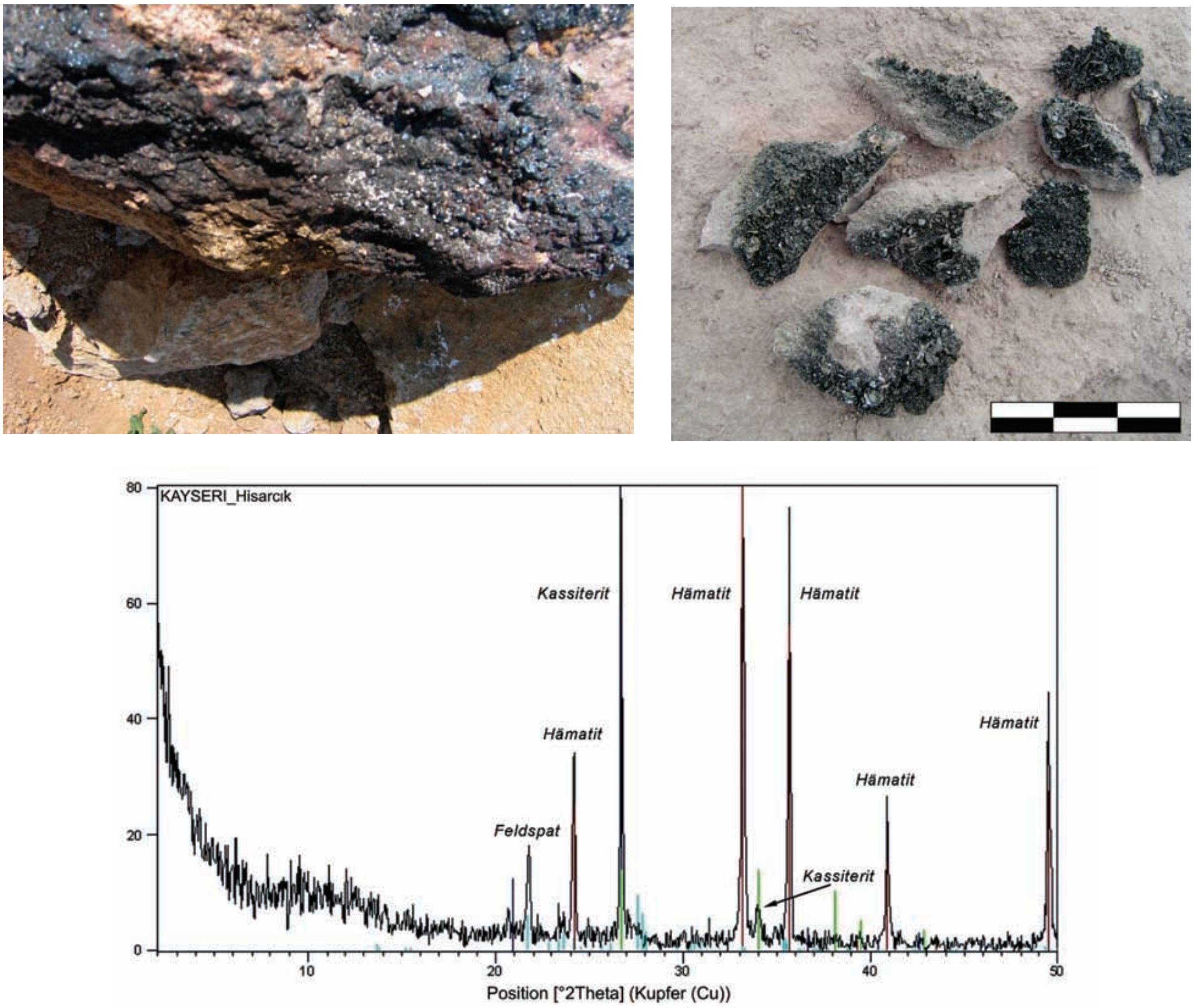


Abb. 4: a: Hämatitschlieren auf den Spaltflächen, b: Spekularitkristalle, entnommen aus dem neuen Steinbruch am Nordende des Höhenzugs Senirsırtı, c: XRD-Diffraktogramm eines Hämatitschichs zeigt, neben dem Hauptmineral Hämatit, immer etwas Kassiterit.

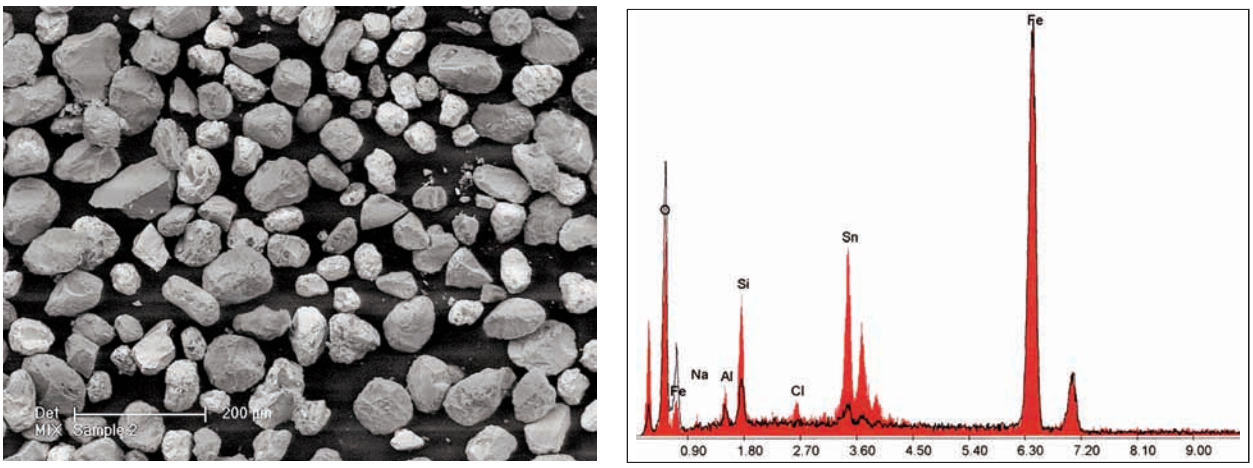


Abb. 5: a: Gemahlener und durch Schlämmen angereicherter Probe enthält bis zu 20 % Kassiterit. Die hellen Körner sind Kassiterit, die dunklen Hämatit; b: REM-Spektrogramm der gemahlenen Probe aus Hisarcık zeigt deutliche Mengen an Zinn.

EVIDENCE FOR EARLY USE OF TIN AT TÜLİNTEPE IN EASTERN ANATOLIA

DOĞU ANADOLU/TÜLİNTEPE'DE KALAYIN İLK KULLANIMINA DAİR VERİLER

Ünsal YALÇIN, H. Gönül YALÇIN

Keywords: Late Chalcolithic, Early Bronze Age, copper, arsenic, nickel, tin, tinning, Tülintepe, Anatolia.

Anahtar Sözcükler: Son Kalkolitik Çağ, İlk Tunç Çağ, bakır, arsenik, nikel, kalay, kalaylama, Tülintepe, Anadolu.

ÖZET

Elazığ Altınova'nın Keban Baraj gölünün su kaplama alanı içinde kalması, eski Elazığ-Bingöl demiryolunun geçiş yolunun değiştirilmesini gerektirmiş ve yeni tren hattının yakınında bulunan Tülintepe 1966 yılında kamulaştırılarak, bir kısım toprağı alınmış ve bu toprak demiryolu düzleminin ovadan yükseltilmesi için dolgu malzemesi olarak kullanılmıştır. İlk Tunç Çağı ve Son Kalkolitik Çağ için önemli veriler içeren höyüğün üst katları böylece tahrip olurken, kaldırılan toprakta tümüyle rastlantısal olarak bir kılıç ve beş mızrak ucundan oluşan bir toplu maden buluntusu açığa çıkmıştır. Daha sonra Tülintepe'de yapılan sistematik kazılar sonucunda ve diğer tarihöncesi yerleşimlerden bilinen benzer buluntu grupları ile karşılaştırılarak adı geçen maden topluluğunun Son Kalkolitik-İlk Tunç Çağı I'e tarihlendirilmesi öngörülmüştür.

Buluntu topluluğunun ortaya çıkmasından yaklaşık 30 yıl sonra, modern yöntemlerle yapılan arkeometalurjik araştırmalar sonucunda söz konusu kılıç ve mızrak uçlarının arsenik ve nikel içerikli bakırdan üretildiği ve yüzeylerinin kalayla kaplı olduğu anlaşılmıştır. Böylece kalayın günümüzden 5000 yıl önce Anadolu'da kullanıldığı belgelenmektedir. Aşağıdaki yazımızda, arkeolojik yayınlara Tülintepe "Hazine Buluntusu" olarak geçen bu maden topluluğunun yapım tekniklerine, yüzey kullanım izleriyle ilgili veriler ve üretilmiş oldukları metallerin kompozisyonlarına ağırlık verilmektedir. Ele aldığımız buluntu topluluğunun yakın çevredeki yaklaşık eş zamanlı benzerleriyle karşılaştırılmasının ve göreli olarak tarihlendirilme önerilerinin yanı sıra, buluntuların yapımında kullanılan metallerin kökeni de ele alınmakta, tüm bu somut bilgiler Eski Dünya'da kalayın bilinen tarihçesi de göz önünde bulundurularak, deneysel bir yaklaşımla belli bir sosyoekonomik çerçeveye oturtulmağa çalışılmaktadır.

INTRODUCTION

The leading role of Anatolia in the development of metallurgy has been mentioned in archaeological publications several times[1]. The first settlers of Anatolia already knew about ores. They collected minerals like hematite, malachite or semi-precious stones in striking colours and worked small beads out of them. In some regions they also gathered native copper and worked small beads out of it or formed objects like pins, fishing hooks or awls. In order to optimize the forming process the new raw material was heated (Yalçın 2000a; 2003; 2008). Pyrotechnology copper working was thus evident long before the firing of ceramics. Thus the craft of metal working started in Anatolia almost 10.000 years ago and turned into one of the most important economic branches in human history. For a long time native copper remained the only metal people used. About 7.000 years ago they succeeded in obtaining copper from its ores. Rolled head pins, chisels and axes from Mersin XVI made of smelted copper are dated to 5.000 BC (Yalçın 2006). By this time the Anatolian settlers were able to gain copper from different ores and to manufacture different tools out of it.

The number of copper artefacts increases in the 4th millennium BC. In this stage of development, workshops with ore pieces, fractures of crucibles, casting moulds and a series of metal finds give us hints about vivid metallurgical activities in the settlements. Examples for these activities have been found all over Anatolia, such as in Eastern Altınova, in the Plain of Antioch in Southeastern Anatolia, as well as in Central and Western Anatolia. Special attention should be paid to Altınova where many prehistoric settlements were found. These settlements maintained flourishing economic and cultural contacts with the Levant, Mesopotamia and Transcaucasia (Hauptmann and Palmieri 2000; Frangipane 2001). In this time of cultural boom the very complex compositions of copper ores were used for metallurgical process (Cu-Pb-Zn-As.Sb-Ni-mineralization, “Fahlerz”, massive sulphide ores). Almost across the whole of Anatolia, a specific metal that appears with frequency can be observed within the territory of the Kura-Araxes-/Karaz-Culture. It consists of a copper-arsenic alloy and contains different amounts of nickel. In this connection it makes sense to ask whether this special kind of copper was responsible for the different qualities of certain metal objects like jewellery, weapons and tools (Yalçın and Yalçın 2008).

Smelting experiments with several ores led to the discovery of new metals. As a result the dominion of copper ended in the 4th millennium BC. Silver, gold and lead were discovered. The first massive objects of silver were found e. g. in Korucutepe in Altınova (van Loon 1978). In this stage of development throughout the Near East the extraction was still done in the settlements. If needed the copper was melted in crucibles and was worked directly on spot. We call this kind of production “household-metallurgy” (Hauptmann 2000). At the beginning of the 3rd millennium BC copper seems to be alloyed with tin. Thus bronze was born. Some rare early examples come from Tell el-Judaidah, Alişar I, Troy I and Thermi I, though the suggested early date is not safe enough (Mellink 1992).

In Malatya-Arslantepe in Eastern Anatolia almost 100 metal objects were found both in a palace and a royal tomb that were dated to 3400-2900 BC. These finds are of great importance for the metallurgy of this period in the Near East. They consist of weapons and ceremonial objects made from arsenical copper and partly from nickel. Among them there is jewellery made from a silver-copper alloy that provides some of the earliest evidence for intentional alloying techniques (Hauptmann *et al*. 2003).

In the Early Bronze Age II-III (in the 3rd millennium BC) the first big change in metallurgical development occurs. As a kind of a first “industrial process” the ores were extracted in the vicinity of the mines (Strahm 1994). From now on the evidence of further working steps like hearths, melting pots, casting moulds, ingots and final products were found in the settlements (Müller-Karpe 1994). Well organized mining, metallurgy and metal trade led to a society with the hierarchical structures and task distribution. With the beginning of the 2nd millennium BC the first regional kingdoms with central organized social structures and an impresive metal culture came into being.

With the beginning of the Early Bronze Age II, the use of tin bronze expanded in Mesopotamia and in

Central Anatolia and reached Troy, while some parts of the Near East and Anatolia were still using arsenical copper. While most of the high-status objects of Alacahöyük, Horoztepe and Troy were made from bronze, arsenical copper was still in use e. g in İkiztepe in the Black-Sea Region and in Tarsus at the Mediterranean coast of Southern Anatolia (Esin 1969; Özbal *et al*. 2002).

With the discovery of bronze, the golden age of metal trade began. Tin probably to be imported over large distances. In the main distribution regions of bronze, tin mines are rare (Yener *et al.* 1989. Consult also the contributions in this book). Only one mine like Kestel would not be capable of delivering tin to the whole Near East in the 3rd millennium BC. The next known tin deposits are in Central Asian countries like Afghanistan, Uzbekistan, Tajikistan and Kazakhstan. From the early 2nd millennium on tin production has been proven to have occurred in all the aforementioned countries (Weisgerber and Cierny 2002; Parzinger 2002; Cierny *et al.* 2005). Yet we cannot associate the original tin mines with tin used for the objects found in the Near East. At the latest the "bronze industry" was established in the Middle Bronze Age in the 2nd millennium BC. Weapons, tools and pieces of furniture were all ideally made from bronze. A wide range of types as well as serial production supported a flourishing metal economy. It is in this phase of industrialisation that iron production starts. Apart from rare finds of meteor iron known from the Near East, the first terrestric iron finds identified with complete certainty had already appeared in Anatolia in the first half of the 3rd millennium BC. But it took a long time until iron and steel pushed bronze aside and were preferred for the mass production of the weapons and tools. This happens at the beginning of the last millennium BC first (Yalçın 1998 b).

Already mentioned is the spectacular metal finds from Arslantepe VI A-B1 (3400-2900 BC) that were published by Frangipane *et al*. (2002) and Hauptmann *et al*. (2003). The analytic investigations have shown that the jewellery was produced from a silver-copper alloy. Furthermore a kind of arsenic enriched copper, partly nickel-bearing, was used in order to produce high-status objects, weapons (also swords and spearheads) and tools. Some swords were decorated with silver stripes afterwards (Palmieri 1981; Frangipane *et al.* 2002). The source of As-Ni-enriched copper is not yet known, as the present investigations do not establish the provenance with certainly as being from any of the known metal mines of Eastern Anatolia (Hauptmann *et al.* 2003). A similar dated hoard of metal objects from Tülintepe in Altınova, lying about 80 km to the north-east of Arslantepe, has not yet been investigated. This completely unknown metal hoard was unearthed by chance during rail-road construction works in 1966. It consists of one short sword and five spearheads. They belong to the same typological class as the metal finds from Arslantepe VI A-B and are dated to about the same range (Harmankaya 1993; oral communication with M. Frangipane)[2]. At this point we may ask some questions about the chemical composition and the provenance of the metals used. Further questions consider the relations between the metal hoard from Tülintepe and the metal finds from Arslantepe VI A-B. Samples from Tülintepe finds were taken at the archaeological Museum of Elazığ[3]. Afterwards they were analyzed. Special attention was paid to the following questions:

1. From which material were the objects produced?
2. Which traces of production and use can be recognized?
3. Which compositional and production similarities do the spearheads from Tülintepe and the metal finds from Arslantepe VI A-B show?
4. Where do the metals come from?

During the check of the metal finds in the archaeological Museum of Elazığ two further metal objects from Tülintepe and three more from Tepecik were discovered. According to the publications of Esin (1986) these metal finds were dated to the Late Chalcholithic and the EBA I like those from Arslantepe VI A-B. The results of the investigations will be briefly presented here[4].

THE ARCHAEOLOGICAL DATA AND THE DESCRIPTION OF THE FINDS

Tülintepe is situated in Altınova about 21 km to the east of Elazığ. Today the site is flooded by the waters of Keban Dam. It was discovered in the early 1940s (Kökten 1947) and was mentioned in many later archaeological reports (Meriggi 1967; Burney 1958; Whallon and Kantman 1970).

During the construction of the Keban Dam the course of the railroad had to be raised or relocated. The needed earth was unfortunately taken from nearby Tülintepe, thus destroyed an essential part of it (Fig. 2). During this work a metal hoard was found by chance in 1966.

In 1967 the topographic plan of the site was drawn by Whallon and Kantman during the survey that preceded the start of the Keban Dam Rescue Project. Between 1971-1974 Ufuk Esin and Güven Arsebük from the University of Istanbul excavated here. Due to the destruction, the excavations were restricted to the Chalcholithic Period and the Early Bronze Age (Esin 2000a: 87). Besides the widespread ceramics of this region and different stone artefacts some copper slags were found in a stone well. These slags indicated metallurgical activities that could be dated to the Chalcholithic Period and the Early Bronze Age I (Esin and Arsebük 1974: 142; Esin 2000a: 88).

The metal hoard of Tülintepe consists of a short sword and five spearheads. Yet the exact find spot could not be named (Fig.3; Table1). Nothing is known about other metal finds and ceramics that belonged to this hoard since they disappeared during the delivery of the earth taken from this spot of Tülintepe. Such accompanying finds would certainly be of a great help for a close dating (Harmankaya 1993: 372).

The short sword has a length of 44.6 cm, a width of 5.3 cm. It weights 324 gr.[5] It rather reminds of a dagger with a pointed triangular hilt-tongue that does not have rivet holes (Yalçın and Yalçın 2008). The sword has a narrowing, well shaped blade that terminates in a to the point. It does not include an exact middle rib. The tip of the blade is broken. The cut shows partial traces of hammering and is a little corroded at the shoulder. Because of the absence of a rivet hole at the hilt-tongue, the form of the hilt cannot be defined exactly. Silvery shining metal rests can be observed on the surface of the sword.

The spearheads were caste in two sided moulds and have leaf-shaped blades with a well-formed middle rib. The sockets are rounded, sometimes rather octagonal. They show a thickening spot which extends to a spine-like point at the lower end. The length of this spine-like end alternates from piece to piece and it is not only pointed but also angular in shape. It helped to fasten the spearhead at the spear. Silvery shining metal rests can be also seen on the surface of the spearheads.

Though the spearheads form a closed typological group together, they show different lengths (38-51 cm) and widths (3.7-6.0 cm), thus the sizes are not constant. The leaf-shaped blades, sockets and spine-like ends also have various sizes. So we can talk about unique pieces here (compare Fig.3).

All six objects are well preserved, though one of the spearheads is broken. They were all restored, necessary samples were taken, and finally they were exhibited in the Archaeological Museum of Elazığ (Fig.4). During the restoration work valuable information about the production techniques was obtained.

During and after the exposure of the surfaces the objects were investigated under a (binocular) microscope. In part the corrosion layer was up to 2 mm thick. It primarily consisted of malachite ($Cu_2 (OH)_2/CO_3$) and atacamit ($Cu_2 (OH)_2Cl$). They formed a hard and firmed layer together with calcareous sediment. Below this greenish layer a black soft layer of corrosion was obvious. It contained partially a silvery shining metal (Fig.6a, b). At close observation under the binocular we could state that the objects were originally completely covered with this "silvery" metal. On one of the spearheads even two of these "silvery" metal layers were observed. We already know that among the comparable metal finds from Arslantepe VI A-B1 there is at least one spearhead with a partially silver decorated surface (Palmieri 1981; Frangipane 2001; Hauptmann *et al.* 2003). Thus we can also speak about a silver decoration or a silver cover in case of Tülintepe. In order to check this hypothesis scientifically, samples were taken from some of these "silvery" fragments.

During the restoration some traces of working were obvious. According to these observations the objects seem to have been cast in two-sided moulds. They were finally formed by hammering. None of the objects showed traces of having been used. We can presume that these metal objects were either not used or that they were not regular weapons. Thus they were probably ceremonial. The "silver" cover confirms this hypothesis and attest to their function as ceremonial objects.

In addition to these weapons a rolled head pin and a metal awl from Tülintepe, two further awls from Tepecik (mentioned above) were also restored and conserved (Table1; Fig.4).

DATING SUGGESTION

The spearheads belong to a wide-ranged typological class in the Near East. The earliest examples come from Arslantepe VI A-B1 (Late Chalcholithic-EBA I; Palmieri 1981; Frangipane 2001), Hassek Höyük (EBA I/II; Behm-Blancke 1981; 1984) and Birecik (EBA I/II; Squadrone *et al*. 2008). Further finds come from Norşuntepe (EBA III; Schmidt 2002), İkiztepe (EBA II; Bilgi *et al*. 2004), Horoztepe (EBA II/III; Özgüç and Akok 1958), Kültepe (EBA; Özgüç 1986) and Karahasan Höyük (EBA III; Harmankaya and Erdoğu 2002). They can closely be compared with the spearheads of Arslantepe. In this way a date similar to Arslantepe VI A-B1 can be suggested.

Both typologically and technologically the sword and the five spearheads discussed above show almost the same features as similar finds from the royal tomb of Arslantepe. In this tomb were found, in addition to the spectacular metal finds, hand-made red-black burnished pottery (Karaz Ware), wheel-made light Syrian-Mesopotamian pottery and reserved slipped ware of the same Syrian-Mesopotamian pottery group (Frangipane 2001:7, fig.21). These ceramic finds are also recorded within the layers of the Early Bronze Age I in Tepecik. Further they were found in the stone well in Tülintepe which is linked to the Early Bronze Age (I/II) defence wall of the settlement (Esin 2000; Yalçın and Yalçın 2008). In this way the finds from the royal tomb of Arslantepe and those from the metal hoard from Tülintepe can be compared. We can even suppose that the sword and the spearheads from Tülintepe originally belonged to a cist grave that was destroyed and lost during railroad-excavation (Harmankaya and Erdoğu 2002). If we consider the well-known cist graves both of Arslantepe and Hassek Höyük with similar finds that are dated almost to the same period, we can assume nearly the same origin for the metal hoard from Tülintepe as well. This funeral tradition can be understood as a connecting link that holds the social structure of the Early Bronze Age I together. Within this common tradition we can consider the wide-spread defence walls of this early phase too that were meant to protect the valuable possessions like metals or metal objects from the alien threat of the invaders. Special attention should be paid to another fact: The valuable weapons or high-status objects from Arslantepe, Tülintepe and Hassek Höyük emphasize a Late Chalcholitic / Late Uruk tradition in the Eastern and Southeastern part of Anatolia. Beyond this they underline further connections between these Anatolian regions and Transcaucasia at the same period.

The royal cist tomb of Arslantepe is dated to Period VI B1 (Frangipane 2001:13; fig.4). In addition, a silver-decorated spearhead of this royal tomb can be compared with three similar decorated swords from the temple of Period VI A (Frangipane 2001:7; fig.17).

Based on this data the sword and the spearheads from Tülintepe can be correlated with the similar metal finds from Arslantepe VI A-B1. This suggests an extended date from the end of Chalcholithic to the beginning of the Early Bronze Age I.

ARCHAEOMETALLURGICAL INVESTIGATIONS

CHEMICAL COMPOSITION

Five spearheads, one sword and two more metal finds from Tülintepe were analysed. Further analyses were done on three metal objects from Tepecik. The results are summarized at Table 3. In this table some analyses of the swords and spearheads from Arslantepe VI A-B1, as well as further analyses of an ingot from Tepecik are comparatively listed. We can obviously see that, apart from one exception, tin as an alloy does not play a part in the samples that were analysed (Table 3).

They consist entirely of copper and always contain some arsenic. In all of the objects the amount of arsenic lies between 0.5 and 3.1 %. Only one sample (Tr-19/7) has 0.2 % As. We can assume that arsenic comes from the extracted ores; thus it is not consciously alloyed with major copper[6]. This is also valid for nickel with an amount up to 2.5 %. Figure 7 provides striking evidence for a positive correlation of As- and Ni-values. Some iron, zinc, antimony, bismuth, silver and some sub-classified lead as further trace elements are always represented. Special attention should be paid to two spearheads (Tr-19/5 and 6) that show 10 times increased Sb- and Ag-values. These two objects showing the highest As- and Ni-amounts, are good candidates giving the very first hints about their provenance.

Comparative samples, e.g. the rolled head pin with a tin amount of 5 % can be clearly differed from the rest finds of Tülintepe. This can obviously considered as a tin copper alloy. Special attention should be drawn to the early date of this find (compare below).

The metal finds of Tepecik are heterogeneously composed. The first two objects of Tepecik contain barely any nickel or a very small amount of it (comp. Table 3). But they show 1 or 2 % arsenic. The third sample (an awl) contains 2.8 % arsenic and 4.4 % nickel. Both of the typologically similar awls from Tülintepe (Tr-19/10) and Tepecik (Tr-21/53) illustrate a similar composition. Esin (1976) dated this find from Tepecik to the Late Chalcholithic Period. The awl and the rolled head pin of Tülintepe are dated to the same period as well.

The Early Bronze Age I ingot from Tepecik contains the highest amounts of As and Ni of all objects available from Tepecik und Tülintepe. In this case we can also presume an extraction of the As-Ni enriched copper ores.

From the finds of Arslantepe (spearheads and swords), except for one sample have traces of nickel. They consist of copper with an arsenic amount of 2-5 %. In addition we observe that the finds from Arslantepe barely contain Fe, Zn, Pb and other trace elements. Only four spearheads from the royal tomb show obvious silver values between 0.04 and 0.3 %. The finds from the palace contain no silver at all (Table 3).

Figures 7 and 8 show As/Ni and As/Sb diagrams of the finds from Arslantepe, Tepecik, and Tülintepe. It becomes obvious, that generally the analyses from Arslantepe show cluster with low amounts of Ni and Sb compared with those from Tülintepe and Tepecik. However it is important to note, that in rare cases some analyses of the Tepecik objects fall into this "Arslantepe cluster" and one analysis of the Arslantepe objects falls into the area where the Tepecik and Tülintepe analyses are plotted. Thus, although generally these diagrams are quite helpful in distinguishing Arslantepe objects from those of Tülintepe and Tepecik, an unequivocal classification is not possible. Nevertheless based on these results it becomes obvious, that the source material for the objects from Arslantepe probably comes from a different ore deposit than that of Tülintepe and Tepecik.

THE SURFACE COAT OF THE OBJECTS

The samples taken from the "silvery" metal coat were investigated by the aid of scanning electron microscope (SEM). All the samples consist homogeneously of tin (fig. 9a-c). The tin layers are uniformly 8-10 μm thin. On the corroded metal surface only small amounts of them were preserved. On one of the spearheads a further fine coat of tin was observed immediately under the first tin layer. Because of the uneven distribution of this former tin coat on the metal objects, we presume that the metal hoard of Tülintepe was completely covered with tin. In case of one spearhead we can even consider a possible double tin coating. Thus the tinning of copper as a new metallurgical technique has been proven to have occurred in Tülintepe.

LEAD ISOTOPY

Lead isotope analyses of the objects from the metal hoards of Tülintepe were also carried out. Table 4 shows the $^{208}Pb/^{206}Pb$, $^{207}Pb/^{206}Pb$, and $^{204}Pb/^{206}Pb$-ratios of the metal objects investigated. In Fig.10 the isotope ratios of the objects from Tülintepe are displayed; for comparative reasons those of the spearheads and the swords from Arslantepe (palace-Arslantepe VI A; royal tomb VI B1) are also shown. From both, the $^{208}Pb/^{206}Pb$ versus $^{204}Pb/^{206}Pb$ - (Fig.10a) and the $^{204}Pb/^{206}Pb$ versus $^{207}Pb/^{206}Pb$- (Fig. 10b) diagrams it becomes obvious, that the objects from the two different localities can be clearly distinguished due to their isotopic compositions. Whereas the analyses of the Tülintepe objects are characterized by low $^{208}Pb/^{206}Pb$-, $^{204}Pb/^{206}Pb$, and $^{207}Pb/^{206}Pb$-ratios, those from Arslantepe behave the opposite way around. Even the finds from Tülintepe can be grouped in two categories: while the three spearheads, Tr-19/5, 6, and 7, exhibit low $^{207}Pb/^{206}Pb$-ratios (at about 0.831) and also low $^{208}Pb/^{206}Pb$- (2.07) and $^{204}Pb/^{206}Pb$- (0.053) ratios, a second group of objects (two spearheads (Tr-19/2, 8) and one sword Tr-19/4) shows considerably higher ratios (see Fig. 10a, b).
We can not talk in terms of real groups here, as only six artefacts were analysed. There are rather trends that point out different provenances for the metals.

The finds from Arslantepe do not show homogenous isotopic relations either. Furthermore there is no overlap at all with the finds from Tülintepe.

DISCUSSION OF THE RESULTS

The proof of the early use of tin in Tülintepe is an important development in Near Eastern archaeology. But it also reveals some new questions. If we do not consider the fact that the rolled head pin from Tülintepe with 5 % tin was dated to the Late Chalcholithic Period by Esin (1986), we can ask whether tinning was discovered earlier than the bronze alloy. But if the dating of this pin is in fact correct, it would be the oldest bronze find in the whole Near East. Till now the EBA I finds from Alişar I, Troy I and Tell el-Judaidah have been believed to embody the earliest evidence for the use of bronze, whereby Mellink (2002: 173) correlates the chronology of Alişar I and Troy I with the Early Bronze Age II (approximately. 2900 BC) of Eastern Anatolia. Yet this date should also be discussed according to new comparative studies based on the ceramics that suggest relations between Central and Eastern Anatolia already at the End of the Late Chalcholithic Period going into the Early Bronze I (Yalçın in press). If we consider the dating and the find context of the rolled head pin from Tülintepe relatively safe, this artefact will probably the earliest tin bronze in the whole Near East.

The metal hoard of Tülintepe is even more interesting. We can date these metal finds by the aid of typology and compare them with the finds from Arslantepe that probably belong to a time span between 3400-2900 BC. Thus there is evidence for copper tinning in Tülintepe for the first time in this period. This fact is in opposition to the theory that tinning was discovered by the Gauls. We refer to a special section in ***Gaius Plinius Secundus***: "*A Gallic invention tin is used to colour the bronze objects, thus one can hardly differ them from silver. They call these bronze articles "incoctita" (coloured by cooking). Later silver was used for colouring either, especially for decorating the harnesses of pack-animals or the cattle; that was in the city of Alesia. The honour of the first mentioned invention is due to Biturigs (inhabitants in Aquitanic Gallia, today Départment du Chèr et de L'Indre*)" (Naturalis Historiae Libri XXXVII, Cap.48 in Rackham 1952: 242-243).

According to Babst (1883) the Gauls should be rejected as the inventors of this method. He supports the view that transient Bronze Age smiths brought tinning from Asia. This method was applied everywhere you can find and melt tin. In the Late Bronze Age even in Bactria people knew how either to produce bronze or tinning (Lenormant 1875)[7]. In the tin-prosperous grasslands of Central Asia, e. g. in Bactria, bronze objects first arrived in the Middle and Late Bronze Age that is the 2nd millennium BC (Parzinger 2002; Cierny *et al*. 2005). However tin had been used in Mesopotamia and Anatolia since the 3rd millennium BC (EBA II) and even sporadically since the Early Bronze Age I. Since there is no evidence about the origin of Central Asian tin in the 3rd millennium BC, we can accept the regional sources of and around Anatolia as the possible origin (Weisgerber and Cierny 2002). The controversial tin mine discussed in Kestel could have served as the supplier of Anatolia. Thus it is not astonishing if we hit upon the use of tin in Tülintepe in the 4th millennium BC. If we consider, the rolled head pin of Tülintepe and the metal hoard are dated to almost the same period; then tinning and alloying interestingly start at the same time.

The finds from Tülintepe yielded some new questions. Are the spearheads and the sword the only tinned copper objects of this period? What about the "silver" decorated swords of Arslantepe? As far as we know the silver plated swords from Arslantepe have not been analyzed. Thus we must ask whether we are dealing with tin plating in part or completely. Our attention is especially drawn to one silver decorated spearhead from the royal tomb. This find was compared either with the similar finds from the palace or with the finds of the metal hoard from Tülintepe (Frangipane 2001). Could the silver decoration of this spearhead consist of tin? If not, did the metallurgists of Tülintepe want to imitate the silver plating from Arslantepe and use tin instead of silver, or vice versa? A new aspect of the beginning of the tin utilization in the Near East must now be discussed.

Through tinning, the surface of an object gains a reflective brightness. This effect surely impressed observers. This trait was probably the reason for this new technique. In this case it was for about high-status objects that were produced for the privileged persons of a new rural society in Tülintepe or in the other settlements like Tepecik, Norşuntepe and

Korucutepe in the Altınova region. These objects could also be used for cult ceremonies. The missing traces of utilization build an additional foundation for this assumption. This is not a surprising result, if we consider the innovative metallurgy of this region. In the 4th millennium BC Anatolia, especially South-Eastern Anatolia, seems to gain importance and advantage over Mesopotamia where there are no ore deposits. Anatolia is not only a supplier of metals but it also gets a full portion in the cultural development of this vast region.

In prehistoric times Altınova was an extraordinarily fertile plain that offered good conditions for farming, which permitted agriculture to flourish. On the other hand the forested mountains, the grazing lands with rich stocks of wild animal as well as the meadows offered pleasant living conditions (Müller-Karpe 1994). The rich ores of this region and the favourable road connections further promoted development. Metal work and the metal trade were especially responsible for cultural growth. About the end of the 4th millennium BC, within the Late Uruk Period, metal work flourished (Müller-Karpe 1994). In the excavated settlements in the Plain of Altınova, in Clicia and the Plain of Antioch the amount of metal finds and relics increase as rural centres were developed. Principalities or small dynasties like Arslantepe and some others in the Plain of Altınova reached interregional importance for the centralized reloading of goods and for demonstrating new technologies from other cultural regions (Frangipane 2002). Though formerly there had been no major distinctions within domestic architecture, from this period on we notice a clear social hierarchy, as for example with the complex plan of the palace in Arslantepe. Traders from Mesopotamia and Northern Syria or nomadic tribes from the northern and eastern regions offered the elites of these centres their goods; they maintained trade links and even settled down there. Certainly it is not accidental that certain pottery groups like the "Karaz-Ware", "Uruk-Wares" or certain sorts of metal gradually appear in the vast area between Caucasus and the Southern Levant. Copper with arsenic and nickel emerges in the Near East from the beginning of the 3rd millennium BC on (Fig.11). The diffusion of metals and the one of Kura-Araxes / Karaz Pottery seems to be closely linked (Fig.12). Could it be that the nomadic tribes of the Orient were trading metal products and a tradition of certain pottery groups? Was it these same nomads that invented tinning in Tülintepe?

Profiting from the flourishing economy, the elites began to live in palaces in the new rural centres and control the trade (comp. Frangipane 2002). The increased circulation of metal for producing weapons, tools and jewellery implies the option of hoarding. Thus the accumulation of wealth was possible and with it, the establishment of an upper class (Müller-Karpe 1994).The need for high status products increased and encouraged further innovation. New discoveries and techniques followed in consequence. The attention now focused on new metals like silver, lead and gold, which were alloyed with each other for the first time. In Korucutepe silver was extracted for the first time (van Loon 1978). In Arslantepe silver was alloyed with copper (Hauptmann *et al.*2003), and in Tülintepe high status objects made from arsenic and nickel containing copper were tinned. The rich funeral gifts in Korucutepe and Arslantepe are evidence of this privileged wealth. These tombs of the Late Uruk Period form the beginning of a gift tradition for the afterlife in the 3rd millennium BC that reaches its peak in Alacahöyük, Horoztepe, İkiztepe and Troy.

If we think about the finds both of Tülintepe and Arslantepe, we recognize that they basically consist of similar kinds of metal. From the metallurgical point of view it is important to ask whether a classification Cu-As and Cu-As-Ni makes sense. These questions were already faced in several recent publications (comp. Pernicka 1995; Hauptmann 2008; Begemann and Schmidt-Strecker 2008). If we follow the appearance of these metals in the Near East, it is remarkable that they always appear together and that arsenic enriched copper always predominates. Thereby the amount of nickel fluctuates from traces to lower ranges as expressed in percentage. Besides the nickel, enriched metal finds occur in the Late Chalcholithic contexts from time to time, but more and more in those of the Early Bronze Age I-II.

The isotopic analyses from Tülintepe presumably point towards two different provenances. We cannot exclude the occurrence of different type of ore mineralisation within the same locality that has deviating or even different lead isotopes. The best examples of this come from the copper deposits of Cyprus. In Cyprus the isotope plots of the particular ore districts like Kalawassos or Apliki do not show close relations, though they belong to the same geological type of ore deposit, and the distance between these two locations is less than twenty kilometres (Gale and Stos-Gale 2005, fig.2-6)[8]. Yener *et al.* (1991) got a similar image from Bolkardağ in Central Taurus. In Bolkardağ four different isotope plots with various poly metallic ore occurrences were defined. Some of them are prehistoric and some were exploited in antiquity (comp. Lehner *et al.*, this book).

Evaluating the present available lead isotope data from the well known ore deposits of Anatolia like Keban, Elazığ-Maden, Siirt and Artvin-Murgul we observe that these deposits stress dissimilar plots/fields (Fig.13a, b). In fact only Siirt and Murgul are overlapping. We certainly emphasize that this evaluation should be taken with caution, as until now there are only a few isotope analyses available from these ore deposits[9]. No data from Tülintepe coincide with the data available from the ore deposits of Eastern Anatolia. Only one part of the Arslantepe data presented for the finds from the palace and the royal tomb shows a correspondence with the data from Murgul and Siirt. Some minor coincidence of a few data from Arslantepe can be considered with the deposit of Maden, however only from the $^{204}Pb/^{206}Pb$- versus $^{207}Pb/^{206}Pb$ diagram (Fig. 13a). According the available isotopic data the provenance of the finds from Tülintepe and most of the finds from Arslantepe is tentative.

If we compare the hoard finds from Tülintepe with the finds in the whole Near East, we can state that a certain kind of arsenic copper and nickel containing copper appears in many of the prehistoric sites (comp. Fig. 11). In numerous Late Chalcholithic an Early Bronze Age sites, in the Southern Levant, in Mesopotamia and in Maikop in Northern Caucasia, we can find metal objects with a similar composition (comp. Pernicka 1995: 85-89, fig. 34; Hauptmann and Palmieri 2000: 79, fig.7). The provenance of this kind of metal was not previously evident. Now let us reflect on the distribution of the different sites in connection with possible ore deposits which may have served as sources. Starting from a high amount of nickel in copper, only certain ore deposits can be regarded as dispersive sources. A possible origin for nickel enriched ore deposits in context with ophiolithes exists in the Alpine mountain chains of Anatolia, in Cyprus, in Iran and in Oman (Fig.11). Because of the geographic closeness and cultural historic background, the ore deposits of Oman can be regarded as the origin of the Southern Mesopotamian metal finds. The origin of the Anatolian finds should be initially searched for in the Anatolian ophiolithic zone that gave way to the corresponding ore deposits. But perhaps the origin should be investigated in the deposits of North-Western Iran. Some scholars suggest Caucasian ore deposits as the source of the delivery (Pernicka 1995; Hauptmann and Palmieri 2000; Hauptmann 2008).

If we focus our attention on the vicinity of Altınova, we should realize that this area emerged from the collision of the Arabian and Anatolian micro platforms as a part of the great Eurasian plate. Altınova and the vicinity belong to the Anatolide-Tauride terrane (for details see Okay 2008). This suture is featured by the ophiolithic zone described above. The heights in the vicinity of Elazığ consist of a narrow zone in the South that is stuck between the Arabian platform and the northern nappe zone (Yılmaz 1993). This zone is characterized by upper Cretaceous to early Miocene sequences of marine sediments, ophiolites, and volcanics that experienced intense tectonic shearing. The lower units in the northern part of area are composed of upper Cretaceous polymetamorphic ophiolitic sequences (lower beds) which are mainly overlain by clastic sediments rocks of the middle Miocene “Maden Group”. The upper unit comprise Palaeozoic and Mesozoic metasediments and metavolcanics. Cover sequences essentially are Pliocene to Quarternary sediments and volcanics (Yılmaz 1993).

Due to these geological formations in Eastern Anatolia, many ore deposits were generated. Some of the Anatolian massive sulphide ore deposits e.g. are closely related to the ophiolithes in Cyprus. There in the root zones of massive sulphide ore bodies the so called stockwork ores were found that are enriched in Fe-Ni-As-Co (Constantinou 1999; Panayitou 1980). Similar ore deposits are also described for Eastern Anatolia, e. g. near Pancarlı (to the North of Siirt) and in Kakbil near Ovacık (Tunceli), also related to ophiolithes. According to an interim report of MTA and an oral communication with Tandoğan Engin, nickel sulphides occur in Pancarlı. They contain about 2 % copper. According to

Seeliger *et al*. (1985) the sulphide deposits in Kedak, near Palu and Haçan and to the West of Maden hang together with serpentinites. Tylecote (1970) described the existence of "Fahlerz" in the cementation zone at Maden (known as Ergani-Maden). Analyses of these ores do not appear in the lists of Seeliger *et al*. (1985) and Wagner *et al*. (1989). In Maden the serpentinites acting as supporter for Cu-Ni-As are in a close context with serpentine rocks (Bamba 1976). U. Esin (1987) mentioned small Ni-deposit in Şehkatili and Havri in the vicinity of Maden. Principally the Cu-Ni-Co-As-S mineralization occur in the ophiolithe sequences together with the chromites. Such ore deposits are found near Guleman in Elazığ and further north in the vicinity of Kop Mountains (to the Northeast of Erzincan) (Engin *et al*. 2000).

We can also consider a couple of further small copper deposits between Malatya and Siirt that are partly connected with the ophiolithes as a possible origin of the As-Ni containing copper objects (Seeliger *et al.* 1985). For this purpose detailed fieldwork at the ore deposits of the Anatolian ophiolithe zones is needed. Moreover a big database for the geochemical access of the ore deposits is necessary. This should be done as well for the major ore deposits like in Maden, Keban, Murgul or Küre.

FINAL REMARKS

This paper provides evidence for the tinning in Tülintepe about 5000 years ago. Almost at the same time the first tin-bronze objects were produced there. With the research contribution presented in this paper the investigations can be focused on the beginning of the Near Eastern tin technology once again and the archaeological data may be reinvestigated from another point of view now.

Our work was financed by the German Research Society (Deutsche Forschungsgemeinschaft). The finds were investigated by the stimulus of late Prof. Dr. Ufuk Esin, with the aid of the Elazığ Museum and the permission of the Ministry of Culture and Tourism of the Turkish Republic. The finds were restaured and drawn by two members of the Restoration School of the University of Ankara, Mrs. Ayşe Ebru Gültekin and Mrs. Ezgi Özpamir. We want to express our warmest thanks to all contributors of this study. Special thanks go to Prof. Dr. Kathleen James-Chakraborty (School of Art History and Cultural Policy – University College Dublin) for editing the English of the manuscript.

NOTES

1. The development of metallurgy in Anatolia has been discussed by the first author in several other papers.
2. The spearheads are compared with Arslantepe from the typological point of view. M. Frangipane, H. Hauptmann and U. Esin regard the same date range with Arslantepe VI-B1 as possible.
3. The finds are stored in the museum of Elazığ. Their preparation and sampling were approved by the Turkish General Directory for Antiquities. The restoration of the finds was undertaken by Mrs. Ayşe Ebru Gültekin and Mrs. Ezgi Özpamir (School for the Restoration and Conservation of the University of Ankara). Mr. Haydar Aksen, the director of the museum, has supported our work. With the help of inventory lists we had the possibility to check through some further metal finds from the Chalcholithic Period and the Early Bronze Age and to sample them. By this way we could check all the metal objects in the depots of the museum. After counting we recognized the huge number of the metal finds almost 4700 pieces. These objects have not been studied neither archeologically nor scientifically yet, demonstrating the urgent need of scientific investigations on the subject "Early Metallurgy in Eastern Anatolia".
4. Parts of the results presented here have been intensely discussed in the last issue of Anatolian Metal (Yalçın and Yalçın 2008). The current contribution of this special issue contains some of the previous results which are updated by new data. In this connection a reiterant publication is intended.
5. The measurements indicate the conditions after their restoration.
6. Similar results were obtained from the Early Bronze Age metal finds from Hassek Höyük. Also hereby the authors presume an "unintended" contamination (Schmitt-Strecker et al. 1992): Here it is not about arsenic bronze but arsenic containing copper or arsenic copper.
7. As a part of the Iranian population the Bactrians lived in the terrain of the present Afghanistan and had access to tin deposits there. The Assyrian merchants got tin probably from these people and brought it to Mesopotamia and Anatolia.

8. Troodos-Ophiolithe, part of the Eastern Mediterranean ophiolithe zone, has rich copper deposits. The massive copper sulphide layers are restricted to the pillow lavas of the ophiolithe series where they consist of four or more ore bodies in five main ore zones around the Troodos Mountains (comp. Constantinou 1999: 38-42, Abb.1).Gale and Stos-Gale (2005) used hundreds of isotope analyses in order to differentiate these ore bodies from each other. Thus it was possible to classify different isotopic fields within the Troodos complex and to associate the archaeological finds with the particular pits.
9. Until now a few samples have been analyzed: From Maden (in the most of the publication: Ergani or Ergani-Maden) and Murgul 6 examples and from Siirt only 3 (Seeliger et al. 1985; own sources). In the other large ore regions of Anatolia we observed the same situation.

REFERENCES

Babst, G. 1883
"L'orfevrerie D'etain – Dans L'antiquite", *Revue Archeologique* 3: 400-409, 464-481.

Bamba, T. 1976
"Güneydoğu Anadolu Ergani Maden Bölgesi Ofiyolit ve İlgili Bakır Yatağı", *MTA Bull.* 86: 35-50.

Begemann, F., E. Pernicka and S. Schmitt-Strecker 1994
"Metal Finds from Ilıpınar and the Advent of Arsenical Copper", *Anatolica* XX: 203-219.

Behm-Blancke, M.-R. 1981
"Hassek Höyük. Vorläufiger Bericht über die Ausgrabungen der Jahre 1978-1980", *Istanbuler Mitteilungen* 31: 5-93.

Bilgi, Ö., H. Özbal and Ü. Yalçın 2004
"Casting of Copper and Bronze", Ö. Bilgi (ed.) *Anatolia - Cradle of Castings*: 1-44. Döktaş Yayınları, İstanbul.

Burney, C.A. 1958
"Eastern Anatolia in the Chalcholithic and Early Bronze Age", *Anatolian Studies* VIII: 157-209.

Cierny, J., Th. Stöllner and G. Weisgerber 2005
"Zinn in und aus Mittelasien", Ü. Yalçın, C. Pulak and R. Slotta (eds.) *Das Schiff von Uluburun – Welthandel vor 3000 Jahren*: 431-448. Deutsches Bergbau Museum, Bochum.

Constaninou, G. 1999
"Der Kupferbergbau auf Zypern im Altertum", R. Busch (ed.) *Kupfer für Europa - Bergbau und Handel auf Zypern*: 34-53. Neumünster.

Engin, T., Y.Z. Özkan, F. Şener and B. Toprak 2000
1/1000000 Ölçekli Türkiye Metalojeni Haritası. MTA Yayınları, Ankara.

Esin, U. 1969
Kuantitatif Spektral Analiz Yardımıyla Anadolu'da Başlangıcından Asur Kolonileri Çağına Kadar Bakır ve Tunç Madenciliği. İstanbul Üniversitesi Edebiyat Fakültesi Yayınları 1427, İstanbul.

Esin, U. 1976
"Die Anfänge der Metallverwendung und Bearbeitung in Anatolien (ca. 7500-2000)", *Des Débuts de la Metallurgie*, Colloque XXIII: 209-232.

Esin, U. 1979a
"Tülintepe Kazısı, 1973", S. Pekman (ed.) *Keban Projesi 1973 Çalışmaları*: 115-119, Taf. 66-77. Orta Doğu Teknik Üniversitesi Keban Projesi Yayınları, Ankara.

Esin, U. 1979b
"Tepecik Kazısı, 1973", S. Pekman (ed.) *Keban Projesi 1973 Çalışmaları*: 79-94, Taf. 46-65. Orta Doğu Teknik Üniversitesi Keban Projesi Yayınları, Ankara.

Esin, U. 1985
"Değirmentepe (Malatya), 1984", *Anatolian Studies* 35: 188-189.

Esin, U. 1987
"Tepecik ve Tülintepe'ye (Altınova-Elazığ) Ait Bazı Metal ve Cüruf Analizleri", *Arkeometri Sonuçları Toplantısı* II: 69-80.

Esin, U. 2000a
"Tülintepe Kurtarma Kazıları", O. Belli (ed.) *Türkiye Arkeolojisi ve İstanbul Üniversitesi*: 87-90. İstanbul Üniversitesi Yayın No. 4242, İstanbul.

Esin, U. 2000b
"Tepecik Kurtarma Kazıları", O. Belli (ed.) *Türkiye Arkeolojisi ve İstanbul Üniversitesi*: 123-129. İstanbul Üniversitesi Yayın No.4242, İstanbul.

Esin, U. and G. Arsebük 1974
"Tülintepe Kazısı 1971", S. Pekman (ed.) *Keban Projesi 1971 Çalışmaları*: 137-159, Taf. 112-133. Orta Doğu Teknik Üniversitesi Keban Projesi Yayınları, Ankara.

Esin, U. and G. Arsebük 1982
"Tülintepe Kazısı 1974", S. Pekman (ed.) *Keban Projesi 1974-1975 Çalışmaları*: 119-133, Taf. 79-98. Orta Doğu Teknik Üniversitesi Keban Projesi Yayınları, Ankara.

Frangipane, M. 2001
"The Transition between Two Opposing Forms of Power at Arslantepe (Malatya) at the Beginning of the 3rd Millennium", *TÜBA-AR* 4: 1-24.

Frangipane, M. 2002
Yakındoğu'da Devletin Doğuşu. Arkeoloji ve Sanat Yayınları, İstanbul.

Frangipane, M. et al. 2002
"New symbols of a new power in a "royal" tomb from 3000 BC Arslantepe, Malatya (Turkey)", *Paléorient* 27/2: 105-139.

Gale, N.H. and Z.A. Stos-Gale 2005
"Zur Herkunft der Kupferbarren aus dem Schiffswrack von Uluburun und der spätbronzezeitliche Metallhandel im Mittelmeerraum", Ü. Yalçın, C. Pulak and R. Slotta (eds.) *Das Schiff von Uluburun – Welthandel vor 3000 Jahren*: 117-132. Deutsches Bergbau Museum, Bochum.

Harmankaya, S. 1993
"Tülintepe Höyüğü (Elazığ) Maden Buluntuları", *Arkeometri Sonuçları Toplantısı* VIII: 369-379.

Harmankaya, S. and B. Erdoğu 2002
Türkiye Arkeolojik Yerleşmeleri. 4a, 4b (İlk Tunç Çağı). İstanbul Task Yayınları 9, İstanbul.

Hauptmann, A. 2000
"Zur frühen Metallurgie des Kupfers in Fenan/Jordanie", *Der Anschnitt* 11: 1-236.

Hauptmann, A. 2008
The Archaeology of Copper: Evidence from Faynan. Springer Verlag, Berlin.

Hauptmann, A. and A. Palmieri 2000
"Metal Production in the Eastern Mediterranean at the Transition of the 4th/3rd Millennium: Case Studies from Arslantepe", *Anatolian Metal* I (Der Anschnitt, Beiheft 13): 75-82.

Hauptmann, A., S. Schmitt-Strecker, F. Begemann and A. Palmieri 2003
"Chemical Composition and Lead Isotopy of Metal Objects from the „Royal" Tomb and Other Related Finds at Arslantepe, Eastern Anatolia", *Paléorient* 28: 43-70.

Kökten, I.K. 1947
"1945 Yılında Türk Tarih Kurumu Adına Yapılan Tarih Öncesi Araştırmalar", *Belleten* XI: 431-472.

Lenormant, F. 1875
Anfänge der Cultur. Bd. 1, Jena.

Van Loon, M. 1978
Korucutepe, Vol. 2. Allard Pierson Foundation, Studies in Ancient Civilization, Amsterdam.

Mellink, M. 1992
"Anatolian Chronology", R.W. Ehrich (ed.) *Chronologies in Old World Archaeology* I: 207-220. University of Chicago Press, Chicago.

Meriggi, P. 1967
"Sesto Viaggio Anatolico", *Oriens Antiquus* VI: 269-303.

Müller-Karpe, A. 1999
Anatolisches Metallhandwerk. Offa-Bücher 75, Neumünster.

Okay, A. 2008
"Geology of Turkey: A Synopsis", *Anatolian Metal* IV (Der Anschnitt, Beiheft 21): 19-42.

Özbal, H. 1983
"Tepecik ve Tülintepe Metal, Filiz ve Cüruf Analizleri Sonuçları", *Tübitak Arkeometri Ünitesi Bilimsel Toplantı Bildirileri* III: 203-217.

Özbal, H., N. Pehlivan, B. Earl and B. Gedik 2002
"Metallurgy at Ikiztepe", *Anatolian Metal* II (Der Anschnitt, Beiheft 15): 39-48.

Özgüç, T. 1986
Kültepe Kaniş II. Eski Yakındoğu'nun Ticaret Merkezinde Yapılan Yeni Araştırmalar. Türk Tarih Kurumu Yayınları V, 41, Ankara.

Özgüç T. and M. Akok 1958
"Horoztepe Eserleri", *Belleten* 21/82: 201-209.

Palmieri, A. 1981
"Excavations at Arslantepe (Malatya)", *Anatolian Studies* 31: 101-119.

Panayitou, A. 1980
Cu-Ni-Co-Fe Sulfide Mineralization. Limassol Forest, Cyprus.

Panayiotou, A. (ed.) 1979
"Ophiolithes", *Proc. Inr. Ophiolithe Symposium*: 102-116. Cyprus, Nicosia.

Parzinger, H. 2002
"Das Zinn in der Bronzezeit Eurasiens", *Anatolian Metal* II (Der Anschnitt, Beiheft 15): 159-177.

Plinius Secundus, C.
Naturalis Historiae Libri XXXIV, Kapitel 48.

Rackham, H. 1952
195MI2 *Pliny, Natural History*, Bd. 9. London-Cambridge.

Rackham, H. and E. Pernicka 1995
"Gewinnung und Verbreitung der Metalle in prähistorischer Zeit", *Jahrbuch d. Römisch Germanischen Zentralmuseums Mainz* 37: t. 1, 21-129.

Schmidt, K. 2002
Norşuntepe. Kleinfunde II. Archaeologica Euphratica, Band II, Philipp von Zabern, Mainz.

Schmitt-Strecker, S., F. Begemann and E. Pernicka 1992
"Chemische Zusammensetzung und Bleiisotopenverhältnisse der Metallfunde vom Hassek Höyük", M. Behm-Blancke (ed.) *Hassek Höyük. Naturwissenschaftliche Beiträge*: 108-123. Istanbuler Forschungen 38.

Seeliger, T.C. et al. 1985
"Archäometallurgische Untersuchungen in Nord- und Ostanatolien", *Jahrbuch d. Römisch Germanischen Zentralmuseums Mainz* 32: 597-659.

Squadrone, F., Ü. Yalçın and K. Sertok 2008
"The Early Bronze Age Metal Finds from the Graves of the Birecik Dam Cemetery, Ayyıldız Höyük and Dibecik Höyük in the Gaziantep Area (SE Turkey)", *Oral Lecture at 6. ICAANE*.

Strahm, Ch. 1994
"Die Anfänge der Metallurgie in Mitteleuropa", *Helvetica Archaeologica* 25: 2-39.
Tylecote, R.F. 1970
"Early Metallurgy in the Near East", *Metal and Materials* 4: 285-293.

Wagner, G.A. et al. 1989
"Archäometallurgische Untersuchungen an Rohstoffquellen des frühen Kupfers Ostanatoliens", *Jahrbuch d. Römisch Germanischen Zentralmuseums Mainz* 36: 637-686.

Wagner, G.A. et al. 2003
"Archäometallurgischer Bericht über Feldforschung in Anatolien und bleiisotopische Studien an Erzen und Schlacken", Th. Stöllner et al. (eds.) *Man and Mining. Studies in honour of Gerd Weisgerber on occasion of his 65th birthday*: 475-494. Der Anschnitt, Beiheft 16, Bochum Bergbau Museum, Bochum.

Weisgerber, G. and J. Cierny 2002
"Tin for Ancient Anatolia?", *Anatolian Metal* II (Der Anschnitt, Beiheft 15): 179-187.

Whallon, Jr.R. and S. Kantman 1970
"Keban Barajı Su Birikim Alanı Yüzey Araştırması", S. Pekman (ed.) *1968 Yaz Çalışmalar*: 1-8, Taf. I-IV. Orta Doğu Teknik Üniversitesi Keban Projesi Yayınları, Ankara.

Yalçın, Ü. 1998a
"Der Keulenkopf von Can Hasan (TR): Naturwissenschaftliche Untersuchung und neue Interpretation", Th. Rehren, A. Hauptmann and J.D. Muhly (eds.) *Metallurgica Antiqua*: 279-289. Der Anschnitt, Beiheft 8, Bochum Bergbau Museum, Bochum.

Yalçın, Ü. 1998b
"Frühe Eisenverwendung in Anatolien", *Istanbuler Mitteilungen* 48: 79-95.

Yalçın, Ü. 2000a
"Anfänge der Metallverwendung in Anatolien", *Anatolian Metal* I (Der Anschnitt, Beiheft 13): 17-30.

Yalçın, Ü. 2000b
"Frühchalkolitische Metallfunde von Mersin-Yumuktepe: Beginn der extraktiven Metallurgie?", *TUBA-AR* 3: 111-130.

Yalçın, Ü. 2003
"Metallurgie in Anatolien", Th. Stöllner et al. (eds.) *Man and Mining - Mensch und Bergbau*: 527-536. Der Anschnitt, Beiheft 16, Bochum Bergbau Museum, Bochum.

Yalçın, Ü. 2008
"Ancient Metallurgy in Anatolia", Ü. Yalçın, H. Özbal and A.G. Paşamehmetoğlu (eds.) *Ancient Mining in Turkey and the Eastern Mediterranean*: 15-42. Atılım Üniversitesi, Ankara.

Yalçın, Ü. and E. Pernicka 1999
"Frühneolithische Metallurgie von Aşıklı Höyük", A. Hauptmann et al. (eds.) *The Beginning of Metallurgy*: 45-54, Taf. II-IV. Der Anschnitt, Beiheft 9, Bochum Bergbau Museum, Bochum.

Yalçın, Ü. and H.G. Yalçın 2003
"Zur Karaz-Keramik von Tepecik – Ostanatolien", M. Özbaşaran, O. Tanındı and A. Boratav (eds.) *Archaeological Essays in Honour of Homo Amatus: Güven Arsebük*: 321-342. Ege Yayınları, İstanbul.

Yalçın, Ü. and H.G. Yalçın 2008
"Der Hortfund von Tülintepe, Ostanatolien", *Anatolian Metal* IV (Der Anschnitt, Beiheft 21): 101-123.

Yener, K.A. et al. 1989
"Kestel: An Early Bronze Age source of Tin Ore in the Taurus Mountains, Turkey", *Science* 244: 200-203.

Yener, K.A. et al. 1991
"Stable Lead Isotope Studies of Central Taurus Ore Sources and Related Artefacts from Eastern Mediterranean Chalcholithic and Bronze Age Sites", *Journal of Archaeological Sciences* 18: 541-577.

Yılmaz, Y. 1993
"New Evidence and Model on the Evolution of the Southeast Anatolian Orogen", *Bull. Geol. Society of. Amer.* 105: 251-271.

lab. no.	inv. nr.	object	dating	type of metal
TÜLİNTEPE				
Finds of the hoard				
Tr-19/2	66.TMKC.11-13	spearhead	LC/EBA I	Cu
Tr-19/4	66.TMKC.11-11	sword	LC/EBA I	Cu-As-Ni
Tr-19/5	66.TMKC.11-12	spearhead	LC/EBA I	Cu-As-Ni
Tr-19/6	66.TMKC.11-14	spearhead	LC/EBA I	Cu-As-Ni
Tr-19/7	66.TMKC.11-15	spearhead	LC/EBA I	Cu
Tr-19/8	66.TMKC.11-16	spearhead	LC/EBA I	Cu-As
Finds of the excavation				
Tr-19/9	71.TMKC.9-28	rolled head pin	LC	Cu-Sn
Tr-19/10	71.TMKC.9-30	awl	LC/EBA I	Cu-As-Ni
TEPECİK				
Tr-21/51	69.TMKC.1021.3-34	awl	LC/EBA I	Cu-As
Tr-21/52	69.TMKC.1033.3-46	needle	LC/EBA I	Cu-As
Tr-21/53	79.TMKC.12-80	awl	LC/EBA I	Cu-Ni-As
BÜ-33/82		ingot	EBA I	Cu-As-Ni

Table 1: Metal finds from Tülintepe and Tepecik. LC: Late Chalcholithic, EBA I: Early Bronze Age I.

ARSLANTEPE (palace: 3400-3000 BC)

lab. no.	inv. nr.	object	dating	type of metal
Tr-8/4	AR2 2316A	sword	LC	Cu-As
Tr-8/8	AR2 2318B	sword	LC	Cu-As
Tr-8/9	AR2 2319A	spearhead	LC	Cu-As
Tr-8/18	AR1 2320A	spearhead	LC	Cu-As
Tr-8/21	AR1 2329A	spearhead	LC	Cu-As
Tr-8/28	AR1 2334A	sword	LC	Cu-As
Tr-8/31	AR1 2331A	spearhead	LC	Cu-As

ARSLANTEPE (royal tomb: 3000-2900 BC)

lab. no.	inv. no.	object	dating	type of metal
Arsl 15	T1 2, y19	sword	EBA I	Cu-As
Arsl 26	T1 2, y42	spearhead	EBA I	Cu-As
Arsl 27	T1 2, y39	spearhead	EBA I	Cu-As
Arsl 28	T1 2, y41	spearhead	EBA I	Cu-As-Ni
Arsl 29	T1 2, y9	spearhead	EBA I	Cu-As
Arsl 30	T1 2, y5	spearhead	EBA I	Cu-As
Arsl 31	T1 2, y37	spearhead	EBA I	Cu-As
Arsl 32	T1 2, y40	spearhead	EBA I	Cu-As
Arsl 33	T1 2, y36	spearhead	EBA I	Cu-As
Arsl 34	T1 2, y43	spearhead	EBA I	Cu-As
Arsl 35	T1 2, y24	sword	EBA I	Cu-As

Table 2: The swords and spearheads from Arslantepe discussed in that paper.

Sample		Cu	Fe	Ni	Zn	Pb	As	Sb	Sn	Bi	Ag
TÜLİNTEPE[1]											
Tr-19/2	spearhead*	98.2	0.35	0.13	0.023	0.006	0.51	0.012	0.002	0.012	0.030
Tr-19/3	spearhead*	98.7	0.36	0.11	0.022	0.004	0.52	0.012	0.001	0.009	0.030
Tr-19/4	sword	96.0	0.44	0.70	0.029	0.020	2.11	0.057	0.016	0.020	0.039
Tr-19/5	spearhead	93.6	0.74	1.98	0.031	0.003	2.59	0.200	0.001	0.046	0.259
Tr-19/6	spearhead	94.4	0.02	0.63	0.025	0.001	2.17	0.320	0.001	0.023	0.234
Tr-19/7	spearhead	97.7	0.29	0.01	0.022	0.002	0.27	0.008	0.001	0.009	0.005
Tr-19/8	spearhead	97.2	1.04	0.06	0.029	0.006	1.16	0.034	0.001	0.013	0.050
Tr-19/9	rolledheadpin	94.3	0.28	0.21	0.053	0.043	0.55	0.029	5.270	0.014	0.039
Tr-19/10	awl	93.8	0.02	2.55	0.032	0.220	3.16	0.210	0.006	0.062	0.041
TEPECIK[1]											
Tr-21/51	awl	97.1	0.34	0.001	0.017	0.140	2.00	0.038	0.049	0.019	0.025
Tr-21/52	needle	93.2	0.61	0.046	0.016	0.570	0.93	0.360	0.037	0.031	0.036
Tr-21/53	awl	92.7	0.06	4.430	0.040	0.038	1.84	0.270	0.001	0.083	0.036
BÜ-33/82	ingot[3]	91.1	<0.01	2.68	0.002	4.82	<0.01	0.02			
ARSLANTEPE (palace: 3400-3000 BC)[2]											
Tr-8/4	sword	93.0	0.012	0.001	0.001		4.93	0.003			0.001
Tr-8/8	sword	95.0	0.084	0.003	0.001		4.05	0.002			0.003
Tr-8/9	spearhead	96.0	0.004	0.001	0.002		3.77	0.005			0.003
Tr-8/18	spearhead	96.0	0.005	0.002	0.002		3.53	0.002			0.001
Tr-8/21	spearhead	98.0	<0.01	0.001	0.003		2.57	0.004			0.001
Tr-8/28	sword	96.0	<0.01	0.001	0.002		4.31	0.001			0.004
Tr-8/31	spearhead	95.0	<0.01	0.002	0.002		4.05	0.001			0.001
ARSLANTEPE (royal tomb: 3000-2900 BC)[2]											
Arsl15	sword	96.0	0.008	0.002	<0.001	<0.001	3.15	0.007	<0.001	0.007	0.001
Arsl26	spearhead	98.0	0.018	0.010	0.003	0.021	2.18	0.008	<0.001	0.019	0.043
Arsl27	spearhead	97.0	0.006	0.003	<0.001	<0.001	2.59	0.007	<0.001	0.005	0.001
Arsl28	spearhead	96.0	0.005	1.690	<0.001	0.030	1.15	0.072	<0.001	0.008	0.310
Arsl29	spearhead	97.0	0.004	0.003	<0.001	<0.001	2.43	0.006	<0.001	0.005	0.001
Arsl30	spearhead	98.0	0.004	0.003	<0.001	<0.001	2.92	0.007	<0.001	0.005	0.001
Arsl31	spearhead**	97.0	0.006	0.002	<0.001	<0.001	3.17	0.007	<0.001	0.008	0.002
Arsl32	spearhead	97.0	0.008	0.003	0.001	<0.001	2.86	0.007	<0.001	0.007	<0.001
Arsl33	spearhead	96.0	0.004	0.003	0.001	0.029	2.17	<0.01	0.008	0.020	0.081
Arsl34	spearhead	93.0	0.010	0.010	0.005	0.021	2.68	0.036	0.017	n.d.	0.113
Arsl35	sword	88.0	0.002	0.009	0.003	0.021	3.80	<0.01	0.003	n.d.	0.016

Table 3: The chemical composition of the metal finds from Tülintepe and Tepecik. For comparative reasons the analyses of the swords and spearheads from Arslantepe are also given.
1: own research; 2: Hauptmann et al. 2002; 3: Özbal 1983: 216; *: same object (from the head (2) and the shaft (3));
**: mean value of two analysis.

lab. nr.	object	type of metal	208Pb/206Pb	207Pb/206Pb	204Pb/206Pb
Tr-19/2	spearhead	Cu	2.0785	0.8368	0.05339
Tr-19/4	sword	Cu-As-Ni	2.0792	0.8355	0.05320
Tr-19/5	spearhead	Cu-As-Ni	2.0681	0.8307	0.05303
Tr-19/6	spearhead	Cu-As-Ni	2.0687	0.8312	0.05305
Tr-19/7	spearhead	Cu	2.0719	0.8320	0.05309
Tr-19/8	spearhead	Cu-As	2.0779	0.8358	0.05335

Table 4: Lead isotopic ratios of the finds from Tülintepe.

Fig. 1: Morphological map of Anatolia with the selected prehistoric sites of the 4th / 3rd millennia BC and showing the old mining locations. Tülintepe and Tepecik are located in Altınova, only 80 km north-eastern of Arslantepe. In the vicinity there are also some prehistoric mining locations.

Fig. 2: The prehistoric mound of Tülintepe in autumn 1966. a) An important part of the site which is destroyed; b) Big trucks are loaded at the mound.

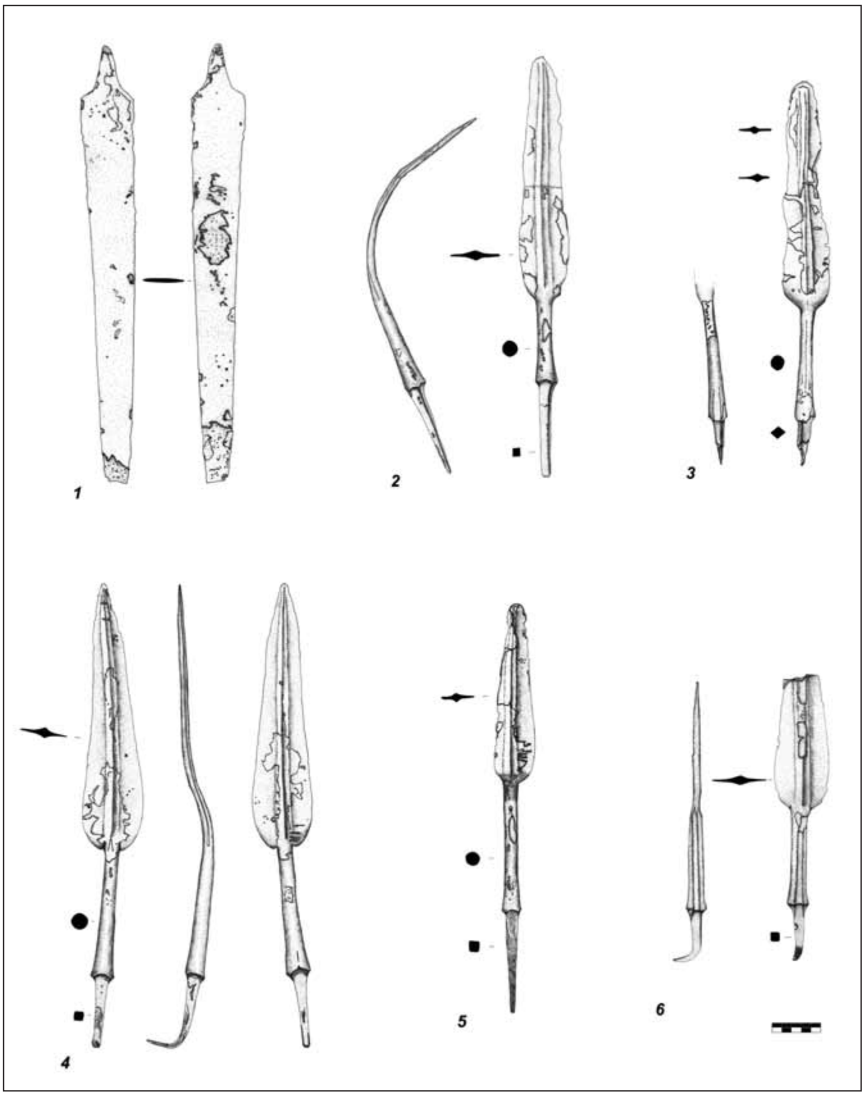


Fig. 3: The hoard finds of Tülintepe consisting of a short sword and five spearheads. 1. Short sword (Tr-19/4; 66.TMKC.11-11), 2. Spearhead (Tr-19/8; 66.TMKC11-16), 3. Spearhead (Tr-19/7; TMKC.11-15), 4. Spearhead (Tr-19/2; 66.TMKC.11-13), 5. Spearhead (Tr-19/5; 66.TMKC.11-12), 6. Spearhead (Tr-19/6; 66.TMKC.11-14) (Drawings by A. E. Gültekin and E. Özpamir).

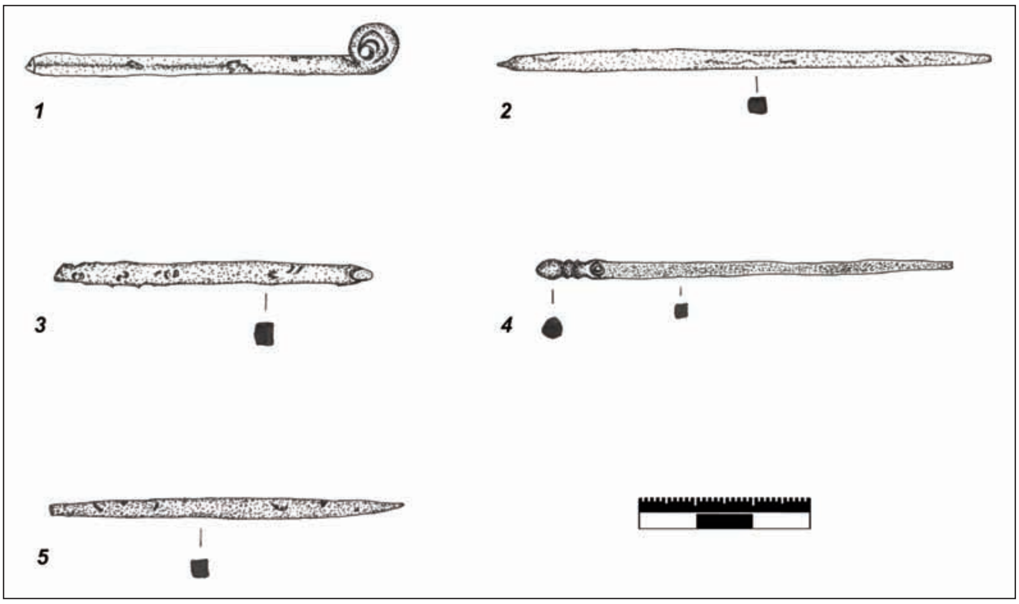


Fig. 4: Further metal finds from Tülintepe and Tepecik.
1.Tülintepe, rolled head pin (Tr-19/9; 71. TMKC.9-28; Tl.71.246), 2. Tülintepe, awl (Tr-19/10; 71.TMKC.9-30; Tl.71.144), 3. Tepecik, awl (Tr-21/51; 69.TMKC.1021.3-34; T.69.940), 4. Tepecik, pin (Tr-21/52; 69.TMKC.1033.3-46; T.69-54), 5. Tepecik, awl (Tr-21/53; 79.TMKC.12-80; T.74.233, VII 12) (Drawings by A. E. Gültekin and E. Özpamir).

Fig. 5: The finds from the hoard of Tülintepe were exhibited after the restoration at the Archaeological Museum of Elazığ.

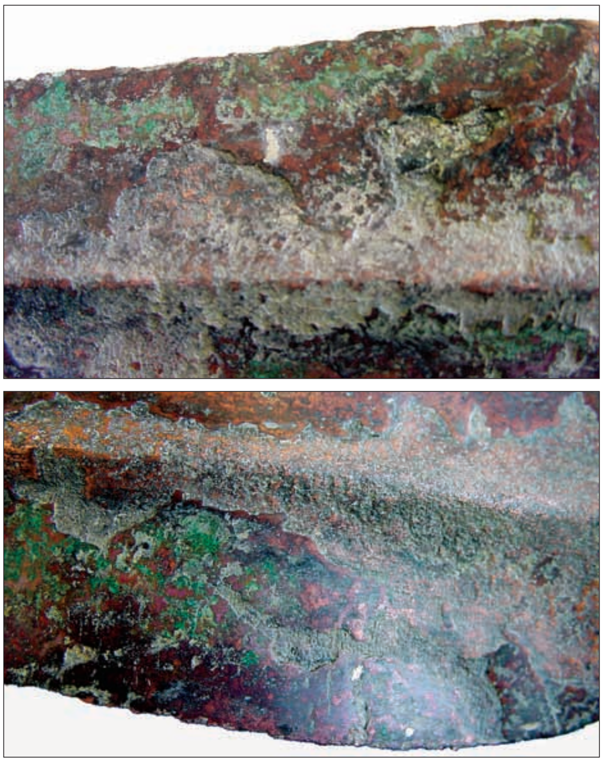


Fig. 6: Relics of tin (white) on the former spearhead surfaces released from the corrosion

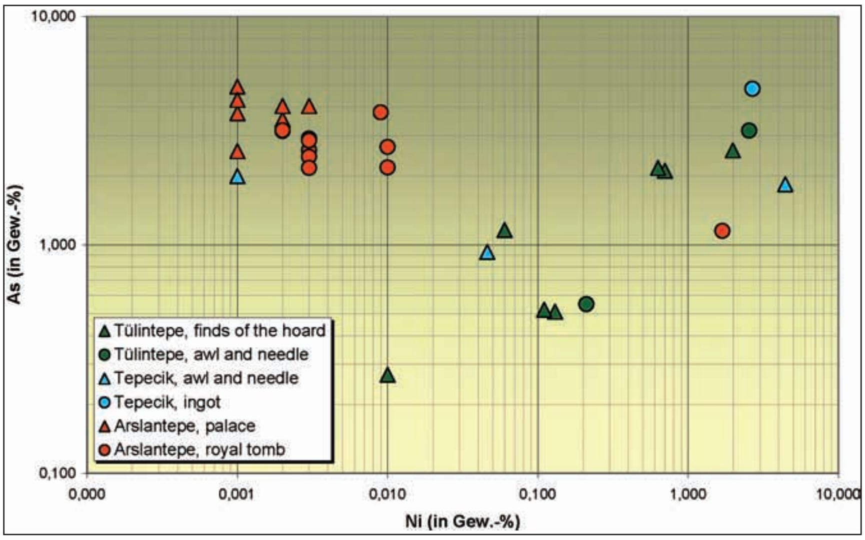


Fig. 7: Distribution of the As and Ni-values (in wt. %) of the finds from Tülintepe. For a comparison the contemporary metal finds from Tepecik and Arslantepe were evaluated here. The data for the ingot from Tepecik are taken from Özbal (1983), and the one for Arslantepe from Hauptmann et al. 2003.

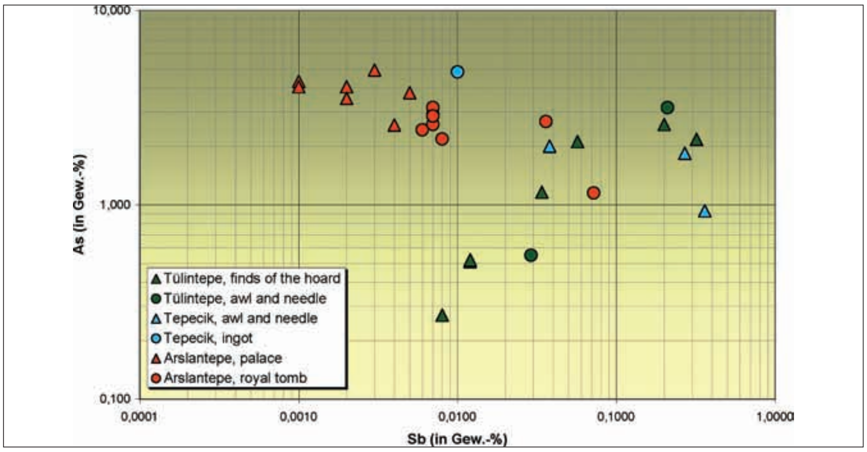


Fig. 8: Distribution of the As and Sb-values (in wt. %) of the finds from Tülintepe. For a comparison the contemporary metal finds from Tepecik and Arslantepe were evaluated here. The data for the ingot from Tepecik are taken from Özbal 1983, and the one for Arslantepe from Hauptmann et al. (2003).

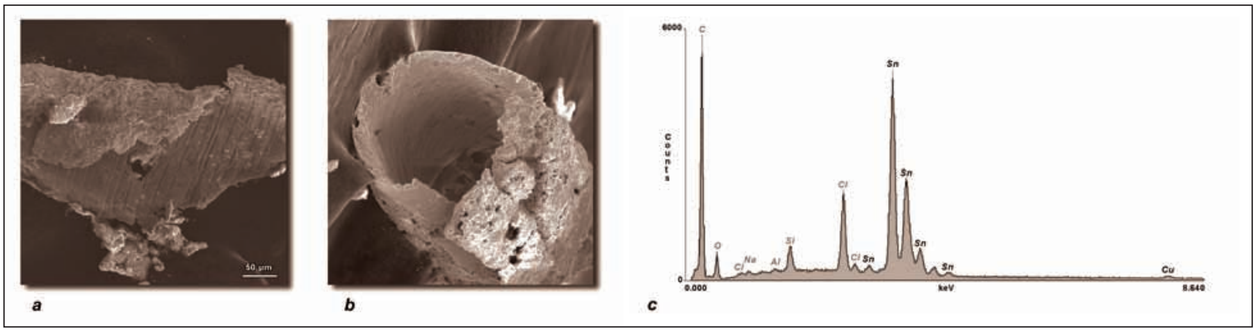


Fig. 9: Tin cover from the short sword (a) and from one of the spearheads (b) under the SEM and its SEM-spectrum (c).

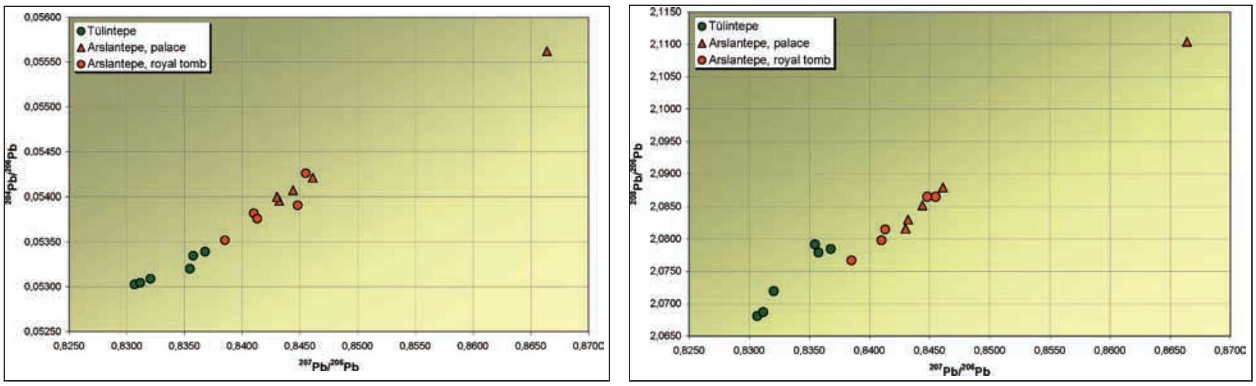


Fig. 10: The lead isotopic ratios of the hoard finds from Tülintepe compared with the contemporary spearheads and swords from Arslantepe.

Fig. 11: The distribution of the arsenic and nickel-containing copper objects in the Near East that are closely connected to the "ophiolithic zones" (expanded after an outline from Pernicka 1995; Hauptmann and Palmieri 2000).

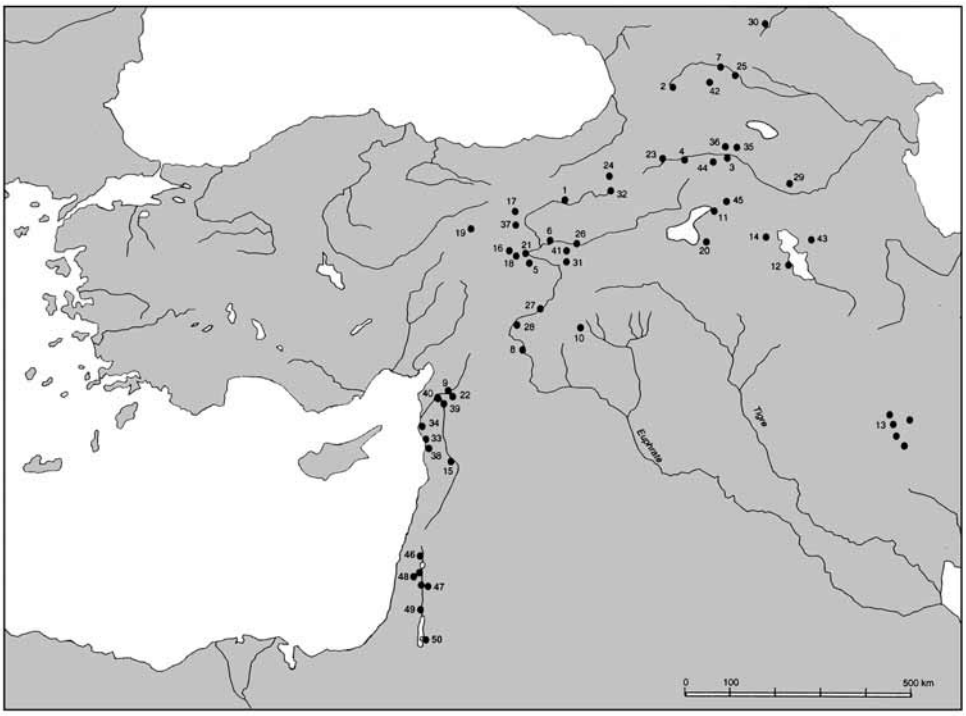


Fig. 12: The distribution of the Karaz / Kura-Araxes / Khirbet Kerak Pottery and the comparable contemporary pottery from the Near East (from Yalçın and Yalçın 2003: Abb.1). 1. Altıntepe, 2. Amiranis Gora, 3. Ararat, 4. Armavir Blur, 5. Arslantepe, 6. Aşvan, 7. Beshtasheni, 8. Kargamış, 9. Amuq-Çatal Höyük, 10. Tell Chuera, 11. Ernis, 12. Geoy Tepe, 13. Godin Tepe, 14. Haftavan Tepe, 15. Hama, 16. Harsatepe, 17. Hornavil, 18. Horomhan, 19. Değirmende Höyük, 20. İremir, 21. İsaköy 22. Amuq-Tell el-Judaidah, 23. Karakuri, 24. Karaz & Güzelova & Sos Höyük, 25. Kiketi, 26. Korucu Tepe. 27. Hayaz & Hassek Höyük, 28. Kurban Höyük, 29. Kültepe, 30. Lugove, 31. Norşuntepe, 32. Pulur-Sakyol, 33. Qal'at er-Russ, 34. Ras Shamra, 35. Shengavit, 36. Shresh Blur, 37. Sivrikaya, 38. Tell Sukas, 39. Tabara el-Akrad, 40. Amuq-Tell Ta'yinat, 41. Tepecik, 42. Trialeti, 43. Yanık Tepe, 44. Yaycı Tepe, 45. Zülfübulak, 46. Tell Qadesh, 47. Tell es-Shuna, 48. Affula & Khirbet Kerak/Beth Yerah, 49. Jericho, 50. Bad edh-Dhra.

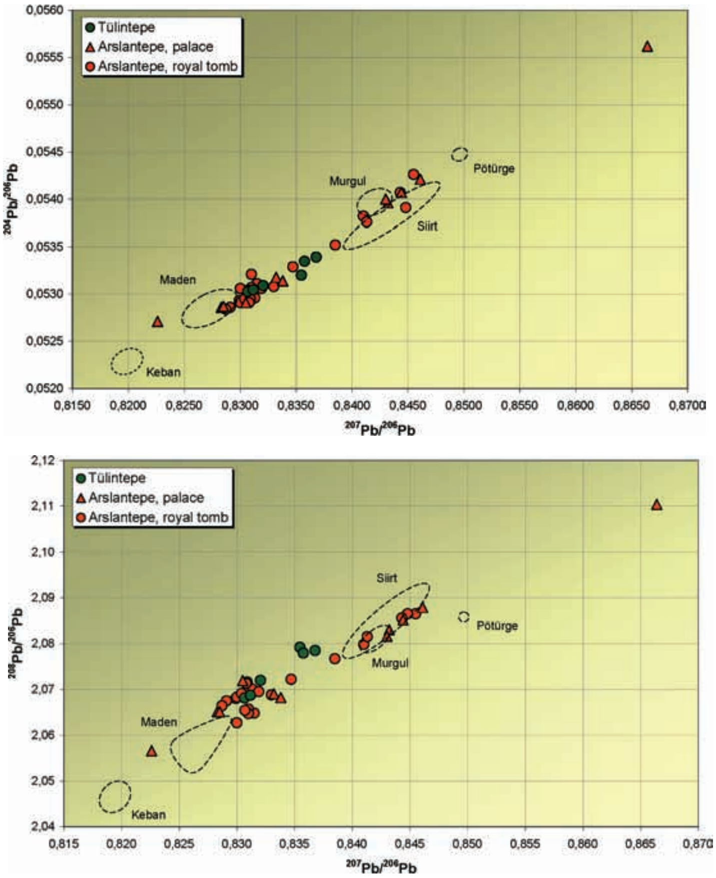


Fig. 13: The lead isotopic ratios of the hoard finds from Tülintepe and the contemporary finds from Arslantepe compared with the data from the metal mines of Eastern Anatolia (the data for Arslantepe are taken from Hauptmann et al. (2003); the data for the mines are from Seeliger et al. (1985) and from own sources of the authors.

STRATEGIC INDUSTRIES AND TIN IN THE ANCIENT NEAR EAST: ANATOLIA UPDATED

YAKIN DOĞU'NUN İLK ÇAĞ'LARINDA STRATEJİK ÜRETİM KOLLARI VE KALAY: ANADOLU VERİLERİNİN GÜNCELLENMESİ

K. Aslıhan YENER

Key words: Tin, bronz, Ancient Near East, Anatolia, Bolkardağ, strategic industries

Anahtar sözcükler: Kalay, tunç, Yakın Doğu'nun İlk Çağ'ları, Anadolu, Bolkardağ, stratejik üretim kolları

ÖZET

Bu makale, Türkiye'de bulunan kalay kaynaklarının bir özeti ile Toroslar'daki Bolkardağı ve Kestel maden bölgeleri ile Kayseri yakınlarındaki Hisarcık'ta yeni keşfedilen bir maden yatağı ile ilgili bulguları sunmaktadır. Yakın Doğu'daki İlk Çağ yerleşmelerine komşu bölgelerde bulunan ulaşılabilir kalay kaynaklarına ilişkin bilgiler de burada tartışılmaktadır. Başta Tel Cüdeyde (Judaidah) olmak üzere Kuzeydoğu Akdeniz'e yakın yerleşimlerde kalay ve tunç kullanımına ilişkin en erken tarihli kanıtlar, Anadolu kalayını ithal eden muhtemel merkezleri saptamaya olanak vermektedir.

INTRODUCTION

While browsing through Jack Sasson's on-line Agade announcements, a listing for a new book to be published by William W. Hallo, *The World's Oldest Literature Studies in Sumerian Belles-Lettres,* called attention to the impact of strategic metals in the ancient Near East. According to the statement for the book "Literature begins at Sumer, we may say. Given that this ancient crossroads of tin and copper produced not only bronze and the entire Bronze Age, but also by necessity, the first system of record-keeping and the technique of writing."

Food production, no doubt, maintains its primacy in terms of Mesopotamian record keeping and social priorities, but the role of metal technology, nevertheless, has been relatively overlooked. This article aims to present an overview of the accessibility of tin metal, critical in the production of the-then high technology of the ancient Near East, bronze. The focus of the article will concentrate on Syro-Anatolian sites which reflect distinct strategies from the above cited Mesopotamian or Aegean systems of procurement.

During the 1970's and 1980's the consensus of archaeological scholarship was that the alloying material, tin, used in the production of Bronze Age tin bronze was not found locally in the Near East.

However nebulous textual evidence in the second millennium BC is about the "eastern" location of tin brought into Kanesh in central Anatolia by the Old Assyrian merchants, the prevailing thought was that Afghanistan or central Asia were the only sources available to the ancient Near East even during the earlier formative third millennium BC (see summaries in Moorey 1999). With the initiation of archaeometallurgy surveys in a number of countries, the understanding of the complexities of these procurement systems has changed markedly. Not only has Turkey become identified as an important ancient source area for tin, but Egypt, the Balkans and Iran have also been documented as having substantial deposits of this strategic metal. Consequently the early notion that tin was supplied from one eastern source has been significantly altered to the compelling question now arising, which is why one source was preferred over another during these critical years of state expansion and empire building. Some procurement networks were established in the Early Bronze Age but the production, trade, and consumption patterns of tin have much in common with shifts in the economic, political and social transformations during the end of the Early Bronze Age.

It has now been over 20 years since the discovery of cassiterite (tin oxide) deposits in the Taurus Mountain range in south central Turkey, ancient Anatolia (Yener *et al.* 1989; see summaries in Yener 2000 and 2008). This paper reiterates the findings at two Taurus sources, Bolkardağ and Kestel and a newly identified source at Hisarcık near Kayseri in central Anatolia. Two articles in this journal by Lehner *et al.* and Özbal present new analyses of the Göltepe bowl furnaces and crucibles that were used in the production of tin and other metals. The work accomplished to date at Early Bronze Age Kestel tin mine and the tin smelting village complexes at Early Bronze Age Göltepe, a special function processing site situated 2 kilometers from the mine, constitutes only one of many other archaeologically unresearched, but reported sources in Turkey. Recent information about neighboring regions accessible to the ancient Near East is also briefly mentioned.[1]

These ancient metal production centers dated to 3000-1500 BC constitute the basis of wide ranging production, extraction, and exchange patterns of bronze and tin, its important alloying material.

STRATEGIC PRODUCTION

Much archaeological evidence has been published of early production attempts, whether intentional or not, of a variety of copper-based alloys throughout Anatolia dating to the fifth through fourth millennia BC (see summaries in Yalçın 2000; 2002; 2005). These copper based products contained varying amounts of lead, antimony, arsenic, tin, and iron depending on the host ore used. Mechanical and visual properties varied in these very early utensils and jewelry and eventually arsenic contents from two to four percent gained precedence in the fourth millennium BC. The advantages of using arsenic as an alloying material with copper were soon recognized, especially given the improvements in mechanical properties (Northover 1989). Optimum hardness for a copper alloy with arsenic is 5-8% giving superior ductility (for casting) and can be worked hot or cold without breaking (Lechtman 1996). Tin above two percent, on the other hand, gives greater hardness and slightly superior strength to copper (Craddock 1995) than arsenic and optimum hardness is achieved at 8-12% (Charles 1967; Lechtman 1996). Preferences for tin or arsenic may also have been culturally mediated as tin based bronzes are golden in coloring and arsenic segregation in copper yields an attractive silvery color. Varying regional preferences for these colors and the intentional selection of alloying materials for particular groups of artifacts regardless of mechanical properties or accessibility of alloying materials has often been pointed out.

The earliest archaeological evidence of tin bronzes cluster around the bend of the northeastern Mediterranean Sea in the Amuq valley of Turkey, Gaziantep, and northern Syria (Figs. 1 and 3). These sites date to the Late Chalcolithic-Early Bronze I, c. 3000 BC and slightly thereafter. This pivotal area linking the coastal Mediterranean with the cultures of Syro-Anatolia has immediate relevance to the early production of tin metal from Taurid sources such as Kestel, Bolkardağ, and Hisarcık. The site of Tell Judaidah in the northeastern passes of the Amuq valley in southern Turkey yielded numerous tin bronze artifacts, which were determined to contain from 5-37 % tin content from Phase G levels in both the TT20 sounding and JK3 operation[2]. The highest quantity of tin measured was from a crucible fragment encrusted with bronze slag from Phase G (JK3 operation). Earlier analysis of this crucible during the 1950's had detected 5 % tin content, whereas new and more sensitive instrumentation has given a much more nuanced understanding of the alloying technique (Fig. 2a and 2b). Eight globules (prills) of bronze entrapped in the crucible slag were tested using SIMS (secondary ion mass spectrometer) and tin ranged from 2.1-12.6 % (also 1.49 % Ni and 1.8 % As) and one bronze prill was found to contain 36.81 % tin content (Adriaens *et al*. 2002).

Clearly a sizable amount of tin was available to make bronze at c. 3000 BC. From the same context at Judaidah come ten tin bronze pins, chisels, and awl fragments, which had been previously tested and again contained appreciable tin content. From the TT20 sounding in a clearly documented and marked context just above floor XIV-3 dated to Phase G (R. Braidwood personal communication, February 23, 1994) and not from a pit as has erroneously been claimed[3], came six polymetallic tin bronze figurines. Regardless of numerous stylistic and iconographic arguments based primarily on parallels to other unexcavated figurines, which can notoriously be erroneous in their chronological implications, these figurines were carefully excavated and still remain part of a whole assemblage of early tin bronzes from various operations at Judaidah dated to Phase G.

Recent Advanced Photo Source synchrotron X-Ray analyses initiated at Argonne National Laboratory on one of the male figurines yielded 10 % tin content (Friedman *et al.* 1999). Lead isotope analysis conducted at the National Institute of Standards and Technology (NIST) on the silver helmet of the figurine as well as other bronze artifacts from the Amuq sites linked all of them to the Taurus ore sources (Sayre *et al.* 1992; Yener *et al.* 1991). That the raw materials for these artifacts are being supplied locally from argentiferous lead and copper rich mines in Aladağ, Bolkardağ, and Çamardı in the central Taurus mountains in the neighborhood of a fully operational Kestel tin mine and are made of tin bronze gives relevance to the suggested directionality of the tin production at Göltepe.

Further evidence of an early technological breakthrough in bronze alloys in this region comes from Gaziantep in southeastern Turkey during the EB II period (Duru 2006: 206. Level III radiocarbon dates calibrated range 3090-2500 BC, 1 s.d.). The analyses of 96 copper-based objects (mostly pins) from burials at the site of Gedikli were determined by AAS. 25 samples were tin-bronzes with an average tin content of 6.33 % (Bengliyan 1985). Tell Qara Quzaq situated in the north Syrian Euphrates region yielded tin bronzes dating to c. 2900-2750 BC, contemporary to Phase G in the Amuq. Two chisels and fourteen pins had tin contents from 1.47-19.07%, one of which is an exceptionally high level of tin (Montero Fenollós 1996). Throughout the third millennium BC during the fluorescence of Kestel mine operations, Tells Tayinat (Snow 2005) and Judaidah in the Amuq valley, Tarsus in Cilicia southern Turkey (Kuruçayırlı and Özbal 2005), north Syrian sites as well as central Anatolian settlements (see summaries in Kuruçayırlı 2007) continued to use tin in the production of bronzes.

The 1980's discovery of the seemingly anomalous occurrence of production sites such as Kestel and Göltepe had the disadvantage of being exotic and unique examples in Turkey and thus initially difficult to comprehend by the scholarly community[4]. These sites, however, have been the harbingers of other special function Bronze Age industrial mining-settlement complexes now being documented in Turkey and neighboring regions. The occurrences of crucible fragments, ingot molds, and vast quantities of ore and ore dressing stones surveyed in mining districts, significantly altered ideas about early urban industrial activity. The appearance of tin bronzes around 3000 BC and their distributions all over Anatolia, Syria, and Mesopotamia in the third millennium BC has long been documented, but their production and transmission, which follows a distinct qualitative and quantitative pattern during the period of early urban formation and increasing demands, demonstrate the potential importance in tracing commercial patterns in this area. The last destination of this initial stage of metal production would be the workshops in the lowland reciprocal town site assuredly situated in agriculturally fertile areas. These lowland workshops are where specialized crafts of refining the rough first-smelt metal, alloying and then casting the molten metal into idiosyncratic shapes.

KESTEL TIN MINE AND GÖLTEPE MINING VILLAGE

A first foreshadowing of tin occurrences in Turkey came from the discovery of stannite in the complex polimetallic ores of Bolkardağ in the Taurus range

(Yener and Özbal 1987; Sayre 2001; Yener *et al.* 1991). However, no ancient workings were identifiable since later Ottoman mines extant until the early twentieth century had obliterated all traces of early operations. Thus the viability of stannite (a complex ore of tin, copper and other minerals) as an early source of tin was hotly debated. Augmenting the evidence of tin in the central Taurus Mountains was the discovery of cassiterite at an Early Bronze Age dated mine, called Kestel, located near Çamardı, Niğde approximately 40 km north of the initial Bolkardağ discovery. The excavations at an Early Bronze Age tin mine at Kestel and its miner's village, Göltepe, shed light on a major enigma puzzling scholars for decades—a third millennium BC source of the elusive tin of antiquity accessible to Bronze Age sites. The discovery attracted wide attention after its publication in *Science* (Yener *et al.* 1989) and much heated discussion was unleashed by this discovery in the 1980s.

As a result of newly discovered tin deposits and mining-settlement complexes at Hisarcık and Kıranardı north of Kestel Mine, the Çamardı workings are no longer unique. It is extremely exciting that tin has been found to be more ubiquitous in Turkey than here-to-fore known, which is not surprising given the early traces detected in analyses of ores by the (Turkish Mineral Research Directorate, hereafter MTA) in Soğukpınar near Bursa in northwestern Turkey (Kaptan 1995). Recently several field projects from the MTA have been investigating the presence of tin in north central Turkey and reports of an important tin source within the Erciyes volcanic complex in Hisarcık and Kıranardı, Kayseri, have brought the location of tin deposits to within a few kilometers of the second millennium BC Kanesh trading system (see Dercksen 2005 on textual evidence for tin and copper trade). The Hisarcik and Kıranardı source is reportedly a mining gallery complex similar to Kestel mine (Özbal personal communication, see also Pehlivan *et al.* 2005). Not only have ore processing equipment and Early Bronze Age ceramics been found and identified, but the iron-rich tin ore resembles Kestel tin ores. Further demonstrating the complexity and variety of tin rich ores in Turkey, Sarp and Cerny (2005) announced the identification of a new mineral, Yazganite, containing tin associated with arsenic and iron. We eagerly await news of this mineral which contains 1.55% tin and the antiquity of the mining operations there.

Cassiterite at Kestel mine occurs in both granite hosted veins in the Niğde Massif and in the form of alluvial deposits in Kuruçay stream, below the mine. The Niğde Massif is a pre-Paleocene metamorphic unit of roughly 800 km^2. Tin is present in approximately 0.1-1% grade in Kestel mine today (undoubtedly higher in antiquity) found in quartz veins or along the contacts between the quartz and marble formations which are part of the young volcanics surrounding and overlaying the Massif. The mineral zonation (telethermal to catathermal) resulted from the Üçkapılı Granidiorite intrusion and extended up as pegmatitic and pneumatolytic zonation carrying the cassiterite (Çopuroğlu and Yalçın 2000). According to geological and mineralogical reports there have been two primary mineralizing episodes, an earlier tin-bearing and a later hematite one with weak tin. The deposit was in small outcroppings and sizeable for antiquity (but not of economic importance today). There was more than one period of mineralization; the most likely mineral mined both on the surface and underground was tin, but with the possibility of subsidiary gold.

Evidence of ore extraction continues below the marble into the underlying quartzite schist and granitic pegmatites with a total of 1.5 km of extraction tunnels explored to date. The underground galleries are extensive, measuring a minimum of 4500 cubic meters. Extrapolating from the low-grade ore composition the space extracted would have yielded approximately 115 tons of tin; Kestel mine was only one of many collapsed gallery entrances. In addition to the Early Bronze Age I-III ceramics excavated in trenches placed in the galleries, five samples of charcoal from excavated contexts inside Kestel mine gave radiocarbon determinations calibrated 3240-3100 B.C to 2870-2200 B.C., dating the use of Kestel mine firmly in the Early Bronze Age.

Tin-bearing veins of Kestel are easily distinguished in appearance from other veins and from the host limestone, in both color and texture. Especially distinct in appearance is the tin-rich hematite ore which has a gray-sometimes burgundy tinted, glittering appearance, unlike the much more matte appearance of hematite ore without tin. Based on excavations inside Kestel mine, tin was mined in similar techniques of firesetting defined at Cwmystwyth copper mine in

Wales. Experiments there showed that 750 kilos dry logs fired against the rock face cracked the ore explosively. The ore was mined with stone hammers and antler picks. One person mined 1.5 tons of rock in a morning. This entailed breaking down the mineral lumps into a size small enough to allow easy smelting and enrichment with repeated washing. Indeed 77% gabro-diabase hand held bucking stones surveyed on the Kestel slope had percussion traces. The exact opposite percentages were found at Göltepe where grinding was predominate.

A large number of tin impermeated hematite ore lumps were recovered during excavations at the miner's village Göltepe and these resemble the ore from Kestel. Analyses of these nodules by AAS yielded an average tin content of 2080 ppm; one sample contained 1.5% tin suggesting that the tin originally mined at Kestel would have been at least a 2% or higher tin-rich ore, a very good grade by today's standards. This strongly suggests that only high tin-containing material was selectively transported from Kestel mine to Göltepe for processing (grinding) and smelting purposes. The over 5,000 ground stone tools used in ore crushing from excavated contexts inside pit house structures at Göltepe support this conclusion. Perhaps the best indication of processing aims supporting tin and not iron, is the undeniable increase of tin content from samples taken from veins in the mine compared to samples from the hematite ore nodules found at Göltepe and finally compared to samples of the multicolored ground ore found stored in vessels and floors of pit house structures. It is strikingly obvious that tin-rich hematite was being enriched on its path from the mine to the smelting stage. None of the other elements analyzed showed this pattern of increase. The final production stage (refuse dump) is noticeable in the marked decrease in the tin content of powdered material from midden samples. Clearly debris from which tin had been extracted was discarded into dump areas of the site. There is no doubt that selective beneficiation of tin was the processing aim of the Göltepe industry (Yener *et al.* 2003).

Göltepe mining village is situated on top of a large natural hill facing Kestel mine. The hill measures close to 60 hectares total and is fortified at the summit with a circuit wall. The excavations uncovered 1500 m^2 of the settlement dating to the Late Chalcolithic through the EB III. Radiocarbon calibrated dates of 4350-2175 BC corroborated the ceramic evidence. Göltepe is architecturally unlike any site in Turkey. The workshop/habitation units are semi-subterranean and fully subterranean pit house structures. These ovoid pit houses measuring 4-6 m. diameter were cut into the greywacke bedrock with wattle and daub superstructures. One pit house structure appeared to be a workshop as inferred from the metallurgical tool kit consisting of a moveable brazier, crucible with stone cover, ground stone ore crushers, mortars, bucking stones, kilos of ground ore and ore nodules. This pit house unit was especially significant since it contained large EBA burnished storage jars full of ground ore. Some 70 kg of ore powder and 50 kg of ore nodules were sampled for analysis. In some of the pit house units, the ground ore was arranged in cups, each with a different color from purple, reddish to pink and when analyzed each contained varying percentages of tin and iron (from 0.3-1.8%). These were subsequently identified by SIMS as unprocessed powdered ore material, tailings from an ore concentration process, and remnants such as crushed slag.

Bronze artifacts excavated at Göltepe were small pins, awls, rings and other fragments. Atomic Absorption analysis (Özbal in Yener *et al.* 2003) revealed that all contained between 4.75-12.3% tin demonstrating the high tin content of the metal unearthed at the site. Interestingly, elevated levels of gold (1.23-52.1 ppm) were also observed, suggesting the possibility that Kestel was the source of the tin used, since gold is a component of this deposit as well. Finds such as a silver-tin-zinc alloy necklace and a lead ingot demonstrate that other metals were present as well. Other indications of ore processing and metal production were a number of sandstone molds with bar-shaped beds carved on several surfaces and clay molds suggest that tin metal was being produced and poured into ingot form before being trans-shipped to locations for bronze alloying.

The single most significant find at Göltepe relating to the processing of tin has been the over one ton of vitrified earthenware bowl furnaces or crucibles with a glassy slag accretion rich in tin. Constructed with a coarse straw and grit tempered ware, they range in size from a rim size of 6 cm. in diameter to 50 cm and have vitrified surfaces (SEM) measuring between 30-90% tin content. AAS analyses support the earlier Smithsonian results with vitrified examples ranging up to 4% tin content, a five fold increase relative to the ground ores. Verification that the crucibles were used for smelting tin metal was given by secondary ion mass spectrometer (SIMS) and microprobe analyses at the University of Chicago and Antwerp (for all residue analyses see *Adriaens et al*. 1996; 1997; 1999a, b). These results indicated that the vitrified ceramics contained a thin accretion layer of silicates with 2-3 % tin oxides. Microprobe analysis of a crucible that had a shiny green glassy material still adhering to its surface, showed that two types of crystals were present. The long thin crystals of tin oxide (SnO^{2}), and equiaxed crystals of iron-tin, with high tin concentrations were consistent with metallic slag. Processing involved intentionally producing tin metal by reduction firing of tin oxide in crucibles. This was achieved with repeated grinding, washing, panning and resmelting[5]. The raw materials being processed in the crucibles consisted of cassiterite in a labor intensive, multi-step, low-temperature process carried out between 800° and 950° C. (Yener and Vandiver 1993).

Having set the processing parameters from the archaeological and analytical information, several replication experiments tested the feasibility of the production model, the physical conditions required and the expected end products. Based on Egyptian depictions from 2500 BC, B. Earl of Cornwall and H. Özbal, successfully smelted tin metal after producing a crucible and using ground ore found in Early Bronze II/III contexts (Earl and Özbal 1996a, b). Enriching with one cup of water a low grade 1% cassiterite ore mixture to approximately 10% by vanning (panning with a shovel), this charge was then placed in a homemade crucible made with local clay and chaff temper. The charge, which was found in cups from the floor of Early Bronze Age pit structures, was placed in successive layers of charcoal and after twenty minutes of blowing through a blowpipe, tin prills entrapped inside an envelope of glassy slag emerged inside the crucible. During this experiment tin metal prills (globules) encased in glass slag were released by grinding with a lithic tool. The slag was thus in powder consistency and virtually invisible (e.g. no slag heaps) unless microscale sampling methods are introduced. Smelting thus resulted in a multistep production of tin metal with refining accomplished by washing, grinding and remelting.

Experimental trials concluded with the successful production of bronze using the results of the tin smelt which contained high levels of iron in the slag. Tin content was assayed by heating the ore sample with a weighed amount of copper to produce a bead of bronze containing nearly all the tin from the ore, leaving the iron as gangue. The melting point of iron is so much higher than that of copper (1540° C vs. 1085° C), nearly all the iron remains solid while the copper or bronze is still liquid and can be poured off. The main points drawn from this discussion is that by the end of the third millennium BC, metal production in the central Taurus range had already been transformed into a multi-tiered operation with wide networks of interaction (Yener 2007). The first tier is the extraction and smelting sites in the mountains; the second tier is the workshops found at urban sites.

OTHER NEAR EASTERN AND ASIAN SOURCES OF TIN

Central Asian sources of tin have often been cited as possible resource zones for Bronze Age tin. Deposits of tin and ancient workings have been identified near Karnab, Samarkand, Lapas, and Changali in Uzbekistan (Boroffka *et al*. 2002). As with Kestel mine, recent analyses of Karnab indicated that the ore samples had a low tin content of 1.3% or less, although according to the authors, a higher level must have existed in the upper extraction operations (Alimov *et al.* 1998). Second millennium BC Andronovo pottery was recovered in the mine as well as a settlement a kilometer away, indicating that this site was somewhat later than the technologically formative third millennium BC dates found in Anatolia. As with the special processing site of Göltepe, this settlement yielded evidence of industrial processing including ground stone tools, smelting droplets and tin ore. Similar second millennium BC workings (radiocarbon dates 1515-1265 BC) were identified at Mushiston in the Penjikent region of Tajikistan. Stannite, the complex mineral of tin and copper was reported, along with cassiterite (tin oxide) with tin contents analyzed between 50-34% (Alimov *et al*. 1998). Kaniuth (2007) correctly points out that these sources became important for the ancient Near East during the second millennium BC. For now, the production phase at Kestel and Göltepe spanning the third millennium BC remains an important earlier resource for central and southern Anatolia, as well as northern Syria during the formative years of tin bronze production.

The aberrant result of the wars that are on-going in Afghanistan vastly reduced research of the tin sources in this region. Often cited as the source of tin for the ancient Near East (Stech and Pigott 1986; Pigott *et al.* 2003; Weeks 2003), the identified low level of tin oxide cassiterite (600 ppm) was analyzed by a French team (Cleuziou and Berthoud 1982; Berthoud *et al.* 1982) surveying the Sarkar valley, south of Herat. Although ancient workings were found, their dates could not be substantiated. Evidence of tin production and the use of tin bronze in Afghanistan during the Bronze Age await the end of hostilities there.

Although tin occurrences have been reported in Georgia in the Caucasus (Kavtaradze 1999), tin contents have not been published. Recent archaeometallurgical surveys in this country have been researching a late fourth, early third millennium BC ancient gold working site (Stöllner *et al.* 2008), which may have relevance to tin as well. During the lecture, trace levels of tin were also reported on a map. The co-occurrence of gold and other heavy metals in the Caucasus dating to the formative period of tin bronzes lends credence to contemporary, similar findings at Kestel and Göltepe.

Early reports (Wertime 1978; Pigott 1999) of tin occurrences in Iran especially in the Dasht-ı Lut desert in eastern Iran were the first foreshadowing of this region as a possible supplier for Mesopotamia during the Bronze Age. Significant tin sources have recently been investigated Deh Hosein in central west Iran. The deposit consists of copper, tin, and gold and the workings have been dated to the late third, early second millennium BC (Momenzadeh *et al.* 2002; Nezafati *et al.* 2008). These sources in Iran have immediate relevance to the early 2nd millennium BC and later tin bronzes found in Luristan, although the earlier third millennium BC workings await clarification. PIXE spectrometry analyses (Sn from 3.5-14.8%) of excavated bronzes from these graves revealed purposefully alloyed tin bronzes (Fleming *et al.* 2005). Lead isotope analysis conducted on these and other Luristan bronzes, however, call into question the authors' conclusion that the tin and copper for these bronzes were imported from Afghanistan and Oman respectively (Begemann *et al.* 2008).

Substantial evidence exists that the eastern desert of Egypt contains important deposits of tin (Rothe and Rapp 1995), although third millennium BC workings were not identified. Again limited surveys may have constrained the documentation of these hydrothermal veins of tin and tungsten, which are said to be 1.5 m in thickness (Muhly 1993). Egyptian antiquities regulations do not permit the exportation of metal samples for analysis and may have played a major role in skewing our understanding of the extent tin bronzes were used in Egypt during the third millennium BC (Old Kingdom) despite the occasional rare items. The overall impression of all this negative evidence has been to dismiss the eastern desert source of Egyptian tin as relevant only for the second millennium BC, certainly important for the rise of palace economies in the Late Bronze Age eastern Mediterranean. Geologically similar deposits of tin and tungsten were identified in Saudi Arabia at Jebel Silsilah and three other sources in western Arabia (Muhly 1993; Wertime 1978; Weeks 2003). Again, as with Egypt, Bronze Age workings were not identified, although the several percentages of tin content warrant a closer examination of this source as well[6].

It is obvious that at the end of the third millennium BC other sources of tin, such as ones now studied in Iran and Central Asia (Weisgerber and Cierny 2002) superseded or were in competition with the Kestel tin source. Perhaps profoundly associated with the newly emerging patterns of consumption are preferences found in factors other than availability. Given the textual clues in the Kanesh cuneiform tablets, the Kanesh trading system of the early second millennium BC tapped into the resources of eastern tin, perhaps Afghanistan, Iran or Central Asia and not the local source, Kestel. Evidence of Middle Bronze Age working has not been found in Kestel. Given the labor intensive extraction of tin found at Göltepe processing site, it is not surprising that Central Anatolian Middle Bronze Age Kingdoms such as Kanesh gave preference to a ready made tin metal product brought by Assyrian merchants.

In conclusion, Early Bronze Age Kestel mine and the industrial center at Göltepe reflect the distinct strategies of the first tier of processing rough metal products, that is, local ore extracted directly from the neighboring mine and smelted into rough form. It is worth reiterating obvious point that the manufacture of metal at the mines and smelting sites are the least-studied major aspect of early states where these products are ultimately used in the production of artifacts of power and prestige.

NOTES

[1]This information is much indebted to Kuruçayırlı (2007). I thank him for allowing me to quote from his fine master's thesis.

[2]Two radiocarbon dates run on samples from a 1995 operation at Judaidah (Edens in Yener *et al*. 2000, Beta-88280, Beta-88281; table 1) gave a date spanning 3090–2710 BC (1 S.D.). Confirming the Phase G dates, Tell Sukas yielded contemporary levels with an average of four identical dates from layers 39–38 (phase L2) in the range 2930–2650 BC.

[3]See arguments in Seeden (1980) and Marchetti (2000). Seeden (footnote 28) cites an unidentified "famous" archaeologist claiming to have visited Judaidah during the excavations, casting unnecessary doubt on direct documentation by the field archaeologists. Such unverifiable information has been the source of much misunderstanding.

[4]See the now irrelevant disavowals of the content and quantity of tin at Kestel mine and the processing site, Göltepe in Boroffka *et al*. 2002; Alimov *et al*. 1998; Muhly 1999; Muhly *et al*. 1991; Weeks 1999.

[5]Ore processing in antiquity often warranted tedious and difficult labor but valuable materials such as tin were meticulously worked such as with gold extraction.

[6]For tin sources in more remote areas see India (Babu 2003), Germany (Niederschlag *et al*. 2003; Weeks 2003), Spain (Muhly 1985; Weeks 2003), Yugoslavia (McGeehan-Liritzis and Taylor 1987, Glumac *et al.* 1991), and Cornwall England (Muhly 1985; Weeks 2003). These sources have also been cited as possible suppliers of Bronze Age tin, although their direct relevance to the Ancient Near East await further study.

REFERENCES

Adriaens, A., K.A. Yener and F. Adams 1996
"Surface Analysis of Early Bronze Age Ceramic Crucibles from Göltepe, Turkey", H.J. Mathieu, B. Reihl and D. Briggs (eds.) *The Proceedings of the 6th European Conference on Applications of Surface and Interface Analysis*: 123-126. Wiley, Chichester and New York.

Adriaens, A., K.A. Yener and F. Adams 1999
"An Analytical Study Using Electron and Ion Microscopy of Thin-Walled Crucibles from Göltepe, Turkey", *Journal of Archaeological Science* 26: 1069-1073.

Adriaens, A., B. Earl, H. Özbal and K.A. Yener 2002
"Tin Bronze Metallurgy in Transformation: Analytical Investigation of Crucible Fragments from Tell al-Judaidah, Amuq (Turkey) Dating to Circa 3000-2900 BC", E. Jerem and K.T. Biro (eds.) *Archaeometry* 98: 273-277. BAR International Series 1043 (II). Archaeopress, Oxford.

Adriaens, A., K.A. Yener, F. Adams and R. Levi-Setti 1997
"SIMS Analyses of Ancient Ceramic Crucibles and Slags from Turkey", A. Benninghoven, B. Hagenhoff and H.W. Werner (eds.) *Tenth International Conference on Secondary Ion Mass Spectrometry SIMS* X: 877-880. Wiley & Sons, Chichester and New York.

Adriaens, A. et al. 1999
"Analytical Investigation of Archaeological Powders from Göltepe (Turkey)", *Archaeometry* 41: 81-90.

Alimov, K. et al. 1998
"Prähistorischer Zinnbergbau in Mittelasien. Vorbericht der ersten Kampagne 1997", *Eurasia Antiqua* 4: 137-199.

Babu, T.M. 2003
"Advent of the Bronze Age in the Indian Subcontinent", P. Craddock and J. Lang (eds.) *Proceedings of the Conference of Ancient Mining and Metallurgy*: 174-180. British Museum Occassional Publications, London.

Begemann, F. et al. 2008
"An Archaeo-Metalurgical Study of the Early and Middle Bronze Age in Luristan, Iran", *Iranica Antiqua* 43: 1-66.

Bengliyan, A. 1985
Trace Element Analysis of Metal Artifacts from Gedikli Hoard by Atomic Absorption Spectroscopy. Yayımlanmamış Yüksek Lisans Tezi, Kimya Bölümü, Boğaziçi Üniversitesi, İstanbul.

Berthoud, T. et al. 1982
"Cuivres et Alliages en Iran, Afghanistan, Oman au Cours des IVe et IIIe Millénaires", *Paléorient* 8: 39-54.

Boroffka, N. et al. 2002
"Bronze Age Tin in Central Asia", K. Bole, C.

Renfrew and M. Levine (eds.) *Ancient Interactions: East and West in Eurasia*: 135-159. Cambridge University Press, Cambridge.

Charles, J.A. 1967
"Early Arsenical Bronzes-A Metallurgical View", *American Journal of Archaeology* 71: 21-26.

Cleuziou, S. and T. Berthoud 1982
"Early Tin in the Near East: A Reassessment in the Light of New Evidence from Western Afghanistan", *Expedition* 25: 14-19.

Çopuroğlu, İ. and M.G. Yalçın 2000
"Niğde Masifi Metalik Maden Yatakları, Metalic Ore Deposits of Niğde", *53. Türkiye Jeoloji Kurultayı (53. Geological Congress of Turkey)*: 16-17. Jeoloji Mühendisleri Odası (Chamber of Geological Engineers of Turkey), Ankara.

Craddock, P.T. 1995
Early Metal Mining and Production. Edinburgh University Press, Washington.

Dercksen, J.G. 2005
"Metals According to Documents from Kültepe-Kanish Dating to the Old Assyrian Colony Period", *Anatolian Metal* III (Der Anschnitt, Beiheft 18): 17-34.

Duru, R. 2006
Gedikli Karahöyük I. The Results of Excavations Directed by Prof. U. Bahadır Alkım in the Years 1964-1967. Türk Tarih Kurumu, Ankara.

Earl, B. and H. Özbal 1996a
"Early Bronze Age Tin Processing at Kestel/ Göltepe, Anatolia", *Archaeometry* 38: 289-303.

Earl, B. and H. Özbal 1996b
"Early Bronze Age Tin Processing at Kestel-Göltepe", S. Demirci, A.M. Özer and G.D. Summers (eds.) *Archaeometry 94. Proceedings of the 29th International Symposium on Archaeometry*: 447-449. Tübitak, Ankara.

Fleming, S.J., V.C. Pigott, C.P. Swann and S.K. Nash 2005
"Bronze in Luristan: Preliminary Analytical Evidence from Copper/Bronze Artifacts Excavated by the Belgian Mission in Iran", *Iranica Antiqua* 40: 35-64.

Friedman, E.S. et al. 1999
"Archaeology at the APS: Illuminating the Past", *Advanced Photon Source Research* 2/1: 12-16.

Glumac, P.D. and J.A. Todd 1991
"Early Metallurgy in South-East Europe: The Evidence of Production", D. Glumac (ed.) *Recent Trends in Archaeometallurgical Research*: 8-19. MASCA Research Papers in Science and Archaeology 8, Philadelphia.

Kaniuth, K. 2007
"The Metallurgy of the Late Bronze Age Sapalli Culture (Southern Uzbekistan) and its Implications for the 'Tin Question'", *Iranica Antiqua* 42: 23-40.

Kaptan, E. 1995
"Tin and Ancient Tin Mining in Turkey", *Anatolica* 21: 197-203.

Kavtaradze, G.L. 1999
"The Importance of Metallurgical Data for the Formation of Central Transcaucasian Chronology", A. Hauptmann et al. (eds.) *The Beginnings of Metallurgy*: 67-103. Der Anschnitt Beiheft 9, Bochum Bergbau Museum, Bochum.

Kuruçayırlı, E. 2007
Tin and Tin-Bronze in the Bronze Age: Their Use, Sources and Trade from the Balkans to India. Unpublished MA thesis, Bryn Mawr University.

Kuruçayırlı, E. and H. Özbal 2005
"New Metal Analysis from Tarsus-Gözlükule", A. Özyar (ed.) *Field Seasons 2001-2003 of the Tarsus-Gözlükule Interdisciplinary Research Project*: 177-195. Ege Yayınları, İstanbul.

Lechtman, H. 1996
"Arsenic Bronze: Dirty Copper or Chosen Alloy? A View from the Americas", *Journal of Field Archaeology* 23: 477-514.

Marchetti, N. 2000
"A Middle Bronze I Ritual Deposit from the 'Amuq Plain: Note on the Dating' and Significance of the Metal Anthropomorphic Figurines from Tell Judaidah", *Vicino Oriente* 12: 117-132.

Mcgeehan-Liritzis, V. and J.W. Taylor 1987
"Yugoslavian Tin Deposits and the Early Bronze Age Industries of the Aegean Region", *Oxford Journal of Archaeology* 6: 287-300.

Momenzadeh, M., N. Nezafati and E. Pernicka 2002
"First Indication of Tin at the Ancient Mining Site near Deh Hosein, West-Central Iran: A Possible Source for Luristan Bronze?", *Paper presented at the*

33rd International Archaeometry Symposium, Amsterdam.http://www.geo.vu.nl/archaeometry/abstracts/ metalgeneral.pdf

Montero Fenollós, J.-L. 1996
"Metallurgia en el Proximo Oriente Antiguo. El Ejemplo de Siria", *Revista de Arqueología* 178: 14-23.

Moorey, P.R.S. 1994
Ancient Mesopotamian Materials and Industries: the archaeological evidence. Eisenbrauns, Winona Lake.

Muhly, J.D. 1985
"Sources of Tin and the Beginning of Bronze Metallurgy", *American Journal of Archaeology* 89: 275-291.

Muhly, J.D. 1993
"Early Bronze Age Tin and the Taurus", *American Journal of Archaeology* 97/2: 239-253.

Muhly, J.D. 1999
"Copper and Bronze in Cyprus and the Eastern Mediterranean", V.C. Pigott (ed.) *The Metallurgy of the Asian Old World*: 15-26. MASCA Volume 16, Philadelphia.

Muhly, J.D. et al. 1991
"The Bronze Age Metallurgy of Anatolia and the Question of Local Tin Sources", E. Pernicka and G. A. Wagner (eds.) *Archaeometry* '90: 209-220. Proceedings of the 27th Symposium on Archaeometry held in Heidelberg, Basel.

Nezafati, N., M. Momenzadeh and P. Pernicka 2008
"New Insights into the Ancient Mining and Metallurgical Researches in Iran", Ü. Yalçın, H. Özbal and A.G. Paşamehmetoğlu (eds.) *Ancient Mining in Turkey and the Eastern Mediterranean*: 329-350. Atılım Üniversitesi, Ankara.

Niederschlag, E., E. Pernicka, T. Seifert and M. Bartelheim 2002
"The Determination of Lead Isotope Ratios by Multiple Collector ICP-MS: A Case Study of Early Bronze Age Artifacts and Their Possible Relation with Ore Deposits of the Erzgebirge", *Archaeometry* 45: 61-100.

Northover, J.P. 1989
"Properties and Use of Arsenic-Copper Alloys", A. Hauptmann and E. Pernicka (eds.) *Old World Archaeometallurgy*: 111-118. G.A. Wagner, Bochum.

Pehlivan, N.A. et al. 2005
"Kıranardı (Kayseri) Kalay Cevherleşmesine ait ilk Jeolojik ve Arkeojeolojik Bulgular (Geological and Archaeological Finds at the Kıranardı (Kayseri) Tin Mineralization, 58)", *Türkiye Jeoloji Kurultayı* (*58. Geological Congress of Turkey)*. Jeoloji Mühendisleri Odası (Chamber of Geological Engineers of Turkey), Ankara.

Pigott, V.C. 1999
The Metallurgy of the Asian Old World. 15-26. MASCA Vol. 16, Philadelphia.

Pigott, V.C., H.C. Rogers and S.K. Nash 2003
"Archaeometallurgical Investigations at Malyan: The Evidence for Tin-Bronze in the Kaftari Phase", N.F. Miller and K. Abdi (eds.) *Yeki Bud, Yeki Nabud*. *Essays on the Archeology of Iran in Honor of William M. Sumner*: 161-176. Cotsen Institute of Archaeology, Los Angeles.

Rothe, R.D. and G.R. Rapp Jr. 1995
"Trace Element Analysis of Egyptian Eastern Desert Tin and its Importance to Egyptian Archaeology", A.A.H. Abdel, M. Miele and S. Riad (eds.) *Proceedings of the Egyptian-Italian Seminar on Geosciences and Archaeology in the Mediterranean Countries*: 229-244. Geological Survey of Egypt, Cairo.

Sarp, H. and R. Cerny 2005
"Yazganite, NaFe3+2 (Mg,Mn)(As04)3.H20, a New Mineral: Its Description and Crystal Structure", *European Journal of Mineralogy* 17: 367-374.

Sayre, E.V., K.A. Yener, E.C. Joel and I.L. Barnes 1992
"Statistical Evaluation of the Presently Accumulated Lead Isotope Data from Anatolia and Surrounding Regions", *Archaeometry* 34: 73-105.

Sayre, E.V. et al. 2001
"Stable Lead Isotope Studies of Black Sea Anatolian Ore Sources and Related Bronze Age and Phrygian Artefacts from Nearby Archaeological Sites. Appendix: New Central Taurus Ore Data", *Archaeometry* 43: 77-115.

Seeden, H. 1980
The Standing Armed Figurines in the Levant. Prähistorische Bronzefunde. Abteilung I, Band I, Beck, Munich.

Snow, H. 2005
The Role of Metals in the Early Bronze Age Economies of North Syria and Anatolia. Unpublished dissertation, Department of Near and Middle Eastern Civilizations, University of Toronto.

Stech, T. and V.C. Pigott 1986
"The Metals Trade in Southwest Asia in the Third Millennium B.C.", *Iraq* 48: 39-64.

Stöllner, Th., I. Gambaschidze and A. Hauptmann 2008
"The Earliest Gold Mining of the Ancient World?", Ü. Yalçın, H. Özbal and A.G. Paşamehmetoğlu (eds.) *Ancient Mining in Turkey and the Eastern Mediterranean*: 271-288. Atılım Üniversitesi, Ankara.

Weeks, R.L. 1999
"Lead Isotope Analysis from Tell Abraq, United Arab Emirates: New Data Regarding the 'Tin Problem' in Western Asia", *Antiquity* 73: 49-64.

Weeks, R.L. 2003
Early Metallurgy of the Persian Gulf. Brill Acedemic Publishers, Boston and Leiden.

Weisgerber, G. and J. Cierny 2002
"Tin for Ancient Anatolia?", *Anatolian Metal* II (Der Anschnitt, Beiheft 15): 179-187.

Wertime, T.A. 1978
"The Search for Ancient Tin: The Geographic and Historic Boundaries", A.D. Franklin, J.S. Olin and T.A. Wertime (eds.) *The Search for Ancient Tin*: 1-6. Smithsonian Institution Press, Washington.

Yalçın, Ü. 2000
"Anfänge der Metallverwendung in Anatolien", *Anatolian Metal* I (Der Anschnitt, Beiheft 13): 17-30.

Yalçın, Ü. (ed.) 2002
Anatolian Metal II. Der Anschnitt, Beiheft 15. Bochum Bergbau Museum, Bochum.
Yalçın, Ü. (ed.) 2005
Anatolian Metal III. Der Anschnitt, Beiheft 18. Bochum Bergbau Museum, Bochum.

Yener, K.A. 2000
The Domestication of Metals: The Rise of Complex Metal Industries in Anatolia (c. 4500-2000 B.C.). E.J. Brill, Leiden.

Yener, K.A. 2007
"The Anatolian Middle Bronze Age Kingdoms and Alalakh: Mukish, Kanesh, and Trade", *Anatolian Studies* 57: 151-170.

Yener, K.A. 2008
"Revisiting Kestel Mine and the Dynamics of Local Provisioning of Tin during the Early Bronze Age", Ü. Yalçın, H. Özbal and A.G. Paşamehmetoğlu (eds.) *Ancient Mining in Turkey and the Eastern Mediterranean*: 57-64. Atılım Üniversitesi, Ankara.

Yener, K.A. and H. Özbal 1987
"Tin in the Turkish Taurus Mountains: The Bolkardag Mining District", *Antiquity* 61: 64-71.

Yener, K.A. and P.B. Vandiver 1993
"Tin Processing at Göltepe, an Early Bronze Age Site in Anatolia", *American Journal of Archaeology* 97: 207-238.

Yener, K.A., A. Adriaens, B. Earl and H. Özbal 2003
"Analyses of Metalliferous Residues, Crucible Fragments, Experimental Smelts, and Ores from Kestel Tin Mine and the Tin Processing Site of Göltepe, Turkey", P. Craddock and Janet Lang (eds.) *Proceedings of the Conference of Ancient Mining and Metallurgy*: 181-197. British Museum Occasional, London.

Yener, K.A. et al. 1989
"Kestel: An Early Bronze Age Source of Tin Ore in the Taurus Mountains, Turkey", *Science* 244: 200-203.

Yener, K.A. et al. 1991
"Stable Lead Isotope Studies of Central Taurus Ore Sources and Related Artifacts from Eastern Mediterranean Chalcolithic and Bronze Age Sites", *Journal of Archaeological Science* 18: 541-577.

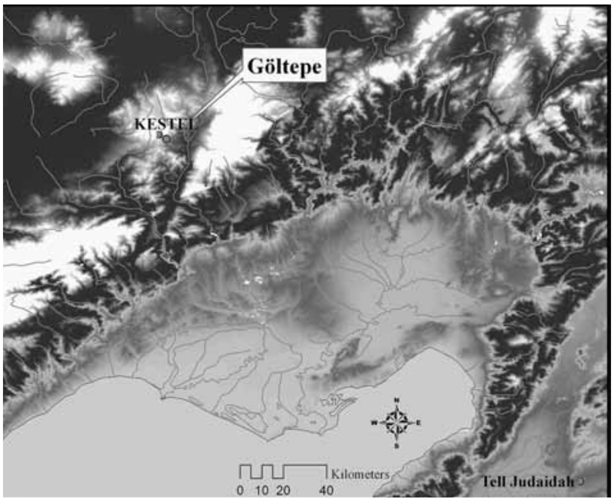


Fig. 1: Map of the Northeastern Mediterranean

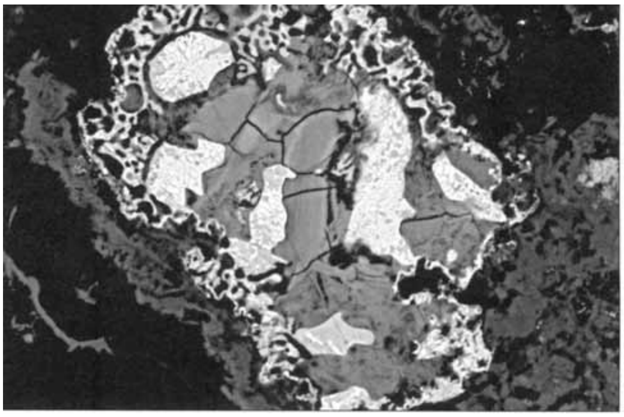


Fig. 2a: Backscattered electron image of residue in Judaidah crucible c. 3000 BC. Mag 720 x (Adriaens et al. 2002: Fig. 5).

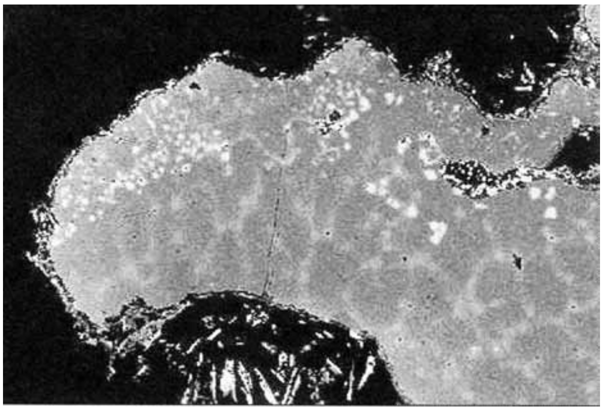
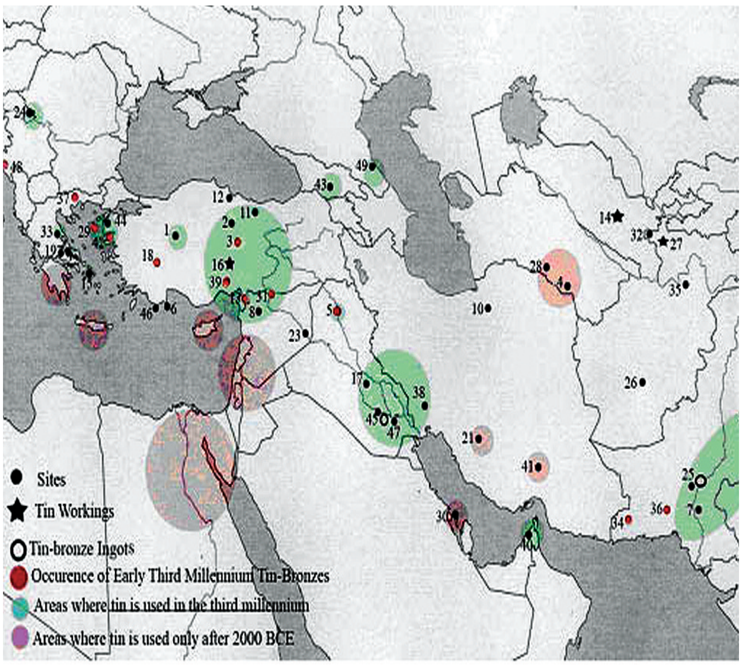


Fig. 2b: Backscattered electron image of residue in Judaidah crucible c. 3000 BC. Mag 440 x (Adriaens et al. 2002: Fig. 4)



1 Ahlatlıbel
2 Alacahöyük
3 Alişar
4 Altın Tepe
5 Assur
6 Cape Gelidonya
7 Chanhu Daro
8 Ebla
9 Harappa
10 Hissar
11 Horoztepe
12 Ikiztepe
13 Judaidah
14 Karnab
15 Kastri
16 Kestel/Göltepe
17 Kish
18 Kusura
19 Lithares
20 Lothal
21 Malyan
22 Manika
23 Mari
24 Maros Basin
25 Mohenjo Daro
26 Mundigak
27 Mushiston
28 Namazga
29 Poliochni
30 Qala'at al-Bahrain
31 Qara Quzaq
32 Sarazm
33 Sesklo
34 Shahi Tump
35 Shortugai
36 Silah Damb
37 Sitagroi
38 Susa
39 Tarsus
40 Tell Abraq
41 Tepe Yahya
42 Thermi
43 Tiraleti
44 Troy
45 Ubaid
46 Uluburun
47 Ur
48 Velika Grouda
49 Velikent

Fig. 3: Distributions of Tin Bronze Artifacts and Tin Sources (after Kuruçayırlı 2005)

NEW ANALYTICAL DATA FROM GÖLTEPE CRUCIBLES

GÖLTEPE POTALARINDAN YENİ ANALİTİK VERİLER

Hadi ÖZBAL

Key words: Göltepe/Kestel, Early Bronze Age, tin smelting

Anahtar Sözcükler: Göltepe/Kestel, İlk Tunç Çağ, kalay ergitmesi

ÖZET

Niğde, Göltepe İlk Tunç Çağı kalay ergitme işliğinden daha önce komposizyonu ve mikroyapıları belirlenmemiş 11 adet pota parçası EDX ve taramalı electron Mikroskobu (SEM) ile incelenmiştir. İncelenen 11 pota parçasından sekiz adedinin iç yüzeylerinde kalay oksit ince bir bant veya granüller olarak yayıldığı belirlenmiştir. Ara tamamen metalik veya kısmen oksitlenmiş 5-20 mikron çapında kalay küreciklere rastlanmıştır. Pota parçalarının çok küçük olmasından dolayı şekilleri ve büyüklükleri belirlenememiştir. Pota parçalarının ya kalay ergitmesi sırasında pota kapağı, ya da ergitmenin yapıldığı pota olarak kullanılmıştır.

INTRODUCTION

Archaeological excavations at the Early Bronze Age site of Göltepe (Map. 1) where cassiterite from the Kestel mine was smelted yielded a large number of crucibles of many different sizes and shapes (Yener *et al.* 1989). Archaeometallurgical study of various crucible fragments indicated that they were used for the processing of tin containing materials (Yener and Vandiver 1993; Adriaens *et al*. 1999a). The eleven crucibles selected for this study were of different sizes, shapes and thicknesses. Yener and Vandiver (1993) have established that similar crucibles fragments that they have studied were generally exposed to different firing temperatures between 700 – 800^{o}C, with a maximum of about 1000^{o}C. Such variations may indicate that different types of thermal processing were taking place at Göltepe. Yener and Vandiver (1993) did not associate different types of crucibles with any particular process. In 1993, a total of 28 crucible fragments from Göltepe, most of them in the form of powder from the inner accretion layer, were brought to Boğaziçi University to determine the tin content of these crucible accretions by atomic absorption spectrometry (Earl and Özbal 1996; Adriaens *et al*. 1999b). Four samples yielded over 1% tin with highest level at 3.65%. The remaining 24 samples had an average of 1070 ppm tin. Eleven of the 28 crucible samples were large enough for cross-sectioning. This paper presents investigations on the microstructure of the crucible cross section profiles by scanning electron microscope (SEM), optical microscope, as well as analyses on the chemical composition of various phases and inclusions using energy dispersive x-ray analysis (EDX).

DESCRIPTION OF THE CRUCIBLE FRAGMENTS

The description of the crucible fragments is given in Table 1. Due to the very fragmentary nature of the samples, it was not possible to predict the approximate size and shape of the crucibles. Thus, the crucibles are grouped according to the presence or absence of tin oxide and by comparing the microstructure, composition and the distributions pattern of tin oxide in the accretion layer on the inner surface of the crucible fragments. Even though the crucibles were constructed in different sizes and shapes and seem to have been used for different processes, the composition and microstructure of the bulk clay material seem similar. Organic fiber was used in all samples. SiO_2 and Al_2O_3 were the major components with minor amounts of CaO, MgO, Na_2O, K_2O and FeO (Table 2). TiO_2 was less then 1.0 %. The main mineral was quartz, followed by albite and muscovite. These minerals are probably derived from the local clay material. The main ceramic body of most crucible samples was overlaid by a rather thin accretion layer that contained tin oxide in the form of globules or as a very thin continuous band. Adriaens (1999a) demonstrated that tin oxide does not penetrate beyond 300-400 μm from the surface and hardly ever found its way into the bulk of the ceramic.

The crucible fragments were recovered from trenches excavated in areas A and B (Yener and Vandiver 1993). Area A, on the southern part of the mound, had mainly subterranean and semi subterranean pit structures some of which could have been workshops. Four out of seven crucible fragments from this area (Trenches A22, A23 and A24) contained a very thin continuous layer or globules of tin oxide on the inner surface of the fragments. The remaining four fragments are from area B, located at the northwest corner of the hill from trenches B01 and B09 which are next to each other near the circuit wall. Area B yielded many fragments of crude porous ware with accretions that contain tin oxide and glassy slag discarded by the circuit wall (Yener and Vandiver 1993). This area may also be considered a workshop where cassiterite processing and smelting took place.

GROUP 1 CRUCIBLES

This group of samples (Table 3, Entries 1-4) was all rim fragments that vary in thickness between 14 and 24.1 mm. They had pale grey to brown and black scorified accretions on the inner surfaces that are about 2 to 3 mm thick. Entry 1 was a small grey to black, highly scorified porous fragment that was exposed to highly reducing conditions. Entries 2, 3 and 4 had a light brown, orange to red, dense, compacted and oxidized exterior bodies. No slag particles could be observed by visual examination or by binocular microscope. Their common characteristic was a continuous thin tin oxide layer located at the interface between the clay bulk matrix and the accretion on the inner surface. Sample MRN 1124 (Entry 1) was unique because the continuous tin oxide had also penetrated into the clay matrix of the crucible and can be seen as a light grey band across the inner surface (Fig. 1). The width of the band reaches up to about 500μm. The sample must have been exposed to relatively high temperatures that probably allowed tin oxide to diffuse into the bulk matrix of the crucible. Embedded in the tin-rich band, there are many globules with diameters as large as 50 μm that appear as bright prills. Close examination of one of the prills indicates that they are composed of SnO_2 (Fig. 2, region A) and pure metallic tin (Fig. 2, region B). It is interesting to note that no iron was detected in any of these prills. The cassiterite ore from Kestel is associated with hematite and the enriched cassiterite powder generally contains considerable amounts of iron. However, highly pure tin inclusions may indicate that it is possible to produce iron-free tin from cassiterite ore even though it contains hematite.

The remaining three crucibles in this group were rim fragments with evidence of scorified inner surfaces represented by 1-3 mm thick light grey bands. The reddish-orange color of the main bulk of the sherds indicates that they were not exposed to reducing conditions. The continuous thin band of tin oxide in these samples was restricted to the interface between the surface accretion and the main ceramic matrix. There was no evidence of diffusion into the clay matrix. Similarly, no residual tin was detected on the outer surface of the crucibles. The bright white coating of tin oxide layer varies only between 1-3 μm. All three must have been constructed for the specific metallurgical process.

A bright thin band of tin oxide can be seen in the back-scattered electron image of sample MRN 4937B (Entry 2) where it appears to be restricted only to the interface between the surface accretion and the clay matrix (Fig 3). The sample was probably not exposed to high temperatures to facilitate diffusion. A partially oxidized metallic tin prill, with a 5μm diameter, imbedded in the tin-rich accretion band is also observed (Fig. 4). Sample MRN 1416 (Entry 3) also displayed a tin oxide-rich band at the surface; however, the layer seems to have greater dispersion. On the surface, there are tin oxide patches which seem to have formed by the accumulation of small (1-2 μm) granules (Fig. 5). EDX analysis of this region yielded 81.3% SnO_2. On the opposite side of this agglomeration, there is a region composed of polyhedral aggregate of iron oxide grains. At higher magnification, the small iron oxide grains displayed a very fine network of tin oxide within the grain matrix (Fig. 6) which is part of the crystallization product of the smelting process. Sample MRN 1591 (Entry 4) in this group also displays a very thin and intense continuous layer of tin oxide at the interface (Fig. 7). Besides the surface coating, the tin oxide layer had also diffused into the cavities just below the surface and has coated the inner walls of the cavities. Some of the cavities were also actually filled with small spherical tin oxide prills (Fig. 8).

Yener and Vandiver (1993) suggest that such a band of tin accretion at the surface rather than within the clay matrix may be due to the precipitation of tin oxide from the vapor with very small amounts of slag during smelting. They also suggest that such a ceramic may have been used as a cover for a crucible. The group one crucibles in this study may also have been used as crucible covers.

GROUP 2 CRUCIBLES

Four fragments are assigned to the group 2 crucibles. This group shows even greater variation in structural features both in thickness and in matrix appearance (Table 1). They were all body fragments and it was not possible to estimate their original sizes and shapes. Samples MRN 1760 (Table 3, Entry 5) had a very similar appearance with the crucibles in group 1 displaying a reddish orange matrix having a scorified inner surface of few a millimeters. Sample MRN 4937C (Table 3, Entry 6) also had similar cross sectional characteristics with a light grey scorified surface; however, it was more than twice the thickness of the other members of the group 2 samples. Sample MRN 4937A (Table 3, Entry 7), on the other hand, was a black fragment with extensive pores and was tempered both with organic matter and quartz. There is a 5-6 mm reddish pale brown layer on the inner surface that does not show the scorification and the porosity of the main body. Sample MRN 4318 (Table 3, Entry 8) was composed of three small fragments. None of the fragments yielded the complete cross sectional profile of a crucible and only one fragment had a possible inner surface face. The cross section of this fragment has a brown-reddish porous matrix with a very thin dark encrustation layer.

The collection of different shaped and sized crucible fragments of group 2 all showed small clusters of tin oxide globules between the main clay body matrix and the surface accretion rather than a continuous thin band as observed in group 1 samples.

Sample MRN 1760 (Table 2, Entry 5) yield a very distinctive narrow interface band between the main ceramics matrix and a surface accretion layer that was composed of relatively fine crystalline material (Fig. 9). The tin globules as large as 50 μm are randomly distributed together with some iron oxides within this narrow accretion band (Fig. 10). Sample MRN 4937C (Table 3, Entry 6) also showed a similar accretion band at the interface with tin oxide globules (Fig. 11). The width of the band that contains the tin globules varies between 20 and 200 μm and is composed of mainly aluminum silicate together with smaller amounts of calcium, iron, and phosphorus oxides with about 5.2% tin oxide (Fig. 12 area B). The chemical composition of this layer resembles that of tin smelting slag (Yener and Vandiver 1993).

One unique feature of these tin globules, especially in these two crucible fragments is that they are fused together with calcite crystals (Fig. 10 and Fig. 12, area A). EDAX analysis of most of the tin oxide globules observed in this group of crucibles yielded high levels of calcium oxide (Table 3). Such accretion layers in crucible samples MRN 1760 and MRN 4937C cannot form if tin is melted in them or if they are used as crucible covers like those of group 1. These globules must have deposited or formed in the band during a high temperature tin processing activity. Sample MRN 4937A (Table 3, Entry 7) that had a completely scorified clay matrix also had globules of tin oxide in a not well-defined accretion band with much less associated calcium oxide (Fig. 13, area A) together with iron oxide crystals (Fig. 13, area B). This sample also contained a 40μm inclusion that was composed of 68.2% FeO and 22.1 and As_2O_3 (Fig. 14). Yener and Vandiver (1993) also report high levels of arsenic. The arsenic probably originates from the ore since some of the powdered ore samples from Göltepe contained about 5 % arsenic (Earl and Özbal 1996). The last sample of this group, MRN 4318, contained three small fragments. None of the fragments yielded a complete cross section profile. Only one fragment had a small area of inner surface that was coated with about 1.5 mm dark accretion layer. This sample also contained tin globules that also contained relatively high levels of CaO (Fig 15, Entry 8 in Table 3). The accretion layer also contained As_2O_3 inclusions.

GROUP 3 CRUCIBLES

The final three crucible fragments MRN 1006, MRN 4390 and MRN 4235 (Table 1), were grouped together since they did not yield any residual tin oxide. Sample MRN 1006 was a very small fragment without any original inner or outer surface. Since tin residues diffuse only about 500 μm into the clay matrix, it is possible that the accretion layer was lost. A loosely attached small residue was observed on the surface of one of the sides (Fig 16). The residue was composed of mainly lead and iron oxides together with minor amounts of antimony, copper and arsenic (Table 3, entry 9). Possible source of such residue needs further investigation. Sample MRN 4390 was also highly scorified, black, and porous, extensively tempered both with organic fibers and siliceous materials and was exposed to highly reducing conditions. The inner surface was coated with a very thin brown layer. EDX analysis of individual bright inclusions showed that they were iron oxide. The final sample of this group, MRN 4235, was a flat, very thin (8 mm) body fragment with a medium grey cross section. It is difficult to decide which side is the inner surface since there was no detectable curvature. One of the faces has a grey partly scarified thin layer. The other side was covered with a thin layer of calcite, probably formed after burial. The scarified face had many metallic oxide inclusions; however, no tin oxide could be detected. This fragment probably was not intended to be used in a metallurgical process.

CONCLUSION

The SEM images and the EDX data complement the results from previous studies and further confirm that these crucible fragments are remnants from processes involving tin metallurgy. It is also conclusively affirmed that these crucibles were not used to make bronze since there was no trace of copper which could be observed either by AA or by EDX analysis.

Kestel cassiterite ore is observed in quartz veins together with hydrothermal hematite and tourmaline (Çağatay and Pehlivan 1988, Willies 1995). In order to liberate the very fine crystalline cassiterite from the associated hematite ore, it had to be ground to a very fine powder ($<200\ \mu$). Cassiterite ore was enriched by washing with water on an inclined surface. It was easy to enrich cassiterite from the ground Kestel ore by a vanning shovel (Bryan and Özbal 1996). To avoid loss of fine powdered cassiterite from the crucible during smelting and also avoid loss of heat, it is very likely that the samples MRN 4937B, MRN 1416 and MRN 1591 among group 1 samples may have been used as crucible covers. Agricola (1556:411-414) describes tin smelting furnaces with a dust chamber to trap the small particles of tin oxide that may escape with the fumes if heating is fast.

The group 2 samples showed globules of tin oxide associated with calcite crystals in the accretion band that covers the inner surface of the crucibles. It is highly possible that these crucibles could have been used for smelting cassiterite where calcite may have been used as some sort of fluxing agent. Alternatively, the calcite may have from the Kestel cassiterite since most of the powdered ore samples contained both calcite and dolomite.

Sample MRN 1124 (Entry 1 in Table 2) was probably from a high temperature process where tin oxide has diffused almost 500μm into the highly glassy upper surface of the crucible which even had a metallic tin prill.

REFERENCES

Adriaens, A., K.A. Yener and F. Adams 1999
"An Analytical Study Using Electron and Ion Microscopy of Thin-walled Crucibles from Göltepe, Turkey", *Journal of Archaeological Science* 26: 1069-1073.

Adriaens, A. et al. 1999
"Analytical Investigation of Archaeological Powders from Göltepe (Turkey)", *Archaeometry* 41: 81-89.

Agricola, G. 1950
De Re Metallica. Translated by H.C. Hoover and L.H. Hoover, Dover Publications Inc., New York.

Çağatay, A. and N. Pehlivan 1988
"Celaller (Niğde-Çamardı) Kalay Cevherleşmesinin Mineralojisi", *Jeoloji Mühendisliği* 32-33: 31-27.

Earl, B. and H. Özbal 1996
"Early Bronze Age Tin Processing at Kestel/Göltepe, Anatolia", *Archaeometry* 38: 289-303.

Yener, K.A. and P. Vandiver 1993
"Tin Processing at Göltepe, an Early Bronze Age Site in Anatolia", *American Journal of Archaeology* 97: 207-237.

Yener, K.A. et al. 1989
"Kestel: An Early Bronze Age Source of Tin Ore in the Taurus Mountains, Turkey", *Science* 244: 200-203.

Willies, L. 1995
"Kestel tin mine, Turkey Interim Report 1995",
Bulletin of the Peak District Mines Historical Society 12/5: 1-11.

Sample	Group	Type	Thickness (mm)	Description	Site location
MRN 1124	1	Rim	14	Porous body with a black scorified inner surface. Tempered with quartz and organic fiber. (7.5YR 4/0-5/0, grey dark grey)	B01-0300-003
MRN 4937B	1	Rim	24,1	Red to orange bulk with a 2 mm light pale grey accretion on the inner surface (7.5YR 6/5-6/6 reddish yellow)	B09-0100-999
MRN 1416	1	Rim	13,3	2 mm light pale grey accretion on the inner surface (5YR 6/6 Reddish yellow)	A24-0100-003
MRN 1591	1	Rim	14,7	2 mm light pale grey accretion on the inner surface (7.5YR 6/6 Reddish yellow)	A24-0100-005
MRN 1760	2	Body	16	2 mm grey accretion on the inner surface (7.5YR 5/4 brown)	A23-0100-005
MRN 4937C	2	Body	38,5	6.5 mm grey accretion on the inner surface (5YR 5/2 Yellowish red)	B09-0100-999
MRN 4937A	2	Body	15,8	Highly charred body with a 6 mm reddish brown clay inner surface (7.5YR 3/0 dark grey)	B09-0100-999
MRN 4318	2	Body		Complete cross section not available. Highly tempered body with a 1.5 mm dark inner surface coating (5YR 5/4 reddish brown)	A22-0500-005
MRN 1006	3	Body		Complete cross section not available scorified body without outer surface. Tempered with quartz and organic fiber (7.5YR 3/0 very dark grey)	A03-0234-003
MRN 4390	3	Body	12,1	Highly scorified body without any distinctive inner accretion. 7.5YR 2.5/0 black)	A06-0400-003
MRN 4235	3	Body	8,3	One side is encrusted with partially scorified layer, other side coated with a thin calcite layer (YR 7.5 YR 4/0 dark grey)	A24-0700-000

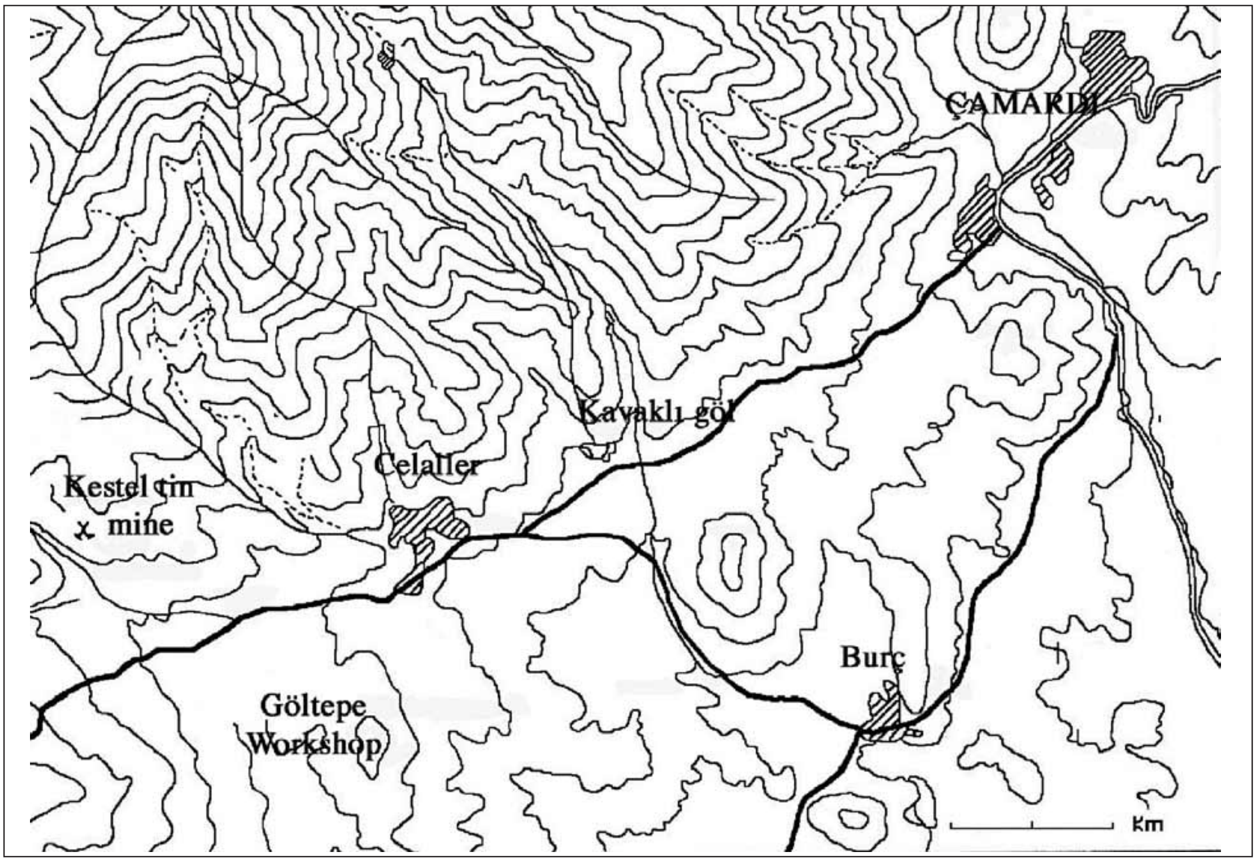
Table 1: Description of crucible fragments

Sample	SiO_2	Al_2O_3	CaO	MgO	Na_2O	K_2O	FeO	TiO_2
MRN 1124	58,6	25,8	1,29	4,13	4,04	2,25	3,92	
MRN 4937B	62,4	22,6	1,33	4,12	2,8	2,18	3,49	0,95
MRN 1416	64,4	18,2	1,81	3,72	2,24	2,23	6,68	0,71
MRN 1591	60,4	17,9	2,14	2,99	3,48	4,11	7,96	1,03
MRN1760	63,4	19,8	1,11	3,3	5,15	1,82	505	
MRN 4937A	60,4	21,1	2,42	3,27	1,95	2,81	7,35	0,73
MRN 4937C	63,8	18,2	2,72	3,11	2,36	3,12	6,14	0,51
MRN 4318	59,4	24,7	1,57	2,8	1,56	2,85	6,29	0,91
MRN 1006	63,9	19,4	1,22	2,75	3,44	3,55	5,34	
MRN 4390	65,3	17,5	3,37	2,51	1,33	3,16	6,05	0,71
MRN 4235	57,8	23,2	2,47	3,19	1,78	3,35	7,36	0,87

Table 2: Composition of the clay matrix of crucible fragments

Sample #	Ent.	Fig.	Region	% SiO_2	% SnO_2	% Al_2O_3	% CaO	% MgO	% MnO_2	% Na_2O	% FeO	% TiO_2	% As_2O_3	% P_2O_5	% CuO	% PbO_2	% SbO_2
MRN 1124	1	1	A	37,9	33	9,12	16,8	1,66		1,52							
		2	A	1,36	95,5	1,24		0,9									
MRN 4937B	2	3	A	22,6	48,3	18,3	2,25	3,34			5,27						
MRN 1416	3	5		6,01	81,3	2,12	5,02	0,9		0,61	4,03						
		6		4,92	22,3	3,12	2,53	2,11		0,49	64,5						
MRN 1591	4	7		34,2	35,9	17,2		3,42	3,7	1,55	4,03						
		8		27,2	49,4	14,9		4		1,37	3,18						
MRN 1760	5	9		18,4	75,4	2,78		2,91									
		10		7,8	27,4	2,29	62,5										
MRN 4937C	6	11		10,7	45,2	2,73	36,4	1,73			1,74			1,6			
		12	A	12,1	47,8	3,17	29,5	2,39			1,54			2,3			
		12	B	50,7	5,16	13,2	8,9	3,51			12,7	1,63		3,2			
MRN 4937A	7	13	A	7,72	88,7	1,87		1,75									
		13	B	8,18	2,71	4,18	1,07	1,72			73,2	7,9					
		14				1,01	8,76				68,2		22,1				
MRN 4318	8	15		31,3	16,6	6,13	14,5	3,69	1,1	0,93	25,7						
MRN 1006	9	16		0,71							37,7		7,54		4,1	47,7	2,3

Table 3: The composition of phases and inclusions in the crucibles



Map. 1: Kestel tin mine and Göltepe workshop.

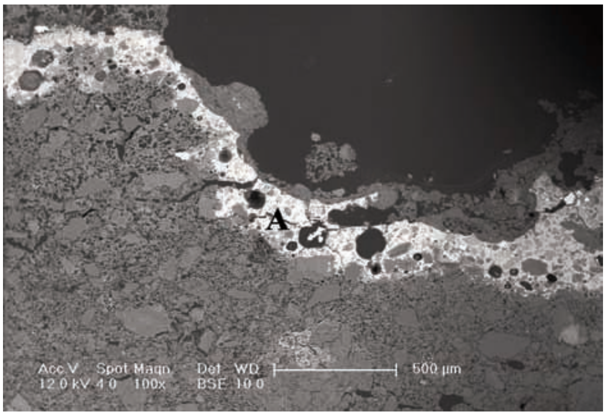


Fig. 1: Tin oxide band (A) on the crucibles inner surface (MRN 1124).

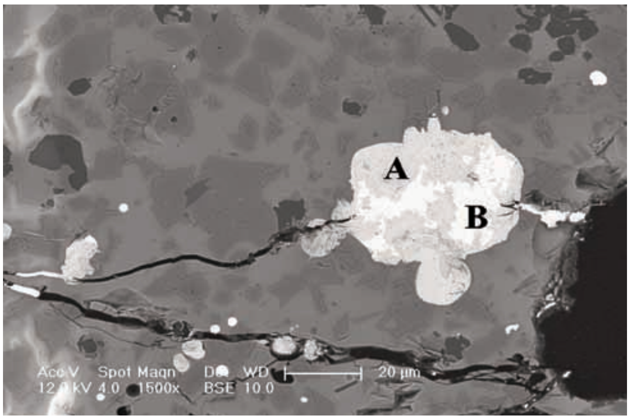


Fig 2: Inclusion composed of tin oxide (A) and metallic tin (B) (MRN 1124).

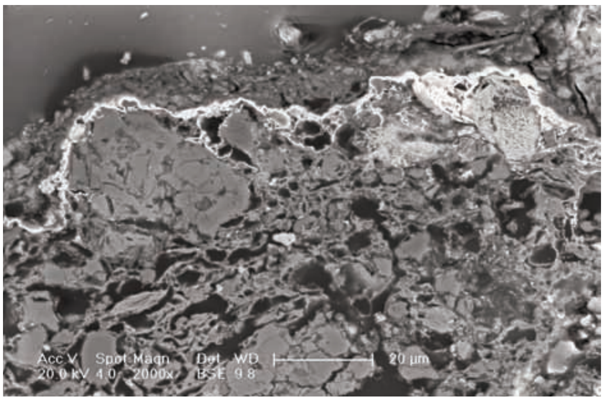


Fig. 3: Tin oxide band (white region) (MRN 4937B).

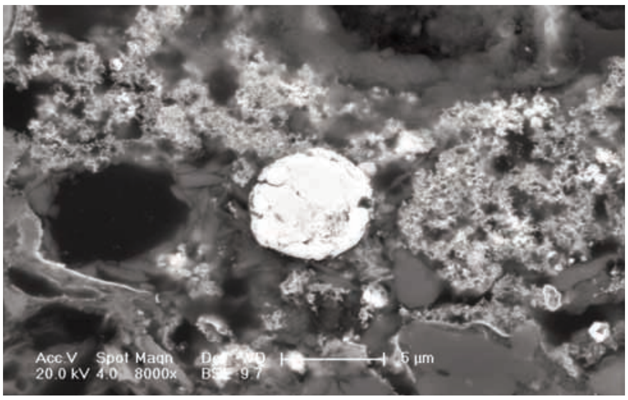


Fig 4: Metallic tin prill (MRN 4937B).

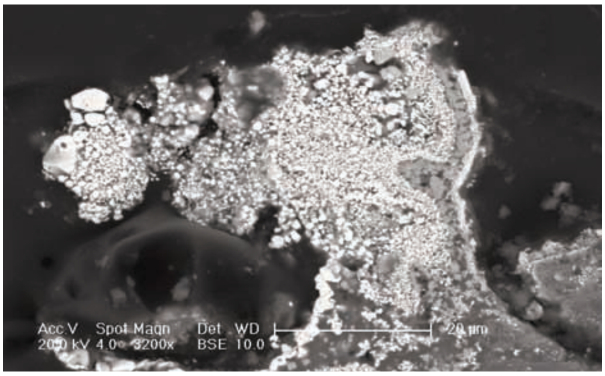


Fig.5: Tin oxide granules (MRN 1416).

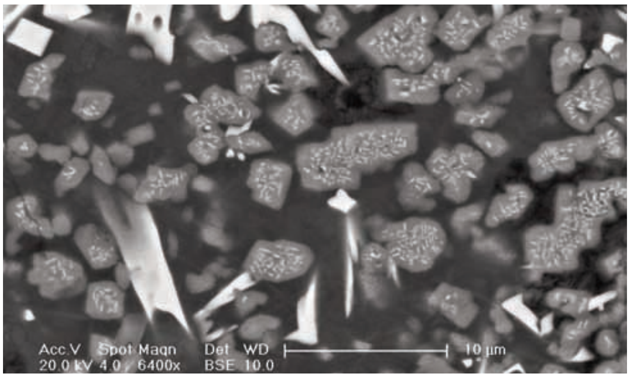


Fig. 6: Network of tin oxide (white specks) in grey polyhedral iron oxide grains (MRN 1416).

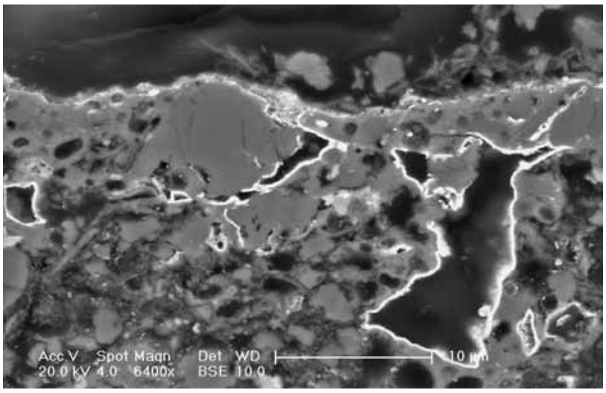


Fig. 7: Tin oxide layer coating cavities (MRN 1591).

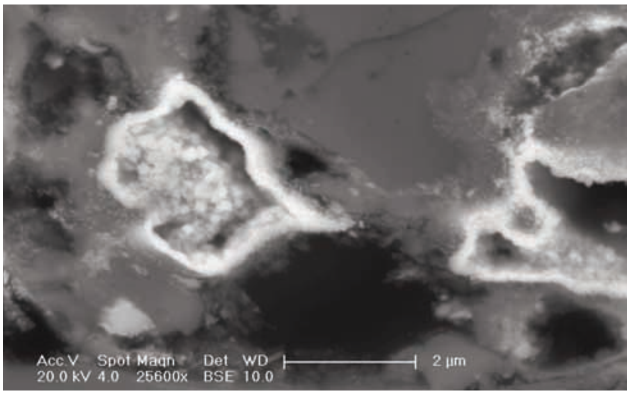


Fig 8: Tin oxide granules in cavities (MRN 1591).

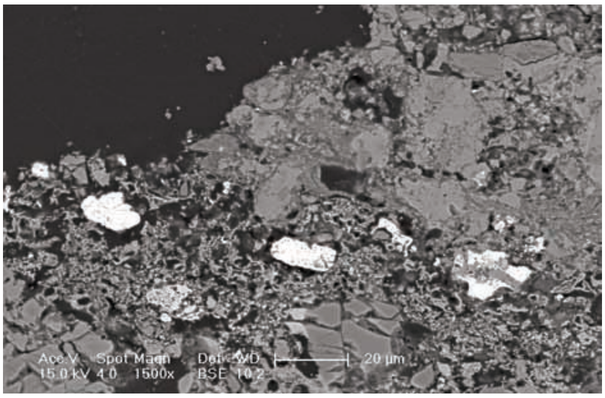


Fig. 9: Polyhedral tin oxide inclusions in the accretion band (MRN 1760).

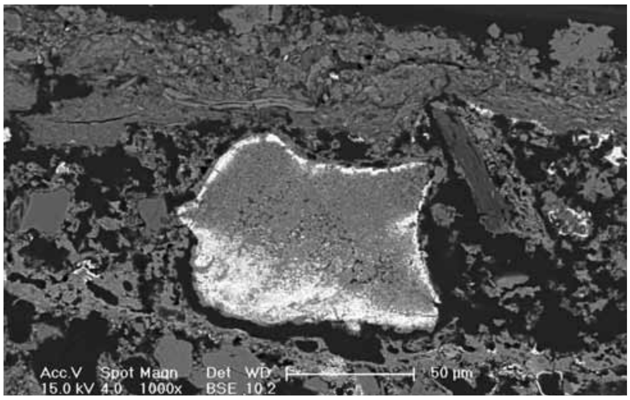


Fig. 10: Calcite crystal impregnated with tin oxide (MRN 1760).

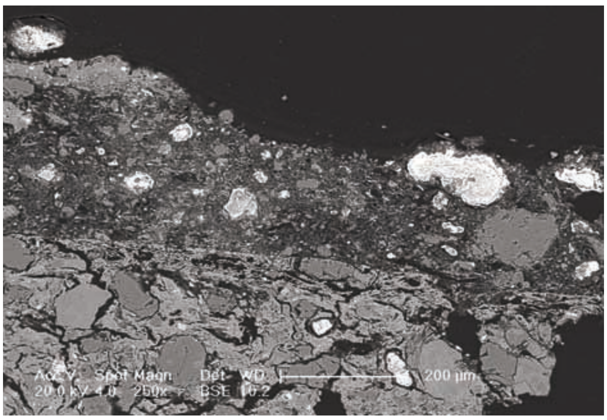


Fig 11: Tin oxide impregnated calcite crystal in the accretion band (MRN 4937C).

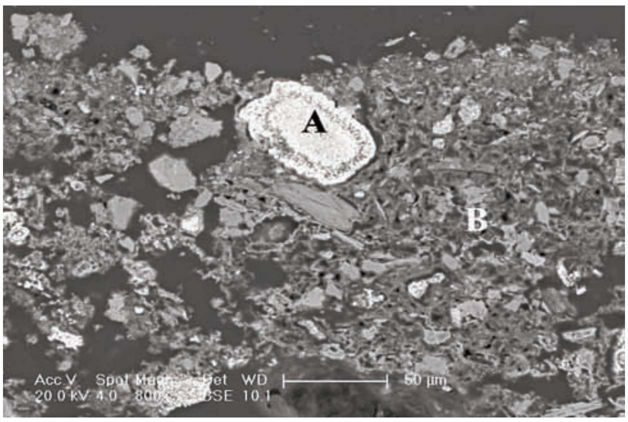


Fig. 12: Tin oxide impregnated calcite crystal (A) in the accretion band (B) (MRN 4937C).

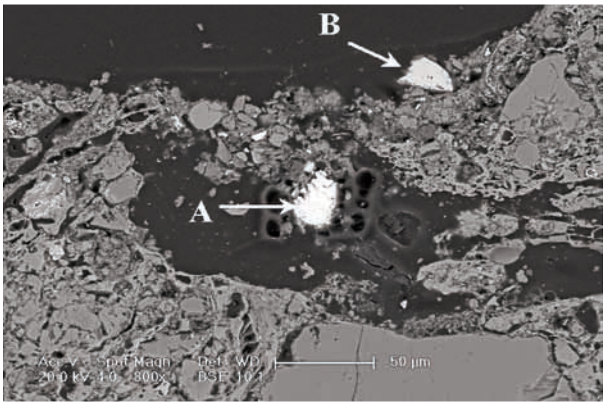


Fig. 13: Accretion layer containing tin oxide (A) and iron oxide inclusions (B) (MRN 4937A).

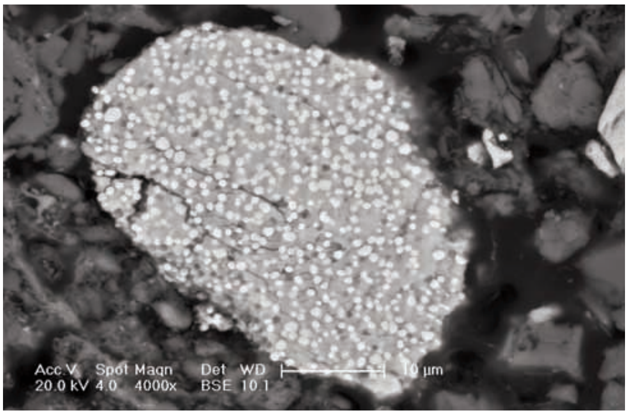


Fig. 14: Inclusion composed of arsenic oxide (white specks) in light grey iron oxide grain (MRN 4937A).

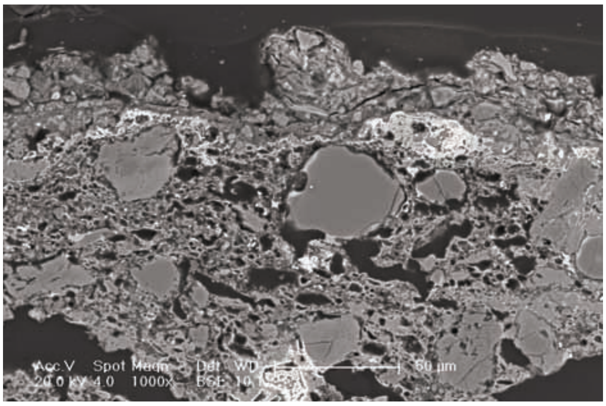


Fig. 15: Tin oxide globule inclusions in surface accretion band (MRN 4318).

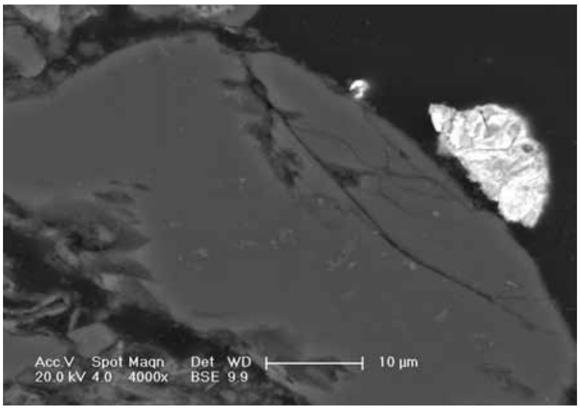


Fig 16: Surface grain composed of lead, iron, antimony, arsenic and copper oxides (MRN 1006).

LEAD ISOTOPE ANALYSIS AND CHEMICAL CHARACTERIZATION OF METALLIC RESIDUES OF AN EARLY BRONZE AGE CRUCIBLE FROM GÖLTEPE : USING ICP-MS

KURŞUN İZOTOP ANALİZLERİ VE GÖLTEPE İLK TUNÇ ÇAĞ'I POTASINDAKİ MADEN ARTIKLARININ KİMYASAL NİTELİĞİ: ICP- MS KULLANIMI

Joseph W. LEHNER, Aslıhan YENER, James BURTON

Key words: Lead isotope, crucible,provenance, Early Bronze Age, Göltepe, Anatolia
Anahtar Sözcükler: Kurşun izotopu, pota, kaynak araştırması, İlk Tunç Çağ, Göltepe, Anadolu

ÖZET

Bu çalışmanın öncelikli amacı, Göltepe'deki bir İlk Tunç Çağ pota parçasında bulunan metal kalıntılarının kurşun izotop oranlarını bilinen pek çok metal madeninden edinilmiş verilerle karşılaştırarak pota kalıntısındaki kurşunun hangi kaynaktan gelmiş olabileceğini saptamaktır. Pota parçası üzerinde yapılan kurşun izotop ölçümü, metal kalıntılarının uzak maden yataklarından mı, yoksa, varsayıldığı gibi, Toros Dağları'nda bulunan daha yakın kaynaklardan mı geldiğini belirleyebilmek için eşsiz bir imkan sunmaktadır. Elde edilen ölçümler, bilinen Toros madenleriyle kısıtlı bir ilişkinin varlığına işaret etmektedir. Buna ek olarak, metal kalıntıların ppb'sindeki elementleri incelemek amacıyla, element kompozisyon analizleri yapılmıştır. Araştırma sonuçları, Anadolu'nun bu yöresinde İlk Tunç Çağ boyunca görülen, madencilik ile ilgili iş bölümü ve organizasyonuyla uyumluluk göstermektedir.

INTRODUCTION

Changes in the organization of metallurgical technologies of the third millennium BC in Anatolia appear to coincide with overarching socioeconomic and political changes in urban regions that surround or are adjacent to highland resource areas (Yener 2000). Early local highland developments in metal technologies, however, likely include indigenous cascades of innovation and long-term practical familiarities with metal producing regions. Network-based relations among these areas, including lowland urban agglomerations, farming communities and highland mining regions, were likely structured in part on access to valuable metal resources. The structure of these relations seem to vary over time, where, by the third millennium BC, economically specialized communities lived within highland mining regions to participate in the extraction, preparation and smelting of locally available metal resources. The site of Göltepe, an Early Bronze

Age settlement situated in the Central Taurus region of southern Turkey ca. 2600 BC, represents the first tier of the multi-scale production of metal. A primary industrial activity at the site was the smelting of tin ore, which is evident from ore crushing tools, processed tin-rich powders, hundreds of excavated crucibles with tin accretions (Yener and Vandiver 1993; Earl and Özbal 1996; Yener *et al*. 2003). In addition, the presence of locally available tin from the Kestel mine, roughly two km northwest of Göltepe, suggests that inhabitants at the site must have been familiar and utilized these resources.

Chemical analyses of major and minor elements of the iron-rich powders and hematites with tin by Earl and Özbal (1996: 296) do suggest similar sources based on their similar weight percentages. However, lead isotope analysis provides an additional line of evidence for discerning this potential similarity. This paper focuses on the later assumption, testing it by use of lead isotope analysis of the tin-rich accretions of one crucible. Our goal is to compare the isotopic fingerprint provided by the analysis of the crucible residues to known signatures of previously analyzed ore bodies in Anatolia. We conclude that the isotopic signatures of the metalliferous residue are compatible with the Central Taurus ore bodies and thus provide evidence of local acquisition of materials.

CONTEXT: 'EARLY BRONZE AGE MINERS' VILLAGE GÖLTEPE

The third millennium BC miners' village, Göltepe, was excavated during 1990, 1991 and 1993 as part of a broader archaeometallurgical research project in the central Taurus Mountains (Yener 2008, in prep). In the immediate environs of the site, the Kuruçay stream emerges from the Niğde massif to the north, carrying with it cassiterite, pyrite, hematite, garnet, tourmaline, magnetite, sheelite, cinnabar, titanite, rutile, apatite, monozite and gold. The Niğde Massif, a volcanic dome within the Taurus Mountain chain, is to the SE of the vast Niğde plains (Fig. 1). The region is an area of intense plate tectonic activity with a succession of subduction zones and consequently mineralization is common in the area. The third millennium BC Kestel tin mine is located on a slope which is pervaded with granite, marble, gneiss and quartzite. The tin ore has been worked in marble which appears to have been originally part of a Triassic sequence of dolomitic limestone. Iron in the form of hematite, magnetite and limonite is visible in the mine and the cassiterite ores were derived from a granite intrusion process.

Göltepe hill is located at 1767 meters above sea level, measures ca. 60 hectares total and is fortified at the summit (Fig. 2a). This well protected miner's village is located two kilometers opposite Kestel tin mine and the size of the intramural settlement are estimated to be between 8-10 hectares. Occupied from Early Bronze I-III, the pit house complexes and rock cut terraced architecture typified a cottage industry processing tin ore from Kestel mine as well as other ores from the polymetallic sources of the region. This production was a labor intensive process of grinding the iron-rich cassiterite into powder consistency before smelting was achieved in crucibles or bowl furnaces with blow-pipes and tuyères. The product, a rough mix of tin metal prills and iron was then enriched by washing, repeated grinding and resmelting.

Crucible M325 (context number B01-0107-003), stems from slope wash abutting the base of a well-built N-S circuit wall (B01-0100-004), which was preserved in some places to ten courses and a height of over a meter (Fig. 2b and 2c). This context yielded hundreds of variously sized tin encrusted crucible fragments weighing over 300 kg.

LEAD ISOTOPE ANALYSIS

The sensitivity of lead isotope ratios coupled with the fact that measureable amounts of lead occur in many materials, including most if not all archaeological metals, allows for a robust method to study material alteration, production, transport and provenience if conducted carefully (Weeks 2004: 129-133; Aggarwal 2008: 2662; Villa 2009). The geological history of Anatolia (see Öztunalı 1989; Okay 2008) is punctuated by discrete events in which the conditions for ore formation processes were established. Particular mining regions (e.g., the Bolkardağ, see Yener *et al.* 1991) where metal bearing ores are most abundant and concentrated may then have specific isotopic fingerprints that relate to their geological histories. However, given that similar ore formation processes existed across many regions of Turkey, it is expected that these regions will also have similar lead isotope fingerprints.

The element lead (Pb) has four stable isotopes ^{208}Pb, ^{207}Pb, ^{206}Pb, and ^{204}Pb. Of these four isotopes, only ^{204}Pb is non-radiogenic where ^{208}Pb, ^{207}Pb and ^{206}Pb are formed by the regular decay of ^{232}Th, ^{235}U and ^{238}U respectively (Faure and Mensing 2005: 214-249; Allègre 2008: 294-312; Tolstikhin and Kramers 2008: 385-390). The relationship among these four isotopes of lead, which are often expressed in ratios, theoretically allow for the calculation of geological age (not archaeological age) based on principles of radiometric geochronology (e.g., U-Pb and Pb-Pb system dating techniques). There exist three important conditions concerning the study of lead isotopes to characterize sources and artifacts:

1.) The relative concentrations of these four isotopes are assumed to have been uniform throughout the earth at the time it was formed;
2.) Isotopes ^{208}Pb, ^{207}Pb, and ^{206}Pb have continued to be formed on earth from the radioactive decay of uranium and thorium. Therefore, naturally occurring lead is composed of a diagnostic mixture of radiogenic and original terrestrial lead
3.) Ratios of lead isotopes vary depending on the geological age of the ore body and the conditions under which it mineralizes, the proportions of which vary among geological formations (Guilbert and Park 2007: 286-290).

Additionally, because different ore sources often have unique lead isotope ratios according to a specific geological origin, *"variation among different sources can in some cases be greater than variation within sources"* (Weigand *et al*. 1977). Under these conditions, the isotopic analyses of archaeological metal and metal-rich residues, which often contain measurable amounts of lead, can be compared to lead isotopes from known ore sources (Brill and Wampler 1967; Gale and Stos-Gale 2000; Stos-Gale 2000). Strong similarities among artifacts and ore sources can be used as evidence for their provenience.

While much debate surrounds the nature of artifact-ore relationships and how one ascertains these relationships (e.g. Pernicka 1995; Budd *et al*. 1996; Knapp 2000; Gale 2001; Begemann and Schmitt-Strecker 2008; Baron *et al*. in press) for the purposes of this study, I will judge artifact-ore relationships in terms of source discrimination. Since geographically distinct ore sources can have very similar lead isotope ratios, similarity in isotope ratios does not necessarily equate to congruity in artifact-ore relationships. For this reason, this study aims to eliminate as many conceivably utilized sources as possible based on comparative isotopic signatures of artifacts and ore bodies.

METHODS

SAMPLE PREPARATION

The crucible was prepared for acid dissolution by taking separate drillings that were separately digested in nitric acid. Six drillings were taken from the Göltepe crucible fragment with an electric tungsten steel hand drill. The drillings consisted of about 1 cm long extractions taken from areas of the crucible that appeared to have visible metal-rich areas (see Fig. 3). The crucible was drilled twice on the exterior (#5.1-5.2) as control samples and four times on the interior (#5.3-5.6), so that comparable measurements may be taken. 1 to 3mg of crucible drillings from each area were then placed into 2 ml vials to which was then added .25 mL of high concentration nitric acid. All the samples were allowed to digest over a period of three days to ensure a more complete digestion of the crucible drillings. After this period of time, all of the samples were centrifuged, and the remaining liquid was carefully removed using a sterile pipette and put into a new sample vial to which was added 4.8 mL of distilled water and shaken. The result was 5 ml of diluted solution. Although nitric acid does not dissolve silicate minerals and this digestion leaves considerable residue, enough lead was solubilized to obtain precise isotope ratio measurements.

ICP-MS PROCEDURES

We analyzed lead isotopes of metalliferous residues using a Finnigan MAT Element I high-resolution magnetic sector ICP-MS at the Laboratory for Archaeological Chemistry, University of Wisconsin – Madison. Accuracy of the ICP-MS measurements is accomplished by comparison of known actual ratios to the average measured ratios of several assayed NIST standards (National Institute of Standards and Technology). A correction value, a value generally slightly above or below the nominal standard, was then computed by subtracting the NIST assays from the nominal standard. These correction values would then be added accordingly to the artifact sample ratio values. Additionally, because each sample's ratio values are based on repeated measurements (n=50), a relative standard deviation (% RSD) was computed. The % RSD is a measurement of precision; a higher value equates to a sporadic and generally dispersed nature of the isotope counts. Low values, where % RSD is generally less than 0.5 %, equates to a relatively non-sporadic spread of the isotope counts, and is a more *precise* measurement. Measured ratios of NIST 981 wire standard compared to the known nominal ratios produced relative standard deviations less than 0.2 % (see table 1), which is appropriate for lead isotope analysis.

The crucible samples are assayed after the level of precision was established and the ICP-MS capillary tubing was flushed. An exploratory assessment of several elements potentially contained within the sample solution was completed. This exploratory analysis measured selected elemental compositions of the residues extractions, namely arsenic (As), copper (Cu), nickel (Ni), lead (Pb), tin (Sn), silver (Ag), niobium (Nb), and tantalum (Ta). Each sample was assayed once and was separated by a period of 30 seconds of downtime in order to prevent contamination. A pitfall of this procedure was that the digestion was not a total digestion and, hence, the results are not quantitative, but merely reveal any anomalous excess or deficit of these elements. Actual concentrations of the elements of the sample could not be determined. This exploratory analysis nonetheless provides an insight into the elemental make-up of the sample solution and thus an insight into the chemical make-up of the artifact sample, which is ultimately a potential reflection of the physical character of the metallic residues. The results are presented below in Table 2.

The four lead isotopes were measured using the same sample solution as the exploratory analysis and the ratios are listed in Table 3. Based on expectations, an effort was made to assay each sample according to the expected level of lead concentration; that is, samples thought to have less lead were run first. The results of the lead isotope analyses were then presented in a standard format that allows for the comparison with the results of others. This format is in the form of isotope ratios. Because there are only four isotopes of lead, there can only be three distinct ratios among a dozen possibilities. While the specific isotope ratios chosen by individual authors may vary, the entirety of the ratios is easily extrapolated from presented forms by a means of common algebra. Those isotope ratios presented in this paper are as follows: $^{208}Pb/^{206}Pb$, $^{207}Pb/^{206}Pb$, and $^{204}Pb/^{206}Pb$. Additionally, only the ratios $^{208}Pb/^{206}Pb$ and $^{207}Pb/^{206}Pb$ will be considered in this paper because of the high % RSD associated with generally lower CPS values for the isotope ^{204}Pb. The higher % RSD value for ^{204}Pb means that any ratio extrapolated from this value would be considerably less accurate.

RESULTS AND DISCUSSION

The Göltepe samples had expectedly low counts of all metals given the diluted nature of the digestion (Table 2, Figure 4), however with generally higher amounts of nickel and tin for the interior drillings #5.3-5.6. It should also be noted that the exterior drillings #5.1-5.2 had up to three times as much lead as the interior, but only trace amounts of tin. The cause of this difference is probably a due to the sampling strategy employed and the heterogeneous character of the residues on the interior surface of the crucible. The Göltepe sample appears to correlate with the other crucible analyses (Yener 2000; Yener and Vandiver 1993; Yener *et al.* 2003), where significant amounts of tin and copper are present. The amounts of lead from the interior of the crucible provide ample quantities for accurate measurements of lead isotopes.

The results for the two ratios, $^{208}Pb/^{206}Pb$ and $^{207}Pb/^{206}Pb$, were plotted in a series of bivariate scatterplots in order to visually observe differences and possible correlations with previously published lead isotope data of known Anatolian ores (see Figs. 5 and 6). Ores are presented with 95% confidence ellipses drawn using the XLSTAT addin for Excel 2007. A multinational effort over the last two decades has accomplished many characterization studies that amounted in the present database of lead isotope ratios of known ore bodies in Turkey. Currently, over 300 ore samples have been published and have been used to characterize known bodies of metal ore (Brill and

Wampler 1967; Begemann *et al*. 2002; Stos-Gale and Gale 1981; Gale *et al*. 1985 Hirao *et al*. 1995; Kuovo 1976; Pernicka 1984; Sayre *et al*. 1992, 2001; Seeliger *et al*. 1985; Vavelidis 1985; Wagner *et al*. 1985, 1986, 1992, 2003; Yener *et al.* 1991). An expected degree of overlap in lead isotope ratio values certainly occurs among many of the sources, however there is a noticeable but not perfect separation of values between Central Anatolian, Pontide and Taurus based ore bodies.

Results indicate that that North Central Anatolian and Pontide ore sources are incompatible with the measured lead isotope ratios (see Fig. 5). Given the geographic location and nature of the social organization and technologically specialized settlement of Göltepe, Occam's Razor eliminates furthest sources when locally available sources are abundant. Much more likely would be the local exploitation of the rich metal resources in the surrounding Taurus Mountains. This is further suggestive with work of Yener and Vandiver (1993) and Earl and Özbal (1996) where similarities in major and minor elemental constituents between the Kestel mine and Göltepe production materials are compatible with similar sources. Similar elemental chemistry, proximity to nearby sources and the apparent specialization of ore processing and smelting at the site lead us to expect that the isotopic signatures should also be compatible with the Central Taurus ore bodies. The measurements are compatible with the Taurus groupings (see Fig. 6), specifically both Taurus 1A and 2B, however two measurements appear to be outliers. Compared to ore samples taken at Kestel (Yener *et al*. 1991: AON399, AON 419, AON463, and AON466), the crucible residue measurements overlap with AON 419 in the Taurus 2B ore group. The other three Kestel samples, however, are situated within the Taurus 1B grouping, which does not comprise a compatible group with the crucible residue measurements.

CONCLUSION

In this paper, we have demonstrated the possibility of extracting elemental data from metalliferous residues from a crucible using an ICP-MS. Two major analyses were completed in order to better understand the metal composition of the residues. The first analysis consisted of the measurement in ppb of several elements that would help characterize the chemical nature of the crucible residues. The most prominent metals included tin and nickel. Trace levels of lead were also measured, which allowed us to measure isotope ratios of lead for provenance analysis. Because lead isotope ratios are a known indicator of possible provenience, we compared our ratio data with published lead isotope ratios. Our data indicate with independent chemical perspective that individuals and communities who once lived at the site of Göltepe actively acquired nearby raw and/or processed ores for use in the first tier of complex metallurgy in the region. Further, these data help substantiate upon the notion that Early Bronze Age cultures in Anatolia were forming economically specialized communities in highland metal resource regions that linked lowland urban centers by trade and exchange.

REFERENCES

Aggarwal, J., J. Habicht-Mauche and C. Juarez 2008
"Application of Heavy Stable Isotopes in Forensic Geochemistry: A Review", *Applied Geochemistry* 23: 2658-2666.

Allègre, C.J. 2008
Isotope Geology. Translated by C. Sutcliffe. Cambridge University Press, Cambridge.

Baron, S., C. Le-Carlier, J. Carignan and A. Ploquin (in press)
"Archaeological Reconstruction of Medieval Lead Production: Implications for Ancient Metal Provenance Studies and Paleopollution Tracing by Pb Isotopes", *Applied Geochemistry*.

Begemann, F. and S. Schmitt-Strecker 2008
"Bleiisotopie und die Provenienz von Metallen", *Anatolian Metal* IV (Der Anschnitt, Beiheft 21): 125-134.

Begemann, F., S. Schmitt-Strecker and E. Pernicka 2002
"On the Composition and Provenance of Metal Finds from Beşiktepe (Troia)", G.A. Wagner, E. Pernicka and H.-P. Uerpmann (eds.) *Ancient Troia and the Troad: Scientific Approach*: 173-201. Springer Verlag, New York.

Brill, R.H. and J.M. Wampler 1967
"Isotope Ratios in Archaeological Objects of Lead", *Application of Science in Examination of Works of Art*: 155-166. Museum of Fine Arts, Boston.

Budd, P. et al. 1996
"Rethinking the Quest for Provenance", *Antiquity* 70: 168-174.

Earl, B. and H. Özbal 1996
"Early Bronze Age tin processing at Kestel/Göltepe, Anatolia", *Archaeometry* 38/2: 289-303.

Faure, G. and T.M. Mensing 2005
Isotopes: Principles and Applications. John Wiley and Sons Inc., Hoboken.

Gale, N. 2001
"Archaeology, science-based archaeology and the Mediterranean Bronze Age metals trade: a contribution to the debate", *European Journal of Archaeology* 4/1: 113-130.

Gale, N.H. and Z. Stos-Gale 2000
"Lead isotope analyses applied to provenance studies", E. Ciliberto and G. Spoto (eds.) *Modern Analytical Methods in Art and Archaeology*: 503-584. Wiley, New York.

Gale, N.H., Z.A. Stos-Gale and G.R. Gilmore 1985
"Alloy Types and Copper Sources of Anatolian Copper Alloy Artifacts", *Anatolian Studies* 35: 143-173.

Guilbert, J. and C.F. Park 2007
The Geology of Ore Deposits. Waveland Press, Long Grove.

Hirao, Y., J. Enomoto and H. Tachikawa 1995
"Lead Isotope Ratios of Copper, Zinc and Lead Minerals in Turkey – In Relation to the Provenance Study of Artefacts", H.I.H. Prince and T. Mikasa (eds.) *Essays on Ancient Anatolia and Its Surrounding Civilizations*: 89-114. Harrassowitz Verlag, Wiesbaden.

Knapp, A.B. 2000
"Archaeology, science-based archaeology and the Mediterranean Bronze Age metals trade", *European Journal of Archaeology* 3/1: 31-56.

Kouvo, O. 1976
"Data reported", *Lead Isotope Data Book, United States Geological Survey Open-File Report*: 77-78.

Okay, A.I. 2008
"Geology of Turkey: A Synopsis", *Anatolian Metal* IV (Der Anschnitt, Beiheft 21): 19-42.

Öztunalı, Ö. 1989
"Lägerstättenkunde und Probleme der Archäometallurgie", *Der Anschnitt* 7: 299-307.

Pernicka, E. 1995
"Crisis or Catharsis in Lead Isotope Analysis?", *Journal of Mediteranean Archaeology* 8: 59-64.

Pernicka, E. et al. 1984
"Archäometallurgische Unterschungen in Nordwestanatolien", *Jahrbuch des Römisch-Germanisches Zentralmuseum* 31: 533-599.

Sayre, E.V., K.A. Yener, E.C. Joel and I.L. Barnes 1992
"Statistical Evaluation of the Presently Accumulated Lead Isotope Data from Anatolia and Surrounding Regions", *Archaeometry* 34/1: 73-105.

Seeliger, T.C. et al. 1985
"Archaometallurgische Unterzuchen in Nord- und Ostanatolien", *Jahrbuch des Römische-Germanischen Zentralmuseums* 32: 597-659.

Stos-Gale, Z.A. 2000
"Trade in metals in the Bronze Age Mediterranean : an overview of lead isotope data for provenance studies", C.F. Pare (ed.) *Metals make the World go round*: 56-69. Oxbow Books, Oxford.

Stos-Gale, Z.A. and N.H. Gale 1981
"Sources of Galena, Lead and Silver in Predynastic Egypt", *Actes du XX Symposium d'Archeometrie* III: 285-295. Bulletin de Liaison du Groupe des Methodes Physiques et Chemiques de l'Archeologie Supplement.

Tolstokhin, I.N. and J.D. Kramers 2008
The Evolution of Matter: From the Big Bang to the Present Day. Cambridge University Press, Cambridge.

Vavelidis, M. et al. 1985
"Geologie und Erzvorkommen", G. Wagner and G. Weisgerber (eds.) *Silber, Blei und Gold auf Sifnos*: 59-80. Deutsches Bergbau Museum, Bochum.

Villa, I.M. 2009
"Lead Isotopic Measurements in Archaeological Objects", *Archaeological and Anthropological Sciences* 1/3: 149-153.

Wagner, G.A. et al. 1985
"Geologische Untersuchungen zur Frühen Metallurgie in NW-Anatolien", *Bulletin of the Mineral Research and Exploration Institute of Turkey* 101/102: 45-81.

Wagner, G.A. et al. 1986
"Geochemische und Isotopische Charakteristika Früher Rohstoffquellen für Kupfer, Blei, Silber und Gold in der Türkei", *Jahrbuch des Römisch-Germanisches Zentralmuseum Mainz* 33: 723-752.

Wagner, G.A. et al. 1992
"Archäometallurgishe Untersuchungen an Rohstoffquellen des Frühen Kupfers Ostanatoliens", *Jahrbuch des Römisch-Germanisches Zentralmuseum Mainz* 36: 637-686.

Wagner, G.A. et al. 2003
"Archäometallurgischer Bericht über Feldforschung in Anatolien und bleiisotopische Studien an Erzen und Schlacken", T. Stöllner (ed.) *Man and Mining - Mensch und Bergbau*: 475-494. Deutsches Bergbau Museum, Bochum.

Weeks, L. 2004
Early Metallurgy of the Persian Gulf. Brill, Leiden.

Weigand, P.C., G. Harbottle and E.V. Sayre 1977
"Turquoise Sources and Source Analysis: Mesoamerica and the Southwestern U.S.A", T.K. Earle and J.E. Ericson (eds.) *Exchange Systems in Prehistory*: 15-34. Academic Press, New York.

Yener, K.A. 2000
The Domestication of Metals: The Rise of Complex Metal Industries in Anatolia. Brill, Leiden.
Yener, K.A. 2008
"Revisiting Kestel Mine and the Dynamics of Local Provisioning of Tin during the Early Bronze Age", Ü. Yalçın, H. Özbal and A.G. Paşamehmetoğlu (eds.) *Ancient Mining in Turkey and the Eastern Mediterranean*: 57-64. Atılım Üniversitesi, Ankara.

Yener, K.A. (in press)
Göltepe Excavations. An Early Bronze Age Mining Town: The Production of Tin in the Central Taurus Mountains, Turkey. Vol. 1/1-2, Vol. 2. Institute for Aegean Archaeology Press, Philadelphia.

Yener, K.A., H. Özbal, B. Earl and A. Adriaens 2003
"The Analyses of Metalliferous Residues, Crucible Fragments, Experimental Smelts, and Ores from Kestel Tin Mine and the Tin Processing Site of Göltepe", P.T. Craddock and J. Lang (eds.) *Mining and Metal Production through the Ages*: 181-197. The British Museum Press, London.

Yener, K.A. and P.B. Vandiver 1993
"Tin Processing at Göltepe, an Early Bronze Age Site in Anatolia", *American Journal of Archaeology* 97: 207-238.

Yener, K.A. et al. 1991
"Stable Lead Isotope Studies of Central Taurus Ore Sources and Related Artifacts from Eastern Mediterranean Chalcolithic and Bronze Age Sites", *Journal of Archaeological Science* 18: 541-577.

Ratio	Nominal	Measured	±	%RSD
$^{208}Pb/^{206}Pb$	2.1681	2.1742	0.002	0.09
$^{207}Pb/^{206}Pb$	0.9146	0.9163	0.001	0.11

Table 1: NIST 981 Lead Wire Standard. Note that relative standard deviations are less than 0.2 %.

Sample #	Ni	Cu	As	Nb	Ag	Sn	Ta	Pb
#5.1	17225	708	83	-	-	64	3	19
#5.2	6508	350	119	-	-	226	5	27
#5.3	16312	228	11	-	-	420	2	4
#5.4	10290	196	3	-	-	546	2	10
#5.5	6835	233	-	-	2	3618	-	4
#5.6	6845	301	-	-	3	4485	-	3

Table 2: Traces of several elements (in ppb) measured from metalliferous residues from the Göltepe crucible. Sample #5.1-5.2 was taken from the exterior of the crucible, while samples #5.3-5.6 were taken from the interior

Sample #	Artifact ID	$^{208}Pb/^{206}Pb$	$^{207}Pb/^{206}Pb$
#5.1	MRN-325	2.0615	0.8281
#5.2	MRN-325	2.0520	0.8235
#5.3	MRN-325	2.0500	0.8241
#5.4	MRN-325	2.0425	0.8261
#5.5	MRN-325	2.0631	0.8370
#5.6	MRN-325	2.0630	0.8288

Table 3: Lead isotope ratios measured from the interior and exterior of the Göltepe crucible.

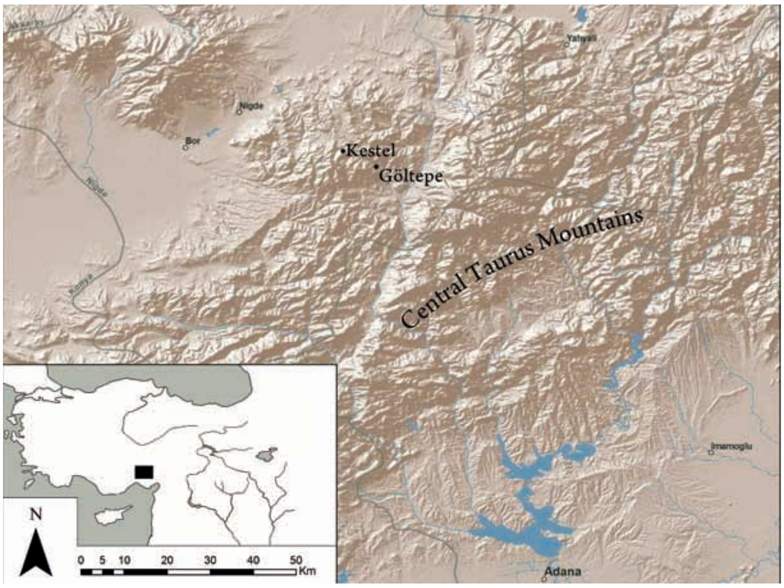


Fig. 1: Geological specimen location map of the Central Taurus (Adapted from Yener et al. 1991:

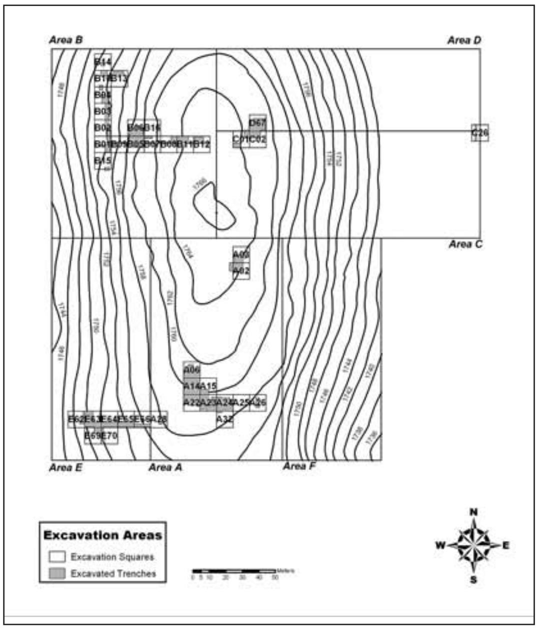


Fig. 2a: Excavation Areas Göltepe

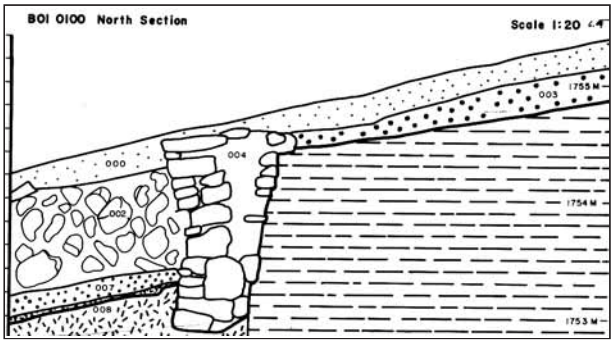


Fig. 2b: Cross section of circuit wall. Crucible MRN 325 in locus B01-0100-007.

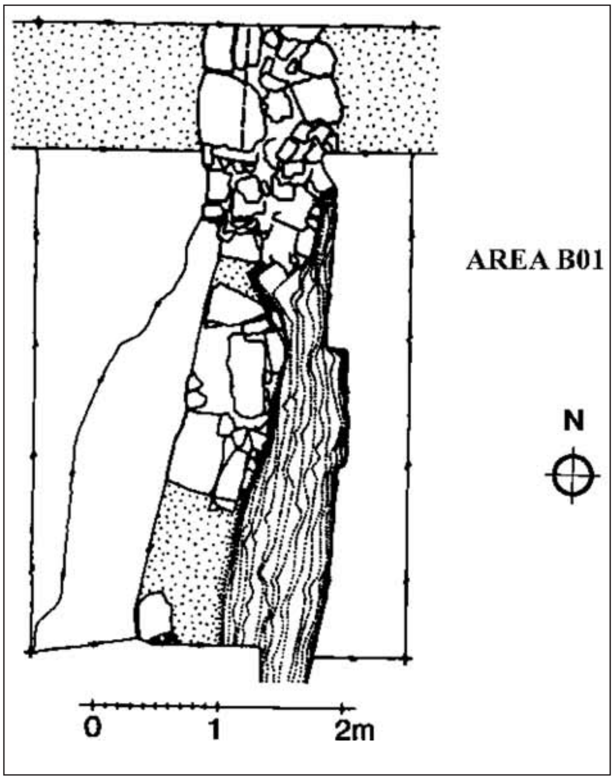


Fig. 2c: Circuit Wall Area B01

Fig. 3: Crucible MRN-325 with drilling areas indicated: (a) interior, (b) exterior.

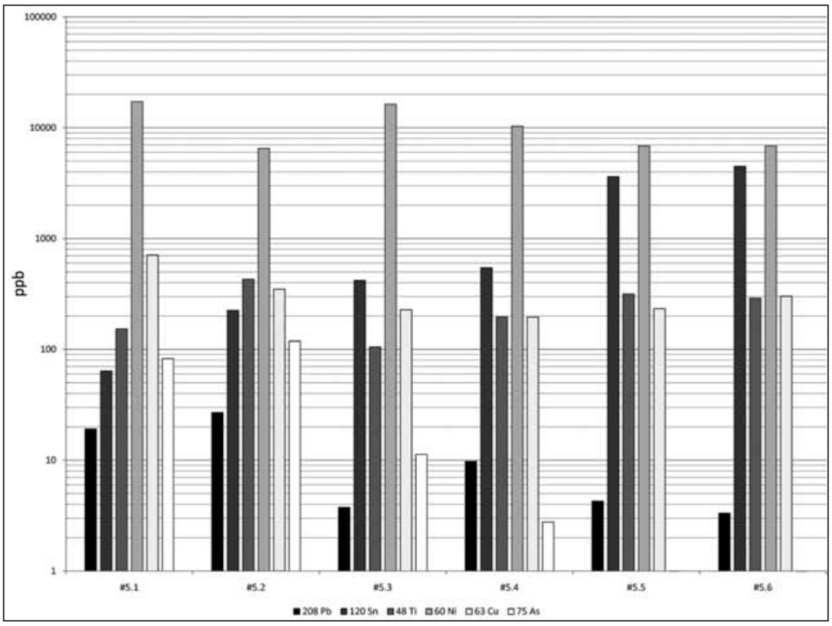


Fig. 4: Elements measured in ppb from Crucible MRN-325.

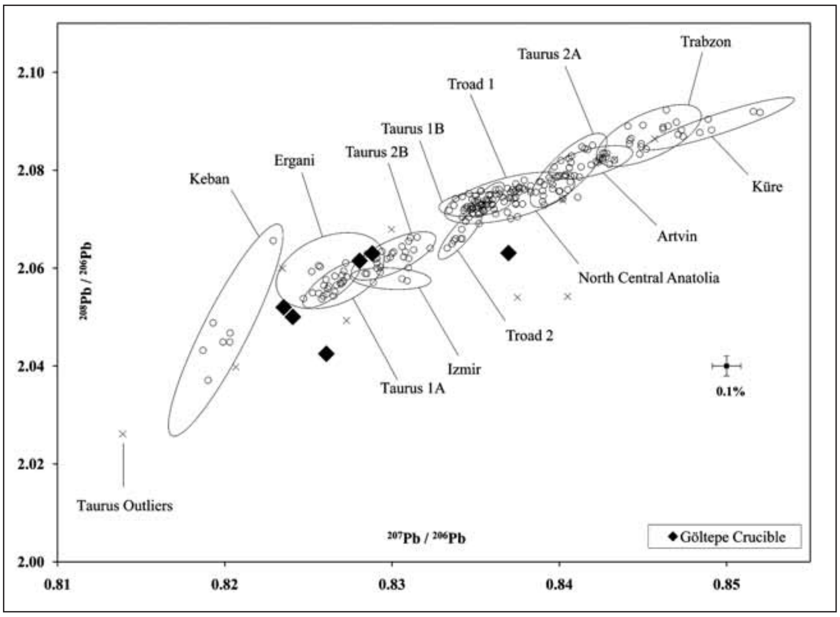


Fig. 5: Scatter plot of lead isotopes in a larger context overlaid by lead isotopes measured from crucible MRN-325.

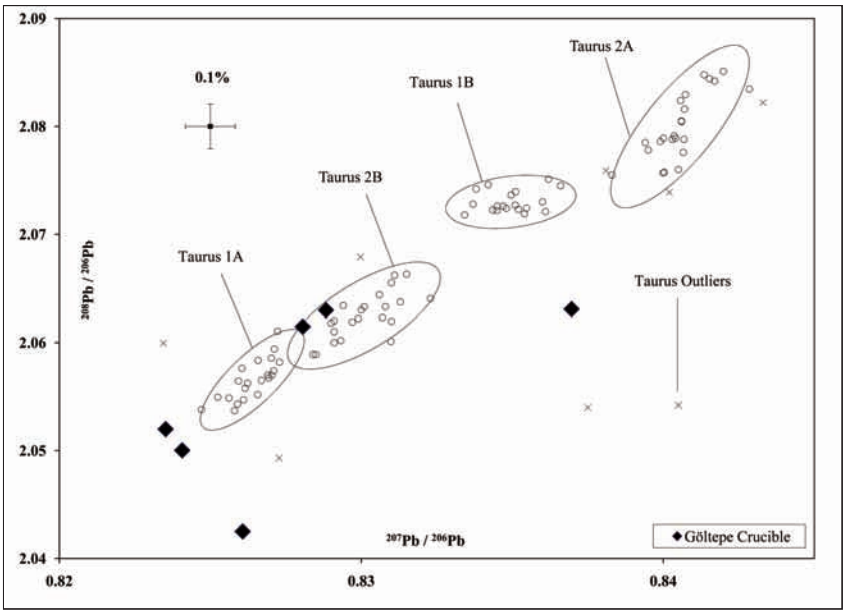


Fig. 6: Scatter plot of lead isotopes measured from Taurus ores overlaid by lead isotopes measured from crucible MRN-325.

ALTASSYRISCHER ZINNHANDEL MIT ANATOLIEN

ASUR'LULARIN ANADOLU İLE OLAN KALAY TİCARETİ

Horst KLENGEL

Schlüsselwörter: Zinnhandel, Assur, Kanesch, Karum-Zeit, Anatolien, Mesopotamien, Ostmittelmeerraum.
Anahtar Sözcükler: Kalay ticareti, Asur, Kaneş, Karum dönemi, Anadolu, Mezopotamya, Doğu Akdeniz Bölgesi.
Key Words: Tin trade, Assyria, Kanesh, Karum period, Anatolia, Mesopotamia, East Mediterranean region.

ÖZET

Doğudan (Orta Asya ve Indus Vadisi, İran) elde edilen kalayın, Doğu Akdeniz bölgesine (Levant) ulaştırıldığı Ön Asya'nın bölgelerarası ticareti, Tunç Çağı ile birlikte değişime uğramıştır. Ticaret, bölgedeki saraylar tarafından kontrol edilmekte ve Ugarit, Gubla\Byblos gibi limanlar üzerinden Mısır'a, ve batıda Ege bölgesine kadar ulaşılmaktaydı. İç kesimlerde ise Kuzey Suriye'deki Halep (Aleppo) ve diğer kavşak noktası olan Katna kentleri önemli rol oynamaktaydı. 2. binin başlarında Anadolu'da ise bu sistemin artık oldukça geliştiği, Kayseri'nin 20 km doğusunda yer alan Kültepe (Kaniş)'nin, sadece kalay ticaretinin değil, yünlü tekstil ticaretinin de yürütüldüğü bir merkez olduğu görülmektedir. B. Hrozny ve daha sonra özellikle T. Özgüç tarafından Kültepe'de yapılan kazı çalışmaları sonucunda ortaya çıkan binlerce tabletten dönemin ticareti ile ilgili bilgiler elde edilmiş ve Asur'dan kalay ile bazı özel kumaşların eşek sırtında Anadolu'ya taşındığı anlaşılmıştır. Eski Asur dilinde yazılmış 20000 den fazla tablet, borç senedi, taşıma sözleşmesi, kervan ortaklığı sözleşmesi gibi belgeleri ve yazışmaları -kimi zaman da adaletin sağlanması için cezai kuralları ve dava sonuçlarını- içermektedir. Diğer yerel saraylar ve kuzey-orta Suriye'li tüccarlarda bu sistemin içindeydiler. Yerel saraylar tüccarlardan vergi almaktaydı. Ayrıca dokumaları alırken öncelikli seçim hakkına sahiptiler. Metinlerden Asur'dan Orta Anadolu'ya ulaşan ticaret yolları hakkında bilgilere de ulaşabilmekteyiz. Toros dağları üzerinden geçen yollar ve aynı zamanda Anadolu'nun güney sahillerindeki deniz yolları kış mevsiminde sınırlı kullanılabilmekteydi. Asur'lu tüccarlar eşek kervanlarıyla Orta Anadolu'ya kalay ve yün ürünleri taşırlar, karşılığında altın veya gümüş alırlardı. Bu şekilde Karum döneminde (40-50 yıl) yaklaşık 10 ton gümüşün Orta Anadolu'dan Asur'a ulaştığını söyleyebiliriz.

Das Thema, mit dem einem Vorschlag von Ü. Yalçın gefolgt wird, ist bereits des öfteren Gegenstand einer allgemeineren Darstellung gewesen, die vor allem auf der keilschriftlichen Überlieferung aus dem frühen 2. Jahrtausend beruht und Zinn als das wesentliche Handelsgut benennt (vgl. bereits Maddin *et al.* 1978: 35 ff., zusammenfassend etwa Klengel 1979: 103 ff. sowie jetzt Veenhof 2003: 69 ff. und Giumlia-Mair and Lo Schiavo 2003). Hatte die vorrangige Richtung des vorderasiatischen Fernhandels im 3. Jahrtausend nach Osten gewiesen und über den Persischen Golf hinaus Iran und das Industal einbezogen sowie auch Teile Mittelasiens, so kam es zu Beginn des 2. Jahrtausends zu einer allmählichen Umorientierung (Klengel 2001: 349 ff.). Diese rückte das östliche Mittelmeergebiet, vor allem seine Anrainerländer Syrien und Anatolien sowie Ägypten, nunmehr stärker in den Vordergrund und fand dabei seine ökonomische Basis in den großen Palastwirtschaften (Astour 1995). Diese betrieben Handel unter dem Schutz von Fürsten, die zugleich von der Präsenz von Kaufleuten und deren Kapital profitierten. Hinzu kam, dass die einstigen Produktions- und Handelszentren im Bereich des östlichen Iran, im afghanischen Badachschan, im Raum des Persischen Golfes sowie in einigen Gebieten weiter östlich davon bis zum Industal an Bedeutung verloren hatten. In Shar-i-Sokhta/Shar-i-Suhte (Vidale 2008: 537 ff.), gelegen im Hochland des Iran, das vor allem vom Schmucksteinhandel mit Karneol und Lapislazuli profitiert hatte, kam es zu einem Niedergang wohl in Verbindung mit dem Austrocknen des Helmand-Deltas. Auch die Siedlung an der Stelle des Tepe Hissar, einst Station am nördlichen Handelsweg des Lapislazuli durch Iran, wurde im 18. Jahrhundert v.Chr. aufgegeben (Deshayes 1975: 428).

Der ostmediterrane Raum, d.h. vor allem die syrische Küste mit Häfen wie Ugarit und Gubla/Byblos, rückte nun stärker in den Vordergrund des überregionalen Handelsverkehrs, von dem vor allem die Zentren im Kreuzungsbereich wichtiger Handelswege - wie etwa Halab und Qatna im syrischen Binnenland - profitieren konnten (vgl. bereits Klengel 1979:100 ff.; 1989: 39 ff.; 1998: 21 ff.). Handelsrouten führten im frühen 2. Jahrtausend jedoch auch vom nördlichen Syrien bis in das zentrale Anatolien, wo sich Händler aus Assur in eigenen Ansiedlungen neben den anatolischen Zentren niedergelassen hatten (Özgüç 2003; Veenhof 2003; vgl. bereits Garelli 1963). Schriftzeugnisse dieser Händler tauchten seit 1880 zunächst auf dem Markt der Stadt Kayseri auf, wobei als deren Herkunftsgebiet „Kappadokien“, angegeben wurde, die antike Bezeichnung für eine Landschaft in der südöstlichen Türkei. Systematische Forschungen sind dann - nach Genehmigung seitens der türkischen Behörden - am 20. September 1925 - in Kültepe (türk. „Aschenhügel“), gelegen 21 km nordöstlich von Kayseri, durch den tschechischen Gelehrten Bedrich/Friedrich Hrozny aufgenommen worden. Schon während der ersten Tage wurden hierbei in den Privathäusern Tontafeln mit Keilschrifttexten gefunden, verfasst in einer älteren Form der assyrischer Sprache, dem Altassyrischen. Erst 1948 konnten die Ausgrabungen dann weitergeführt werden, diesmal von türkischer Seite unter der Leitung von Tahsin Özgüç. Es kamen dabei noch mindestens 10000 weitere Tontafeln zutage, verteilt auf vier Siedlungshorizonte. Schicht II lieferte dabei die Hauptmasse der inzwischen gefundenen Tontafeln, in denen die Ansiedlung assyrisch als ein ‚karum’, etwa „Kai“ bzw. Handelsniederlassung, bezeichnet wird; eine kleinere Handelsstation wurde als ein ‚wabartum’ notiert. Es waren, dem Textzeugnis zufolge, mindestens drei Generationen von Kaufleuten, die hier unter dem Schutz altassyrischer Herrscher etwa in dem Zeitraum zwischen 1920 und 1840 v.Chr. tätig waren. Diese Kaufmannssiedlung ist dann durch einen Brand zerstört worden. Später erbauten die Bewohner auf den eingeebneten Flächen ihre Wohnstätten nach relativ kurzem zeitlichem Abstand (Hecker 1998: 297 ff.) wieder auf (Schicht I b, etwa 1840-1740), jedoch in einer etwas veränderten Bauweise und gekennzeichnet durch eine andersartige Keramik; auch in dieser Schicht wurden – wenngleich nicht mehr so zahlreiche - Tontafeln gefunden.

Die Keilschrifttexte aus Kültepe/Kanisch, das in hethitischen Quellen Nescha genannt wurde (dazu Wilhelm 1999: 232 ff.), belaufen sich insgesamt auf mehr als 21000 Tontafeln. Sie sind in einer älteren Form des Assyrischen verfasst worden, wie es zu dieser Zeit auch in der „Mutterstadt“ Assur gesprochen wurde. Bei den Schriftzeugnissen, die bei den Ausgrabungen im Geschäftsviertel/Karum dieser Stadt gefunden wurden, handelt es sich vor allem um Urkunden und Briefe betreffend wirtschaftliche Angelegenheiten sowie damit verbundene rechtliche Fragen, ferner auch um familiäre Ereignisse. Die keilschriftliche Überlieferung behandelt Schulden, Zinsen, Darlehen, Transportverträge, Partnerschaften im Karawanenverkehr und Gerichtsprozesse, enthält aber auch Beschwörungstexte. Gefunden wurden diese Tontafeln nicht in staatlichen, sondern in privaten Familienarchiven; die Chefs der Firmen waren jedoch meistens in Assur wohnhaft. Im Handelsviertel von Kanisch waren zudem auch Geschäftsleute aus syrischen Zentren tätig, so etwa aus dem nordsyrischen Urschu, das einen eignen Karum mit einem heiligen Symbol des Gottes Assur besaß, bei dem Eide geleistet werden konnten (Klengel 1989: 263 ff.), ferner aus der nordsyrischen Stadt

Ebla sowie aus der Oase Tadmur/Palmyra. Die Kaufleute schlossen sich aus praktischen Gründen auch zu Gesellschaften zusammen, wobei der entsprechende Begriff ‚naruqqum' eigentlich den (ledernen) Geldbeutel bezeichnete. Der ‚Palast' (ekallum, ‚großes Haus'), zog bei den Fernkaufleuten in den Niederlassungen Steuern bzw. eine Exportgebühr (nish atum) ein – so etwa 5 Prozent auf Textilien und 3 Prozent auf Zinn – d.h. auf die beiden wichtigsten Handelsgüter. Die lokalen Paläste besaßen dabei ein Vorkaufsrecht auf 10 Prozent der Textilien.

Die Ausgrabungen von T. Özgüç in Kanisch haben gezeigt, dass die Kaufmannshäuser zwei Stockwerke besitzen konnten, wobei sich im Erdgeschoss auch die Magazine für das Handelsgut befanden (Özgüç 2003: 77 ff.). Auch im Inventar haben sich die Häuser der fremden Kaufleute, nach dem Grabungsbefund zu urteilen, nicht wesentlich von denen der einheimischen Bewohner des Karums von Kanisch unterschieden; auffällig sind im häuslichen Bereich jedoch Keramiken in Form von Schuhen mit hochgebogener Spitze, wie sie oft auch auf hethitischen Reliefs abgebildet sind, oder Tierfiguren mit geometrischen Mustern. Die Keilschrifttexte aus Kültepe nennen zudem noch eine ganze Reihe weiterer Orte, die solche Handelsniederlassungen besaßen – ausgestattet mit einer eignen Verwaltungsbehörde und einer Gerichtsbarkeit, die in der Karum-Behörde (bit karim) nach dem Vorbild Assurs praktiziert wurde (Veenhof et al. 1980: 369 ff.). Vom Karum in Kanisch aus wurden auch die geschäftlichen Unternehmungen der anderen assyrischen Faktoreien koordiniert; auch kreuzten sich in Kanisch mehrere Handelswege, und die Übergänge über die Tausrusketten in den syrisch-obermesopotamischen Raum hinein waren zudem nicht allzu fern.

Die, Mutterstadt' Assur am Tigris war – in der Luftlinie gerechnet – etwa eintausend Kilometer von Kanisch entfernt. Die Wege führten über Gebirge und durch Steppenzonen und waren im Winter zeitweilig verschneit; in einem der altassyrischen Briefe wird darüber geklagt, dass Kälte und Hunger der Karawane stark zugesetzt hätten (Kienast 1975: 498). Hinzu kamen zuweilen Raubüberfälle auf den zudem oft durch schwieriges Gelände führenden Wegen, auf denen die Eselkarawanen der Händler zwischen Assur und Kanisch unterwegs waren. Es lassen sich einige Routen rekonstruieren, die von Assur am Tigris bis in das anatolische Kanisch verliefen (Nashef 1987: 61 ff.). Sie führten durch die nordmesopotamischen Ebenen zunächst von Assur nach Karkemisch am Euphrat und weiter über die Tauruspässe (vgl. die Routenkarte bei Veenhof 1995: 863) nach Anatolien. Da das ausdauernde und hinsichtlich seiner Tränke genügsame Kamel zur Zeit der altassyrischen Handelsniederlassungen im frühen 2. Jahrtausend v. Chr. noch keine Rolle als Lasttier spielte, waren Esel die wichtigsten Transporttiere.

Auf diesen Wegen wurden vor allem zwei Handelsgüter von Assur nach Anatolien gebracht: Zinn sowie wollene Textilien. Zinn, das wichtiges Legierungsmetall und als Erzminerale Kassiterit und Stannin bezeugt ist, wurde mit Kupfer zu Bronze legiert und dann über Assur nach Anatolien verhandelt; es hatte offenbar bereits einen weiten Weg von Mittelasien (Usbekistan, Tadschikistan, Ostkasachstan, vgl. Cierny *et al.* 2005: 431 ff.; sowie in Parzinger 2002; Weisgerber-Cierny 2002) sowie aus Afghanistan zurückgelegt, bevor es durch den Iran aus verschiedenen Routen nach Nordmesopotamien (d.h. Assur) und weiter bis in das zentrale Anatolien transportiert wurde (Muhly 1985: 275 ff.; 1995: 1506 ff., vgl. auch Giumlia-Mair and Lo Schiavo 2003). Die jeweiligen Lagerstätten müssen für eine lohnende Ausbeutung des Minerals mehr als 1,5 % Zinn enthalten; solche Vorkommen befanden sich jedoch außerhalb Anatoliens, ein Umstand, der den Endpreis des Zinns zweifellos beträchtlich erhöhte. In Assur selbst wurde eine Eselslast Zinn - als Standard jeweils etwa 130 Pfund - für etwa 9-12 Pfund Silber gehandelt (vgl. dazu Muhly 1973: 248 ff.; Muhly and Metalle 1997: 131 f.; ferner Veenhof 2003: 69 ff.; und bereits ders. 1995: 862 ff.).

Für den Weitertransport des Zinns nach Anatolien wurden die Eselkarawanen gewöhnlich in Assur neu zusammengestellt und mit dem Handelsgut – vor allem beträchtlichen Mengen von Zinn sowie zahlreichen Wolltextilien – ausgestattet (Özgüç 2003: 50). Am Bestimmungsort wurde das Handelsgut dann für Silber und Gold verkauft (vgl. das Diagramm bei Veenhof 1995: 864). Ein in Kanisch ansässiger assyrischer Kaufmann – so etwa der in den einschlägigen Texten öfter genannte Enlil-bani - schrieb dafür zunächst einen Transportauftrag aus, durch den einem bestimmten Agenten Mittel anvertraut wurden, für die in Assur Handelsgut erworben werden sollte (Larsen 1967: 8 ff.): „Die 30 Minen Silber – die Abgabe ist beigefügt, die Gebühr ist bezahlt – die Dadaja dem Kukkulanum, dem Sohn des Kutaja, anvertraute und die er nach ‚der Stadt' (d.h. Assur) zu bringen begann, um Einkäufe zu machen: Dieses Silber gehört Enlil-bani. Er wird von hier (d.h. Kanisch) im Namen des Enlil-bani das Land durchqueren, und Waren werden ‚die Stadt' verlassen und das Land wiederum im Namen des Enlil-bani durchqueren. Die Waren werden in Kanisch ankommen und Enlil-bani wird sie in Empfang nehmen" (es folgen die Namen von drei Zeugen; ein Datum wird nicht angegeben). Nachdem somit ein Mitarbeiter des Enlil-bani diesen Transportauftrag über 30 Minen Silber gegeben hatte, wurde ein Schreiben an die Vertreter des ‚Hauses' in Assur ausgefertigt, das genauere Angaben darüber machte, was für das Silber eingekauft werden sollte. Dabei werden eingangs die Namen von fünf Agenten (eingerechnet den des Kukkulanum) genannt; es folgt dann der Wortlaut des Enlil-bani-Auftrags, demzufolge in Assur gemeinsam mit Kukkulanum für die eine Hälfte der Summe Textilien, für die andere Hälfte Zinn gekauft werden sollten. Eine notarielle Beglaubigung des Geschäftes wurde schließlich am Stadttor von Assur vorgenommen, wobei auch die Siegel an die Verpackung des Handelsgutes angelegt worden sind, womit dafür gebürgt wurde, dass der Inhalt dem Auftrag entsprach und nunmehr bereit war für den Transport.

Es wurden also in Assur wollene Textilien sowie verschiedene Qualitäten Zinn erworben, ferner einige – bezeugt werden sogar bis zu 14 Tiere - Esel gekauft; schließlich war ja der Transport des Handelsgutes nach Kanisch erheblich aufwändiger als später der des Erlöses von 30 Minen, etwa 15 Kilogramm, Silber auf dem Rückweg. Es mussten daher zusätzliche Treiber angeworben werden, die zudem auch Silber für den Erwerb wärmerer Kleidung - im Hinblick auf das kühlere Klima Zentralanatoliens - erhielten. Lohn und Verpflegungsgeld waren im „Arbeitskapital" einbegriffen; Futter und Anschirrung für die Tragtiere mussten erworben werden, und zu den „Extras" gehörte auch jene Abgabe, die dann in Assur selbst noch zu entrichten war. Das Transportgut für Anatolien bestand normalerweise aus Stoffen und Gewändern sowie aus 3 Talenten und 3 Minen Zinn. Die für die Reise notwendigen Esel konnten in Kanisch dann zum Teil verkauft werden, da man für die Rückreise mit dem erworbenen Silber nicht mehr Lasttiere in gleicher Zahl wie auf dem Hinweg nach Kappadokien benötigte. Eine in Stoffe gehüllte und versiegelte Eselsladung Zinn wog etwa 130 Minen, d.h. um 65 Kilogramm. Hinzu kamen 10 Minen (etwa 5 Kilogramm) loses Zinn für die Ausgaben unterwegs sowie 10 Stücke Wolltextilien in der Standard-Abmessung von 4,5 Quadratmetern (etwa jeweils 2,25 kg). Es ergab sich daraus eine durchschnittliche Gesamtlast pro Esel von etwa 90 Kilogramm (Larsen 1976: 102). Loses Zinn wurde auf die beiden Satteltaschen der Tragtiere sowie auf eine Packung in der Mitte verteilt. An beiden Endpunkten der Reise wurden die Ladungen schließlich vor Zeugen nachgewogen.

Die bereits erwähnten Urkunden aus dem Archiv des Kaufmanns Enlil-bani in Kanisch zeigen drei verschiedene Typen von Texten des Assur-Kanisch-Handels: Den Kontrakt mit demjenigen, dem das Silber – d.h. Bargeld – für die Reise nach Assur anvertraut wurde, die Anweisung für die Vertreter des Geschäftshauses am Bestimmungsort sowie die Abrechnung nach der Erledigung des Geschäfts; zudem konnten andere Händler dann in Anatolien den weiteren "Vertrieb" übernehmen. Um das notwendige Reisekapital aufzubringen, mussten sich die Kaufleute meist zusammentun und ihre Mittel dann einem Agenten übergeben. (Larsen 1967: 8 ff.). Auch wenn manche Details dieser Geschäfte zwischen Assur und Kanisch noch unklar sind und dem Händler wohl auch ein gewisser Ermessensspielraum gegeben war, lässt sich für den Handel mit Zinn nach Kanisch jedoch ein durch die altassyrischen Texte weithin abgesichertes Bild zeichnen. Darüber hinaus finden sich unter den Kanisch-Texten auch sogenannte Verpflichtungsscheine mit Nennung von Guthaben und Rückzahlungstermin – entweder versehen mit einem bestimmten Datum oder aber einfach „nach der Rückkehr von der Geschäftsreise". Bei Nichtzahlung konnte ein Zinsaufschlag erhoben werden, wie er bereits vorgesehen oder im Karum festgelegt worden war. Zinsschulden konnten auch durch Dritte beglichen werden, die dann als neue Gläubiger in das Schuldverhältnis eintraten. Eine Haft wegen Schulden ist jedoch ebenfalls bezeugt, und Gerichtsprotokolle lassen erkennen, dass wegen nicht eingelöster Zahlungsverbindlichkeiten auch Prozesse geführt wurden. Ferner wurden auch lokale Wolltextilien in den Handel einbezogen, in die auch das Zinn für den Transport eingeschlagen werden konnte. Auch das Eselsgeschirr aus der Gegend von Assur wurde in Anatolien mit verhandelt, ebenso wie die Lastesel selbst (Veenhof 2003: 72). Das mitgeführte Zinn konnte in Anatolien jedenfalls für einen Preis verkauft werden, der etwa doppelt so hoch war wie in Assur. Die Lasten, die von den Eseln zu tragen waren, hatten oft ein recht erhebliches Gewicht. Außer ihrem Geschirr, dem privaten Besitz und der mitgeführten Nahrung bestand die Ladung aus etwa 10 bis 12 Minen losem Zinn, dazu vier bis sechs Textilien zu jeweils etwa 5 Minen sowie dem in Tüchern eingeschlagenen Zinn. Maximal konnte sich die Last eines Esels auf bis etwa 130 Minen belaufen, und nach Möglichkeit wurde noch etwas loses Zinn zugeladen, um es unterwegs nach Bedarf einzusetzen. Die Karawane konnte sich, soweit in den publizierten Texten erkennbar, aus mehr als 15 Tieren zusammensetzen und die Ladung sich dann insgesamt auf bis zu 650 Kilogramm Zinn sowie etwa 300 Stück Textilien belaufen (Veenhof 1972: 69 ff.).

Im Laufe der Karum-Zeit, also während eines Zeitraums von 40 bis 50 Jahren, könnten von Anatolien nach Assur dann schätzungsweise 10 Tonnen Silber gebracht worden sein (Larsen 1967: 89 f.). Am Ziel der Reise, d.h. in Kanisch oder in einem anderen ‚Karum' Anatoliens, wurde die Ladung der Esel genau geprüft. Für eine Mine Zinn, d.h. etwa ein halbes Kilogramm des wertvollen Legierungsmetalls, konnten je nach Angebot und Nachfrage mindestens 4 Sekel Silber verlangt werden, und für jedes der etwa 5 Minen schweren Textilstücke ungefähr 5 bis 6 Sekel Silber. Die Gewinne also waren trotz der langen Handelsreise sowohl bei Zinn als auch bei den Textilien gewiss noch beträchtlich. Über diesen Teil des Handelsgeschäfts, d.h. das ‚Versilbern' der Ware in Anatolien, ist allerdings bisher nur wenig bekannt.

Für schwerere Ladungen, so etwa beim Transport von Kupfer, sind wohl Eselkarren verwendet worden; die Texte geben hier jedoch keine genaueren Hinweise; ihr Einsatz dürfte sich auch nach der Beschaffenheit der Wege gerichtet haben, die im Winter oft schwer zu benutzen waren, nach der Notwendigkeit eines Übersetzens über Flussläufe, was dann eine Anmietung von Booten erforderte, nach der jeweiligen lokalen Situation und den entsprechenden Autoritäten, die allerdings den auch für sie einträglichen Handelsverkehr meist kaum behindert haben werden, falls es nicht zu Konflikten über die Wegegebühren kam.

Die Abgaben, die für die Durchreise zu entrichten waren, werden in den Texten oft genannt. So gab es eine Art Exportzoll, den man bereits beim Verlassen der Stadt Assur zu entrichten hatte, d.h. eine „Ausgangsabgabe", die ungefähr nach dem Wert des Handelsgutes bemessen war. Um sich für die oft schwierige und zuweilen auch gefährliche Reise der Gunst der Götter zu versichern, machten die Karawanenführer in Assur gelegentlich auch eine Stiftung an den Tempel. Unterwegs kamen ferner Durchzugsgebühren hinzu für den wirklichen oder vorgegebenen ‚Schutz' der Handelreisenden, den diese dann dementsprechend nach Möglichkeit zu umgehen suchten. Bekannt ist auch eine Abgabe, die in Kanisch selbst zu entrichten war – etwa von fünf Prozent bei Textilien und von etwa drei Prozent für das transportierte Zinn (Veenhof 1972: 85 f.). Sie wurde im sogenannten Bit Karim, d.h. dem Zentrum der Handelsniederlassung entrichtet, das sowohl als eine Art Bankhaus als auch eine Verwaltungsbehörde fungierte.

Die lokalen Autoritäten, allen voran der Herrscher, haben diesen überregionalen Handel auch aus eignem Interesse geschützt und gefördert. Der Herrscher erhielt von den Kaufleuten Abgaben von etwa 1/20 des Wertes der importierten Textilien sowie von 2/65 der Zinnladung, ferner wurde ihm ein Vorkaufsrecht auf 10 Prozent der Textilien zugesprochen sowie ein Handelsmonopol bei bestimmten Luxusgütern, darunter dem noch seltenen Eisen, das gewiss ein besonders begehrter Werkstoff war. Das „Haus des Karum" vermochte den lokalen Fürsten durch Darlehen in den Besitz von Mitteln und Gütern zu setzen, die ihm sonst nicht zur Verfügung gestanden hätten. Dafür gewährte der Stadtherr dann Wohn- und Niederlassungsrecht sowie den Schutz auf den Reisewegen, soweit das möglich war.

Der Gewinn, den die Kaufleute Assurs im Geschäft mit Anatolien machten, belief sich oft auf mehr als 100 %. Es wurde aber auch versucht, Abgaben unterwegs durch Schmuggel zu umgehen und dadurch den eignen Gewinn wesentlich zu erhöhen. Das konnte jedoch bei Entdeckung zu einer Beschlagnahme der Waren führen oder sogar zu einer Gefängnishaft (Kienast 1960: Nr 62 sowie Veenhof 1972: 312). Der Kaufmann konnte jedoch auch dabei ertappt und bestraft werden. So wird in einem Brief, den drei investierende Kaufleute an einen gewissen Puzur-Assur richteten (Kienast 1960: Nr.62), davon berichtet, dass der Schmuggel bekannt wurde und zur Beschlagnahmung der Ware führte; der Täter wurde von der lokalen Behörde, dem

Palast, ergriffen, ins Gefängnis geworfen und streng bewacht. Die Konsequenz des gescheiterten Betruges war, dass der Verfasser des Schreibens dem Missetäter den dringenden Rat gab: „Wenn aber irgendjemand wegen Silber – wegen eines Sekels oder soviel wie du hast- dich überreden möchte und folgendermaßen spricht:' Gib mir Zinn oder Stoffe, dann will ich sie schmuggeln, ich kann das besorgen', so sollst du darauf nicht achten". Es ist auch versucht worden, durch Umwege die unterwegs eingerichteten Zollstationen zu vermeiden und weniger bekannten Routen zu folgen. In einem Brief (Veenhof 1972: 312) heißt es, man solle das Zinn auf Umwegen und unter Vermeidung von Kontrollen schmuggeln, indem man die Ware entweder durch die einheimischen Leute in Mengen von je einem Talent in die Stadt Hurrama schaffen lässt oder in kleinen Packungen von 10 oder 15 Minen durch die Karawanenleute selbst unter ihrer Kleidung in die Stadt hereinbringt. Erst wenn ein Talent Zinn sicher abgeliefert worden sei, dürfe jeweils ein weiteres Talent Zinn (vgl. zu den Gewichtsangaben Powell 1990) in die Stadt gebracht und dann jeweils mit der ersten abgehenden Karawane weitergeschickt werden (Veenhof 1972: 312). Die Kontrolle am Stadttor und die dabei fällige Abgabe sollten also auf diese Weise umgangen werden. Andere altassyrische Texte bezeugen, dass für das Schmuggeln von Handelsgut regelrechte Verträge abgeschlossen worden sind, wofür der Schmuggler mit einer Mine Zinn „als Taschengeld" bedacht wurde (Veenhof 1972: 314). Immerhin ist es bemerkenswert, dass trotz einer drohenden Bestrafung selbst eine derartige Abmachung vor Zeugen beurkundet worden ist. Auch in die regulären Transporte ist gelegentlich solches Schmuggelgut mit einbezogen worden (Veenhof 1972: 314). Als ein Beispiel sei ein Text zitiert (Kienast 1960: Nr.62, Z.28 ff.), in dem es heißt: „Der Sohn des Irra/Waadra'a hat Schmuggelware dem Puschu-ken geschickt. Sein geschmuggeltes Gut wurde jedoch (von den Behörden) beschlagnahmt, und,. den Puschu-ken hat der Palast (d.h. die Stadtbehörde des Herrschers) ergriffen und ins Gefängnis geworfen. Die Wachen sind streng!"

Im archäologischen Befund der Handelsniederlassung von Kanisch (Özgüç 2003) zeichnet sich das Ende der Siedlung II in einer dicken Brandschicht ab, vielleicht auch entstanden als Ergebnis innerer Konflikte. Die meist zu Füßen der schützenden Burg gelegene Niederlassung der fremden Kaufleute fand sich dann mit veränderten Bedingungen konfrontiert. Die in der Schicht I b gefundenen Tontafeln dürften andeuten, dass nun nicht mehr Zinn und Textilien aus Assur nach Anatolien gebracht wurden und die fremden Kaufleute einer strengeren Kontrolle des assyrischen Königs unterworfen waren. Es sind zudem im archäologischen Fundgut Anzeichen dafür auszumachen, dass nun auch Angehörige jener Bevölkerung in Anatolien präsent waren, die dann als „Hethiter" für etwa ein halbes Jahrtausend zur maßgeblichen politischen Kraft in Anatolien geworden sind (Klengel 1998: 21 ff.).

BIBLIOGRAPHIE

Cierny, J., Th. Stöllner and G. Weisgerber 2005
"Zinn in und aus Mittelasien", Ü. Yalçın, C. Pulak and R. Slotta (eds.) *Das Schiff von Uluburun. Welthandel vor 3000 Jahren*: 431-448. Deutsches Bergbau Museum, Bochum.

Deshayes, J. 1975
"Hissar, Tepe (Iran)", *Reallexikonder der Assyriologie* IV: 426-429.

Garelli, P. 1963
Les Assyriens en Cappadoce. Bib 19, Paris.

Giumlia-Mair, A. and F. Loschiavo 2003
"Le problème de l'étain à l'origine de la métallurgie / The Problem of Early Tin", *Akten des XIV UISPP-Kongresses*. Liège.

Hecker, K. 1998
"Zur Dauer des Intervalls zwischen den Schichten Karum II und I b am Kültepe", *Acts of the IIIrd International Congress of Hittitology 1996*: 297-308. Zero Books, Ankara.

Kienast, B. 1960
Die altassyrischen Texte des Orientalischen Seminars der Universität Heidelberg und der Sammlung Erlenmeyer-Basel. De Gruyter, Berlin.

Kienast, B. 1975
"Hungersnot", *Reallexikonder der Assyriologie* IV: 498-500.

Klengel, H. 1979
Handel und Händler im alten Orient. Böhlau, Graz.

Klengel, H. 1989
"Syrischer Handel und die Texte aus Kültepe/Kanis", K. Emre et al. (eds.) *Anatolia and the Ancient Near East. Studies in Honor of Tahsin Özgüç*: 263-268. Anadolu Medeniyetleri Araştırma ve Tanıtma Vakfı Yayınları, Ankara.

Klengel, H. 1998
Geschichte des hethitischen Reiches. Brill, Leiden.

Klengel, H. 2001
"Zwischen Indus und Ägäis. Zum überregionalen Austausch in der Bronze- und frühen Eisenzeit", *Orientalische Liberaturzeitung* 96: 349-355.

Klengel, H. (in press)
"Handel mit Lapislazuli, Türkis und Karneol im alten Vorderen Orient", *Anatolian Metal* V.

Klengel Astour, H. 1995
"Overland Trade Routes in Ancient Western Asia", J. Sasson (ed.) *Civilizations of the Ancient Near East* III: 1408-1420.

Larsen, M.T. 1967
Old Assyrian Caravan Procedures. Nederlands Instituut voor het Nabije Oosten, Leiden.

Larsen, M.T. 1976
The Old Assyrian City-State and its Colonies. Akademik Forlag, Copenhagen.

Maddin, R., T.S. Wheeler and J.D. Muhly 1978
"Tin in the Ancient Near East: Old Questions and New Finds", *Expedition* 19: 35-47.

Muhly, J.D. 1973
Copper and Tin. The Connecticut Academy of Arts and Sciences, New Haven.

Muhly, J.D. 1985
"Sources of Tin and the Beginnings of Bronze Metallurgy", *American Journal of Archaeology* 89: 275-291.

Muhly, J.D. 1995
"Mining and Metalwork in Ancient Western Asia", J. Sasson (ed.) *Civilizations of the Ancient Near East* III: 1501-1521.

Muhly, J.D. and B. Metalle 1997
"Tin", *Reallexikonder der Assyriologie* VIII: 119-136.

Nashef, Kh. 1987
Rekonstruktion der Reiserouten zur Zeit der altassyrischen Handelsniederlassungen. L. Reichert, Wiesbaden.

Özgüç, T. 2003
Kültepe, Kaniš/Neša. The earliest international trade center and the oldest capital city of the Hittites. Middle Eastern Culture Center in Japan, Tokyo.

Parzinger, H. 2002
"Das Zinn in der Bronzezeit Eurasiens", *Anatolian Metal* II (Der Anschnitt, Beiheft 15): 159-177.

Powel, M.A. 1990
"The Old Assyrian "sack" system", *Reallexikonder der Assyriologie* VII/7-8: 499.

Veenhof, K.R. 1972
Aspects of Assyrian Trade and its Terminology. Brill, Leiden.

Veenhof, K.R. 1995
"Kanesh: An Assyrian Colony in Anatolia", J. Sasson (ed.) *Civilizations of the Ancient Near East* II: 859-871.

Veenhof, K.R. 2003
"Trade and Politics in Ancient Assur. Balancing of Public, Colonial and Entrepreneurial Interest", C. Zaccagnini (ed.) *Mercanti e politica nel mondo antico*: 69-118. L'Erma di Bretschneider, Roma.

Veenhof, K.R., W. Orthmann and E. Porada 1980
"Kanis, karum", *Reallexikonder der Assyriologie* V: 369-389.

Vidale, M. 2008
"Šahr-e Suhte (Šahr-i-Sohta)", *Reallexicon der Assyrologie* XI: 537-540.

Weisgerber, G. and J. Cierny 2002
"Tin for Ancient Anatolia?", *Anatolian Metal* II (Der Anschnitt, Beiheft 15): 179-186.

Wilhelm, G. 1999
"Nesa", *Reallexikonder der Assyriologie* IX/3-4: 232-235.

DIE BEDEUTUNG VON ZINN IM LICHT DER HETHITISCHEN TEXTE

HİTİT ÇİVİ YAZILI BELGELER IŞIĞINDA KALAYIN ÖNEMİ

Metin ALPARSLAN – Meltem DOĞAN-ALPARSLAN

Schlüsselwörter: Zinn, Hethitische Texte, Keilschrift, Anatolien

Anahtar Sözcükler: Kalay, Hitit metinleri, çivi yazısı, Anadolu

Key Words: Tin, Hittite texts, cuneiform, Anatolia

ÖZET

Hitit yazılı belgeleri MÖ 2.binyılda kalaya verilen önemi açık olarak göstermektedir. Hitit Çivi Yazılı belgelerde kalay çoğunlukla Sümerce NAGGA, çok az örnekte ise Hitit dilinde arzili- şeklinde yazılmıştır. Kalay metalinin geçtiği Hititçe metinleri İdari Metinler (Vergi-Metinleri ve Dini Metinler) olmak üzere iki ayrı grup altında toplanabilir, en önemli metin grubunu "Vergi-Metinleri" oluşturur. Bu metinlerde vergi olarak kalay gönderen yerlerin adları belirtilmekte ise de, bu yer adlarından Kizzuwatna dışındakiler, yalnızca ad olarak bilinmektedir.

Metinlerden, kalayın doğrudan işlenmediği, daha ziyade alaşım olarak kullanıldığı anlaşılmakta, genellikle bakır ile belgelenen kalayın, bakıra oranla daha değerli bir hammadde olduğu sonucuna varılmaktadır. Ayrıca kalayın büyük bir ekonomik güce sahip olduğu görülmektedir. Metinlerde kalayın nasıl kullanıldığı da tanımlanmıştır; örneğin ahşap malzemede kakma olarak, ya da izolasyonda sıvama malzemesi olarak kullanımı gibi. Dini metinlerden kalayın bazen tılsım, büyü için, tanrılara adak ya da hastalıklardan korunmak için de kullanıldığı anlaşılmaktadır.

ALLGEMEINES

Zinn ist ein relativ weiches Metall, dessen Schmelzpunkt mit 231,9 C, weit unter den Schmelzpunkten von Edelmetallen (Gold: 1063 C; Silber: 960,5 C), aber auch unter denen der im II. Jt. v. Chr. oft verwendeten anderen Metallen (Kupfer: 1083 C; Eisen: 1536 C; Blei: 327,4) liegt. Die Verhüttung dieses Metalls ist dementsprechend leicht. Zinnstein kommt sowohl in primären Lagerstätten (sog. Bergzinn) als auch in sekundären vor (sog. Zinnseifen). Die sogenannten Zinnseifen, waren vielleicht die wichtigsten Quellen für die Vor- und Frühgeschichte (Reiter 1997: 206) und somit auch für die hethitische Periode. Allerdings muss erwähnt werden, dass es bis heute nicht möglich war, sichere Abbaugebiete von Zinn für die Frühgeschichte der Kulturen Vorderasiens festzustellen. Für die Herkunft des hethitischen wie auch mesopotamischen Zinns wurden bisher Südtürkei, Afghanistan, Iran und Zentralasien angenommen (s.

z.B. Parzinger and Boroffka 2003). Die hethitischen Quellen geben darüber leider nur begrenzte Auskünfte (s. unten). Einer Erwähnung der babylonischen lipšur-Litaneien zufolge kam Zinn von den Bergen Zarha und BAR-gùn-gùn-nu. Beide Länder werden dort als „Land des Zinns“ bezeichnet (Haas 2003: 219). Über deren geographische Lage ist allerdings nichts bekannt (Reiter 1997: 258). Um genaue Angaben über die Herkunft dieses Metalls geben zu können, müssen weitere Proben von archäologischen Funden untersucht und vielleicht neue Vorkommen von Zinnlagern gefunden werden.

Soweit fassbar scheint Zinn in der zweiten Hälfte des II. Jt. v. Chr. in Assyrien eine Funktion als Zahlungsmittel gehabt zu haben (Faist 2001: 61). Diese Funktion konnte Zinn in Anatolien aber nie erreichen, hier blieb Silber das dominierende Zahlungsmittel.

ZINN IN DEN HETHITISCHEN TEXTEN

In den hethitischen Texten wird das Metall Zinn vorwiegend in sumerographish „NAGGA“ geschrieben[1]. Das hethitische Wort für Zinn wurde indes erst vor kurzem als arzili- definiert, während man bisher von einem Adjektiv dankui-> dunkles (Metall)=Zinn mit Adjektiv “dankuli-” > zinnern (HHW: 164) ausging, das sich somit als falsch erwiesen haben dürfte[2].

Bei einer Untersuchung der hethitischen Texte, in denen Zinn und Gegenstände aus Zinn vorkommen, fällt ein Schwerpunkt in den Verwaltungstexten (einschl. den Kultinventaren) einerseits und den Texten kultischen Charakters (mit einem Schwerpunkt bei den magischen Ritualtexten) andererseits auf. Diesen beiden Textgattungen sei deshalb auch in unserer Untersuchung besondere Aufmerksamkeiten geschenkt.

ZINN ALS ÖKONOMISCHER ROHSTOFF BEI DEN HETHITERN

In den ökonomisch ausgerichteten hethitischen Texten wird Zinn, neben anderen Metallen, in Zusammenhang mit der Entrichtung von Steuer bzw. den Tributbeträgen erwähnt. Es handelt sich hierbei um *MAN-DÁ-TUM* und IGI.DU$_8$.A Abgaben. Zinn-Abgaben werden, soweit bisher bekannt ausschließlich mit Adlergewichten (KI.LÁMUŠEN) gewogen und erscheinen nur mit einer Gewichtsangabe (wie Gold). Es wird somit nicht wie z.B. Kupfer auch in Form verschiedener Gegenstände (Äxte, Beile, Pfeilspitzen, Sicheln usw.) entrichtet. Dass man es nicht speziell formt, deutet auf die Eigenheit als Legierungsbestandteil hin. Zinn tritt in diesen Texten im Allgemeinen mit Kupfer zusammen auf, wobei die Menge des Zinns immer niedriger ist als die des Kupfers und auch genauer berechnet worden zu sein scheint[3]. Die Verhältnisse von Kupfer zu Zinn, die zusammen in den Texten über Abgaben eingetragen sind, variieren, weisen aber einen Durchschnitt von 1:10 auf, was auch ungefähr die Ideallegierung für Bronze ergeben würde[4]. Von welchen Orten bzw. Ländern Zinn geliefert wird, ist meistens nicht feststellbar, da die Texte sich größtenteils in einem sehr schlechten Zustand befinden und die erhaltenen Ortsnamen oft nicht lokalisierbar sind. Zinn kommt, soweit bekannt, aus Tetu[mna][5], Kizzuwatna[6], vielleicht [K]apitatamna[7], Muna[-[8], Šahhu[-[9], Ar-[x-]huhi[-[10] und Awan[a-[11] (Siegelova 1986: 549). Dass der Name Kizzuwatna unter den steuerzahlenden Orten vorkommt, muss natürlich nicht bedeuten, dass dieses Metall auch dort abgebaut wurde. Dennoch ist es auffällig, dass das einzige bis heute festgestellte mögliche Abbaugebiet für Zinn innerhalb Anatoliens bei Kestel nahe an der Region Kizzuwatna liegt.

Nach den Steuertexten des hethitischen Reiches handelt es sich bei Zinn um einen Rohstoff, den der hethitische Staat benötigte und darum gezielt von seinen Vasallen bzw. angegliederten Ortschaften in die „Staatskasse“ fließen lies. Neben größeren Gebieten, wie Kizzuwatna finden sich auch kleinere Ortschaften wieder, von denen Zinn als Steuern bezogen wurde. Dies hingegen dürfte darauf deuten, dass sich die Zinnlagerstätten in der Nähe dieser kleineren Ortschaften befunden haben, denn eine Ortschaft kann nur den Rohstoff abgeben, von dem es selber genug besitzt. Dass dieser relativ teure Rohstoff durch Fernhandel in diese Orte kam, ist eher auszuschließen. Zu einem ähnlichen Ergebnis kam schon Frau Siegelova (Siegelova 1986: 549), ohne diese Gedanken allerdings weiterzuführen, denn daraus könnte man auch auf Zinnvorkommen innerhalb Anatoliens schließen. Auch wenn diese Ortsnamen, außer Kizzuwatna, nicht sicher bestimmbar sind, liegt bei allen Orten doch eine Lokalisation in Anatolien nahe (siehe z.B. Anm. 7). Wenn dies richtig sein sollte, müssen wir wahrscheinlich mit mehr als einem Zinnabbaugebiet in Anatolien rechnen. Der mittelassyrische Text KAJ 249 würde die Annahme solcher Zinnvorkommen in Anatolien unterstützen, denn diesem Text zufolge bringen babylonische Händler 1 Talent Zinn aus Hatti nach Mesopotamien (Faist 2001: 90f.).[12] Bei dem Begriff „Hatti“ darf hier allerdings nicht unbedingt das Kernland der Hethiter verstanden werden, sondern um hethitisches Hoheitsgebiet. Diese Vermutung von Zinnvorkommen in Anatolien, kann allerdings nur durch neue Forschungen in der Archäometallurgie bewiesen werden.

Im Text KUB 40.95 II 6 geben die *parwala*-Leute des Königs mindestens 1, wahrscheinlich 2 Talente Zinn aus. Diese Erwähnung ist deshalb so wichtig, weil es gleichzeitig auch die bisher größte Menge von Zinn in den hethitischen Texten darstellt. Es handelt sich also um ca. 30 oder 60 kg Zinn, während bei den *MAN-DÁ-TUM* Texten höchstens ca. 9 kg belegt ist.[13]

Natürlich wird Zinn in den hethitischen Texten nicht nur als Rohstoff genannt. Wir erhalten auch Auskünfte über Anwendungen und Bearbeitungen dieses Metalls. Interessant ist z.B. eine Erwähnung in KUB 42.11 V 22, in dem von 40 gefüllten Holzgefäßen (GIŠBUNIN) die Rede ist, die mit Zinn besetzt/belegt (GAR.RA) sind. Es handelt sich hier wohl um eine Art von Zinn-Intarsie, bei der das Zinn in ein ins Holz eingeschnitzte Muster gegossen wird.[14] Desweiteren wird Zinn zur Verzierung oder als Überzug von Gegenständen verwendet (ḫališša-; KUB 38.1 IV 4). Die Anwendung von Zinn zur Isolation oder ähnlichem Zweck ist aus KBo 21.22 Rs. 41‘-43‘ bekannt, in dem von einem Brunnen des Wettergottes die Rede ist, welcher aus Kupfer gebaut, mit Zinn verputzt (haniš-) und mit Eisen bestrichen ist (Soysal 2006: 111)[15].

Auf die ökonomische Bedeutung dieses Rohstoffs deutet auch eine Erwähnung in einem literarischen, aber leider nur fragmentarisch erhaltenen Text hin (KBo 24.34 + 12.42), in dem Händler aus Ura und Zallara(?) Fülle und Üppigkeit ins Land bringen. Zuerst werden Zivilgefangene, Rinder, Schafe, Pferde, Maultiere und Esel genannt. Es folgen Getreide (bzw. Gerste) und Wein. Als dritte Kategorie werden Metalle und wertvolle Steine genannt: Silber, Gold, Lapislazuli, [Karneol?], Glas (Babylon-Stein), Quarz, Eisen, Ku[pfer] und Zinn[16].

Während in den hethitischen Texten für die meisten wichtigen Metalle Schmiede feststellbar sind (Gold, Silber-, Eisen- und Kupferschmiede), scheinen diese für Zinn und Bronze gänzlich zu fehlen (Pecchioli-Daddi 1982: 37-44; Siegelova 1993: 117f.; Doğan-Alparslan 2003: 41). Daraus kann man nur folgern, dass die Kupferschmiede (URUDU.DIM.DIM) eben auch für Zinn und somit auch für Bronze zuständig waren. Das ergibt sich daraus, dass diese Schmiede zur Bronzeherstellung ohnehin zu 90% Kupfer brauchten und somit eben auch nach diesem Metall benannt wurden[17].

DIE ROLLE DES ZINNS IN DEN KULTISCHEN HANDLUNGEN DER HETHITER

Im hethitischen Kultsystem glaubte man an die magischen Kräfte von Metallen, so dass ihnen magische Bedeutungen zugesprochen wurden. Dies ist auch der Grund dafür, dass ein großer Teil der kultischen Texte, in denen Zinn Erwähnung findet, magische Rituale beinhaltet. Die Verwendung von Zinn in diesen Texten ist im Gegensatz zu den anderen Metallen, mit denen es oft auch zusammen auftritt, relativ gering. Als Beispiele für Stoffe, die zusammen mit Zinn belegt sind, können unter anderen Honig, Öl und Gerät aus gebranntem Ton genannt werden[18].

Eines der auffälligsten magischen Rituale, in dem Zinn vorkommt, ist das Ritual der Ambazzi, das zur Ermittlung des Grundes der Krankheit und für die Heilung von dieser veranstaltet wird. In diesem kathartischen Rituale übergibt die Frau Ambazzi durch einen Mittler den Krankheitsdämonen verschiedene Metalle und Edelsteine, um die bösen Geister dazu zu bewegen von dem Kranken abzulassen:[19] “[ ] kocht man in einem Kupfergefäß. [Und man iß]t und trinkt. Dann schüttet sie [der Gottheit] hin, (nämlich) etwas Silber, Gold, [Blaustein], Karneol, Babylonstein, *lulluri*-Stein, Lebensstein, [*para*]*šha*-[Stein], Eisen, Zinn, Kupfer (und) Bronze, [von allem] ein wenig, hin” (Christiansen 2006: 46-47). In einer anderen Passage des gleichen Textes (Rs. III 64-66) wird unter anderen Metallen auch Zinn vor die Gottheit geschüttet und folgendermaßen rezitiert: „ ‚Geh, durchstreife die Berge und das Grün! Und tritt ferner von den Patienten weg! Geh, nun gehe, zu allen Gottheiten sprich Gutes!‘ “ (Haas 2003: 189-190; Christiansen 2006: 54-55). Soweit aus dieser Passage hervorgeht, wird Zinn mit anderen Metallen als eine Art Lösegeld an die Krankheitsverursacher benutzt.

In einer anderen magisch-rituellen Handlung zum “rituellen Erwerb” wird Zinn unter den wertvollen

Gegenständen erwähnt: „Nun bringt der Diener des Ritualherrn ein saures Brot in das Haus des Schmiedes und gibt es dem Schmied, und (er erhält) vom ihm Silber, Gold, Eisen, Zinn, Blei, *lulluri*-Stein, Lapislazuli, Karneol, Bergkristall, Babylonstein, (und) *parašha*-Stein, von allem etwas. Und dies erwirbt er mit dem Brot. Und er besiegelt es dem Schmied und bring es zum Haus (des Ritualherrn). Der Korb (steht) an einem verborgenen (Platz) im Haus" (Ritual der Magierin Allaiturahi KBVM 57 Vs. 6'-10'; Haas 2003: 187-188). Auch in diesem Text ist wohl von einer Art Lösegeld, in Gestallt der besagten Metalle und Gesteine die Rede. Das Gleiche gilt auch für das Heilungsritual für Išhara(?), in dem der Priester der Krankheitsverursacherin Išhara neben anderen Edelsteinen und Metallen auch Zinn als Lösegeld für den Patienten anbietet (KUB 12.24 I 7'-12').

Auch in anderen Ritualen findet das Metall Zinn neben anderen Metallen seinen Platz. Es ist bisher in einem Ersatzritual für den hethitischen König (KUB 24.5 Vs. x+2, 4', 25'), einem Ritual „Mann des Wettergottes" (KBo 12.78 II 11), dem Ritual der Mastigga von Kummanni (KUB 41.12 Rs. 13'), dem Ritual der Uruwanda gegen Behexung (KBo 11.11 III 3'), einem hattisch-hethitischen Grundsteinlegungsritual (KUB 28.87 Rs x+2) und dem Ritual der Hutuši beim Feldzug (KUB 17.34 IV 4) belegt. In allen diesen Ritualen werden die Metalle in Zahl oder Gewicht genannt, wobei für Zinn nur Gewichtangaben vorhanden sind[20], und können als Lösegeld oder Kompensationszahlung interpretiert werden.

In einem Entsühnungsritual (KBo 15.10 I 8-11) wird Silber, Gold, Lapislazuli, Babylonstein, *parašha*-Stein, Bergkristall, *lulluri*-Stein, Kupfer und Zinn in Verbindung mit einer hölzernen Waage erwähnt (Szabó 1971: 12-13), woraus man vielleicht schließen kann, dass alle diese wertvollen Objekte streng gewogen und kontrolliert benutzt wurden. Diese Kontrolle geht auch aus einem Hausreinigungsritual (KUB 41.8 Rs. III 18-20) hervor, in dem die Kontrolle von Silber, Gold, Eisen, Zinn, Lapislazuli und Karneol mit einer Waage befohlen wird.

In einer anderen Passage des Ambazzi-Rituals versucht der Magier die Krankheit von einem Menschen oder einem Gott[21] auf eine Maus zu übertragen.[22] Zinn wird in diesem Ritual als eine Art leitendes Objekt benutzt, das die Krankheit von dem Gott, bzw. Menschen, auf die Maus überleitet: "[Gott Al]auwaima, bekämpfe sie nicht länger! [Geh], bekämpfe fortan diesen Riegel! Und treibe das Böse damit von ihnen fort!' Und sie/er wickelt ein wenig Zinn in eine Bogensehne ein und windet es den Herren rechts um seine Hand und seinen Fuß. Dann nimmt sie/er es von ihnen weg und windet es um eine Maus: ‚Von euch/ihnen habe ich das Böse weggenommen und habe es um eine Maus gewunden. Nun soll diese Maus über hohe Berge, durch tiefe Täler, auf weiten Wegen forttragen' "[23] (Christiansen 2006: 44-45).

In einem Bauritual[24] wird dem hethitischen König, eine Gestalt aus Zinn geformt: „Der Sonnengott und der Wettergott haben dem König das Land wiederum anvertraut, haben ihm die (Lebens)jahre wiederum erneuert, den Respekt erneuert. Sie machten ihm die Gestalt aus Zinn, sein Haupt machten sie aus Eisen. Die Augen machten sie ihm (wie) die eines Adlers, während sie ihm die Zähne (wie) die eines Löwen machten"[25] (Starke 1980: 73ff.; Haas 2003: 220-221). Statuen dieser Art werden in den hethitischen Texten fast ausschließlich aus Gold oder Silber angefertigt. In dieser Hinsicht dürfte die Gestalt aus Zinn eine Ausnahme sein, die aber trotzdem auf die Wertschätzung dieses Metalls deutet.

ZUSAMMENFASSUNG

Zinn ist ein ökonomisch wichtiger Rohstoff, den die Hethiter benötigten und gezielt für den Staat sammeln ließen. Er war wichtig für die Bronzeproduktion und somit auch wichtig für die Waffenherstellung, die als wichtiger Teil der hethitischen Kriegsführung und folglich auch der hethitischen Herrschaft gelten darf. Auch wenn die Herkunft dieses Zinns bis heute noch immer nicht feststeht, weisen doch mehrere Indizien in Richtung Anatolien. Auch die hethitischen Quellen würden solche Zinnabbaugebiete in oder um Anatolien anbieten. Es bleibt abzuwarten, ob sich diese Vermutungen bestätigen. Sicher kann man aber sagen, das Zinn von den Hethitern in großen Mengen benötigt wurde, auch wenn die wenigen, uns erhalten gebliebenen Texte eher spärliche Auskünfte bieten.

Wie dargelegt spielte Zinn im Kult der Hethiter eher eine kleine Rolle. Seine Bedeutung unterscheidet sich kaum von anderen Metallen, es kommt aber seltener vor. Wie andere Metalle auch, hatte Zinn eine magische Kraft, die besonders in den Ritualen der Ambazzi in den Vordergrund tritt.

ENDNOTE

1 Früher wurde dagegen die Schreibung AN.NA bevorzugt.

2 Auch wenn das hethitische Wort arzili-, bisher nur in einem Text belegt war, konnte dank eines neuen Fragments aus Ortaköy/Šapinuwa (Or 90/328), welches ein Duplikat von KUB 29.1 (Bauritual) darstellt, die Bedeutung dieses Wortes ohne Zweifel festgestellt werden (Soysal 2006: 110f.).

3 Während Kupfer ausschließlich in Minen berechnet wird, werden die Zinnabgaben in Minen und Šekel angegeben.

4 Es ist leider nicht immer möglich, die genauen Verhältnisse von Zinn zu Kupfer in den Steuerabgaben festzustellen, da es sich hauptsächlich um Tafelfragmente handelt. Folgende Verhältnisse können ungefähr errechnet werden; 1:8,4 (KUB 26.67 r. Kol. 1‘-3‘), 1:8 (KUB 26.67 r. Kol. 4‘-6‘), 1:10,33 (KUB 26.67 r. Kol. 7‘-9‘), 1:2,35 (KUB 26.67 r. Kol. 10‘-13‘), 1:11,4 (KBo 7.24 5‘-8‘), 1:19 (KBo 18.164 r. Kol. 3‘-5‘), 1:14,5 (KBo 18.164 r. Kol. 6‘-8‘).

5 Zur Zeit gibt es für einen Ort, der mit diesen beiden Zeichen beginnt, keine andere Alternative als den Ort Tetumna. Der Ort ist leider nicht sicher lokalisierbar (s. RGTC 6/2: 170).

6 Im Text $^{\text{URU}}$Gaz-zu-wa[- (KUB 26.67 r. Kol. 6‘) geschrieben und von Siegelova wohl richtig als Kizzuwatna gedeutet (Siegelova 1984: 164f.). Kizzuwatna ist somit der einzige sicher lokalisierbare Ortsname in diesen Texten. Zwei weitere Erwähnungen, die vielleicht auf Kizzuwatna deuten könnten, finden sich in KBo 18.164 lk. Rd. 3‘ (-]x-na-aš) und 6‘ (-]x-at-na-aš) (Košak 1982: 77). Siegelova vermutet hingegen bei Zeile 6’ einen anderen nicht definierbaren Ortsnamen (Siegelova 1986: 162 Anm. 3).

7 Von Siegelova ergänzt (Siegelova 1986: 166 Anm. 7). Scheint sich weiter im Norden von Hattuša befunden zu haben, da es unter anderen zusammen mit Turmitta und Wašhaniya belegt ist (KBo 12.53 Vs. 16’).

8 Vielleicht als Munapta zu ergänzen (s. dafür RGTC VI/2: 107).

9 Leider nicht ergänzbar. Für Ortsnamen, die mit dieser Schreibung beginnen, siehe RGTC VI: 329 und RGTC VI/2: 132.

10 Nicht ergänzbar.

11 Nicht ergänzbar.

12 Es scheinen auch noch andere Texte auf einen Zinnhandel von Anatolien nach Assur hinzuweisen (Faist 2001: 65).

13 In dem leider nur fragmentarisch erhaltenen Kultinventar Bo 5106 (Vs. II 4‘) wird ebenfalls 1 Talent Zinn erwähnt.

14 Die Zinn-Intarsie ist eine Verzierungstechnik, die im 16. und 17. Jh. n.Chr. in Europa wieder in Mode kam. Sie ist sehr widerstandsfähig, da die unterschnittenen Konturen das Zinn mit absoluter Sicherheit im Holz halten. Vergleichbare Arbeiten (GAR.RA) finden wir auch für Szepter/Stäbe ($^{\text{GIŠ}}$PA: KUB 38.10 III 9‘), Stierfiguren aus Holz (GU$_4$.MAH: KBo 2.1 I 28‘, KUB 38.10 IV 1‘, KUB 38.6 IV 15‘), Adlerfiguren (KUB 38.1 IV 5) und nicht näher bestimmbare Gegenstände (KUB 57.106 II 40). Es muss allerdings festgehalten werden, dass diese Art von Intarsien auch für andere Metalle vorhanden sind, da das sumerische Wort GAR.RA auch mit anderen Metallen erscheint (siehe z.B. KUB 38.11 14‘ mit Eisen).

15 Im Zusammenhang mit einem Brunnen erscheint Zinn auch im Text KUB 57.106 II 25, hier allerdings mit dem sumerischen GAR.RA (PÚ$^{\text{HI.A}}$-*ŠU*? NAGGA GAR.RA XI PISAN$^{\text{MEŠ}}$ x[ ]). Hier dürfte aber eher nicht von einer Intarsie die Rede sein.

16 Košak 2003: 249-252.

17 Dies könnte auch ein Beweis dafür sein, dass die Hethiter das Determinativ für Kupfer (URUDU) auch für Bronzegegenstände benutzt haben (s. dazu Alparslan and Doğan - Alparslan im Druck) und nicht ausschließlich für Kupfergegenstände.

18 z.B. Hausreinigungsritual (KUB 7.41 II 70-71) und Ritual für die Sonnengöttin der Erde (KUB 24.12 III 2’).

19 KUB 27.67 Vs. II 58-62. Außerdem im gleichen Text Rs. III 61-66 und Rs. IV 34-39.

20 Dieser Unterschied wird in dem Ritual „Mann des Wettergottes“ besonders deutlich, da 12 Pflock Eisen, 1 šekel Zinn, 12 Pflock Kupfer und ein 1 Mine (schwere) Bronzedolch zusammen genannt wird (KBo 17.78 II 10-13).

21 Es sind verschiedene Götter, die es im Ambazzi-Ritual von den Krankheiten zu heilen gilt; belegt sind die Götternamen Alauwaima, Tarpatašša und Zarniza. In einer anderen Passage ist der König der zu heilende (IBoT 2.122 6’; Christiansen 2006: 168).

22 Eine der von den Hethitern zur Abwehr des Bösen oder Heilung von Kranken angewendeten Methoden ist die Methode des „Sündenbocks“, bei der das Böse auf ein Tier (wie Maus, Schaf, Esel, oder Ziege), übertragen wird.

23 KUB 9.25 + KUB 27.67 Vs. II 31-40:
[$^{\text{D}}$A-l]a-u-wa-i-mi le-e-aš nam-ma za-ah-hi-iš-ki-ši
[i-it-z]a ku-u-un $^{\text{GIŠ}}$tar-zu-un nam-ma za-ah-hi-iš-ki
nu-wa-aš-ma-aš i-da-la-u kat-ta-an ar-ha na-an-ni

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nu-uš-ša-an NAGGA te-pu $^{\text{SÍG}}$iš-tág-ga-i an-da hu-u-la-li i-e-ez-zi
na-at-ša-an *A-NA BE-LU-TIM* ku-un-ni *A-NA QA-TI-ŠU* GÌR-*ŠU* na-a-i

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Eine ähnliche Formulierung ist im gleichen Text noch einmal belegt (Vs. I 30-41, Rs. III 38ff.).

24 Nach Haas 2003: 220 handelt es sich hierbei um ein Palas erneuerungsritual.

25 KUB 29.1 Vs. II 48-54:
……………… …. nu $^{\text{D}}$UTU-uš
$^{\text{D}}$U-aš-ša ut-ne-e EGIR-pa LUGAL-i ma-ni-ah-hi-<ir>
MU$^{\text{HI.A}}$-aš-ši EGIR ne-wa-ah-hi-ir na-ah-ša-ra-at-ta-[an]
ne-wa-ah-hi-ir

ALAM-iš-ši NAGGA-aš i-e-er SAG.DU-*ZU* AN.BAR-aš
i-e-er ša-a-ku-wa-aš-ši Á$^{\text{MUŠEN}}$-aš i-e-er
ZU$_9$$^{\text{HI.A}}$-ma-aš-ši UR.MAH-aš i-e-er

BIBLIOGRAPHIE

Alparslan, M. and M. Doğan-Alparslan (in press)
"Symbol der ewigen Herrschaft: Metall als Grundlage des hethitischen Reiches", Ü. Yalçın (ed) *Anatolian Metal* V.

Christiansen, B. 2006
Die Ritualtradition der Ambazzi (Studien zu den Boğazköy Texten 48). Harrassowitz Verlag, Wiesbaden.

Doğan-Alparslan, M. 2003
"Hitit Dönemi'nde Esnaf ve Zanaatkârlar", *Osmanlı Öncesi ile Osmanlı ve Cumhuriyet Dönemlerinde Esnaf ve Ekonomi Kongre Bildirileri*: 37-48. Globus Dünya Basımevi, İstanbul.

Faist, B. 2001
Der Fernhandel des assyrischen Reiches zwischen dem 14. und 11. Jh. v.Chr.. Ugarit-Verlag, Münster.

Haas, V. 2003
Materia Magica et Medica Hethitica, Vol. I/II. Walter de Gruyter, Berlin.

IBoT *İstanbul Arkeoloji Müzelerinde Bulunan Boğazköy Tabletleri*. I-IV. Türk Tarih Kurumu, İstanbul 1944, 1947, 1954, 1988.

KBMV *Keilschrifttexte aus Boğazköy im Vorderasiatische Museum, in der Reihe: Vorderasiatische Schriftdenkmäler der Stattlichen Museen zu Berlin NF*. Mainz 1997.

KBo *Keilschrifttexte aus Boğazköy*. Gbr. Mann Verlag, Leipzig/Berlin 1916ff.

Košak, S. 1982
Hittite Inventory Texts (CTH 241-250). Carl Winter, Heidelberg.

Košak, S. 2003
"A Note on "The Tale of the Merchant", A. Hoffner (ed.) *Eisenbrauns*: 249- 252. Winona Lake.

KUB *Keilschrifturkunden aus Boğazköy*. Akademie Verlag, Berlin 1916-1990.

Parzinger, H. and N. Boroffka 2003
Das Zinn der Bronzezeit in Mittelasien I. Phillip von Zabern, Mainz am Rhein.

Pecchioli-Daddi, F. 1982
Mestieri, Professioni e Dignita Nell' Anatolia Ittita. Edizioni Dell'Ateneo, Roma.

Reiter, K. 1997
Die Metalle im alten Orient (AOAT 249). Ugarit-Verlag, Münster.

RGTC VI Del Monte G.F. – J. Tischler, *Die Orts- und Gewässernamen der hethitischen Texte*. Wiesbaden, 1978, Dr. Ludwig Reichert Verlag.

RGTC VI/2 Del Monte G.F. *Die Orts- und Gewässernamen der hethitischen Texte – Supplement*. Wiesbaden, 1992, Dr. Ludwig Reichert Verlag.

Siegelova, J. 1986
Hethitische Verwaltungspraxis im Lichte der Wirtschafts- und Inventardokumente. National Museum Praha, Praha.

Siegelova, J. 1993
"Metalle und Metallurgie. A.II. In den hethitischen Texten", *Reallexikon der Assyriologie und der Vorderasiatischen Archäologie* 8/1-2: 112-119.

Siegelova, J. 2005
"Metalle in den hethitischen Texten", *Anatolian Metal* III (Der Anschnitt, Beiheft 18): 1835-1840.

Soysal, O. 2006
"Das hethitische Wort für 'Zinn'", *Historische Sprachforschung* 119: 109-116.

Starke, F. 1980
"Halmašuit im Anitta-Text und die hethitische Ideologie vom Königtum", *Zeitschrift für Assyriologie und vorderasiatische Archäologie* 69: 47-120.

Szabó, G. 1971
Ein hethitisches Entsühnungsritual (Texte der Hethiter 1). Carl Winter Universitätsverlag, Heidelberg.

THE ULUBURUN TIN INGOTS AND THE SHIPMENT OF TIN BY SEA IN THE LATE BRONZE AGE MEDITERRANEAN

ULUBURUN KALAY KÜLÇELERİ VE AKDENİZ'DE SON TUNÇ ÇAĞ'INDA DENİZ YOLUYLA KALAY TİCARETİ

Cemal PULAK

Keywords: Uluburun shipwreck, Late Bronze Age, maritime trade, tin ingots, copper ingots, ingot marks, lead-isotope analysis

Anahtar Sözcükler: Uluburun batığı, Son Tunç Çağ, deniz ticareti, kalay külçe, bakır külçe, külçe işareti, kurşun izotop analizi

ÖZET

Kaş yakınlarındaki Uluburun Mevkii'nde 14. yüzyıl sonlarında batmış olan ticari bir geminin yükleri arasında külçe halinde 10 ton kadar bakır ve bir ton kadar da kalay yer almaktadır. Uluburun gemisi olarak bilinen bu batıktaki kalay külçeler, kesin olarak tarihlenebilen ve külçe şekilleri belirgin olan en eski kalay grubunu oluşturmaktadır. Kalay külçelerine ek olarak, gemide kalaydan yapılmış bazı kaplar da bulunmuştur. Külçelerin bir kısmı korozyon nedeniyle zarar görmüş veya tamamiyle eriyerek yok olmuşlarsa da, bir çoğu orijinal şekilleriyle günümüze kadar kısmen veya tamamen korunmuş olarak ulaşmıştır. Uluburun gemisinde taşınmakta olan kalay külçelerinin birçoğu, gemiye yüklenmesinden çok önce kesilerek parçalara bölünmüşlerdir. Gemide en az yedi farklı tipteki kalay külçesinin taşındığı saptanmıştır. Bunlardan dördü için elimizde tam olan örneklerin bulunmasına karşın, diğer külçe tipleri ancak kesilmiş parçaların incelenmesi sonucunda anlaşılabilmektedir. Nispeten sağlam durumda ele gecen 110 adet kalay külçesinden en az 70 adedi öküzgönü biçimindedir. Öküzgönü külçelerin hemen tamamı kesilerek kabaca çeyrek veya ¼'lük bölümlere ayrılmış olmakla birlikte, iki adet sağlam ve bir miktar da yarım külçe buluntular arasında yer almaktadır. Kalay külçelerinden yaklaşık 25 adedinde sonradan yapılmış olan işaretler bulunmaktadır. Bunlardan belirgin olan 16 adet işaretin bir bölümü sadece kalay külçelerinde yer almakta, diğerleri ise gemideki bakır külçelerinde de görülen işaretlerdendir. Yapılan kurşunizotop analizleri sonucunda, kalay külçelerinden bir kısmının Orta Toros'lardaki polimetalik cevher izotopları ile benzerlik gösterdiği, bir bölümünün de Akdeniz'de görülmeyen, ancak Orta Asya'da bulunan cevherler ile ortak özellikler gösterdiği anlaşılmaktadır. Ancak, külçelerin kesin kaynağı henüz tespit edilmemiş olmakla birlikte, tamamının Akdeniz dışındaki kaynaklardan temin edilmiş olması da söz konusudur. Uluburun gemisi, bakır ve kalay külçelerinin yanısıra diğer birçok ham ve mamül malzemenin Doğu Akdeniz kıyılarından denizaşırı diğer bölgelere ulaştırılması konusundaki en önemli ve belirgin örneklerimizden birini oluşturmaktadır.

INTRODUCTION

The Late Bronze Age shipwreck excavated off Uluburun, approximately nine kilometers southeast of Kaş, in southern Turkey, has provided our clearest glimpse thus far of Late Bronze Age trade in the Mediterranean. Dated to the last quarter of the 14th century BC, the ship carried the largest and wealthiest Bronze Age cargo yet discovered in the Mediterranean. The vessel's cargo consisted primarily of raw materials, but also included a wide variety of manufactured goods (Bass 1986; Bass et al. 1989; Pulak 1988; 1997; 1998; 2001; 2005a; 2005b; 2008a). The raw materials on the ship consisted of about ten tons of copper ingots, most in the typical oxhide shape common to the Late Bronze Age Mediterranean, about one ton of tin ingots, including many in the oxhide shape (Pulak 2000a; 2008b), more than half a ton of terebinth resin (Pistacia cf. atlantica) carried in ceramic jars, nearly three hundred disk-shaped glass ingots, hippopotamus teeth and an elephant tusk, ostrich eggshells, and ebony logs. Manufactured goods on the ship included Cypriot pottery packed in large storage jars or pithoi, copper and tin vessels, faience drinking cups, ivory cosmetic containers, glass and faience beads, and inlaid seashell rings (Pulak 2001; 2008a: 296-297; other objects from the shipwreck may be found on the following pages of the same catalog: 313-333, 336-348, 350-358, 360-378). Artifacts for shipboard use included galley wares, tools, fishing implements, foodstuffs, seals, gold and silver jewelry, a jeweler's hoard of gold and silver scrap, weapons, ceramics, and balance weights (Pulak 2000b). These objects represent some of the personal possessions of the ship's crew and passengers. The distribution of artifacts on the seabed at Uluburun and the surviving portions of the hull suggest that the vessel was about 15 meters long (Pulak 1999; 2002) and, based on the cargo, stone anchors, and ballast recovered, had a capacity of at least 20 tons burden. However, since the amount of perishable cargo on board is not known and very little of the vessel's hull survived, estimates of the ship's size and capacity remain somewhat speculative.

An analysis of the ship's cargo illuminates many aspects of long-distance trade in the Late Bronze Age Mediterranean. Most of the raw materials and trade goods on the ship are of Canaanite and Cypriot origin, while others would have been obtained from nearby hinterlands or sources farther inland, all of which would have been brought by caravan to ports before they were loaded on the ship. The Uluburun ship, therefore, is yet another indicator of a sea route for the east-west transport of raw materials and other goods.

Assigning a specific home port for the Uluburun ship and its crew is not an easy task. Based on an analysis of the personal effects of those on board the ship and specific objects intended for shipboard use, it would appear that the ship began its journey somewhere along the Levantine coast, even though a major portion of the ship's diverse cargo originates from Cyprus. Preliminary petrographic analysis of the ship's stone anchors and its galley wares, such as plain bowls, jugs, and all the oil lamps used by the crew aboard the ship, has helped narrow down the origin of the vessel to an area most likely located on the northern Carmel coast of Israel, and southernmost Lebanon. A port city in this general region, such as Tell Abu Hawam, may have been the homeport of the Uluburun ship or at least the origin of its final voyage (Pulak 2008a: 299). It is likely that the ship took on most or all of its cargo, regardless of origin, from a single port on the mainland, which served as an entrepot or a way station, rather than directly from Cyprus. This is suggested by the Canaanite origin of the ship and its crew, the diverse nature of the non-Cypriot component of the cargo assembled from many sources near and far, and the way in which some Cypriot fine wares were stored with and stacked inside mainland wares from the northern Carmel Coast. While the Cypriot pottery cargo comprises nearly all major export types made on the island, there is considerable variation in style, size, and craftsmanship among the individual pieces within a given type. This suggests that the assemblage consisted of limited or leftover pieces obtained over a long period of time through different shipments and, perhaps, from diverse workshops. Had all the pottery been procured directly from Cyprus together as a single group, they would have been significantly more homogeneous within the type groups (Pulak 2008a: 299). Although not certain, the variations observed among the basic copper ingot shapes and the array of incised markings on them suggest that the ingots were also previously transshipped from Cyprus to a mainland entrepot where they were probably stored for an indeterminate length of time before being loaded on the ship. This entrepot was most likely located near the ship's homeport, possibly at Tell Abu Hawam itself or a similar site in the same general region. Although Tell Abu Hawam is a comparatively small site, excavations there have uncovered an international assemblage of artifacts, including many Cypriot wares, leading to its identification as the port city associated with the major inland site of Megiddo.

The general direction of the voyage is also clear. Winds and currents on the southern coast of Anatolia run from east to west, and these were exploited by Bronze Age seafarers. From its likely origin on or just north of the Carmel Coast, the Uluburun ship sailed north along the Levantine coast and then headed west, hugging the southern coast of Anatolia, most likely keeping the northern coast of Cyprus to its port side until it sailed past the island, and Cape Gelidonya to its starboard, a site of another Bronze Age shipwreck (ca. 1200 B.C.), only to founder at Uluburun. Mycenaean objects on the ship strongly suggest the presence of at least two high-ranking Mycenaeans on board, perhaps messengers or officials escorting the vessel's rich cargo to a destination in the Aegean (Pulak 2005c; for Uluburun Mycenaean pottery, see Rutter 2008). With its ten tons of copper ingots and one ton of tin ingots, therefore, the Uluburun ship provides our strongest, indisputable evidence for a Late Bronze Age east-west sea route for shipping basic raw metals along the southern coast of Anatolia. Tin is an essential component of bronze, the eponymous metal alloy of the period. However, because it was unavailable locally in the Mediterranean during the Bronze Age, it was supplied to Mediterranean civilizations using ships such as that found at Uluburun. It is also in the Uluburun tin ingots that we have our first archeological evidence for the bulk trade of tin in the form of distinct metal ingots, and for the range of ingot shapes, including the oxhide shape, in which tin was cast and traded during this period.

Other evidence for Bronze Age trade in metals along this sea route includes approximately two tons of copper oxhide ingots recovered by sponge divers in 1907 or 1908 from a 16th–14th-century B.C. shipwreck site reported near Side in the Bay of Antalya, southern Turkey (Buchholz 1959: 27, Pl. 3:5-6, 30; 1966: 63, Fig. 2b, 65). An unpublished report about the site suggests that the approximately two tons of copper oxhide ingots salvaged by the sponge divers from the wreck represent only a fraction of the ship's cargo of copper ingots. Although none of the objects described by the sponge divers from this wreck are tin ingots like those excavated at Uluburun, it does not negate the possibility that tin ingots were also carried on the ship alongside the copper ingots. Further west on the southern Turkish coast, the remains of a smaller, late 13th-century BC shipwreck were found at Cape Gelidonya. The cargo of the ship consisted of primarily scrap metal in the form of bronze tools, weapons, and other items, as well as at least 34 copper oxhide ingots and also some tin. Although the tin had disintegrated, it was most likely originally in ingot form and not tin oxide ore or cassiterite (Bass 1967: 52-83). Bass noted that three piles of white, powdery tin oxide were found on the wreck under the copper ingots. A single tin pile collected from the seabed weighed 8 kg when dry, and represented approximately half of what had been preserved on the wreck. The tin was only preserved where it was covered by the cargo of copper ingots, so it is possible that more tin was on board and was later washed away. Spilled tin oxide was recovered from a roughly rectangular concretion (approx. 6 x 6 cm) in one area; Bass suggests that the concretion formed over the tin ingot before it was destroyed by electrolytic action due to its physical contact with the copper (Bass 1967: 82-83). On a return trip to Cape Gelidonya in 1987, the author collected two amorphous metal lumps, presumably fragments of ingots, from the original excavations spoil heap. The metal lumps were identified as tin-lead alloys, of approximately 65% tin and 35% lead.[1] It was concluded that such a percentage of lead must have resulted from deliberate alloying rather than the lead content of the ore, since lead does not occur in tin deposits in such high concentrations.[2]

The maritime trade route continued west, passing the Uluburun promontory, before reaching the southwestern tip of Turkey, where a sponge trawler is said to have netted a copper oxhide ingot off Knidos in water more than 100 meters deep (the ingot was later dumped back into the sea) (Bass 1986: 272). From this region, ships would have likely continued west, towards Greece, or north into the northern Aegean. Other Bronze Age metal ingots found on or near probable coastal trade routes include an oxhide ingot found on land near Sozopol on the Bulgarian coast of the Black Sea (Karaitov 1978; Dimitrov 1979: 70, 73, Fig. 3; Bouzek 1985: 20-21, pl. 4:2; Gale 1989: 248, Fig. 29:1), an oxhide ingot corner found 3 km from the coast at Şarköy near the Sea of Marmara (Harmankaya 1995: 232-233, 254, pl. 17), and a hoard of 19 copper ingots from a shipwreck near Kyme in Euboea, Greece (Buchholz 1959: 35-37, Pl. 5:3-4; 1966: 62). The Kyme ingots, however, are smaller, have much smoother surfaces than the typical oxhide ingots, and shaped somewhat differently from their Late Bronze Age counterparts, and may therefore be of a later period.

Copper, tin, and lead ingots dating to the Late Bronze Age have also been found at two probable shipwreck sites near Haifa on the Israeli coast. One of these, found just south of Haifa, on the Hishuley Carmel coast, yielded four typical Bronze Age stone anchors with a single apical cable hole, a copper oxhide ingot, and five tin ingots (Galili et al. 1986: 25-34). The tin ingots are of an irregularly-shaped, sand-pit cast, plano-convex form, with their weights varying between 2.2 and 4.2 kg. Three of these ingots bear incised marks of unknown origin, but provisionally thought to be from the Cypro-Minoan syllabary by the excavators (Galili et al. 1986: 32). The second site, slightly farther north on the same coast, at Kfar Samir, thought to date to the 14th or 13th century BC, yielded five typical Late Bronze Age stone anchors more or less of the same size, a bronze sickle-sword, various smaller bronze objects, five small lead ingots, eight bar-shaped tin ingots, and two large plano-convex, roughly discoid tin ingots. One of the latter tin ingots was sawn in half in antiquity and weighed a massive 36 kg (Raban and Galili 1985: 326-329). One of the bar-shaped tin ingots bore an incised mark, as did all five of the lead ingots. Two rectangular tin ingots, thought to have come from a site off shore near Haifa, Israel, are without a secure archaeological context. The ingots are 31.4 cm and 32.4 cm long, 19.0 cm and 21.6 cm wide, and 3.7 cm and 3.6 cm thick, and weigh 11.4 and 11.9 kg, respectively (Maddin et al. 1977: 35-47). Each ingot has two incised marks on their wider top surfaces, with one of the marks found on both ingots. Two of the three incised marks are identified as being of Cypro-Minoan syllabary, and the third, although not represented in its exact form among Cypro-Minoan syllabary, is thought to be a member of the same family of signs. Since Cypro-Minoan is known to have been used from the end of the 16th century to the end of the 11th century BC, the ingots were thought to date to that period (Maddin et al. 1977: 46). Although the source of the tin would have lain outside of Cyprus, it is assumed that the ingots passed through Cyprus where they received the Cypro-Minoan markings, which are also found on some Late Bronze Age copper oxhide and plano-convex discoid ingots found at various sites around the Mediterranean. Two additional ingots found later, of the same shape and size as the earlier ingots, also carried a pair of incised marks on each ingot. The two marks on one of the ingots was identical to one of the two marks found on each of the two earlier ingots, suggesting that all four ingots came from the same unknown shipwreck (Artzy 1983: 52-53). This same ingot, however, also had the impression of a human bust, identified as the fountain goddess Arethusa, and thus the ingot was dated to the 5th century BC on stylistic considerations. If this attribution is correct, then the tin ingots could not have come from a Bronze Age shipwreck. Consequently, the origin of these ingot markings were sought outside of Cyprus, with Iberia proposed as a possible source (Artzy 1983: 54). It is hoped that future lead-isotope analysis will be able to resolve the question of origin for these four ingots.

Although copper oxhide ingots and ingot fragments occur at a number of Bronze Age coastal sites in the eastern and central Mediterranean (Gale 1999: 111), tin is noticeably absent at these locations. One probable reason for this is that, unlike copper, tin corrodes and becomes difficult to recognize in the archaeological record by the non-specialist archeologists and therefore is easily overlooked. At the port town of Mochlos on Crete, however, recent finds include fragments of copper oxhide ingots and a tin ingot in a LM IB context (c. 1400 BC), which had disintegrated into tin oxide but whose rectangular slab shape was preserved by a plaster cast (Soles 2005, 2008; Whitley 2005:102-104). These ingots would have reached Crete on ships such as those that sank at Uluburun and Cape Gelidonya with their cargo of copper and tin ingots. Recent reevaluation of three early archaeological excavations on Nuragic Sardinia, as well as a few fragments of recently discovered tin metal from another site, have now also confirmed the use of metallic tin in Sardinian bronze making (Lo Schiavo 2003: 121-124).

THE TIN INGOTS FROM THE ULUBURUN SHIP

The Uluburun ship's primary cargo of copper and tin ingots is the largest discovery of metal ingots from the Bronze Age Mediterranean (Pulak 2000a; 2008b). Much of the copper was in the form of 354 copper oxhide ingots, with a preserved weight of approximately 18 to 30 kg each. The ingots were of raw, blister copper rather than recycled copper or bronze (Hauptmann 2002: 13). Most are of the "four-handled" shape known from many Late Bronze Age sites, but 31 are of a unique shape with only two "handles" or corner protrusions. Six smaller oxhide ingots, two pairs of which were cast in the same mold, a smaller ingot with the same general shape as the previous four but without corner protrusions, and a thick, unique ingot with short, bulky corner protrusions were also found.[3] The ship additionally carried 121 smaller copper bun or plano-convex discoid ingots, varying in weight, but averaging about 6.2 kg apiece. Fragments of 10-15 copper bun ingots were also recovered. It is logical that copper and tin would have been shipped together, and presumably in the appropriate proportions, since they were used together to make bronze. The ten tons of copper and one ton of tin on the Uluburun ship approximates the required proportions of the two metals to produce 11 tons of bronze at the optimal copper-to-tin ratio of 10:1.

The Uluburun ship's tin ingots are the earliest known from a well-established archaeological context and are the first with distinct, easily-recognizable ingot shapes of at least seven different types. Some of the tin ingots excavated on the ship had disintegrated through the action of corrosive salt water and perhaps also by electrolytic reaction, which resulted in the production of tin oxide with a consistency of toothpaste, which readily washed away under water during excavation. Corrosion damage to the ingots varied, from small and large holes in otherwise intact ingots to the complete loss of the ingot's original shape and mass (Fig. 1). Tin corrosion products were collected from the site whenever possible, but the total weight of tin recovered must be much less than that of the original cargo. Nevertheless, the recovered quantity of tin weighs approximately one ton.

Although several different types of intact ingots were recovered, the majority of the tin cargo consists of pieces of larger ingots that had been cut some time before they were stowed on the ship. At least 70 of the approximately 110 relatively well-preserved tin ingots and ingot fragments recovered from the wreck are in the oxhide shape used for most of the copper ingots. Most of the tin oxhide ingots consisted of precut corners of complete oxhide ingots (Fig. 2); only two of them were uncut and complete (Fig. 3), and eight were sectioned into half or near-half ingots. Although poorly preserved, the complete examples of the better-preserved tin oxhide ingots suggest their weights to be roughly comparable to those of the copper oxhide ingots. Other ingot shapes are also represented, including complete (Fig. 4) and partial rectangular slab ingots (Fig. 5), quadrants of rectangular ingots with rounded corners and beveled sides, wedge-shaped sections cut from very thick ingots of indeterminate shape (Fig. 6), halves of elongated ovoid ingots, bun or plano-convex discoid ingots (Fig. 7), and a unique thick rectangular ingot pierced at one end, having the appearance of a stone anchor of the type carried on the Uluburun ship (Fig. 8). Although some of the complete ingots and ingot fragments have one or more perforations punched through them, probably to facilitate their handling or aid in securing them to pack animals for transport, none of the oxhide ingots, whether intact or cut, were perforated.

The uncut, complete copper and tin oxhide ingots probably represent the primary shape in which the smelted metal was transported from mining areas to trading or distribution centers. Having reached these destinations, most of the tin ingots were cut up before redistribution; perhaps ingot pieces of smaller weights were considered more convenient for weighing, transporting, or trading. Smaller ingot pieces would also have been required when only a limited quantity of tin was required for exchange. The Uluburun tin ingot assemblage was, therefore, most likely gathered through a variety of mechanisms such as direct trade from a primary source, local barter, levies, taxes, or gifts in order to achieve the 1:10 tin-to-copper ratio found in the metal cargo of the Uluburun ship. The fragmentary state of most of the tin ingots suggests that they were collected from one or more distant sources, perhaps changing hands several times and then being stored over an extended period before being loaded on the ship. On the other hand, much of the copper cargo consists of intact ingots (with a small number of cut and broken ingots also found) and was almost certainly procured directly from Cyprus, without having changed hands and being cut into smaller pieces during this process, before being stockpiled in a mainland entrepot. This situation also indicates a closer link to the source or sources of the copper ingots.

THE INCISED MARKS ON THE ULUBURUN INGOTS

The marks incised on the Uluburun copper and tin ingots offer some evidence for the organization of this trade, although the significance of these marks is still poorly understood (Table 1). All marks, whether on copper or tin ingots, were made by cutting or incising with a chisel, using multiple strokes; thus, all of the marks are secondary marks, which could have been placed on the ingots any time after the ingots had been cast and allowed to cool. Preliminary examination of the copper ingots show that at least 162 of the copper oxhide ingots are incised with at least one, and rarely up to three, marks on their upper surfaces. At least 32 different types of marks occur on the upper, rough surfaces of the copper oxhide ingots; 13 appear more than once, and one is repeated as many as 17 times. At least 26 copper oxhide ingots have linear markings chiseled into the sides of the ingot. Five of the ingots with such marks (KW 2512, 2744, 2816, 3027, and 4003) also have incised marks or score marks on their rough, or upper, surfaces (Pulak 1998: 194-196; 2000b: 152-153). These marks, usually consisting of single, opposing, diagonal strokes that form alternating 'V's, are much simpler than those placed on the upper surfaces of the ingots and may be tally marks rather than marks with the same function as those on the rough surfaces of the oxhide ingots. Among the plano-convex discoid or bun ingots, 62 have marks incised into their lower or smooth mold surfaces. This is in contrast to the oxhide ingots, where the marks are placed only on the rough upper surfaces of the ingots. These marks are similar or identical to marks found on the copper oxhide ingots. Seven different varieties of marks occur on the copper bun ingots, five of which also occur on the copper oxhide ingots. Some of the Uluburun ingot marks appear to have maritime themes: fishhooks, fish, possible quarter rudders, ships, and perhaps also tridents, which suggest that they were made in an area near the sea (Pulak 1998: 194-196). Some of the marks have counterparts in ancient scripts, especially in the Cypro-Minoan syllabary, such as the trident-shaped mark (Table 1: b2) mentioned above, but others do not appear to correspond to any known mark and may simply be figural or abstract representations.

At least 25 Uluburun tin ingots were found with incised marks, although only 16 are fully preserved, four are partially preserved, and the shape of one is indeterminate. Other marks may have been completely obliterated by corrosion and blistering of the ingots' surfaces. With one exception, that of a quarter rectangular slab ingot, with mark f5 (Table 1), which may be a partly preserved variant of mark d6, all of the marked ingots are quarter oxhide ingots; none of the intact tin ingots bear any marks. These marks comprise ten different types, six of which are found only on tin ingots (Table 1: f3-6, g1-2). Some of these marks seem to be minor variations of the other marks. For example, the mark found on tin ingot KW 203 (Table 1: g2) is found on both the copper oxhide and bun ingots, as well as on two of the tin ingots, but without the chiseled line parallel to one of the arms of the 'U' (Table 1: b3). The mark on tin ingot KW 2777 (Table 1: f4) is similar to one seen on four other tin ingots (Table 1:f3), but lacks several extra strokes at the terminus of the arms and body of the mark. Finally, the marks on ingots KW 315 and KW 946 (two parallel chisel marks—Table 1: g1) are similar to that on KW 722 (three parallel chisel marks-Table 1: f6).

Four of the tin ingot marks (Table 1: a5, b3-4, d6) also occur on either the copper oxhide or copper bun ingots. Two tin ingots (KW 403 and KW 3061) have two identical or nearly identical marks incised on both the upper and mold surfaces of the ingots. Other tin ingot fragments have incised marks that may be only random chisel marks, guidelines for cutting the ingot, or accidental excavation damage; two such ingots (KW 946 and KW 1772) also have incised marks. Score marks occur on up to 16 of the copper oxhide ingots from Uluburun, where they usually bisect the ingot or delineate a corner to be broken or cut off. This was a common method for breaking up metal ingots, as seen from the oxhide ingot assemblages at Cape Gelidonya, Şarköy, and other sites. In the case of copper ingots, however, after scoring the ingots, breaking proceeded by forcefully striking the ingot with a sledge hammer, causing it to fracture along the score mark. With tin ingots, the ductility of the metal prevented this. All the cut tin ingots from Uluburun, whose edges were sufficiently preserved, reveal that the ingots were cut deeply with a chisel from either one or both sides and the remaining bridge of metal broken through by fatiguing the metal through bending it forward and backward repeatedly (Fig. 9).

The marks on all of the Uluburun copper and tin ingots are incised, which suggests that they were made at a point of export or receipt rather than at the point of manufacture. This is all the more applicable for the Uluburun tin ingots since only the cut ingots are thus marked. The marks could be owners' marks or marks indicating the receipt of ingots from a particular source or through a certain agent or consignor. This evidence contrasts with other copper ingots, such as those from the Cape Gelidonya shipwreck, where some of the ingots are marked with 'primary marks' that were cast into the ingot or impressed on the ingot when the metal was still soft (Bass 1967: 72). Along with the fragmentary state of the tin ingots, the secondary marks suggest that the ingots were assembled from a variety of secondary sources, where they were divided and marked, collected at a central trading settlement, and then sent on to the port where the Uluburun ship was loaded. That some of the tin ingot marks have Cypro-Minoan counterparts is seen as an indication that the tin ingots passed through Cypriot hands on Cyprus (Maddin et al. 1977: 46; Muhly 1978: 45; Wheeler-Stech et al. 1979: 148), which may well have been the case. The presence of these marks on the Uluburun tin ingots and those found off the coast of Israel have also been interpreted as a control and manipulation of the tin supply by Cypriots, who marketed the imported tin along with their Cypriot copper (Kassianidou 2003: 115-116). This may be so, but one must keep in mind that not all the tin ingots are marked, those that bear marks similar to Cypro-Minoan script have similar counterparts in other ancient scripts of the region, and many other marks on the tin ingots do not appear to correspond to any kind of ancient script. Moreover, since the tin came from the mainland and had to pass through the hands of various city-states along the Levantine coast, unlike the copper which was produced on Cyprus, it would have been impractical and difficult for the Cypriots to procure all the tin from their maritime merchant neighbors only to sell some of it back to them, as well as marketing it exclusively to other tin-starved Mediterranean cities. One could only assume at this point, therefore, that some of the tin circulating in the eastern Mediterranean, where tin was an important commodity sometimes used as a form of currency, was exchanged through Cypriot hands. Since the Uluburun tin ingots represent a stockpile of previously-circulated tin that was accumulated over time, it is only logical that some of the ingots also carry Cypro-Minoan syllabary.

THE OXHIDE INGOT SHAPE AND TIN SOURCES IN THE MEDITERRANEAN

The origin of the oxhide ingot shape is unknown, but it appears to have developed some time in the first half of the second millennium BC. The earliest evidence thereof appears at 16th-century sites on Crete and is shown in contemporary Egyptian tomb paintings, where they are often associated with Syrian merchants and tribute-bearers (Pulak 1998: 193; 2000b: 138; Bass 1967: 62-67). Later copper oxhide ingots, in contexts dating between the 14th and 12th centuries BC, have been found in Iraq, Syria, the Nile Delta, Turkey, Greece, Cyprus, Israel, Crete, Bulgaria, Sicily, Sardinia, Corsica, southern Germany, and southern France (Domergue and Rico 2002: 141-144; Lo Schiavo 2005: 402-408, 406-408; Gale 1991: 200-201; 1999: 117; Primas 2005: 389; Primas and Pernicka 1998: 27-50). Lead-isotope data indicates that nearly all of the copper oxhide ingots derive from several copper deposits in Cyprus, although a selection of the earliest oxhide ingots from Crete come from an unknown source or sources, which, based on the early geological (Precambrian and Devonian) dates of these ores, appear to be outside the Mediterranean region; ores of such early geological dates, however, are found in Central Asia (Gale and Stos-Gale 2005: 117-131; Stos-Gale 2004: 53-59; Gale et al. 2000: 339; Stos-Gale et al. 1997: 109-112; 1998: 115-126).

The sources of Bronze Age tin for the eastern Mediterranean region have been more difficult to determine. Tin bronzes begin to appear in significant numbers in the Near East and the Aegean during the third millennium BC. The Persian Gulf site of Tel Abraq may have been supplied with tin from the same source as a number of Aegean sites, perhaps indicating large-scale mining and export from a single region (Weeks 1999: 49-50, 52, 59). Ancient texts from Mari in Syria dating to the early second millennium BC indicate that tin was exported to the west of the city and probably came from a source or sources to the east or northeast (Pulak 1998: 199; Dossin 1970: 101-106; Muhly 1985: 283-285; Weeks 1999: 51). The tin from Mari was transported in the form of slabs of approximately 7 minas (2.5 kg) each (Veenhof 1972: 34-35). Recent research has uncovered tin deposits in the Zeravshan Valley of Uzbekistan and Tajikistan. In this region, at the sites of Karnab and Mushiston, ancient tin mining galleries dating to the Andronovo culture (c. 2000-1500 BC) were identified based on ceramic and radiocarbon dates (Cierny and Weisgerber 2003: 24-29; Cierny et al. 2005). Tin deposits have also been identified in eastern Kazakhstan (Cierny et al. 2005: 440). Excavations in central Anatolia at an ancient mine at Kestel and a nearby Bronze Age settlement at Göltepe show that a tin deposit in the Taurus Mountains north of Bolkardağ was exploited during the Early Bronze Age and, perhaps, intermittently over the next thousand years (Yener 2000: 71-109; Yener et al. 2003: 181-187). However, at this site there is no evidence of Late Bronze Age exploitation. A tin deposit has been found in Turkey at Madenbelentepe, in the Handere Valley near Soğukpınar, south of Bursa, but there is no evidence of any ancient exploitation at this deposit (Belli 1991: 7). The Tell al Rimah tablets, dated to the early 13th century BC, contain references to 25 kg of tin imported by Assyrians from the land of Nairi in southeastern Anatolia (Belli 1991:2) as well as varying amounts of tin (up to ten talents) in a number of loan contracts (Wiseman 1968: 175-176). Belli (1991:2-3) notes that Assyrian tributaries in the lands southeast of Lake Van, Diyarbakir, and northern Syria paid tribute in tin, probably obtained from a major trade route running from Afghanistan to the Mediterranean.

During the 19th century BC tin was exported overland from Assur to an Assyrian trading settlement at Kaneş/Kültepe in south-central Anatolia. Clay tablets excavated from the site detail the importation of large amounts of tin from Assyria for sale in Anatolia (Veenhof 1972). Estimates vary on the amounts imported: based on surviving tablets, McKerrell (1978: 21) estimated that approximately one ton of tin a year was imported, while Larsen (1976: 91) estimates that about 13,500 kg of tin were imported to Kaneş/Kültepe over fifty years. Tin exports from the source used by Old Assyrian merchants may well have been much larger than indicated by the Kaneş/Kültepe tablets. A clay mold from the site for making bar-shaped ingots has been identified as being used for tin ingots, but this identification has yet to be verified.[4]

Surviving documents of Assyrian merchants from Kaneş/Kültepe indicate that tin was transported in donkey caravans and was carried in several forms. In some instances, tin quantities are called riksum, from a root word meaning "tied up, bound together"; riksū of gold and silver are mentioned in texts as weighing between a few shekels and two minas, while riksū of tin are recorded as weighing between 5-15 minas (Veenhof 1972: 33). Several references involve dividing or mixing metal loads into riksū; this appears to indicate that the tin was handled in small, possibly irregular pieces wrapped into bundles of a standard weight (Veenhof 1972: 34-35). Bags, probably of leather, called šuqlum were used to carry gold and silver objects and amounts of copper up to 100 minas; these may have also been used to transport and store tin (Veenhof 1972: 40-41). For long-distance transport, however, wrapped bundles called šuqlum, or "standard weight", of approximately 65 minas (c. 32.5 kg), were commonly used (Veenhof 1972: 28-30; Veenhof and Eidem 2008: 82). Textiles were "systematically" used for wrapping the tin load into bundles of specific weight; two "textiles for wrapping" were used for each šuqlum, which was then loaded on one side of a donkey (Veenhof 1972: 28-30). Each donkey carrying tin was typically loaded with two šuqlum packed in two half-packs, one each hanging from either flank of the donkey; these packs would contain a total of around 130 minas of tin. A smaller top-pack of 10-12 minas of "loose tin", in addition to several textiles and perhaps some food and personal possessions, would be loaded on top of the donkey. The large packs were sealed with clay bullae before departure to prevent tampering en route, while the 'loose tin' in the top pack could be used to pay expenses on the road (Veenhof 1972: 31-32, 45).

Several of the Kaneş/Kültepe documents indicate that tin was also transported in the form of oblong ingots or slabs; one document mentions a slab of approximately 4.1 kg, while another mentions a load of 3 slabs weighing 32 ¼ minas, or approximately 4.9 kg apiece (Veenhof and Eidem 2008: 82). These slab ingots are listed in groups which together make up a standard weight of approximately 29.6 kg, the weight transported in one half-pack of a donkey (Veenhof and Eidem 2008: 82). This weight corresponds to a talent weight and appears to roughly correspond to the weight of the better preserved, heavier Uluburun copper ingots and also, to some extent, the weight of the Uluburun rectangular slab and oxhide ingots. The Kaniş/Kültepe texts show that tin was imported in large amounts overland to Anatolia from an eastern source, perhaps the same source or sources which supplied the tin ingots of the Uluburun shipwreck 500 years later. There is no evidence that indicates the use of oxhide ingots in this period, however.

The importation of tin from a western source is also theoretically possible, but so far there is no direct evidence for such a link during the Bronze Age (Muhly 1973: 183, 268-269; 1985: 286-287; Penhallurick 1986: 123-138).[5] Scraps of imported tin have been found on Nuragic sites in Sardinia, and small tin deposits are known on the island, but evidence of Bronze Age mining and exploitation of local deposits is lacking (Valera and Valera 2003: 3-4). Recently discovered alluvial cassiterite deposits and copper ores in the mountains of western Serbia, in the Central Balkans, also lack evidence for their exploitation during the Bronze Age. Although many mining activities and remains of artifacts such as hammers and ceramics in the region exists, these appear to be connected with the exploitation of copper only (Durman 1997: 11). Small tin deposits occur in Greece and Tuscany, but these show no evidence of exploitation in the Bronze Age (Skarpelis 2003; Gale and Stos-Gale 2002: 291). There is a similar lack of evidence for the export of tin to the Mediterranean from the Erzgebirge mines in the Alps of northern Bohemia and southern Saxony (Muhly 1985: 288-290; Stos-Gale et al. 1998: 119-120; Niederschlag and Pernicka 2002: 51)[6] or from smaller deposits in the Eastern Desert of Egypt, Saudi Arabia and Yemen (Muhly 1985: 283; Rapp et al. 1999; Weeks 1999: 50, 60).

Thirty-two tin ingots were sampled from the Uluburun ship by drilling and the microscopic structure of the metal examined using optical emission spectrometry. The tin ingots found were found to be highly corroded, often with only a small core of metal remaining, surrounded by tin corrosion products, formed by a combination of tin, copper, and precipitation from seawater. Microscopic observation of the tin ingots showed that they were structurally homogenous and had few inclusions of any kind, other than a few small crystals of magnetite (Hauptmann et al. 2002: 15-16). Chemical analyses of the sampled tin ingots were also performed. These tests showed that the tin ingots were extremely pure, with few trace elements, and that the lead levels in the Uluburun tin ingots were generally low. Among a group of 72 tin ingots, the lead concentrations ranged from less than 10 parts per million (ppm) to 2,759 ppm, with five of the ingots having concentrations greater than 3,000 ppm, and, in one instance, as high as 10,805 ppm. Of these ingots, 32 have lead concentrations below 100 ppm, 17 between 100 and 1,000 ppm, and 23 greater 1,000 ppm.[7] Roughly similar groupings based on lead concentrations were obtained from earlier chemical analyses of tin ingots from Uluburun, and the Hishuley Carmel and Kfar Samir shipwrecks near Haifa, Israel. The tin ingots with low-lead content from Uluburun generally correspond closely to the lead content of tin ingots from the Hishuley Carmel shipwreck, while the Uluburun tin ingots with the higher lead content correspond to the lead content in an ingot from Kfar Samir shipwreck (Hauptmann et al. 2002: 16-17). The four tin objects from Uluburun (discussed below) match the analyzed group of tin ingots with the higher lead content (Pulak 2000a: 155).

Lead-isotope analyses of 99 of the Uluburun tin ingots also show two fairly distinct groups: a group (B) with an average high-lead content that overlaps well with polymetallic ores and tin from the Bolkardağ region of the Taurus Mountains of south-central Anatolia, and a group (A) with an average low-lead content that has no overlap with the lead-isotope fingerprint of Taurus ores (Fig. 10). It may be suggested, therefore, that Group B ingots originate from the Taurus range and Group A ingots from Central Asia (Stos-Gale et al. 1998: 119; Pulak 2000a: 153-155; 2001: 23). It should be stressed, however, that the proposed sources for the Uluburun tin ingots is only a tentative one. Future research and geological prospecting may reveal additional tin deposits with similar lead-isotope fingerprints to that of Group B located outside the Mediterranean region. Group A tin ingots, however, are from tin ores of geologically early origins that do not occur in the Mediterranean, and their source is likely to be in somewhere in Central Asia, including Afghanistan. Weeks (1999: 60-61) points out that tin deposits in Afghanistan vary in age from Precambrian to Oligocene; thus, if two nearby tin deposits of different geological ages were exploited for tin, the resulting ingots could easily have different lead isotope signatures. What is clear, however, is that the lead-isotope data from the Uluburun tin ingots do not overlap with any of the major tin sources in Europe, specifically with those of the Erzgebirge region of the Alps or with tin sources in Cornwall and Spain (Pulak 2001: 23) (Fig. 11). Moreover, none of the ingots' lead-isotope signatures match that of an Early Bronze Age tin bangle found at Thermi on Lesbos (Stos-Gale et al. 1998: 119). The lead-isotope signature of the tin ingots found off the Israeli coast at Hishuley Carmel overlaps that of the Uluburun Group A tin ingots with low lead concentration; the lead-isotope signature of this group has not yet been matched to a specific tin source but, based on its early geological origins, is thought to lie in Central Asia. Of the 99 Uluburun tin ingots, for which lead-isotope values are available, 29 are of Group A, and have an average lead concentration of approximately 15 ppm. The remaining 70 ingots conform to Group B and have an average lead concentration of approximately 1,100 ppm (Fig. 10). There seems to be no clear correlation among the analyzed tin ingots between the shape of an ingot and its lead-isotope group. While tin oxhide ingots occur both in Groups A and B, Group A ingots consist of only oxhide ingots with three exceptions, two of which are wedge-shaped ingots cut from very thick ingots of indeterminate shape (the two wedges may have been cut from the same ingot), and a corner of a rectangular slab ingot.

Very few finished tin objects are known from the Late Bronze Age Mediterranean (Pulak 1997: 243; 2001: 43; Muhly 1980: 34-35). An Early Bronze Age bracelet or ring was found on Lesbos (Lamb 1936), and two rings occur in the Late Bronze III sanctuary at Phylakopi on the island of Melos (Renfrew and Cherry 1985). A tin ring was found in a tomb at Tel Abraq in the United Arab Emirates dating to the end of the third millennium BC (Weeks 2003: 123-124), and a tin-lead bangle dating to the early second millennium BC was discovered at Tepe Yahya in southeastern Iran (Thornton 2007: 130). Four tin objects were found on the Uluburun shipwreck. Three are vessels: a plate (KW 422), a mug (KW 313), and a tin pilgrim flask (1085). The pilgrim flask is very similar to an example from an 18th-Dynasty Egyptian tomb (Ayrton et al. 1904: 50, Pl. XVII.20); the other two vessels are unique. Gillis (1999) has also proposed that some Mycenaean ceramic vessels had occasionally been covered in tin to give them the appearance of vessels made of precious metals (Gillis 1999: 141-142). The fourth tin object from the Uluburun ship is an elbow joint of a drinking straw (KW 419), probably for drinking beer. The drinking end and an elbow joint would have been metal, while the two tubes of the straw would have been made of cane (Weisgerber 2005).[8] Iconographic evidence from Egypt and Anatolia show how a complete beer straw would have been used (Weisgerber 2005). The rarity of tin vessels in the Bronze Age Mediterranean suggests that the vessels on the Uluburun ship were prestige items intended as gifts for royalty or high-ranking individuals at the ship's destination.

The tin ingots of the Uluburun shipwreck represent the largest body of physical evidence for the large-scale transport of tin in the Bronze Age. Further archaeometric analysis is needed for determining the source or sources of the Uluburun tin, but preliminary lead isotope analyses suggest that the metal originated from at least two separate sources, one in the Taurus Mountains of south-central Anatolia, the other an as-yet unidentified source, most likely in Central Asia. Geological evidence for tin sources in the eastern and central Mediterranean open the possibility of local exploitation of tin for bronze, but no direct evidence exists for the use of any of these deposits as major sources of tin for the eastern Mediterranean in the Late Bronze Age. The bulk of the tin used in this period likely arrived in the eastern Mediterranean region along the same trade routes traveled by the tin ingots of the Uluburun ship, first being carried overland from their source or sources (probably in central Asia) to a Levantine port, then transported by sea to Cyprus and the Aegean, and other destinations. Evidence of these sea routes in the form of copper and tin ingots from underwater sites and port towns occurs on the coast of Israel, the southern coast of Anatolia, the Aegean, and at the port town of Mochlos in Crete. These finds are doubtless only a miniscule proportion of the total tin cargo shipped in this period.

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NOTES:

1 Robert Brill of the Corning Museum of Glass, personal communication, August 31, 1989. The tin-lead alloy metal lumps or ingot fragments from Cape Gelidonya could have been produced experimentally, or the lead deliberately added as an adulterant, or to make a very early example of pewter or a solder; a single metal clasp from a 10th-century AD deposit at Shamsir Ghar in Afghanistan has a similar composition to the alloy recovered from the Cape Gelidonya wreck (Dupree 1958: 292).

2 A single tin ingot from the Uluburun wreck (KW 199) was found to contain at its core two pieces of partially melted small lead bar ingots (Pulak 2000a: 155, fig. 24). This was an extensively corroded plano-convex discoid or bun ingot, much cruder than the other tin ingots found at Uluburun; unlike the other tin ingots, KW 199 appears less likely to have been cast at a primary source, and was perhaps formed from tin scrap instead.

3 The unique small oxhide ingot with short, bulky corner projections has an unusual lead-isotope fingerprint, which appears similar to the isotopic field of Lavrion in Greece. Even so, the ingot must have originated from Cyprus, but was probably made from copper ores that were different than those smelted for most of the other ingots on the Uluburun ship. (Pulak 2001: 21-22).

4 Müller-Karpe (2005: 492; 1994: Taf. 21,2) identifies a clay mold for bar-shaped ingots from Kaniş/Kültepe as being for tin due to the approximate weight of four shekels (32-34 g); he reasons that this weight is perfect for adding to the re-melting of a one mina (approximately 500 g) copper ingot, to produce a 6-7% tin bronze, a similar copper-to-tin ratio found in bronze artifacts from the site. However, the re-melting of ingots or tin scrap imported by Assyrian merchants would be an unnecessary expenditure of time and fuel; the tin would melt more easily in small pieces than as a large ingot, and it could have simply been broken up and weighed before being combined it with the copper.

5 Shipments by sea of tin ingots from western tin sources, however, do occur after the Bronze Age. The Archaic shipwrecks of Cala Sant-Vicenç (520-500 BC) (Nieto and Santos 2008: 238-241) and Bajo de la Campana A (6/5th century BC) (Bernal et al. 1995, 16: 30-32), both in southern Spain, and Roman shipwrecks of Bagaud B (late 2nd century/early 1st century BC) (Long 1985: 93-94; 1987: 151-153) and Port-Vendres II (AD 42-48) (Colls et al. 1977: 7, 11, 18) in southern France, Rodona (Ist century AD) (Parker 1992: 365) in southern Spain, and Capo Bellavista (late 1st century BC/1st century AD) (Gianfrotta 1996: 138) off Sardinia, are among the more noted examples of wrecks with tin ingots. Since these ingots have not been subjected to lead-isotope analysis, their precise sources are not known.

6 Niederschlag and Pernicka (2002: 51) mention the discovery of Late Bronze Age or Early Iron Age pottery in the vicinity of a tin alluvial deposit in the Erzgebirge region. Bronze Age settlements are also located approximately 20 km from the ore deposits of the eastern Erzgebirge. However, no evidence for direct Bronze Age tin exploitation (stone hammers or other mining tools, mineshafts, furnaces, etc.) has been found.

7 The analyses for lead content and lead-isotopes were made at the Isotrace Laboratory at Oxford and have not yet been published in full.

8 Weisgerber (2005: 157) identifies the elbow-joint of the drinking straw as lead, but a chemical analysis by Robert Brill (personal communication, August 31, 1989) identified a sample from the object as tin-lead alloy.

REFERENCES

Artzy, M. 1983
"Arethusa of the Tin Ingot", *Bulletin of the American Schools of Oriental Research* 250: 51-55.

Ayrton, E.R., C.T. Currelly and A.E.P. Weigall 1904
Abydos III. Egypt Exploration Fund, London.

Bass, G.F. 1967
"Cape Gelidonya: A Bronze Age Shipwreck", *Transactions of the American Philosophical Society* 57: 8.

Bass, G.F. 1986
"A Bronze Age Shipwreck at Ulu Burun (Kaş): 1984 Campaign", *American Journal of Archaeology* 90: 269-296.

Bass, G.F., C. Pulak, D. Collon and J. Weinstein 1989
"The Bronze Age Shipwreck at Ulu Burun: 1986 Campaign", *American Journal of Archaeology* 93: 1-29.

Belli, O. 1991
"The Problem of Tin Deposits in Anatolia and Its Need for Tin, According to the Written Sources", A. Çilingiroğlu and D.H. French (eds.) *Anatolian Iron Ages* (The Proceedings of the Second Anatolian Iron Ages Colloquium held at Izmir): 1-10. Oxbow Books, British Institute of Archaeology at Ankara Monograph, Oxford.

Bernal, B.R., M.M. Camino and Mª A.P. Bonet 1995
"El yacimento submarino del Bajo de la Campana", *Cuadernos de Arqueología Maritíma* 3: 11-362.

Bouzek, J. 1985
The Aegean, Anatolia, and Europe: Cultural Interrelations in the Second Millennium BC. Paul Åströms Förlag, Studies in Mediterranean Archaeology 29, Göteborg.

Buchholz, H.-G. 1959
"Keftiubarren und Erzhandel im zweiten vorchristlichen Jahrtausend", *Prähistorische Zeitschrift* XXXVII: 1-40.

Buchholz, H.-G. 1966
"Talanta, Neues über Metallbarren der ostmediterranean Spätbronzezeit", *Schweizer Münzblätter* 16/62: 58-72.

Cierny, J. and G. Weisberger 2003
"Bronze Age Tin Mines in Central Asia", A. Giumlia-Mair and F. Lo Schiavo (eds.) *The Problem of Early Tin*: 23-34. Archaeopress, BAR International Series 1199, Oxford.

Cierny, J., Th. Stöllner and G. Weisberger 2005
"Zinn in und aus Mittelasien", Ü. Yalçın, C. Pulak and R. Slotta (eds.) *Das Schiff von Uluburun. Welthandel vor 3000 Jahren*: 431-448. Deutsches Bergbau Museum, Bochum.

Colls, D. et al. 1977
L'épave Port-Vendres II et le commerce de la Bétique a l'époque de Claude. Archaeonautica I. Éditions du Centre National de la Recherche Scientifique, Paris.

Dimitrov, B. 1979
"Underwater Research along the South Bulgarian Black Sea Coast in 1976 and 1977", *International Journal of Nautical Archaeology* 8/1: 70-79.

Domergue, C. and C. Rico 2002
"À propos de deux lingots de cuivre antiques trouvés en mer sur la côte languedocienne", *Vivre, produire et échanger: reflets méditerranéens. Mélanges offerts à Bernard Liou*: 141-152. Éditions Monique Mergoil, Montagnac.

Dossin, G. 1970
"La route de l'étain en Mésopotamie au temps de Zimri-Lin", *Revue d'assriologie et d'archéologie orientale* 64: 97-106.

Dupree, L. 1958
"Shamsir Ghar: Historic Cave Site in Kandahar Province, Afghanistan", *Anthropological Papers of the American Museum of Natural History* 46/2: 141-311.

Durman, A. 1997
"Tin in Southern Europe?", *Opuscula Archaeologica* 21: 7-14.

Gale, N.H. 1989
"Archaeometallurgical Studies of Late Bronze Age Ox-Hide Copper Ingots from the Mediterranean Region", A. Hauptmann, E. Pernicka and G.A. Wagner (eds.) *Old World Archaeometallurgy*: 247-268. Selbstverlag des Deutschen Bergbau Museums, Bochum.

Gale, N.H. 1991
"Copper Oxhide Ingots: Their Origin and Their Place in the Bronze Age Metals Trade in the Mediterranean", N.H. Gale (ed.) *Bronze Age Trade in the Mediterranean*: 197-240. Paul Åströms Förlag, Studies in Mediterranean Archaeology XC, Jonsered.

Gale, N.H. 1999
"Lead Isotope Characterization of the Ore Deposits of Cyprus and Sardinia and its Application to the

Discovery of the Sources of Copper for Late Bronze Age Ingots", S.M.M. Young et al. (eds.) *Metals in Antiquity*: 110-121. BAR International Series 792, Archaeopress, Oxford.

Gale, N.H. and Z.A. Stos-Gale 2002
"Archaeometallurgical Research in the Aegean", M. Bartelheim, E. Pernicka and R. Krause (eds.) *The Beginnings of Metallurgy in the Old World*: 277-302. Verlag Marie Leidorf, Rahden.

Gale, N.H. and Z.A. Stos-Gale 2005
"Zur Herkunft der Kupferbarren aus dem Schiffswrack von Uluburun und der Spätbronzezeitliche Metallhandel im Mittelmeerraum", Ü. Yalçın, C. Pulak and R. Slotta (eds.) *Das Schiff von Uluburun. Welthandel vor 3000 Jahren*: 117-132. Deutsches Bergbau Museum, Bochum.

Gale, N., Z. Stos-Gale and G. Maliotis 2000
"Copper Oxhide Ingots and the Mediterranean Metals Trade: A New Perspective", *Acts of the Third International Congress of Cypriot Studies*: 327-344. Society of Cypriot Studies, Nicosia.

Galili, E., N. Schmueli and M. Artzy 1986
"Bronze Age Ship's Cargo of Copper and Tin", *International Journal of Nautical Archaeology* 15/1: 25-37.

Gianfrotta, P.A. 1996
"Un problema insoluto: Il relitto di Capo Bellavista", *Bolletino D'Arte: Archeologia Subacquea* 3: 135-138.

Gillis, C. 1999
"The Economic Value and Colour Symbolism of Tin", S.M.M. Young et al. (eds.) *Metals in Antiquity*: 140-145. BAR International Series 792, Archaeopress, Oxford.

Harmankaya, N.S. 1995
"Kazman Deresi Mevkii (Şarköy, Tekirdağ) Maden Buluntular", *Readings in Prehistory. Studies Presented to Halet Çambel*: 217-254. Graphis Yayınları, İstanbul.

Hauptmann, A., R. Maddin and M. Prange 2002
"On the Structure and Composition of Copper and Tin Ingots Excavated from the Shipwreck of Uluburun", *Bulletin of the American School of Oriental Research* 328: 1-30.

Karaitov, I. 1978
"Cretan Copper Ingot from the Village Tcherkovo, Burgas Region", *Numismatika* I: 13-17.

Kassianidou, V. 2003
"The Trade of Tin and the Island of Copper", A. Giumlia-Mair and F. Lo Schiavo (eds.) *The Problem of Early Tin*: 109-119. BAR International Series 1199, Archaeopress, Oxford.

Lamb, W. 1936
"Excavations at Thermi", *Annual of the British School at Athens* 30: 1-52.

Larsen, M.T. 1976
The Old Assyrian City-State and Its Colonies. Copenhagen Studies in Assyriology Volume 4, Akademisk Forlag, Copenhagen.

Lo Schiavo, F. 2003
"The Probem of Early Tin from the Point of View of Nuragic Sardinia", A. Giumlia-Mair and F. Lo Schiavo (eds.) *The Problem of Early Tin*: 121-132. Archaeopress, BAR International Series 1199, Oxford.

Lo Schiavo, F. 2005
"Metallhandel im zentralen Mittelmeer", Ü. Yalçın, C. Pulak and R. Slotta (eds.) *Das Schiff von Uluburun. Welthandel vor 3000 Jahren*: 399-414. Deutsches Bergbau Museum, Bochum.

Long, L. 1985
"L'épave antique Bagaud 2", *VI Congresso internacional de arqueologia submarina Cartagena 1982*: 93-98. Museo y Centro Nacionales de Investigaciones Arqueológicas Submarinas, Madrid.

Long, L. 1987
"Quelques precisions sur le conditionnement des lingots d'etain de l'épave antique Bagaud 2 (Var)", *Actes du colloque Mines et Métallurgie en Gaule et dans les provinces voisines*: 149-163. Éditions Errance, Paris.

Maddin, R., T. Stech-Wheeler and J.D. Muhly 1977
"Tin in the Ancient Near East: Old Questions and New Finds", *Expedition* 19/2: 35-47.

McKerrell, H. 1978
"The Use of Tin-Bronze in Britain and the Comparative Relationship with the Near East", A.D. Franklin, J.S. Olin and T.A. Wertime (eds.) *The Search for Ancient Tin*: 7-23. U. S. Government Printing Office, Washington.

Muhly, J.D. 1973
"Copper and Tin: The Distribution of Mineral Resources and the Nature of the Metals Trade in the Bronze Age", *Transactions of the Connecticut Academy of Arts and Sciences*, v. 43: 155-535. Archon Books, Hamden.

Muhly, J.D. 1978
"New Evidence for Sources of and trade in Bronze Age Tin", A.D. Franklin, J.S. Olin and T.A. Wertime (eds.) *The Search for Ancient Tin*: 43-48. U.S. Government Printing Office, Washington.

Muhly, J.D. 1980
"The Bronze Age Setting", A.D. Franklin, J.S. Olin and T.A. Wertime (eds.) *The Coming of the Age of Iron*: 25-68. Yale University Press, New Haven.

Muhly, J.D. 1985
"Sources of Tin and the Beginnings of Bronze Metallurgy", *American Journal of Archaeology* 89: 275-291.

Müller-Karpe, A. 1994
Altanatolisches Metallhandwerk. Wachholtz Verlag, Neumünster.

Müller-Karpe, A. 2005
"Metallbarren bei den Hethitern", Ü. Yalçın, C. Pulak and R. Slotta (eds.) *Das Schiff von Uluburun. Welthandel vor 3000 Jahren*: 485-492. Deutsches Bergbau Museum, Bochum.

Niederschlag, E. and E. Pernicka 2002
"The Provenance of Early Bronze Age Copper from Northern Bohemia and Central Germany: First Results from Physico-chemical Investigations", B.S. Ottaway and E.C. Wagner (eds.) *Metals and Society: Papers from a Session Held at the European Association of Archaeologists Sixth Annual Meeting in Lisbon 2000*: 51-60. BAR International Series 1061, Archaeopress, Oxford.

Nieto, X. and M. Santos 2008
Ex vaixell grec archaic de Cala Sant Vincenç. Monografies de CASC 7, Museu d'Arqueologia de Catalunya, Barcelona.

Parker, A.J. 1992
Ancient Shipwrecks of the Mediterranean & the Roman Provinces. BAR International Series 580, Tempus Repartum, Oxford.

Penhallurick, R.D. 1986
Tin in Antiquity: Its Mining and Trade throughout the Ancient World with Particular Reference to Cornwall. The Institute of Metals, London.

Primas, M. 2005
"Ochsenhautbarren in Europa", Ü. Yalçın, C. Pulak and R. Slotta (eds.) *Das Schiff von Uluburun. Welthandel vor 3000 Jahren*: 385-391. Deutsches Bergbau Museum, Bochum.

Primas, M. and E. Pernicka 1998
"Der Depotfund von Oberwilflingen. Neue Ergebnisse zur Zirkulation von Metallbarren", *Germania* 76: 25-65.

Pulak, C. 1988
"The Bronze Age Shipwreck at Ulu Burun, Turkey: 1985 Campaign", *American Journal of Archaeology* 92: 1-27.

Pulak, C. 1997
"The Uluburun Shipwreck", S. Swiny, R.L. Hohlfelder and H.W. Swiny (eds.) *Res Maritimae: Cyprus and the Eastern Mediterranean from Prehistory to Late Antiquity* (Proceedings of the Second International Symposium "Cities on the Sea", Nicosia, Cyprus): 233-262. Cyprus American Archaeological Research Institute Monograph Series 1, Atlanta.

Pulak, C. 1998
"The Uluburun Shipwreck: An Overview", *International Journal of Nautical Archaeology* 27/3: 188-224.

Pulak, C. 1999
"The Late Bronze Age Shipwreck at Uluburun: Aspects of Hull Construction", W. Phelps, Y. Lolos and Y. Vichos (eds.) *The Point Iria Wreck*: *Interconnections in the Mediterranean, ca. 1200 BC* (Proceedings of the International Conference, Island of Spetses): 209-238. Hellenic Institute of Marine Archaeology, Athens.

Pulak, C. 2000a
"The Copper and Tin Ingots from the Late Bronze Age Shipwreck at Uluburun", *Anatolian Metal* I (Der Anschnitt, Beiheft 13): 137-157.

Pulak, C. 2000b
"The Balance Weights from the Late Bronze Age Shipwreck at Uluburun", C.F.E. Pare (ed.) *Metals Make the World Go Round*: *The Supply and Circulation of Metals in Bronze Age Europe* (Proceedings of a Conference held at the University of Birmingham): 247-266. Oxbow Books, Oxford.

Pulak, C. 2001
"The Cargo of the Uluburun Ship and Evidence for Trade with the Aegean and Beyond", L. Bonfante and V. Karageorghis (eds.) *Italy and Cyprus in Antiquity 1500-450 BC*: 13-60. Costakis and Leto Severis Foundation, Nicosia.

Pulak, C. 2002
"The Uluburun Hull Remains", H. Tzalas (ed.) *Tropis* VI (7th International Symposium on Ship Construction in Antiquity): 615-634. Hellenic Institute for the Preservation of Nautical Tradition, Athens.

Pulak, C. 2005a
"Das Schiffswrack von Uluburun", Ü. Yalçın, C. Pulak and R. Slotta (eds.) *Das Schiff von Uluburun. Welthandel vor 3000 Jahren*: 55-102, with accompanying artifacts catalog on 559-633. Deutsches Bergbau Museum, Bochum.

Pulak, C. 2005b
"Discovering a Royal Ship from the Age of King Tut: Uluburun, Turkey", G.F. Bass (ed.) *Beneath the Seven Seas* (Adventures with the Institute of Nautical Archaeology): 34-47. Thames and Hudson, London.

Pulak, C. 2005c
"Who Were the Mycenaeans Aboard the Uluburun Ship?", R. Laffineur and E. Greco (eds.) *Emporia: Aegeans in the Central and Eastern Mediterranean (Aegeum 25):* 295-310, Pl. LXX-I. Université de Liège, Liège.

Pulak, C. 2008a
"The Uluburun Shipwreck and Late Bronze Age Trade", J. Aruz, K. Benzel and J.M. Evans (eds.) *Beyond Babylon*: *Art, Trade, and Diplomacy in the Second Millennium B.C.*: 288-305. The Metropolitan Museum of Art, New York.

Pulak, C. 2008b
"Cargo: Selection of Ingots", J. Aruz, K. Benzel and J.M. Evans (eds.) *Beyond Babylon*: *Art, Trade, and Diplomacy in the Second Millennium B.C.*: 307-310. The Metropolitan Museum of Art, New York.

Raban, A. and E. Galili 1985
"Recent Maritime Archaeological Research in Israel - A Preliminary Report", *International Journal of Nautical Archaeology* 14/4: 321-356.

Rapp, G., R. Rothe and Z. Jing 1999
"Using Neutron Activation Analysis to Source Ancient Tin", S.M.M. Young et al. (eds.) *Metals in Antiquity*: 153-162. BAR International Series 792, Archaeopress, Oxford.

Renfrew, C. and J. Cherry 1985
The Archaeology of Cult. Thames & Hudson, London.

Rutter, J. 2008
"The Mycenaean Pottery", J. Aruz, K. Benzel and J.M. Evans (eds.) *Beyond Babylon*: *Art, Trade, and Diplomacy in the Second Millennium B.C.*: 379-380. The Metropolitan Museum of Art, New York.

Skarpelis, N. 2003
"Ancient Potential Tin Sources in the Aegean", A. Giumlia-Mair and F. Lo Schiavo (eds.) *The Problem of Early Tin*: 159-164. Archaeopress, BAR International Series 1199, Oxford.

Soles, J. 2005
Excavations at Mochlos, Crete, in 2004. Paper Read at the Annual Meeting of the Archaeological Institute of America, 6-9th January, Boston.

Soles, J. 2008
100 Years at Mochlos, Gateway to Crete. Paper Read at the Annual Meeting of the Archaeological Institute of America, 4-6 January, Chicago.

Stos-Gale, Z.A. 2004
"The Geological Sources", J.S. Soles and C. Davaras (eds.) *Mochlos IC Period III. The Neopalatial Settlement on the Coast. The Artisans' Quarter and the Farmhouse at Chalinomouri. The Small Finds*: 52-59. INSTAP Academic Press, Philadelphia.

Stos-Gale, Z.A., G. Maliotis, N.H. Gale and N. Annetts 1997
"Lead Isotope Characteristics of the Cyprus Ore Deposits Applied to the Provenance Studies of Copper Oxhide Ingots", *Archeometry* 39/1: 83-124.

Stos-Gale, Z.A. et al. 1998
"The Copper and Tin Ingots of the Late Bronze Age Mediterranean: New Scientific Evidence", *Proceedings of the Fourth International Conference on the Beginning of the Use of Metals and Alloys* (*BUMA*-IV): 115-126. The Japan Institute of Metals, Aoba.

Thornton, C.P. 2007
"Of Brass and Bronze in Prehistoric Southwest Asia", S. La Niece, D. Hook and P. Craddock (eds.) *Metals and Mines*: *Studies in Archaeometallurgy*: 123-135. Archetype Publications, London.

Valera, R. and P. Valera 2003
"Tin in the Mediterranean: History and Geology", A. Giumlia-Mair and F. Lo Schiavo (eds.) *The Problem of Early Tin*: 3-14. Archaeopress, BAR International Series 1199, Oxford.

Veenhof, K.R. 1972
Aspects of Old Assyrian Trade and Its Terminology. E. J. Brill, Leiden.

Veenhof, K.R. and J. Eidem 2008
Mesopotamia in the Old Assyrian Period. Academic Press Fribourg, Vandenhoek & Ruprecht, Fribourg, Göttingen.

Weeks, L.R. 1999
"Lead Isotope Analyses from Tell Abraq, United Arab Emirates: New Data Regarding the 'Tin Problem' in Western Asia", *Antiquity* 73: 49-64.

Weeks, L.R. 2003
Early Metallurgy of the Persian Gulf: Technology, Trade, and the Bronze Age World. Brill, Boston.

Weisgerber, G. 2005
"Biertrinker an Bord? Ein seltener Fund aus Blei!", Ü. Yalçın, C. Pulak and R. Slotta (eds.) *Das Schiff von Uluburun. Welthandel vor 3000 Jahren*: 157-165. Deutsches Bergbau Museum, Bochum.

Wheeler-Stech, T., J.D. Muhly and R. Maddin 1979
"Mediterranean Trade in Copper and Tin in the Late Bronze Age Mediterranean", *Istituto Italiano di Numismatica*, *Annali* 26: 139-152.

Whitley, J. 2005
"Archaeology in Greece 2004-2005", *Archaeological Reports* (2004-2005): 1-118. The Society for the Promotion of Hellenic Studies 51, London.

Wiseman, D.J. 1968
"The Tell al Rimah Tablets, 1966", *Iraq* 30: 175-205.

Yener, K.A. 2000
The Domestication of Metals: The Rise of Complex Metal Industries in Anatolia. Brill, Leiden.

Yener, K.A., A. Adriens, B. Earl and H. Özbal 2003
"Analyses of Metalliferous Residues, Crucible Fragments, Experimental Smelts, and Ores from Kestel Tin Mine and the Tin Processing Site of Göltepe, Turkey", P.T. Craddock and J. Lang (eds.) *Mining and Metal Production Through the Ages*: 181-197. British Museum Press, London.

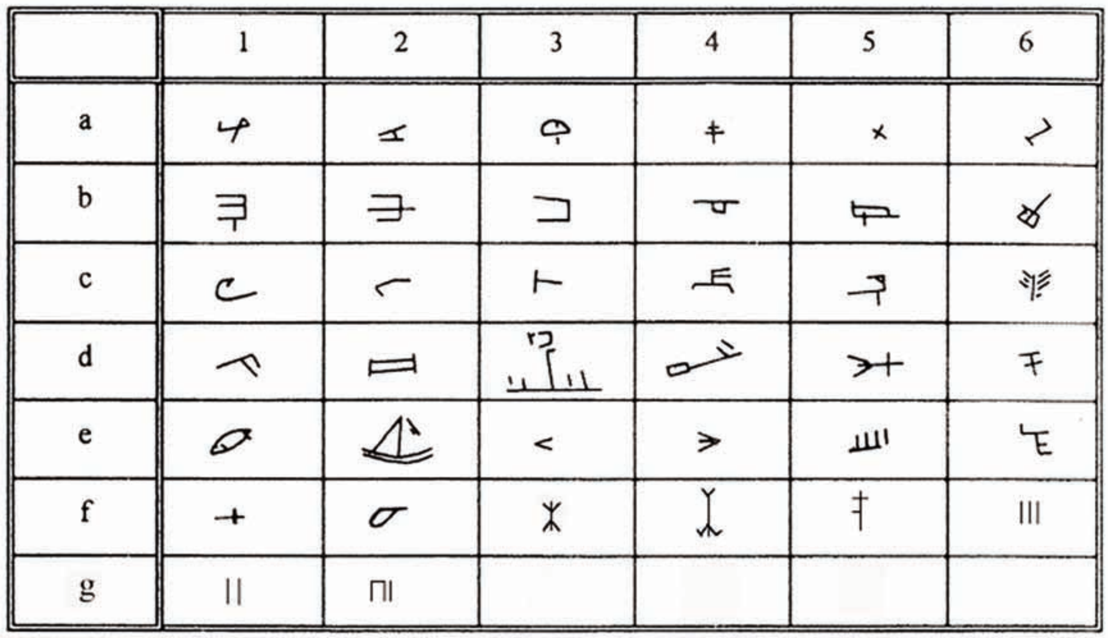

Table 1: Incised marks found on the Uluburun copper oxhide and plano-convex discoid or bun ingots, and tin ingots. Symbols f3-6, and g1-2 are marks found only on the tin ingots

Fig. 1. Two intact tin ingots *in situ* on the Uluburun shipwreck. An oxhide ingot lies under a rectangular slab ingot, both of which are trapped beneath one of the ship's 24 stone anchors. The disintegrating portion of the oxhide ingot was reinforced with metal bars and consolidated with plaster before being raised to the surface.

Fig. 2. Quarter oxhide ingots cut in antiquity from four separate intact tin oxhide ingots. No matching quarters have yet been located. Clockwise from top left: KW 204, KW 633, KW 403, and KW 205. Note that three of the ingots are marked with incised marks: b4 (KW 205) and d6 (KW 204 and KW 403), see table 1.

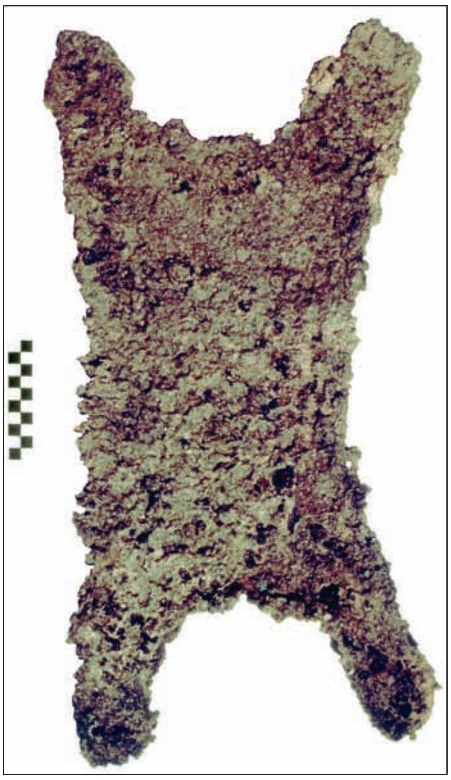

Fig. 3. One of three intact tin ingots (KW 1932) recovered from the wreck.

Fig. 4. Rectangular slab ingot (KW 2915) with corner cleaned of marine encrustation, revealing original surface of ingot blemished with corrosion "warts". Note chisel-punched hole at center of cleaned section.

Fig. 5. Three rectangular slab-ingot sections cut in antiquity (KW 2434, top left; KW 201, top right; KW 244, bottom). Note chisel-punched holes roughly corresponding to the center of each quadrant, presumably for ease of carrying the ingot and its fragments with lines passed through them. Lower ingot is half an ingot, hence the presence of two holes. That the lower left hole was cut through during the sectioning of the ingot indicates that all four holes were pre-drilled before the ingot was cut into sections. This indicates that the ingots were “designed” to be cut and transported in quadrants at a later time.

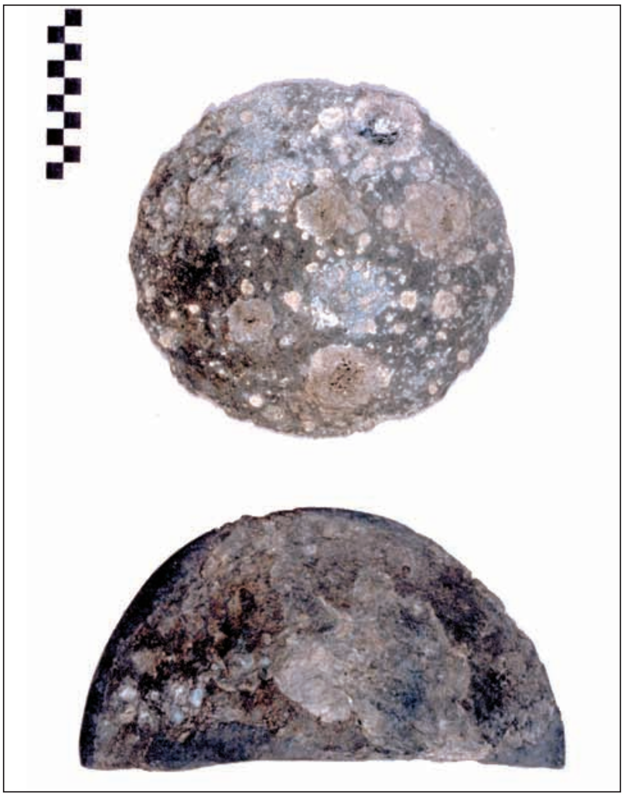

Fig. 7. Intact small (KW 401) and cut large (KW 519) plano-convex discoid or bun tin ingots.

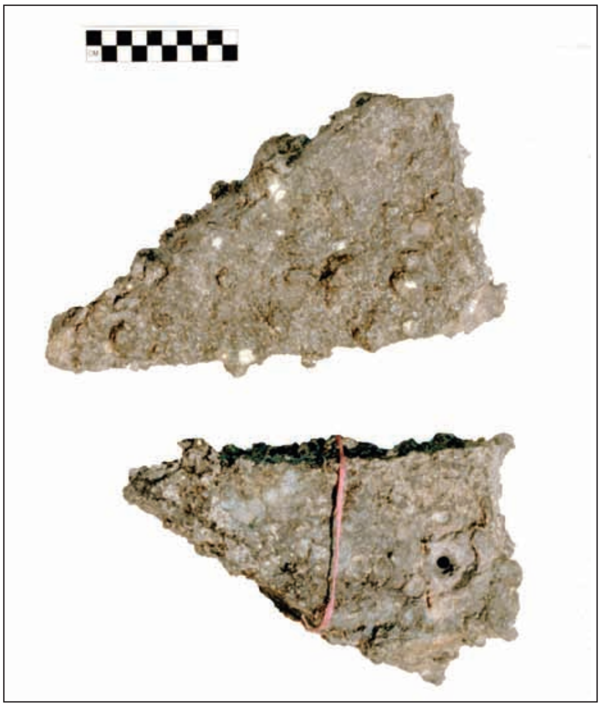

Fig. 6. Two tin ingot wedges cut from a very thick and heavy ingot of possibly discoid shape; KW2365 (top) and KW 2329 (bottom).

Fig. 8. Large rectangular tin ingot (KW 3935) with apical hole, resembling the stone anchors aboard the ship.

Fig. 9. Edge of quarter oxhide ingot KW 204 showing evidence of cutting from both sides with a chisel and then breaking the portion of bridging metal in the middle by repeated bending of the ingot in opposite directions.

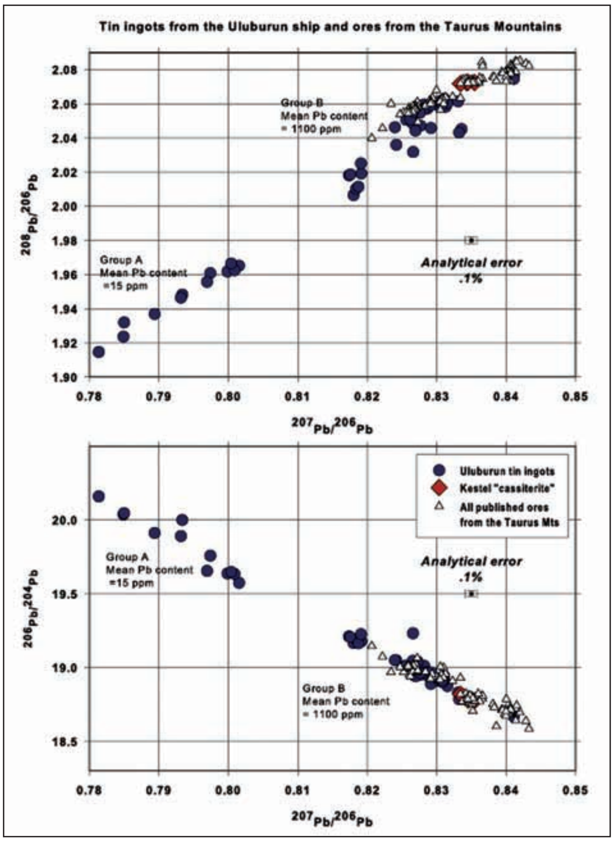

Fig. 10. Lead-isotope diagram of 99 Uluburun tin ingots and ores from south-central Taurus Mountains. The lead-isotope ratios of the Uluburun tin ingots form two separate signature groups: A and B. Group A tin ingots have significantly lower average lead concentration that that of Group B ingots. Only Group B ingots overlap the lead-isotopic field of Taurus ores. Courtesy of Zofie Stos-Gale, Noel H. Gale, and Robin Clayton.

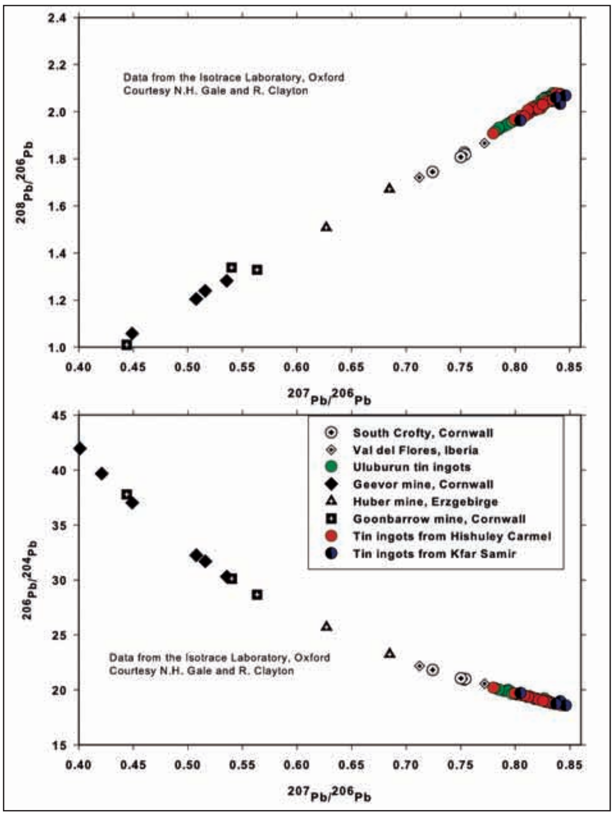

Fig. 11. Lead-isotope diagram of European tin ores (cassiterites) from three mines in Cornwall, the Huber mine in the Erzgebirge region of the Alps, Val del Flores in Iberia, and 99 tin ingots from Uluburun. Ten tin ingots from Kfar Samir and five tin ingots from Hishuley Carmel shipwrecks off the coast of Haifa, Israel, are also shown. The two shipwreck ingots overlap the lead-isotope field of the Uluburun ingots, suggesting that all originate from the same source or sources. Courtesy of Zofie Stos-Gale, Noel H. Gale, and Robin Clayton.

RETHINKING THE TIN MOUNTAINS: PATTERNS OF USAGE AND CIRCULATION OF TIN IN GREATER IRAN FROM THE 4TH TO THE 1ST MILLENNIUM BC

KALAY MADENİ OLAN DAĞLAR HAKKINDA YENİ YAKLAŞIMLAR: MÖ 4 – 1. BİNYILDA İRAN GENELİNDE KALAYIN KULLANIM VE DOLAŞIMI

Barbara HELWING

Keywords: Iran, tin, Bronze Age, tin alloy, metal trade

Anahtar Sözcükler: İran, kalay, Tunç Çağ, kalay alaşımı, metal ticareti

ÖZET

İran'da bakır ve kalay yataklarının bulunduğu yüksek kesimler ile, Mezopotamya'nın ilk kent devletlerinin ve özellikle bunların gelişen endüstrileri arasında yakın bir ilişki olduğu uzun yıllardan bu yana öngörülmekteydi. Sümer metinleri MÖ 3. binyıldan itibaren Mezopotamya'ya kalayının geliş yeri olarak İran'ın güney kesimlerine atıfta bulunmaları da bu yargıya varılmasına neden olmuştur. Buna rağmen bu yüksek düzlüklerde yakın zamana değin uygun niteliklere sahip eski kalay işletmelerine rastlanamamıştır. İran'ın orta ve doğu bölgelerinde gelişmekte olan ve uzun mesafeli ticarete yer alan kent devletlerin de kalayı bilinçli olarak kullanmadıkları bilinmekteydi. Ancak son yıllarda yapılan araştırmalar Zagroslar'da daha önceden bilinmeyen kalay, bakır ve altın madenlerinin varlığını ortaya çıkarmıştır. Yeni araştırmalar ışığında ve gelişen analiz yöntemleri ile bu maden yataklarının MÖ 3. binyılın başlarından itibaren yerel olarak kullanıldığı belirlenmiştir. Böylece tunç üretiminde kullanılan ve özellikle ünlü Luristan tunç aletleri için gerekli kalayın geliş kaynağı açısından yeni seçenekler ortaya çıkmış bulunmaktadır.

INTRODUCTION

The appearance of tin as the second major alloying partner of copper to produce bronze is regarded as one of the markers of the beginning of the Bronze Age in most parts of the Old World. This applies as well to Southwestern Asia, where bronze, and henceforth tin, is widely used since the later 3rd millennium BC in the nascent states of Mesopotamia. The sources that supplied Mesopotamian metal industry with tin remain elusive, however, no adequate sources for tin were known in the wider region and the question for the origin of this tin remained a controversially debated one in archaeometallurgical research. Sumerian texts of the late 3rd millennium position the origin of this metal somewhere east of Mesopotamia, so that Iran and its neighbouring countries figure as possible candidate to supply tin to Mesopotamia. From the point of view of metallo-genesis, the nearest tin sources east of Mesopotamia can be expected in Eastern Iran and Afghanistan, where indeed tin deposits are attested. The sheer geographic distance between these possible sources and the consumers in Mesopotamia is puzzling but can be overcome through organized long distance trade. Models on long distance procurement of tin (Stech and Pigott 1986) have therefore found wide acceptance and are corroborated through recent findings of possible intermediaries of the maritime trade via the Persian Gulf (Weeks 2003).

The incentive to review the debate on ancient tin from the lands east of Mesopotamia (Fig. 1) is due to the impact of several new sets of data that add considerable detail to our knowledge. The recent discovery of tin sources such as the mining area of Deh Hossein in the Iranian Central Zagros (Nezafati *et al.* 2006), that was possibly exploited in antiquity, considerably alters our map of source areas. Likewise, ongoing programs of archaeometallurgical analyses[1] with regard to artefact composition and provenience provide important detailed information.

The following paper aims at a review of the archaeological evidence surrounding the question of exploitation and usage of tin in ancient Iran from the beginning until the Early Iron Age[2], in order to determine models of usage, alloying practice and consumption, with a specific focus on recent research that has considerably altered our understanding of the usage of tin in ancient Iran. Among the issues discussed are; (1) the location of raw material sources east of Mesopotamia; (2) the beginning of the use of tin in Iran and its neighbourhood; (3) the uneven distribution and the apparent "technological conservatism" in the central Iranian highlands in contrast to the assumed trade networks that made eastern tin available to Mesopotamian bronze working centres; (4) the procurement of tin for the usage in the famous Lorestan bronzes. In conclusion, this evidence will be discussed within the wider context of historical and cross-cultural relations.

BACKGROUND: TEXTUAL EVIDENCE FOR THE USE OF TIN AND TIN ALLOYS

The first tin alloys appear in Mesopotamian metal working sometime at the beginning of the 3rd millennium BC, although as singular specimen and not all of them beyond doubt with regard to find context and circumstances.[3] Textual sources, by contrast, refer for the first time to the regular use of tin bronze and its deliberate distinction from copper only in Sumerian texts dating to the Ur I period (Moorey 1994: 298). Indeed, this correlates in time with the first archaeological evidence for the systematic large scale usage of bronze in the ED IIIa period, for example in the famous cemetery at Ur and in other burial assemblages of the late ED period[4]. Metallic tin is equally used since the same time, either as a solder material or as a coating for copper vessels (Moorey 1994: 297). Texts from the Ebla archives, written at about the same time, refer to recipes and standard mixtures of copper and tin for the production of spearheads and other weapons (Van Lerberghe 1988; Waetzold 1993), indicating that by the mid 3rd millennium BC, the use of tin was an established practice in the production of metal artefacts, and was most probably to a large extent controlled by the central authorities. Such a standard usage of a material as of the mid 3rd millennium BC in Mesopotamia is only possible if a reliable and accessible source for the procurement of this material can be located.

According to the textual sources there are two major areas renowned for the occurrence of tin: one area refers to countries in the Iranian highlands, some of them explicitly named while often less specifically only "tin mountains" are mentioned, an area that cannot be verified; the second are lands in the Persian Gulf area, specifically the island Dilmun and the land of Meluhha. These latter seem to have functioned not as a source region but as an intermediary of long distance trade since the later 3rd millennium BC and are attested as suppliers of tin in the texts from the Ebla archives and in texts from Gudea (Moorey 1994: 298).

In the Iranian highlands, epic texts mention the lands of Aratta whose soil is said to have consisted of "tin stone". Tempting as it is, Aratta must be excluded as a possible source of tin: the name Aratta seems not to refer to a real land, but rather to a mental concept of "a land of plenty", including tin[5]. A second source area reported in the Iranian highlands are the lands of Zabshali/Shimashki in the Southern Zagros[6], commemorated for a rich booty of tin by the Ur III king Shusin, and the lands of Anshan, to be equated with the modern site Tal-e Malyan and its hinterland, in highland Fars. Anshan, and further west Susa, are actually known as on the road stations for donkey caravans that reached to Mari on the Middle Euphrates via Eshnunna and the Diyala valley (Joannès 1991). According to the Mari archive texts, these caravans were run by agents with Elamite names and transported tin ingots of a standard weight (Moorey 1994: 298, Potts 1999: table 6.2).

ISSUE 1: SOURCES OF TIN IN THE EAST

Scholars who had been aware of the textual evidence referring to tin sources in the highlands east of Mesopotamia[7] have undertaken various attempts to locate deposits of tin ores. Reports by the medieval Arabian geographers Moghaddasi and Mostofi on the existence of tin sources in the area of Hamadan and Lorestan in the Central Zagros could not be verified by Theodore Wertime who worked in that area in the 1960s (Muhly 1973). Northwest Iran, specifically the Lake Orumiye neighbourhood close to Tabriz and the estuary mouth of the Sefidrud to the Caspian Sea, have been claimed also as sources for tin (Muhly 1973). Again, the Geological Service of Iran could not verify the existence of tin deposits neither in Tabriz or the Orumiye Lake area, nor on the Sefidrud. The only claim that seems to hold, albeit sparsely, is Strabo's (XV 2, 10) mention of ancient Drangiana, modern Sistan, where the Geological Service reports the tin deposits from Chah Kalapi, Shahkuh and Chah Ruh (Vatandoust 1999: 123 map fig. 2). The Sistan sites form part of a larger area with sparse tin occurrences in the Hilmand basin that extends further east and northeast until the area of Herat in western Afghanistan (Stech and Pigott 1986: 44-45). It is only beyond this zone that considerable tin deposits are known to have existed: well known are the tin mineralizations in the Kandahar – Badakhshan area (Stech and Pigott 1986: 44). Equally long known are tin mines in the Zarafshan Valley in Usbekistan/Kasakhstan that were only recently excavated and seem to have been in use since the later 3rd or early 2nd millennium BC (Parzinger and Boroffka 2003).

Such a distribution of tin sources in the extreme East of Iran, in Afghanistan and the Zarafshan Valley seems to indicate that highland Iran could at no time have functioned as a direct supplier of tin to the Mesopotamian states. Instead, mention of tin from the towns in highland South Iran in the Ur III texts and later-on could be related to the status of these towns as intermediaries, channelling the trade of tin from the sources located even further east.

RE-THINKING TIN SOURCES IN IRAN

This seemingly clear-cut pattern – sources in East Iran and Afghanistan – controlled trade in tin via South Iran – processing and consumption in Mesopotamia/and adjacent countries of Khuzestan and Lorestan is now at stake against the considerable evidence that has more recently become available.

While it was never categorically excluded and remains a possibility on the grounds of its geological setting (Muhly 1973: 260-261), evidence for the existence of tin sources in Iran, except for Sistan, is generally weak (Wertime 1978: 3). Likewise, tin was not mined or used systematically in the medieval or more recent periods (Moorey 1994: 299). However, as M. Momenzadeh has recently pointed out, specific associations with tin can occur in polymetallic deposits together with copper, wolfram and gold (Momenzadeh 2004: 13; Nezafati *et al.* 2008: 86). Such deposits may in ancient times have been exploited as sources for gold or copper, with no immediate attention to tin. The metallogenetic conditions in some areas of Iran are such that the existence of Cu-Sn-W-Au-deposits can indeed be assumed. He points at four areas where such conditions can be observed: one is the middle part of the Sanandaj-Sirjan-Belt in the Zagros, where the recently recognized mining area of Deh Hossein (Nezafati *et al.* 2006; Nezafati *et al.* 2008) is located. The site has ample evidence for ancient mining, latest from the 1st millennium BC onwards, although the date of its most ancient exploitation is difficult to determine.

ISSUE 2: THE EARLY USE OF TIN IN IRAN – EVIDENCE FROM ARTEFACTS

In Southwestern Asia, the earliest artefacts produced from copper-tin alloys date to the 4th and early 3rd millennium. Since the beginning of the Bronze Age in the Old World is *per definition* linked to the occurrence of tin bronze in the archaeological record,[8] the appearance of the earliest tin-copper alloys has always been regarded with special scrutinity. None of the canonized pre-3rd millennium bronzes holds up against close examination. Often, stratigraphic evidence for the dating of the objects is unreliable, or objects analysed long ago are not available for re-analysis.[9] Early 3rd millennium

BC copper-tin alloys, however, were recorded in a more reliable way as singular objects or small groups from various areas at wide distance from each other.[10] Often, the amount of tin included is small, and the objects may be the result of the smelting of polymetallic ores rather than a deliberate production of an alloy (Nezafati 2006: 77).

The use of copper-tin alloys in the first half of the 3rd millennium was established through analyses on material from elite burials in the Y cemetery in Kish (Stech 1988; 1999; Müller-Karpe 1989: 184; 2004: no. 752; Lutz and Pernicka 2004: no. 752). To this early material can be added samples from Abu Salabikh (Lutz and Pernicka 2004: no. 8, 10, 18; Müller-Karpe 2004: no. 8, 10, 18), Tell Razuk (Lutz and Pernicka 2004: no. 723, Müller-Karpe 2004: no. 723), and a metal curl probably from a statue from Tell Ağrab (Lutz and Pernicka 2004: no. 45; Müller-Karpe 2004: no. 45; see fig. 2). Along the Middle Euphrates, copper-tin alloys have recently been brought to light in a chamber tomb of the EBA I period in Qara Quzaq (Montero Fenollós 1995, Montero 1997: 16 fig. 1, Montero Fenollós 2000).

New finds of early copper-tin alloys are also recorded for the Caucasus from a multiple burial in Velikent/Daghestan (Kohl 2002) and from a burial mound in Talin in Armenia (Meliksetiyan *et al*. 2003).

Results from chemical analyses recently carried out on material from Lorestan now add considerable to this picture of emerging copper-tin-alloying in the early 3**rd** millennium BC. The burials from area AI in Kalleh Nisar, excavated by Louis Vanden Berghe in the 1960s, yielded some decorative items (2 finger rings, 2 bracelets, 1 pin) that all contained at least 3.5% tin and are considered deliberate alloys (Fleming *et al.* 2005: 36-37, 47 tab. 1). They date to the EB I period in Lorestan, contemporary with the Jamdat Nasr to ED I period in Mesopotamia. Properly speaking, the tin-copper alloys attested in the Kalleh Nisar AI tombs are among the earliest evidence for the use of tin as an alloying material in Southwestern Asia.

The Kalleh Nisar tombs are located in close geographic proximity to the recently discovered tin deposits from Deh Hossein. Although not attested yet for this early period,[11] it cannot be excluded that such tin sources were exploited earlier in antiquity as part of experimenting with polymetallic ores as suggested above. Isotope analyses indicate that ores from Deh Hossein could indeed have been used for the production of some of the Lorestan bronzes sampled by N. Nezafati and F. Begemann/S. Schmitt-Strecker (Nezafati 2006: tab. 7.4; Nezafati *et al.* 2008: 84-87 fig. 5; Begemann *et al.* 2008: 29). All sampled artefacts date to a period later in the 3**rd** millennium BC though.

This thought can be developed further: given the distribution of the few early copper-tin alloys in Northern Mesopotamia (listed above), especially in Kish, Razuk and Ağrab, it is tempting to link these isolated occurrences[12] with the experimental exploitation of localized tin occurrences such as Deh Hossein. Kish, indeed one of the paramount urban centers and, according to the Sumerian king list, the seat of the dynasty of Kish during the earlier ED period, may have had access to such sources in the mountains at that time.

The Qara Quzaq EB I group of tin bronzes (listed above) may be indicative of a similar phenomenon. Isotope analyses for this material have not been carried out so far; it is tempting, however, to suggest the possibility that another small scale local source may have been exploited for this production.

THE INTRODUCTION OF TIN BRONZES IN WESTERN IRAN

Area C on the site of Kalleh Nisar yielded several corridor graves with subsequent multiple burials dating from the earlier part of the 3rd millennium BC until around 2400 BC. Chemical analyses of this material yielded 15 out of 19 sampled artefacts in tin bronze (Fleming *et al.,* 2005: 37, 47 tab. 2), thus indicating a more standardized and regular use of this material. Such a development would closely reflect developments that are observed in the lowlands of Khuzestan, where tin bronzes appear in Susa since period IVb and become a common material only in period V, around the turn towards the 2nd millennium BC (Malfoy and Menu 1987: 360-362 tab. D). This development is not shared in Lorestan, however. Towards the end of the EBA, that is, during the last two centuries of the 3rd millennium BC, represented by single tombs in Kalleh Nisar area AII, there is a sharp drop in the amount of tin bronze in the burials: only four out of 13 sampled artefacts contain significant amounts of tin (Fleming *et al.,* 2005: 38, 48 tab. 3).

In conclusion, evidence on the early use of tin alloys in western Iran reveals an interesting pattern: a period of early usage of ores containing tin, possibly of local origin is attested. The exploitation of these sources correlates in time with the appearance of isolated finds of copper-tin alloys in elite burials in the Hamrin and the Mesopotamian alluvium. This pattern may indicate a period of experimenting with new materials such as polymetallic ores, possibly not even with the aim to obtain tin bronze, but a search for optically and technologically attractive materials. Whether this very raw material is used throughout the following centuries remains unknown and deserves further analytical scrutiny with regard to provenience. It is well possible that with the integration of parts of Western Iran into the realm of the expanding empires of Akkad and Ur III, local production ceased. Trade in bulk metals would then have come under closer control of the lowland state, with a distribution organized via central agencies in the urban centres. Naturally, the swaying of political circumstances may then be reflected in the reliability of metal supply also to the highlands. The lack of tin bronze in the Western Iranian highlands during the final centuries of the 3rd millennium BC would in such a scenario underline the growing dependency on central authorities.

ISSUE 3: THE LACK OF TIN IN SITES OF THE CENTRAL AND EASTERN IRANIAN HIGHLANDS AND THE LATE ADOPTION OF TIN USE

In contrast to western Iran, tin bronze was hardly used in eastern and southeastern Iran before the 2nd millennium BC. Even further east and hence closer to the tin sources in Afghanistan are only a few isolated finds from the 4th and 3rd millennium BC recorded, none of them beyond doubt.[13] Solely the 3rd millennium BC Indus culture again used tin bronzes to a considerable extent (Kenoyer and Miller 1999).

Sites in eastern Iran, including the large urban centers of Shahr-e Sukhte (Hauptmann 1980, Hauptmann *et al.* 2003; Artioli *et al.* 2005) and Shahdad (Hakemi 1997), hardly yielded any tin alloys from the 3rd millennium BC, and the few bronzes that occur are considered imports (Tallon 1987: 335). Also, people in Tappe Hesar, another urban size site further west on the northern edge of the Central Iranian desert, apparently did not make use of tin (Pigott 1989: 32). Only at Tappe Yahya is tin sporadically attested since period IVB, resp. in the last third of the 3rd millennium BC (Thornton *et al.* 2002; Thornton *et al.* 2005). Tal-e Malyan, ancient Anshan, is besides Yahya the only site where tin bronze is in regular use since the late 3rd/early 2nd millennium BC Kaftari phase (Pigott 2004: 34).

A review of 3rd millennium BC sites around the Central and East Iranian desert reveals that the apparent "void" in the use of tin may be exaggerated through the general problem of site recognition in this part of the country throughout the 3rd millennium BC. Major sites are abandoned at the end of the Protoelamite period, that is, sometime during the first half of the 3rd millennium BC,[14] and there is hardly any evidence for continuous occupation. Various models to understand this site distribution pattern have been brought forward, including environmental constraints and related shifts towards a more mobile and archaeologically less visible lifestyle (Sumner 1989). However, sound explanations for this pattern will have to await further fieldwork with regard to site detectibility, possible sedimentation coverage and other problems.[15]

Despite this bias obvious in the archaeological data, a pattern of "avoidance" of tin uses in 3rd millennium BC East and Central Iran can still be stated. This is even the more surprising since the circum desert towns of Eastern and Central Iran seem to have actively engaged in trafficking various kinds of raw materials over long distances. Trade in stone vessels made from chlorite and alabaster, in semiprecious stones like lapis lazuli and cornelian, but probably also in other materials seems to have been of major importance throughout the 3rd millennium BC.[16] Many models on the tin trade link it to the trade in other precious and prestigious materials with restricted and known proveniences (Herrmann 1964; Crawford 1974; Stech and Pigott 1986), especially with gold and lapislazuli that abound in 3rd millennium BC elite burials in Mesopotamia. While such stone materials are indeed richly attested in Eastern and Central Iran burial sites, copper and possibly tin that could have travelled alongside these are not attested in the same contexts. Obviously, tin did not yet enter the general circulation of goods then (Stech 1999: 64; Muhly and Stech 2003: 423). This puzzling pattern has propelled various explanatory models.

One possibility aims at the recognition of long distance trade relations for the 3rd millennium BC that would have run under the tight control of central authorities in Mesopotamia, respectively their agents. The lack of tin bronze in the towns close to the source areas can then be judged as indicative of a restricted access to this raw material.[17] Only Elam in Southern Iran that was over periods included in the political sphere of the Akkad and the Ur III Empire would have participated in this trade network and would thus have received tin via maritime trade on the Persian Gulf for further distribution towards Mesopotamia and the Elamite hinterland.

A different model proposed first by T. Stech and V. Pigott (Stech and Pigott 1986; lastly: Pigott 2004: 30) suggests a deliberate "technological conservatism" evident in the Southeast Iranian 3rd millennium BC towns. Communities in this area, where arsenic-copper alloys were amply used since the early 4th millennium BC, may not have felt any need to change their craft traditions. According to this model, a culturally conditioned choice is obvious behind the decision to not adopt tin alloy technologies in these sites. Results from a program on further analysis recently run on the basis of materials from Tappe Yahya (Thornton *et al.* 2002; Thornton *et al.* 2005) is interpreted to corroborate the validity of the pattern of deliberate non-adoption of tin use as a matter of cultural choice: in Yahya IVB (2400-2000 BC), earliest alloys with traces of tin occur, but still in period IVA (2000-1700 BC) only five out of 34 copper base objects can be considered tin bronzes (all data according to Thornton *et al.* 2005). The usage of tin bronze in Yahya is established on a regular base only from the 17th century BC onwards and is assigned variously to impacts from Central Asian cultures where the availability of tin from the Zarafshan valley sources would have fuelled the development of a tin bronze metallurgy there that would have reflected upon the eastern Iranian cultures.[18]

Whether the choice against the use of tin bronze in the Eastern and Central Iranian sites is motivated by a "cultural choice" against a material that is based on reasoning such as function, aesthetics or else, remains unknown. However, a scenario that, instead of advocating a "cultural choice", considers obstacles that exclude the communities of the Iranian towns from participating in the circulation of the necessary raw materials, through political measures such as restrictions on access, restricted trade relations or other possibilities, is probably more likely. Any decision towards the one or other model requires, however, beforehand more knowledge regarding the historical landscape of Eastern Iran that is only recently beginning to emerge, as is demonstrated by the discovery of the Jiroft cemeteries and the definition of a Halilrud culture (Majidzadeh 2003; 2008).

ISSUE 4: TIN FOR THE LORESTAN BRONZES AND THE FURTHER DEVELOPMENT OF BRONZE WORKING IN WESTERN IRAN

Following the early adoption of tin bronze working in the EBA and its drop at the end of the 3rd millennium BC, the development of copper processing in Western Iran seems to become more stable throughout the 2nd millennium BC. Reliable data for Lorestan bronze working are sparse for the 2nd millennium BC, and it is only with the beginning of the Late Bronze/Early Iron Age that Lorestan bronze working reaches a new and original height with the so-called canonical Lorestan bronzes. Lorestan bronzes form a heterogeneous group of copper-base artefacts that have become known since the 1920s mostly through the art's market.[19] Only few derive from regular excavations, for example by Erich Schmidt in the 1930s in various places in Lorestan (Schmidt *et al.* 1989), and by a Danish team in Tappe Guran (Thrane *et al.* 2001). Most noteworthy are the results of the Belgian Lorestan Expedition directed by L. Vanden Berghe since 1965 (Overlaet 2003). From this it can be stated that Lorestan bronzes fall into different style groups of chronological significance, beginning roughly around 1300/1200 BC and running into the Iron Age.

In Susa is the regular production of artefacts from tin bronze attested since period V, roughly to be equated with the Ur III – Isin-Larsa period in Babylonia (Tallon 1987: 340-352). Susa is also one of the way stations for the tin trade since the Ur III period at least. In the material excavated at Susa, a deliberate choice of alloy varieties is evident: tin bronzes are preferably used for the production of weapons, such as shaft hole axes, indicating a raw material selection according to functionally desired properties (Malfoy and Menu 1987: 362; Tallon 1987: 352). Since it is generally though that the metal used in Lorestan reaches there through trade via Mesopotamia or Elam (Haerinck and Overlaet

2004), it can be expected that the development of bronze working in Lorestan does not depart much from the development observed in Susa. This is, however, not fully the case: the material used in Susa and in Lorestan differs insofar as the copper used in Susa bronzes is less "pure" (Tallon 1987: 352), indicating a higher degree of recycling. A comparison of the isotope abundance ratios between Lorestan material and Mesopotamian artefacts indicates that the Lorestan objects had less varieties of raw material at their disposition (Begemann *et al.* 2008: 36). Both observations are strong arguments against a bronze production in the Lorestan highlands that would have been dependant on raw material procurement controlled by lowland authorities (Begemann *et al.* 2008) (vs. Haerinck and Overlaet 2004; Fleming *et al.* 2005). Instead, local dynamics of bronze production must be considered, and the discovery of possible raw material sources for the essential tin, and possibly copper, opens new venues of research there. First steps have been undertaken - in terms of element composition, the Deh Hossein deposit could have been a source supplying copper and tin to the production of Lorestan bronzes (Nezafati 2006; Begemann *et al.* 2008); isotopically speaking, Deh Hossein is equally a good (but not the sole) candidate for Lorestan bronzes.

IN CONCLUSION

The ongoing discussion on the origins of tin for the bronze producing metalworkers of Mesopotamia and Western Iran has received considerable impact through the availability of new data of original research – the discovery of new raw material deposits in Western Iran, and the analyses of excavated and well-dated materials from Lorestan. Considering the development of early copper processing in Western Asia in general, a period of experimentation in various materials available from locally confined sources of tin-copper, lead and possibly other ma-terials can be stated to have occurred during the early 3rd millennium BC. This early start, however, does not lead to the formation of a stable industry. In the later Early Dynastic city states of Mesopotamia, elites seem to have taken over control of the traffic in such items through the newly developing maritime trade on the Persian Gulf, thereby possibly discouraging local industries from further developments. Susa begins only during the later part of the 3rd millennium to participate in the tin trade network, and in the 2nd millennium BC becomes one of its controlling nods, as was Anshan further east.

With the Late Bronze Age, when an original tradition of bronze working develops in Lorestan with the so-called Lorestan bronzes, there seems to be a new reliance of the usage of local sources. It remains to be securely established whether the Deh Hossein deposit functioned as a raw material supplier to the these bronze workshops; in terms of element composition and isotope ratios that have so far been carried out only to a limited extent, it is in any case a good candidate.

NOTES

1 Hauptmann and Pernicka 2004; Fleming *et al.* 2005; Fleming *et al.* 2006; Begemann *et al.* 2008; Begemann and Schmitt-Strecker 2009.

2 Canonized archaeological and textual evidence for the use of specific metals in ancient Southwestern Asia is presented in a clearly arranged way in Muhly 1973; Pernicka 1990; Joannès 1991; Muhly 1993; Joannes 1993-1997; Moorey 1994 and will not be repeated here.

3 See Weeks (2003: 165-195) for an up-to-date summary of the current state of archaeological research in Southwestern Asia.

4 According to the results of the research project "FMM – Early Metal in Mesopotamia", by ED IIIa about 40 of the copper base objects in the Ur cemetery are produced from bronze (Müller-Karpe 1991: tab. 1, for summaries on this research, consult Stech 1999: tab. 3.1, a list of analyses of the FMM project is provided by J. Lutz in Hauptmann and Pernicka 2004).

5 The discover of rich graveyards on the Halil Rud („Jiroft") in Southeastern Iran has recently provided new fuel on the discussion for a location of this mystical land of Aratta, (see most recently Michalowski 1986, Potts 2004, see most recently Steinkeller 2007: 2-3 Footnote 4 with further references).

6 For a location of Zabshali, see Potts (1999: 141-143).

7 For an overview on the sources referring to Eastern tin, see Parzinger *et al.* (2003: 1-4); Potts 1994: 156 tab. 4.2.

8 See Moorey (1982: 87), who claims that the significance assigned to the appearance of tin is indeed exaggerated.

9 Among the canonized objects are specimen from Gawra VIII in Northern Iraq (Speiser 1935: 102; the object is not available for re-analysis, Stech and Pigott 1986: 43), Susa I and II (Cleuziou *et al.* 1982: 47-48 tab. C) and Sialk III5 (Halm 1939: 206-207). For a critical assessment of the evidence, see (Müller-Karpe 1989: 183-184; Weeks 2003: 174-178).

10 Amongst these, a group of figural bronzes from Çüdeyde/Amuq (Braidwood and Braidwood 1960: 300-315 figs.

240-245; analyses 516-519) remains difficult to date, and a tin stamp seal from Mersin is equally not certified (following Müller-Karpe 1994: 13).

11 The open cast workings at Deh Hossein are currently dated to at least the 1st millennium BC, but an earlier beginning of its exploitation cannot be excluded.

12 One further group of metal items from early 3rd millennium BC contexts in the Hamrin that was qualified as "bronze" in the excavation report (Fujii 1981) and introduced as such into the literature (Van Lerberghe 1988), but was without element analysis, would then become much less exotic than before.

13 A 4th millennium BC date is claimed but not verified for a bronze from Mundigak III (Casal 1961: 37-48) in the Hilmand basin of western Afghanistan; the same applies to some unstratified objects from the Ghar-e Mar (Caley 1971). On the Pakistan side of Baluchistan, the oldest tin bronze artefacts date to the first half of the 3rd millennium BC (Ullah 1931; Asthana 1993; Besenval 1997; Possehl 1999).

14 For example, Tappe Sialk and Arisman are abandoned, and a surface survey in the Arisman hinterland revealed no alternative sites of the 3rd millennium BC (Chegini and Helwing in prep.). The sequence at Tal-e Malyan seems to be interrupted between the Banesh and the Kaftari phase as well; however, it seems as if this occupational gap is much less severe than previously thought, comp. Miller and Sumner (2003).

15 Large scale silting-up of plains may be partly responsible for the patterns of site discovery in these regions, comp. Schmidt and Fazeli (2007), Helwing *et al.* (in prep.).

16 Herrmann 1964; Beale 1973; Crawford 1974; Majidzadeh 1982; Stech and Pigott 1986.

17 Beale 1973; Alden 1982; see Lamberg-Karlovsky 2009 for a discussion of models regarding early trade.

18 Thornton *et al.* (2005) consider an Andronovo influence, Lamberg-Karlovsky (2003: 16) from the Namazga complex. Since the Zarafshan Valley sources seem to have been exploited only since the later 2nd millennium BC, and since they seem not to have supplied tin even to bronze producing cultures in the immediate neighbourhood, this model has been refuted by K. Kaniuth (2006: 170; 2007: 33).

19 Study of the so-called Lorestan bronzes is gravely hampered by the almost complete lack of reliable find contexts and through the existence of a considerable number of fakes and pastiche specimen. For a discussion of the problems related to the study of Lorestan bronzes, see Muscarella (2000).

REFERENCES

Alden, J.R. 1982
"Trade and Politics in Proto-Elamite Iran", *Current Anthropology* 23: 613-640.

Artioli, D. et al. 2005
"The exploitation and tranformation of copper ores at Shahr-i Sokhta (Iran): preliminary results", U. Franke-Vogt and H.J. Weisshaar (eds.) *South Asian Archaeology 2003.* Forschungen zur Archäologie Außereuropäischer Kulturen 1, Aachen.

Asthana, S. 1993
"Harrapan trade in metals and minerals: A regional approach", G.L. Possehl (eds.) *Harappan Civilisation: A recent prespective*: 271-285. American Institute of Indian Studies, New Delhi.

Beale, T.W. 1973
"Early trade in highland Iran: a view from a source area", *World Archaeology* 5: 133-148.

Begemann, F. and S. Schmitt-Strecker 2009
"Über das frühe Kupfer Mesopotamiens", *Iranica Antiqua* 44: 1-45.

Begemann, F. et al. 2008
"An archaeo-metallurgical study of the Early and Middle Bronze Age in Luristan, Iran", *Iranica Antiqua* 43: 1-66.

Besenval, R. 1997
"The chronology of ancient occupation in Makran: Results of the 1994 season at Miri Qalat, Pakistan Makran", B. Allchin and R. Allchin (eds.) *South Asian Archaeology 1995*: 199-216. IHB Publishing, Oxford.

Braidwood, R.J. and L.S. Braidwood 1960
Excavations in the Plain of Antioch I. The Earlier Assemblages Phases A-J. Oriental Institute Publications 61, The University of Chicago Press, Chicago.

Caley, E.R. 1971
"Analyses of some metal artifacts from ancient Afghanistan", R.H. Brill (ed.) *Science and Archaeology*: 106-112. MIT Press, Cambridge MA.

Casal, J.M. 1961
"Fouilles de Mundigak", *Mémoirs de la délégation archéologique francaise en Afghanistan* 17/1-2 : 260.

Chegini, N.N. and B. Helwing (in press)
"Archaeological survey in the hinterland of Arisman and Kāšān", *Early mining and metallurgy on the Central Iranian Plateau. Report on the first five years of research of the Joint Iranian-German Research Project*. Archäologie in Iran und Turan, Philipp von Zabern, Mainz am Rhein.

Cleuziou, S. et al. 1982
"Cuivres et alliages en Iran, Afghanistan, Oman au cours des IVe et IIIe millénaires", *Paléorient* 8: 39-54.

Crawford, H.E.W. 1974
"The problem of tin in Mesopotamian bronzes", *World Archaeology* 6: 242-247.

Fleming, S.J. et al. 2005
"Bronze in Luristan: preliminary analytical evidence from copper/bronze artifacts excavated by the Belgian Mission in Iran", *Iranica Antiqua* 40: 35-64.

Fleming, S.J. et al. 2006
"The archaeometallurgy of War Kabud, Western Iran", *Iranica Antiqua* 41: 31-57.

Fujii, H. 1981
"Preliminary report of excavations at Gubba and Songor", *al-Rafidan* 2: 1-242.

Haerinck, E. and B. Overlaet 2004
"The chronology of the Pusht-i Kuh, Luristan", K. Folsach et al. (eds.) *From handaxe to Khan. Essays presented to Peder Mortensen on the occasion of his 70th birthday*: 118-135. Aarhus University Press, Aarhus.

Hakemi, A. 1997
Shahdad: Archaeological excavations of a Bronze Age center in Iran, *Istituto Italiano per il Medio ed Estremo Oriente*. IsMEO, Roma.

Halm, L. 1939
"Analyse chimique et étude micrographicque de quelques piéces de métal et de céramique provenant de Sialk", R. Ghirshman (ed.) *Fouilles de Sialk, près de Kashan 1933, 1934, 1937* (II). série Archéologique, tome V Paris, Geuthner.

Hauptmann, A. 1980
"Zur frühbronzezeitlichen Metallurgie von Shahr-i Sokhta (Iran)", *Der Anschnitt* 32: 55-61.

Hauptmann, H. and E. Pernicka 2004
Die Metallindustrie in Mesopotamien bis zum Zweiten Jahrtausend v. Chr. Orient-Archäologie 3, Marie Leidorf, Rahden.

Hauptmann, A. et al. 2003
"Early Bronze Age Copper Metallurgy at Shahr-i Sokhta (Iran), reconsidered", *Der Anschnitt* 16: 197-213.

Helwing, B. et al. (in press)
Prehistoric settlement patterns in Darre-ye Bolaghi, Fars, Iran: Results of archaeological and geoarchaeological fieldwork. 6. ICAANE.

Herrmann, G. 1964
"Lapis Lazuli: the early phases of its trade", *Iraq* 30: 21-57.

Joannes, F. 1991
"L'étain, de Elam à Mari", L.D. Meyer and H. Gasche (eds.) *Mésopotamie et Elam* : 67-76. Mesopotamian History and Environment Occasional Publications 1, Ghent.

Joannes, F. 1997
"Metalle und Metallurgie. A. I. in Mesopotamien", *Reallexikon der Assyriologie und vorderasiatischen Archäologie* 8: 96-112.

Kaniuth, K. 2006
Metallobjekte der Bronzezeit aus Nordbaktrien. Archäologie in Iran und Turan 6, Verlag Phillip von Zabern, Mainz.

Kaniuth, K. 2007
"The metallurgy of the Late Bronze Age Sapalli Culture (Southern Uzbekistan) and its implications for the 'tin question'", *Iranica Antiqua* 52: 23-40.

Kenoyer, J.M. and H.M.L. Miller 1999
"Metal Technologies of the Indus Valley Tradition in Pakistan and Western India", V.C. Pigott (ed.) *The Archaeometallurgy of the Asian Old World*: 107-151. University Museum Monograph 89, Science Press, Philadelphia.

Kohl, P.L. 2002
"Bronze Production and utilization in Southeastern Daghestan, Russia: c. 3600-1900 B.C. (with an appendic on lead-isotope analyses of selected Velikent tin-bronzes by L. Weeks)", M. Bartelheim et al. (eds.) *Die Anfänge der Metallurgie in der Alten Welt*: 161-178. Forschungen zur Archäometrie und Altertumswissenschaft 1, Verlag Marie Leidorf, Rahden/Westf.

Lamberg-Karlovsky, C.C. 2003
"Civilization, state, or tribes? Bactria and Margiana in the Bronze Age", *The Review of Archaeology* 24: 11-19.

Lamberg-Karlovsky, C.C. 2009
"Structure, agency and commerce in the Ancient Near East", *Iranica Antiqua* 44: 47-88.

Lutz, J. and E. Pernicka 2004
"Röntgenfluoreszenzanalysen", E. Pernicka and H. Hauptmann (eds.) *Die Metallindustrie in Mesopotamien bis zum Zweiten Jahrtausend v. Chr.*: 109-150. Orient-Archäologie 3, Marie Leidorf, Rahden.

Majidzadeh, Y. 1982
"Lapis lazuli and the Great Khorasan Road", *Paléorient* 8: 59-69.

Majidzadeh, Y. 2003
Jiroft. The earliest oriental civilization. Printing and Publishing Organization of the Ministry of Culture and Islamic Guidance, Tehran.

Majidzadeh, Y. 2008
"Excavations at Konar Sandal in the region of Jiroft in the Halil Basin: First preliminary report (2002-2008)", *Iran* 46: 69-104.

Malfoy, J.-M. and M. Menu 1987
"La métallurgie du cuivre à Suse aux IVe et IIIe millénaires: analyses en laboratoire", F. Tallon (ed.) *Métallurgie Susienne*: 355-377. Notes et Documents des Musées de France 15, Editions de la Réunion des musées nationaux, Paris.

Meliksetian, K. et al. 2003
"Geochemical characterisation of Armenian Early Bronze Age metal artefacts and their relation to copper ores", R. Badalyan, P. Avetissyan and E. Pernicka (eds.) *Associazione Italiana di Metallurgia*: 597-606. Proceedings of the International Conference on Archaeometallurgy in Europe, Milano.

Michalowski, P. 1986
"Mental Maps and Ideology: Reflections on Subartu", H. Weiss (ed.) *The Origins of Cities in Dry Farming Syria and Mesopotamia in the Third Millennium B.C.*: 129-156. Four Quarters Publishing Co., Guilford, Connecticut.

Miller, N.F. and W.M. Sumner 2003
"The Banesh-Kaftari interface. The view from operation H5, Malyan", *Iran* 41: 7-19.

Momenzadeh, M. 2004
"Metallische Bodenschätze in Iran in antiker Zeit. Ein kurzer Überblick", T. Stöllner et al. (eds.) *Persiens antike Pracht*: 8-21. Deutsches Bergbau Museum, Bochum.

Montero Fenollós, J.-L. 1995
"Estudio provisional del ajuar metalico del conjunto funerario de los loci 12 E y 12 W. Tell Qara Quzaq (Siria). Campagna 1992", *Aula Orientalis* 13: 25-30.

Montero Fenollós, J.-L. 2000
"La métallurgie du bronze dans le bassin syro-mésopotamien au début du IIIe millénaire avant J.-C.", P. Matthiae et al. (eds.) *Proceedings of the First International Congress on the Archaeology of the Ancient Near East*: 1093-1104. Università degli studi di Roma "La Sapienza", Roma.

Montero, J.-L. 1997
"L'activité métallurgique dans la vallée du Haut-Euphrate Syrien (IIIe-IIe millénaires av. J.C.)", *Akkadica* 103: 6-28.

Moorey, P.R.S. 1982
"The archaeological evidence for metallurgy and related technologies in Mesopotamia c. 5500-2100 BC", *Iraq* 44: 13-38.

Moorey, P.R.S. 1994
Ancient Mesopotamian Materials and Industries. The archaeological Evidence. Clarendon Press, Oxford.

Muhly, J.D. 1973
Copper and tin. The distribution of mineral resources and the nature of the metal trade in the Bronze Age. Transactions of the Connecticut Academy of Arts 43, Archon Books, Hamden CT.

Muhly, J.D. 1993
"Metalle. B. Archäologisch", *Reallexikon der Assyriology* 6: 348-364.

Muhly, J.D. and T. Stech 2003
"The Metallurgy of Ninevite 5", E. Rova and H. Weiss (eds.) *The Origins of North Mesopotamian Civilization: Ninevite 5 Chronology, Economy, Society*: 417-428. Subartu 9, Brepols, Turnhout.

Müller-Karpe, A. 1989
"Neue Forschungen zur frühen Metallverarbeitung in Mesopotamien", *Jahrbuch des Römisch-Germanischen Zentral-Museums* 36: 179-192.

Müller-Karpe, A. 1991
"Aspects of early metallurgy in Mesopotamia", E. Pernicka and G.A. Wagner (eds.) *Archaeometry* '90: 105-116. Proceedings of the 27th Symposium on Archaeometry held in Heidelberg, Basel.

Müller-Karpe, A. 1994
Altanatolisches Metallhandwerk. Wachholtz Verlag, Offa-Bücher Neumünster.

Müller-Karpe, A. 2004
"Katalog I: Untersuchte Metallobjekte aus Mesopotamien", H. Hauptmann and E. Pernicka (eds.) *Die Metallindustrie in Mesopotamien bis zum Zweiten Jahrtausend v. Chr.*: 1-90. Orient-Archäologie 3, Marie Leidorf, Rahden.

Muscarella, O.W. 2000
The lie became great, *Studies in the Art and Archaeology of Antiquity* 1. Styx Publications, Groningen.

Nezafati, N. 2006
Au-Sn-W-Cu-Mineralization in the Astaneh-Sarband Area, West Central Iran. Including a comparison of the ores with ancient bronze artifacts from Western Asia. PhD dissertation, Geowissenschaftliche Fakultät, Tuebingen.

Nezafati, N., E. Pernicka and M. Momenzadeh 2006
"Ancient tin: Old question and a new answer", *Antiquity* 80/308. (On line, Project Gallery) http://antiquity.ac.uk /ProjGall/nezafati%20et%20al/index.html

Nezafati, N. et al. 2008
"Iranian ore deposits and their role in the development of ancient cultures", *Anatolian Metal* IV (Der Anschnitt, Beiheft 21): 77-90.

Overlaet, B. 2003
Luristan Excavation Documents IV. The Early Iron Age in the Pusht-i Kuh, Luristan, *Acta Iranica.* Troisième série vol. XXVI 40, Peeters, Leuven.

Parzinger, H. and N. Boroffk 2003
"Einführung. Das Zinn der Bronzezeit in Mittelasien I", *Archäologie in Iran und Turan* 5: 1-14.

Pernicka, E. 1990
"Gewinnung und Verbreitung der Metalle in prähistorischer Zeit", *Jahrbuch des Römisch-Germanischen Zentralmuseums Mainz* 37: 21-129.

Pigott, V.C. 1989
"Archaeometallurgical investigations at Bronze Age Tappeh Hesar", R.H. Dyson and S. Howard (eds.) *Tappeh Hesar: Reports of the Restudy Project, 1976*: 25-33. Monografie di Mesopotamia II, Casa Editrice Le Lettre, Firenze.

Pigott, V. 2004
"Zur Bedeutung Irans für die Erforschung prähistorischer Kupfermetallurgie", T. Stoellner, R. Slotta and A. Vatandoust (eds.) *Persiens antike Pracht*: 28-43. Deutsches Bergbau Museum, Bochum.

Possehl, G.L. 1999
Indus Age. The beginnings. University of Pennsylvania Press, Philadephia.

Potts, D.T. 1994
Mesopotamia and the East. An Archaeological and Historical Study of Foreign Relations ca. 3400/2000 BC. Monograph 37, Cambridge University Press, Oxford.

Potts, D.T. 1999
The Archaeology of Elam. Formation and Transformation of an Ancient Iranian State. Cambridge World Archaeology, University Press, Cambridge.

Potts, D.T. 2004
"Exit Aratta: Southeastern Iran and the land of Marhashi", *Name-ye Iran-e Bastan* 4: 1-11.

Schmidt, A. and H. Fazeli 2007
"Tepe Ghabristan: a Chalcolithic tell buried in alluvium", *Archaeological Prospection* 14: 38-46.

Schmidt, E.F. et al. 1989
The Holmes expeditions to Luristan. The University of Chicago Oriental Institute publications 108, Chicago.

Speiser, E.A. 1935
Excavations at Tepe Gawra I. Levels I-VIII. Publications of the American Schools of Oriental Research, University of Pennsylvania Press, Philadelphia.

Stech, T. 1988
Early Metallurgy in Mesopotamia and Anatolia. *The emergence and development of metallurgy* (Tbilisi 26.9.-8.10.1988).

Stech, T. 1999
"Aspects of Early Metallurgy in Mesopotamia and Anatolia", V.C. Pigott (ed.) *The Archaeometallurgy of the Asian Old World*: 59-71. University Museum Monograph 89, Science Press, Philadelphia.

Stech, T. and V.C. Pigott 1986
"The metals trade in Southwest Asia in the Third Millennium B.C.", *Iraq* 48: 39-64.

Steinkeller, P. 2007
"New light on Marhasi and its contacts with Makkan and Babylonia", *Journal of Magan Studies* 1: 1-17.

Sumner, W.M. 1989
"Anshan in the Kaftari Phase: Patterns of settlement and land use", L.D. Meyer and E. Haerinck (ed.) *Archaeologia Iranica et Orientalis: Miscellanea in honorem Louis Vanden Berghe*: 135-161. Peeters Press, Gent.

Tallon, F. 1987
Métallurgie Susienne I. De la fondation de Suse au XVIIIe avant J.-C.. Notes et Documents des Musées de France 15, Editions de la Réunion des musées nationaux, Paris.

Thornton, C.P. et al. 2002
"On pins and needles: Tracing the evolution of copper-base alloying at Tepe Yahya, Iran, via ICP-MS analysis of common-place items", *Journal of Archaeological Science* 29: 1451-1460.

Thornton, C.P. et al. 2005
"Stech and Pigott revisited: new evidence concerning the origins of tin bronze in the light of chemical and metallographic analyses of the metal artefacts from Tepe Yahya, Iran", H. Kars and E. Burke (eds.) *Proceedings of the 33rd International Symposium on Archaeometry*. Geoarchaeological and Bioarchaeological Studies 3, Vrije Universiteit, Amsterdam.

Thrane, H. et al. 2001
Excavations at Tepe Guran in Luristan: the Bronze Age and Iron Age periods. Jutland Archaeological Society publications 38, Aarhus University Press, Højbjerg, Aarhus.

Ullah, M.S. 1931
"Copper and bronze utensils and other objects. Part I. Sources and metallurgy of copper and its alloys", S.J. Marshall (ed.) *Mohenjo-Daro and the Indus Civilization* 2: 484-488. Arthur Probsthain, London.

Van Lerberghe, K. 1988
"Copper and Bronze in Ebla and Mesopotamia", H. Waetzold and H. Hauptmann (eds.) *Wirtschaft und Gesellschaft von Ebla*: 253-256. Heidelberger Studien zum Alten Orient 2, Heidelberger Orient-Verlag, Heidelberg.

Vatandoust, R. 1999
"A view on prehistoric Iranian metalworking: Elemental analyses and metallographic examinations", *Der Anschnitt* 9: 121-140.

Waetzold, H. 1993
"Zur Bewaffnung des Heeres von Ebla", *Oriens Antiquus* 29: 1-38.

Weeks, L.R. 2003
Early metallurgy of the Persian Gulf. Technology, trade, and the Bronze Age World. American School of Prehistoric Research Monograph Series 2, Brill Academic Publishers Inc., Boston.

Wertime, T.A. 1978
"The search for ancient tin: The geographic and historic boundaries", A.D. Franklin et al. (eds.) *The search for ancient tin*: 1-6. US Governement Printing Office, Washington.

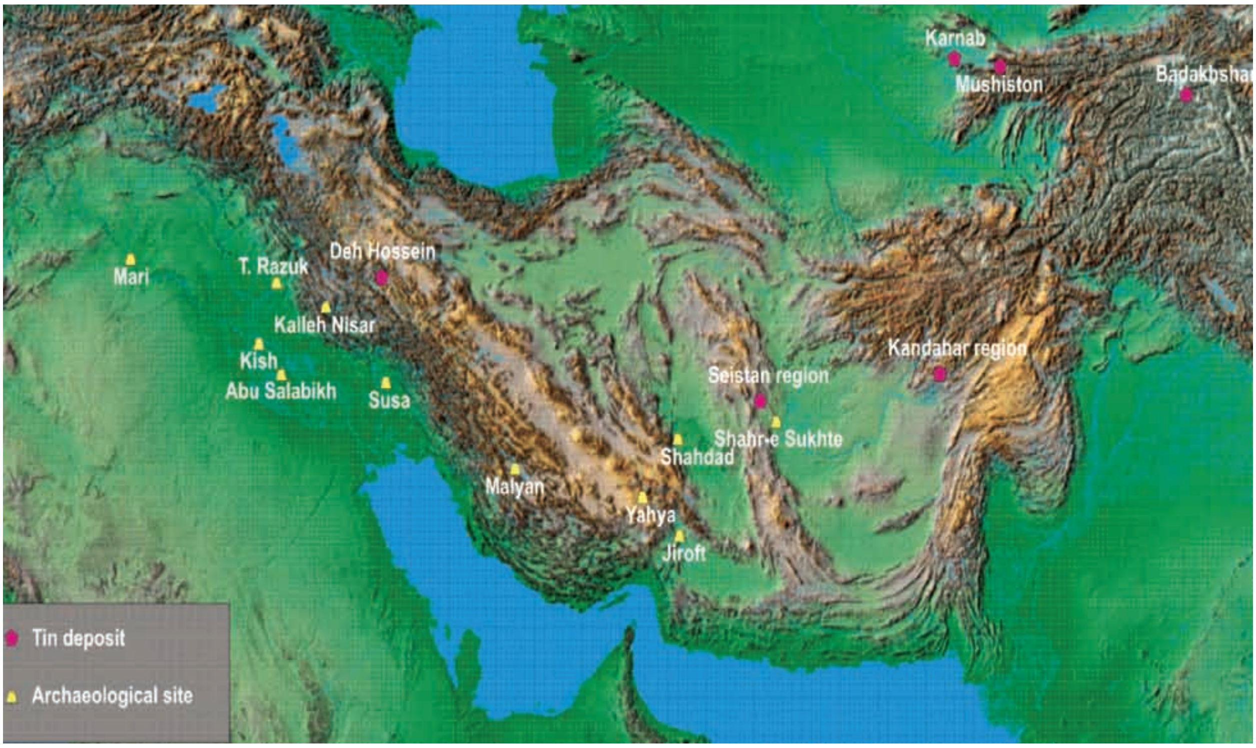

Fig. 1: Map showing tin deposits in the Deh Hossein area and sites discussed in the text.

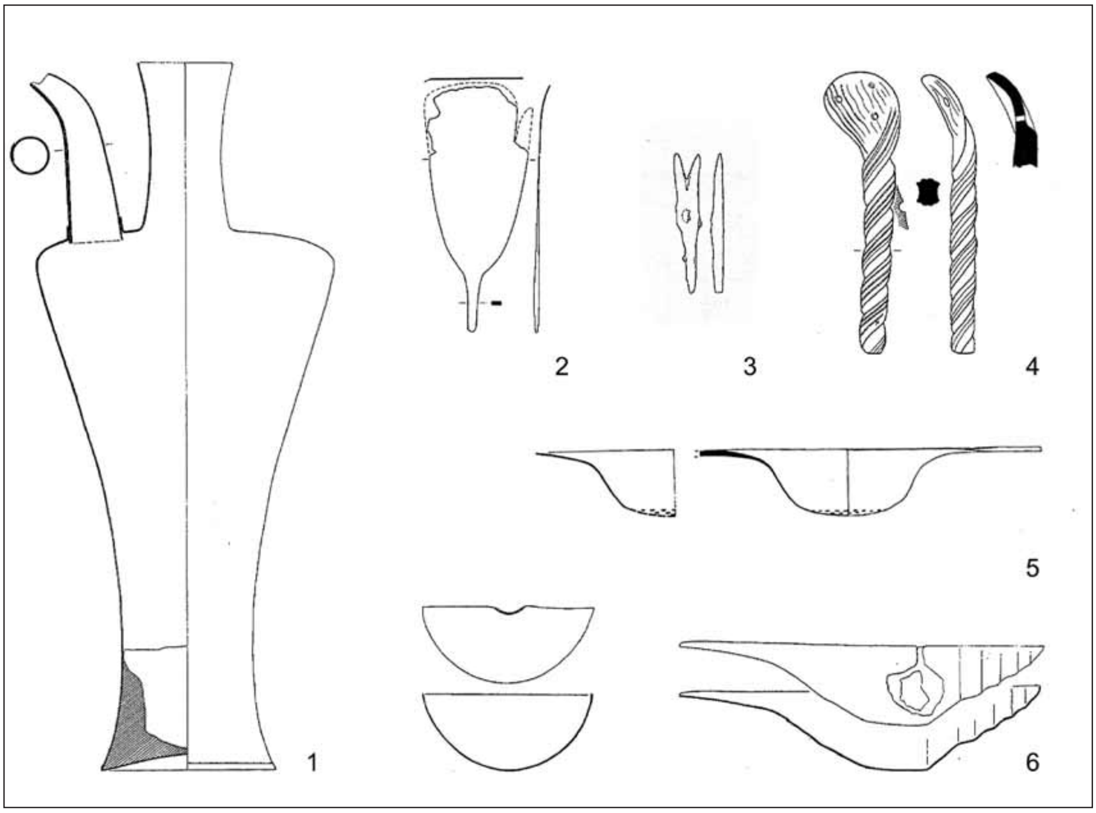

Fig. 2: Mesopotamian metal artefacts (first half of 3rd millennium BC) with > 1% tin (no. 2: razor, Kish, typologically dated to ED I/II; no. 3: point, Tell Razuk level IV, round building, ED I; no. 4: twisted rod, possibly braid of a statue, Tell Agrab, Shara temple, earlier building, ED II) and metal vessels with tin >10% (nos. 1, 6, Abu Salabikh, area A level V grave 2, ED II; no. 5, Abu Salabikh, area A level V, ED II); all drawings from Müller-Karpe 2004, no. 8, 10, 18, 45, 572, 723.

INTRODUCTION OF THE DEH HOSEIN ANCIENT TIN-COPPER MINE, WESTERN IRAN: EVIDENCE FROM GEOLOGY, ARCHAEOLOGY, GEOCHEMISTRY AND LEAD ISOTOPE DATA

BATI İRAN'DAKİ ESKİ BİR KALAY MADENİ, DEH HOSEİN'İN TANITIMI: JEOLOJİ, ARKEOLOJİ, JEOKİMYA VE KURŞUN İZOTOP VERİLERİ

Nima NEZAFATI, Ernst PERNICKA, Morteza MOMENZADEH

Keywords: Deh Hosein, ancient mining, tin, copper, bronze, lead isotope analysis, archaeometry, Western Iran

Anahtar Sözcükler: Deh Hosein, eski madencilik, kalay, bakır, tunç, kurşun izotop analizi, arkeometri, batı İran

ÖZET

İran'ın orta kesiminin batısında bulunan eski bakır ve kalay işletmesi Deh Hosein'in keşfinin ardından yapılan yeni araştırmalar, batı Asya uygarlıklarının yararlandıkları kalay kaynaklarının neresi olduğu sorusuna önemli yeni bir açılım kazandırmıştır.. Deh Hosein bakır-kalay madeninden elde edilen cevher örneklerinin analizi yapılmış ve bu sonuçlar, Luristan ile Mezopotamya'daki tunç buluntular ile karşılaştırılarak aralarındaki ilişki sorgulanmıştır.

^{14}C analizleri ve arkeolojik kanıtlarla birlikte burada bulunan çok sayıda eski ocağın ve madencilik ile ilgili kalıntılarının en geç MÖ 2. binyıl başı ile MÖ 1. binyıl arasına ait olduğu ortaya çıkmıştır. Ayrıca yapılan cevher analizleri sonucunda Sn, Cu, As, Pb, Zn, ve Au'nun da yoğun olduğu görülmüştür. Daha da önemlisi cevher örneklerindeki kurşun izotop oranları dar bir yelpaze içindedir ve MÖ 2. binyıla ait Luristan, MÖ 3. binyıla ait Basra Körfezi'nin güneyi, Ege ve yine Luristan ile Mezopotamya'nın bu tarihe ait örnekleri ile uyum sağlamaktadır. Ayrıca iz analizi ve tarihlendirme sonuçlarının yanı sıra Mezopotamya'nın doğusunu kaynak olarak işaret eden yazılı metinler de, Deh Hosein'in İran, Mezopotamya ve hatta belki batı için önemli bir kalay kaynağı olduğunu düşündürmektedir.

INTRODUCTION

In spite of rather extensive archaeological and geological investigations in Western Asia during the past decades, the source of tin for the huge bronze production in the ancient Near- and Middle-East has long remained enigmatic. Recently, by discovery of an ancient tin-copper mine at Deh Hosein in West Central Iran (Momenzadeh *et al.* 2002) on the eastern rim of the Zagros Mountains; it seems that a pivotal clue for solving this old riddle has emerged. In this paper the ancient mine at Deh Hosein will be introduced and described. Lead isotope as well as compositional analyses of ores from Deh Hosein are compared with results of Early Bronze and Iron Age bronze artifacts from Luristan and Western Asia. As will be seen, much geological, analytical, chronological, and geographical evidence together with archaeological and textual records attest that the Deh Hosein mine has been a major ore supplier for bronze in prehistoric times.

The Deh Hosein ancient Sn-Cu-(Au) mine (Fig. 1), in the northeastern rim of the Luristan area and eastern part of central Zagros Mountains is located in the northern part of the Sanandaj-Sirjan tectonic unit which consists mainly of Mesozoic schist, Middle Jurassic-Early Tertiary intrusive rocks and their contact metamorphic aureoles and pegmatite. The Sanandaj-Sirjan zone (Stöcklin 1968) is a metamorphic NW-SE aligned belt. This belt ranges parallel to the Zagros Mountains and extends from Sanandaj in the northwest to Sirjan in the southeast of Iran. Magmatism in the northern part of the Sanandaj-Sirjan zone including the study area is manifested by exposure of large intrusive bodies with a northwest-southeast general trend, named as west Iranian granitoids in the Sanandaj-Sirjan zone (Valizadeh 1992), which favors the occurrence of Deh Hosein-like deposits. Regional metamorphism in the area has reached a peak of green schist facies, but further metamorphism has occurred locally, associated with granitoid emplacement.

ANCIENT WORKS AND RELICS AT DEH HOSEIN ANCIENT MINE

The recently discovered (2000) ancient mine of Deh Hosein has been named after the adjacent village of Deh Hosein which is located 7 km southeast of the town of Astaneh. The ancient workings at Deh Hosein occur as numerous (more than 75) big ellipsoidal open depressions, along the mineralized horizons, in an area of 4.5 x 6 km^2 (Figures 1 and 2a). The old workings are up to 70 by 50 by 15 meters in size which are aligned over a length of up to 500 m (Fig. 2a, and 2b). All the visible ore bearing zones on the surface are worked out by ancient miners. Small remains of the ore are visible as weak mineralized selvages of the diggings or as scattered pieces in the dumps. It is possible that underground workings extend underneath each depression and the adits are blocked by debris. Huge waste dumps are piled up at the periphery of some depressions.

Several hammer stones of two different materials, namely silicified phyllite and granite (which are common rocks in the area) and pottery shards have been found in the open cast mines (Fig. 2). Besides the diggings two rather small areas with building structures were found, possibly houses for living or workshops. Pieces of ore within the structures relate them to the mining site. Several grinding stones, hammer stones and pottery shards are visible on the surface of these sites. The larger site is a rectangular (50 x 30 m^2) structure on a hill, on the northeastern side of the mining area which overlooks all mining sites. A rather big rectangular grinding stone (70 x 35 cm^2) and several pieces of smaller ones of granitoidic material (Fig. 2f), a carved stone with an unknown sign, plenty of pottery shards (Fig.2g) and pieces of copper ore were found on the surface of the site. The grinding stones are of two types, concave and convex with smooth surfaces. The pottery shards are variable in color and thickness and are sporadically depicted with a black material which according to preliminary inspection by archaeologists, date to the early first millennium BCE (Fig. 2g).

During a mining exploration campaign accomplished by Zaryaban Exploration Company, pieces of charcoal were found in one of the diggings in a depth about 2 m. Radiocarbon measurement of this charcoal yielded a date of 3380±55 BP, which on calibration results in an interval of 1775-1522 BCE at the 2-sigma confidence level (95% probability). It has to be noted that this date relates to an intermediate layer of the mine; the earliest mining activity can be even older.

No evidence for ancient smelting was found in the vicinity of the mine. The ore exploited may have been transported to the settlements and smelted outside the area. Also, no sign of medieval or modern mining has been observed in the area of ancient mining.

GEOLOGY, MINERALOGY AND GEOCHEMISTRY OF DEH HOSEIN

The mineralization of Deh Hosein is located in Jurassic meta-sedimentary rocks, which have experienced a green schist metamorphic facies and were intruded by the Astaneh complex in the north. The area has a moderate topography and is covered with many farm fields that in some cases have covered the ancient diggings (Fig. 1 and 2a).

The mineralization continues in the southern part of the Astaneh intrusion at its contact with the metamorphic country rocks. The meta-sedimentary rocks consist of alternating meta-sandstone, phyllite, schist, spotted slate and hornfels at the contact with the Astaneh intrusion. Although the mineralization is not restricted to any specific rock unit, it shows an obvious connection with intercalations of meta-sandstone present in phyllite, schist and spotted slate. The mineralization has occurred in the form of quartz, sulfide (arsenopyrite) and quartz-sulfide veins and veinlets. These fracture-controlled veins show mainly NW-SE, NE-SW and sporadically E-W trends which are up to 1.5 m wide and several 10 m long. Furthermore, the mineralization appears in the form of disseminations and impregnations, especially in the vein selvages. Quartz veins hosting the sulfide mineralization is the dominant ore-related feature of mineralization. The mineralization continues into the contact granodiorite and tourmaline-granite but it is less intense there.

On the surface the mineralization is highly altered by weathering and many sulfide minerals are thoroughly oxidized (Fig. 3a). Arsenopyrite and chalcopyrite are the dominant sulfide minerals, with lesser amounts of pyrite, pyrrhotite and cassiterite. Ore microscopy has revealed some 35 different ore minerals in the Deh Hosein occurrence, including arsenopyrite, chalcopyrite, native copper, cuprite and other supergene copper minerals, cassiterite, native bismuth and bismuth minerals, ferberite, galena, limonite, pyrite, pyrolusite, pyrrhotite, sphalerite, stannite and sulfosalts (Figure 3, Nezafati *et al*. 2005; Nezafati 2006). Cassiterite is a rather abundant ore mineral and has been observed in both meta-sedimentary and granitic host rocks. It has been observed in quartz-sulfide (gossan) veins at Ghara Ghouii, Ahmad Jigi II, and at the east and center of the occurrence (including samples 7A, 42, 43, and 47, table 1 and Fig. 1).

Cassiterite occurs in the form of grains up to 250μm in size and is in association with oxidized copper minerals and gossan (Fig. 3c and 3d). In addition, heavy mineral prospection in the streams of the ancient mining area by Zaryaban Exploration revealed nuggets of cassiterite.

18 ore samples from Deh Hosein were analyzed by Neutron Activation Analysis (NAA) at Actlabs, Canada (for gold and trace elements by programs Au+48 and Au+34) in order to examine the content of trace elements in the ore (Table 1). According to results, the tin in the veins ranges from 0.01 to 6.72%. The Cu, As, Pb, Zn, Au and, W amounts of veins are as much as 10%, 23.9%, 3.7%, 0.75%, 13.3 ppm and 2420 ppm. Ag, Sb and Ni show also rather considerable amounts in the ore. The highest gold concentrations are found in samples containing visible arsenopyrite, chalcopyrite, pyrite, sulfosalts and highly oxidized iron (gossan).

The high content of arsenic and copper along with tin in the ore of Deh Hosein is noteworthy, especially when we consider this fact that the co-occurrence of arsenic and tin is characteristic of Early Bronze Age metallurgy in Mesopotamia (Fleming *et al*. 2005).

The comprehensive analytical research on Luristan bronzes of different periods performed by Fleming *et al.* (2005) show high arsenic contents in the early artifacts which clearly becomes lower with time and technological improvements in the Iron Age. As a result of this fact arsenic is no longer an important alloying ingredient in the Iron Age. According to this study (Fleming et al. 2005), it has also been realized that there was usually no technical control on the percentage of tin in the final products (either weapons or ornaments) and the admixture has occurred randomly. This variation in Sn contents in finished artifacts may imply that they have simply used a naturally mixed source of copper and tin which could be the Deh Hosein.

Comparison of the analytical results of the ore from Deh Hosein with the results of Luristan bronzes accomplished by Rickenbach 1992, Fleming *et al.* 2005, and Nezafati 2006 implies that the Deh Hosein ore, with up to 6.72% Sn and up to 10% Cu, could well be the source of many of these artifacts. In addition to copper and tin, other elements like arsenic, iron, lead, and zinc show high contents in many samples of both sides. Gold, silver, nickel and antimony which indicate traces in the artifacts also show anomalies in the ore.

LEAD ISOTOPE ANALYSIS (LIA)

The study of lead isotope ratios has nowadays consolidated its status in archaeological sciences and greatly contributed to the provenance studies (Pernicka *et al*. 1984). Geological studies of this technique had demonstrated that a large range of potential lead isotope "fingerprints" could be expected from different types of mineralization formed at different periods in the Earth's history (Gulson 1986; Weeks 2004). The existence of isotopically discrete ore fields from particular regions lead to the speculation that isotope ratios of archaeological objects could be related to these discrete fields, thus providing a provenance for the analyzed object (Weeks 2004). Since the isotope composition of lead is more or less constant within an ore body and is not changed at all by chemical reactions during smelting or corrosion (Hezarkhani and Pernicka 2000), it is possible to utilize the lead isotope ratios as fingerprints of individual ore deposits whose ores have been used for production of certain finished artifacts. This is true as long as the ore of two or more deposits of different lead isotope ratios were mixed for the production of artifacts. In case of admixture of ores from different sources, the lead isotope ratios would be homogenized and the results differ from each individual deposit. Therefore, the application of lead isotope ratios provides, strictly speaking, conclusive evidence only in the negative sense, i.e. a specific ore deposit can be conclusively excluded as a possible source of raw metal when its isotope fingerprints do not match the artifact under study (Hezarkhani and Pernicka 2000).

For lead deposits and ancient lead artifacts the application of LIA is straightforward, but similar reasoning applies to copper deposits, because most copper ores contain at least small concentrations of lead that pass through the smelting process and end up with the copper metal. If the ancient copper or copper-based alloy does not contain more than a few percent of lead, the necessary precondition that lead in copper is an accidental contamination deriving from the copper ore and is thus an indicator for the provenance of the copper can be regarded as fulfilled. This even holds true for copper-tin alloys, because tin metal is usually very pure, even in antiquity, and its concentration in bronze rarely exceeds 15% (Hezarkhani and Pernicka 2000).

18 ore samples from Deh Hosein were examined with a multi-collector inductivity coupled plasma mass spectrometer, VG Axiom MC, for lead isotope ratios (Table 2). All 2σ (95% confidence level) errors are less than 0.05% for the $^{207}Pb/^{206}Pb$ and $^{208}Pb/^{206}Pb$ ratios. All experiments were performed at the Institute of Archaeometry at the TU Bergakademie Freiberg. The samples were prepared and measured following the procedure of Niederschlag *et al*. (2003).

The lead isotope data of bronze artifacts of different periods and locations published by Weeks (Southern Persian Gulf including Al Sufouh, Tell Abraq, Unar 1 and Unar 2, 1999, 2004), Begemann et al. (Thermi in the Aegean, 1992) as well as data from Nezafati (2nd and 1st millennium Luristan, 2006), and Begemann *et. al*. (3rd millennium Luristan, Troia, Mesopotamia and, Jordan, 2008) have been used in order to compare the results and have more accurate conclusion.

By comparison of the lead isotope ratios of the ores from the ancient mine at Deh Hosein with bronze artifacts from Luristan, the southern Persian Gulf, Mesopotamia, and the Aegean (Fig. 4) the following conclusions can be drawn:

The Deh Hosein deposit shows a rather small variation of lead isotope ratios disregarding if the ratio is from copper minerals, galena, arsenopyrite, copper and tin minerals or bulk samples which contain different range of minerals.

The metal used in a number of the bronze artifacts is isotopically compatible with the Deh Hosein deposit. These include most of the 3rd millennium BCE Luristan artifacts, half of the 1st and 2nd millennium BCE Luristan objects, some southern Persian Gulf artifacts, two samples from Thermi, one artifact from Kish (Mesopotamia), and Zeiraqun (Jordan). This indicates that the Deh Hosein ancient mine could have been a major supplier of the tin which was used in the contexts of a wide area from western Turkey to southern Persian Gulf in a rather wide period of time from the third to the first millennium BCE.

Although a sample from Kish, two samples from Tell Abraq, two samples from Unar 2, the sample from Zeiraqun, and a sample from Thermi do not match exactly the samples from Deh Hosein, they plot in the same area as the Deh Hosein samples.

Interestingly, the lead isotope ratio of a tin-arsenic bangle from the site Tell Abraq reported by Weeks (1999, 2004) matches very well with the isotope ratio of the ore at Deh Hosein.

There are rather numerous outliers to the main distribution (not all shown in figure 4). These outliers which are from the sites of Tell Abraq, Unar1, Unar 2, Al Sufouh, Thermi and some 1st and 2nd millennium BCE Luristan artifacts indicate that either another source of tin has been used for them or their metal derives from a mixture of Deh Hosein ore with some copper ore with a different lead isotope ratio.

Although a positive assignment is not possible out of principle, the very small variation of lead isotope ratios in the Deh Hosein deposit and the almost identical lead isotope ratios in ores from there and in bronze samples from Luristan, Southern Persian Gulf, Western Turkey and Mesopotamia strongly suggest that the ore from Deh Hosein have already been known and exploited as early as the third millennium BCE. It is also reasonable because the Deh Hosein ancient mine is the only so far known copper-tin deposit which is located in the vicinity of ancient cultures and its lead isotope ratios matches the ones from ancient artifacts. In the other hand, if tin sources are very scarce, one or a very limited number of sources could have supplied a very large area, and such isotopic matches could be a reflection of shared provenance (Weeks 2004).

Except for the Deh Hosein ancient mine, some tin deposits have lately been discovered in different regions of western and central Asia. These include *Kestel/Göltepe* in Turkey (Yener and Özbal 1987; Yener *et al*. 1989; Yener and Goodway 1992; Willies 1990, 1992; Yener and Vandiver 1993), *Jabal Silsilah* and *Kutam* in the western Arabian Peninsula (Stacey *et al*. 1980; Du Bray 1985; Du Bray *et al*. 1988; Kamilli and Criss 1996; Overstreet *et al*. 1988), Abu *Dabbab, Nuweibi, Igla, El Mueilha, and Homr Akarem* in Eastern Desert of Egypt (Wertime 1978; Muhly 1978; 1993), *Mesgaran* in Afghanistan (Shareq *et al*. 1977; Berthoud 1979; Stech and Pigott 1986), and *Kharnab* and *Mushiston* in Central Asia (Masson and Sarianidi 1972; Wertime 1973; 1978; Crawford 1974; Ruzanov 1979; Alimov *et al*. 1998; Boroffka *et al*. 2002) which could be considered as suppliers of the ancient tin needs. But based upon the recent lead isotope studies accomplished by Weeks (1999, 2004), along with archaeological evidence (Garenne-Marot 1984; Muhly 1973; Glanzman 1987; Fleming and Pigott 1987; Wertime 1978; Weeks 1999; 2004), many of these deposits including deposits of Egypt and the Arabian Peninsula as well Anatolia (Kestel) have been withdrawn as possible sources of tin for the early Bronze Age.

SUMMARY AND CONCLUSIONS

The recent discovery of the Deh Hosein tin-copper occurrence together with ancient mining along with new analytical results (including lead isotope analysis) of bronze artifacts from Iran, United Arab Emirates, and some other ancient sites, provide a pivotal clue to find an answer for the old archaeological question in terms of tin and tin-copper ore. The following evidence attest that the Deh Hosein ancient mine has been a major supplier of tin for ancient civilizations of ancient Iran and Mesopotamia and even perhaps further localities to its west:

THE MINERALOGICAL AND ANALYTICAL EVIDENCE

The simultaneous occurrence of tin and copper minerals within one mineralization, the strong correspondence of lead isotope ratios as well as good correlation between trace elements of the Deh Hosein ancient mine and the ancient artifacts including high tin, copper and arsenic contents attest to the role of this mine in supplying copper-tin ore of the ancient workshops.

THE CHRONOLOGICAL EVIDENCE

According to ^{14}C dating and archaeological evidence, the Deh Hosein ancient mine has been in operation at least from early second millennium till first millennium BCE.

THE ANCIENT TEXTUAL RECORDS (REPEATED TEXTUAL REFERENCE)

In the ancient cuneiform texts, it has been several times mentioned that copper, bronze and tin come from the east. Among these texts, the text from Kanesh which refers to tin coming overland through the Zagros Mountains to Mesopotamia from northwestern Iran (Muhly 1973), and the text referring to mines behind Jabal Hamrin (Ebih) (*Innana and Ebih,* Muhly 1973) may have mentioned Deh Hosein Mine.

THE GEOGRAPHICAL EVIDENCE

The recently discovered Deh Hosein ancient mine is the only known tin (-copper) bearing source in close distance to the eastward Mesopotamia and Luristan area.

THE STATISTICAL EVIDENCE

The abundance of bronze artifacts from the mid Bronze Age to the end of Iron Age in the whole Mesopotamia and western Iran attests to a rich source of ore in the vicinity of these areas, especially when it would be taken into consideration that this abundance has emerged mainly in these areas and not to adjacent areas.

THE DENOMINATION EVIDENCE

The Greek word for tin, κασσιτεροζ ((Kassiteros), can be interpreted as metal “coming from the country of the Kassites” (Ghirshman 1954), and the Kassites lived in central and west central Iran. Also the characteristic Luristan Bronze artifacts appear under the reign of the Kassites in west central Iran and Mesopotamia. Finding two canonical artifacts of Luristan Bronze on Samos and Crete islands (Muscarella 1988) may confirm the influence of Kassites (or Luristani people) and the export of their wares to ancient Greek territories in the late 8th or 7th century BCE. Although the huge amount of bronze finds in the ancient sites of Western Asia implies that the ancient mine at Deh Hosein may not have been the only source of copper-tin ore in antiquity, the geological evidence indicates that the whole northern part of Sanandaj-Sirjan belt is favourable for the occurrence of such types of ore deposits. It is thus a major target for the prospection of ancient workings. As an example, the Nezam Abad prospect (about 12km southwest of Deh Hosein) with up to 0.87% tin and 10% copper has already revealed some ancient workings and shows similar lead isotope ratios to Deh Hosein. Although the number of ancient diggings is smaller and the content of tin lower than at Deh Hosein, it could nevertheless an indication that there may be even more tin-bearing mines in the region.

Since Deh Hosein has only recently been discovered (2000), it may well lead to more extensive surveys in the in the northern part of the Sanandaj-Sirjan zone once one knows what to look for.

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REFERENCES

Alimov, K. et al. 1998
“Prähistorischer Zinnbergbau in Mittelasian, Vorbericht der ersten Kampagne 1997”, *Eurasia Antiqua* 4: 137-199.

Begemann, F. and S. Schmitt-Strecker 2006
“Materialanalysen, Untersuchungen zur Herkunft der Rohstoffe, in Die Metallindustrie Mesopotamiens von den Anfängen bis zum 2. Jahrtausend v. Chr.”, H. Hauptmann and E. Pernicka (eds.) *Orient-Archäologie*. Rahden/Westfahlen.

Begemann, F., S. Schmitt-Strecker and E. Pernicka 1992
“The metal finds from Thermi III-V: a chemical and lead-isotope study”, *Studia Troica* 2: 219-239.

Begemann, F. et al. 2008
“An archaeometallurgical study of the Early and Middle Bronze Age in Luristan, Iran”, *Iranica Antiqua* XLIII: 1-66.

Berthoud, T. 1979
Etude par l’Analyse de Traces et la Modélisation de la

Filiation Entre Minerais de Cuivre et Objets Archéologiques du Moyen Orient. PhD, University of Paris VI, Paris.

Boroffka, N. et al. 2002
"Bronze Age tin from Central Asia, in Ancient Interactions: East and West", K. Boyle, C. Renfrew and M. Levine (eds.) *Eurasia*: 135-159. McDonald Institute Monographs, McDonald Institute for Archaeological Research, Cambridge.

Crawford, H.E.W. 1974
"The problem of tin in Mesopotamian bronzes", *World Archaeology* 6: 242-246.

Du Bray, E.A. 1985
"Geology of the Silsilah ring complex, and associated tin mineralization, Kingdom of Saudi Arabia-a synopsis", *American Mineralogist* 70: 1075-1086.

Du Bray, E.A., J.E. Elliot and J.S. Stuckless 1988
"Proterozoic peraluminous granites and associated Sn-W deposits, Kingdom of Saudi Arabia", R.P. Taylor and D.K. Strong (eds.) *Recent Advances in the Geology of Granite-Related Mineral Deposits*: 142-156. Canadian Institute of Mining and Metallurgy Special Volume 39, Canadian Institute of Mining and Metallurgy, Montreal.

Fleming, S.J. and V.C. Pigott 1987
"Archaeometallurgy, in Site Reconnaissance in the Yemen Arab Republic, 1984", W.D. Glanzman and A.O. Ghaleb (eds.) *The Stratigraphic Probe at Hajar Ar-Rayhami*, *The Wadi Al-Jubah Archaeological Project,* Volume 3: 171-181. American Foundation for the Study of Man, Washington.

Fleming, S.J., V.C. Pigott, C.P. Swann and S.K. Nash 2005
"Bronze in Luristan: Preliminary analytical evidence from copper/bronze artifacts excavated by the Belgian mission in Iran", *Iranica Antiqua* 40: 35-64.

Garenne-Marot, L. 1984
"Le cuivre en Égypt Pharaonique: sources et métallurgie", *Paléorient* 10: 97-126.

Ghirshman, R. 1954
Iran: from the earliest times to the Islamic conquest. A volume in the Pelican archaeology series, Penguin Books.

Glanzman, W.D. 1987
"Metallurgical debris, in Site Reconnaissance in the Yemen Arab Republic, 1984", W.D. Glanzman and A.O. Ghaleb (eds.) *The Stratigraphic Probe at Hajar Ar-Rayhami*, *The Wadi AI-Jubah Archaeological Project,* Volume 3: 145-148. American Foundation for the Study of Man, Washington.

Gulson, B.L. 1986
Lead isotopes in mineral exploration. Science Publishing Company Inc., Elsevier.

Hezarkhani, Z. and E. Pernicka 2000
"Provenance studies on metal ores and artifacts", *Archäologische Mitteilungen aus Iran und Turan* 32: 305-310.

Kamilli, R.J. and R.E. Criss 1996
"Genesis of the Silsilah tin deposit, Kingdom of Saudi Arabia", *Economic Geology* 91: 1414-1434.

Masson, V.M. and V.I. Sarianidi 1972
Central Asia: Turkmenia before the Achaemenids. Praeger, New York.

Momenzadeh, M., N. Nezafati and E. Pernicka 2002
"First indication of tin at the ancient mining site near Deh Hosein, West-Central Iran: a possible source for Luristan bronze?", H. Kars and E. Burke (eds.) *Proceedings of the 33rd International Symposium on Archaeometry*: 116-117. Vrije Universiteit, Amsterdam.

Muhly, J.D. 1973
"Copper and tin", *Transactions, The Connecticut Academy of Arts and Sciences* 43: 155-535.

Muhly, J.D. 1978
"New evidence for sources of and trade in Bronze Age tin", A.D. Franklin, J.S. Olin and T.A. Wertime (eds.) *The Search for Ancient Tin*: 43-48. U.S. Government Printing Office, Washington.

Muhly, J.D. 1993
"Early Bronze Age tin and the Taurus", *American Journal of Archaeology* 97: 239-253.

Nezafati, N. 2006
Au-Sn-W-Cu-Mineralization in the Astaneh-Sarband Area, West Central Iran, including a comparison of the ores with ancient bronze artifacts from Western Asia. PhD thesis, University of Tübingen.

Nezafati, N., P.M. Herzig, E. Pernicka and M. Momenzadeh 2005
"Intrusion-related gold occurrences in the Astaneh-Sarband area, west central Iran", J. Mao and F.P. Bierlein (eds.) *Mineral deposit research: meeting the global challenge*: 445-448. Springer.

Nezafati, N., E. Pernicka and M. Momenzadeh 2006
"Ancient tin: old question and a new answer", *Antiquity* 80/308.http://antiquity.ac.uk/ProjGall/nezafati%20et%20al/index.html

Niederschlag, E., E. Pernicka, T. Seifert and M. Bartelheim 2003
"Determination of lead isotope ratios by multiple collector ICP–MS: a case study of Early Bronze Age artifacts and their possible relation with ore deposits of the Erzgebirge", *Archaeometry* 45: 61-100.

Ojaghi, B., K. Shabani, S. Asfari and N. Nezafati 2001
Geological map of the Deh Hosein area, scale: 1:5000. Zaryaban Exploration, Unpublished.

Overstreet, W.C. et al. 1988
"Mineral resources of the al-Jubah quadrangle, Yemen Arab Republic", W. Overstreet, M.J. Grolier and M.R. Toplyn (eds.) *Geological and Archaeological Reconnaissance in the Yemen Arab Republic*, 1985, *The Wadi Al-Jubah, Archaeological Project,* Volume 4: 359-418. American Foundation for the Study of Man, Washington.

Pernicka, E. et al. 1984
"Archäometallurgische Untersuchungen in Nordwestanatolien", *Jahrbuch des Römisch-Germanischen Zentralmuseums Mainz* 31: 533-599.

Rickenbach, J. 1992
Magier mit Feuer und Erz, Bronzekunst der frühen Bergvölker in Luristan, Iran. Museum Rietberg Zürich.

Ruzanov, V. 1979
"On general ancient tin ore sources on the territory of Uzbekistan", *Material for the History of Uzbekistan* 15: 98-104.

Shareq, A. et al. 1977
Mineral resources of Afghanistan, Edition 2 Kabul: Ministry of Mines and Industries. Afghan Geological and Mines Survey, United Nations Development Support Project, AFG/74/012.

Stacey, J.S. et al. 1980
"A lead isotope study of mineralization in the Saudi Arabian Shield", *Contributions to Mineralogy and Petrology* 74: 175-188.

Stech, T. and V.C. Pigott 1986
"The metals trade in southwest Asia in the third millennium BC", *Iraq* 48: 39-64.

Stöcklin, J. 1968
"Structural history and tectonics of Iran. A review", *Amer. Assoc. Petrol. Geol. Bull.* 52/7: 1229-1258.

Valizadeh, M.V. 1992
"Granitoids and the problem of crustal transformation in west of Iran", *Experimental petrology and global tectonics*, Volume II: 409-423. (in Persian), University of Tehran.

Weeks, L.R. 1999
"Lead isotope analyses from Tell Abraq, United Arab Emirates: new data regarding the `tin problem' in Western Asia", *Antiquity* 73: 49-64.

Weeks, L.R. 2004
Early metallurgy of the Persian Gulf; Technology, trade and the Bronze Age World. Brill Academic Publishers Inc., Boston.

Wertime, T.A. 1973
"The beginnings of metallurgy: a new look", *Science* 182/4115: 875-887.

Wertime, T.A. 1978
"The search for ancient tin: the geographic and historic boundaries", A.D. Franklin, J.S. Olin and T.A. Wertime (eds.) *The Search for Ancient Tin*: 1-6. U.S. Government Printing Office, Washington.

Willies, L. 1990
"An Early Bronze Age tin mine in Anatolia, Turkey", *Bulletin of the Peak District Mines Historical Society* 11/2: 91-96.

Willies, L. 1992
"Reply to Pernicka et al.: Comment on the discussion of ancient tin sources in Anatolia", *Journal of Mediterranean Archaeology* 5: 99-103.

Yener, K.A. and H. Özbal 1987
"Tin in the Turkish Taurus Mountains: the Bolkardağ mining district", *Antiquity* 61: 220-226.

Yener, K.A. and M. Goodway 1992
"Response to Mark E. Hall, and Sharon R. Steadman, 'Tin in Anatolia: another look'", *Journal of Mediterranean Archaeology* 5: 91-98.

Yener, K.A., P. Vandiver and L. Willies 1993
"Reply to J.D. Muhly, 'Early Bronze Age tin and the Taurus'", *American Journal of Archaeology* 97: 255-262.

Yener, K.A. et al. 1989
"Kestel: an Early Bronze Age source of tin ore in the Taurus Mountains", *Science* 244: 200-203.

Sample No.	Description	Location	As ppm	Au ppb	Ag ppm	Cu %	Pb ppm	Zn ppm	S %	Sn %	W ppm	Bi ppm	Sb ppm	Se ppm	Fe %	Ni ppm	Co ppm	Ba ppm
DHN-1A	Chalcopyrite, Bi-minerals, pyrite, Fe-oxides	N33° 45.406′, E049° 18.993′, Digging east of the prospect	44.7	31	19.2	6.039	2117	228	0.64	<0.02	17	1252	98.9	29	4.11	60	16	<50
DHN-1B	Chalcopyrite, galena, pyrite, Fe-oxides	N33° 45.406′, E049° 18.993′, Digging east of the prospect	17.1	22	59.6	0.031	37694	31	0.71	<0.02	18	3	223	<3	0.47	3	3	<50
DHN-2	Pyrolusite + Fe-oxides	39s 0341207, UTM 3738556, Cheshmeh Jafar Khan	278	34	<0.3	0.204	1064	413	0.07	<0.02	<1	<2	36	4	41.2	92	46	<50
DHN-4	Fe-oxides + pyrite	39s 0341626, UTM 3737312, North of Deh Dosein village	2150	28	1.1	0.086	202	48	0.03	<0.02	1	115	33.3	<3	25.8	32	28	<50
DHN-5	Chalcopyrite, pyrite, Fe-Cu-oxides	Ancient settlement	378	47	14	3.492	52	459	0.04	<0.02	6	5	6	<3	5.16	41	29	460
DHN-7A	Pyrite, chalcopyrite, cassiterite, pyrolusite, galena, stannite	39s 0343347, UTM 3737263, Ghara Ghouii	2450	161	49.7	3.964	2591	1245	0.66	<0.01	57	50	1530	<3	29.5	44	48	120
DHN-10A	Chalcopyrite, pyrite, arsenopyrite	39s 0342443, UTM 3737013, Ahmad Jigi I	4100	135	21.8	3.691	37	156	0.02	<0.02	<1	<2	35.4	6	3.02	20	11	<50
DHN-10B	Chalcopyrite, pyrite, delafusite	39s 0342443, UTM 3737013, Ahmad Jigi I	3350	53	26.7	5.069	98	186	0.71	<0.02	<1	<2	28.1	<3	2.51	21	7	<50
DHN-15B	Fe-oxides + pyrite, chalcopyrite	39s 0340895, UTM 3738846, Ghaiidan	1600	50	1	0.249	209	662	0.01	<0.02	7	44	23.3	<3	22.5	67	35	<50
DHN-16B	Fe-oxides + pyrite	39s 0340182, UTM 3739756, Ghaiidan	1380	372	26.9	0.211	9793	7544	0.23	<0.03	<1	43	65.6	15	51	249	219	<50
DHN-34	Native copper, pyrite, arsenopyrite	39s 0342443, UTM 3737013, Ahmad Jigi I	19600	206	103.3	10	54	266	2.08	<0.02	<1	73	107	<3	10.2	54	28	<50
DHN-38	Arsenopyrite, pyrite, chalcopyrite, Bi-minerals	39s 0342546, UTM 3736831, Ahmad Jigi II	214000	5359	6.5	0.722	234	20	3.78	<0.02	<1	1686	1277	66	19.4	12	28	<50
DHN-42	Chalcopyrite, pyrite, cassiterite, Fe-oxides, etc.	39s 0343347, UTM 3737263, Ghara Ghouii	1660	109	27	2.93	279	625	0.58	0.42	32	800	137	<3	15.6	60	12	<50
DHN-43	Fe-oxides + pyrite, cassiterite, sphalerite	39s 0344246, UTM 3737047, Close to the ancient settlement	16000	1101	98.4	0.438	3930	2010	0.09	6.72	150	916	1353	<3	39.5	79	61	<50
DHN-47	Chalcopyrite, arsenopyrite, gold, cassiterite, ferberite, Fe-oxides	N33° 46.61′, E049° 19.99′, Granodiorite	541	845	19	4.478	541	106	1.39	<0.02	2420	1805	10.8	30	8.23	51	38	<50
DHN-60	Fe-oxides +pyrite, arsenopyrite	N33° 46.083′, E049° 18.992′, Northeast of the prospect	4340	314	130	N.A.	N.A.	897	N.A.	<0.01	<1	N.A.	178	29	17.8	<20	9	<50
DHN-71	Fe-oxides + pyrite, chalcopyrite	N33° 45.337′, E049° 18.406′, Beside the dirt road	9270	<2	<6	N.A.	N.A.	<50	N.A.	<0.01	<1	N.A.	<1	<3	33.9	<25	3	<50
DHN-93	Arsenopyrite, Bi-minerals	39s 0342443, UTM 3737013, Ahmad Jigi I	239000	13300	<5	N.A.	N.A.	<50	N.A.	<0.05	<20	N.A.	428	75	20.6	<50	913	<100

Table 1: Chemical analyses of ore samples from the Deh Hosein ancient mine, measured by NAA.
Detection limits: Au (2 ppb), As (0.5 ppm), Ag (0.3 ppm), Bi (2 ppm), Sb (0.1 ppm), W (1 ppm), Sn (0.01%)

Sample No.	Location	Description	$^{206}Pb/^{204}Pb$	$^{207}Pb/^{206}Pb$	$^{208}Pb/^{206}Pb$
DHN-1A	N33° 45.406´, E049° 18.993´, Digging east of the prospect	Copper ore	18.439	0.8488	2.0938
DHN-1B	N33° 45.406´, E049° 18.993´, Digging east of the prospect	Galena	18.415	0.8494	2.0949
DHN-7A	39s 0343347 . UTM 3737263, Ghara Ghouii	Copper ore, cassiterite, parite, galena	18.445	0.8484	2.0924
DHN-7B	39s 0343347 . UTM 3737263, Ghara Ghouii	Oxidized copper ore	18.446	0.8487	2.0928
DHN-10A	39s 0342443, UTM 3737013, Ahmad Jigi I	Copper ore. arsenopyrite	18.437	0.8488	2.095
DHN-10B	39s 0342443, UTM 3737013, Ahmad Jigi I	Copper ore, pyrite	18.528	0.8452	2.0959
DHN-12A	Ahmad Jigi II	Chalcopyrite, pyrite	18.453	0.8482	2.0926
DHN-15B	39s 0340895 . UTM 3738846, Ghaiidan	Copper ore, pyrite	18.461	0.84838	2.0933
DHN-16B	39s 0340182 . UTM 3739756, Ghaiidan	Oxidized ore	18.429	0.84868	2.0933
DHN-34	39s 0342443 . UTM 3737013, Ahmad Jigi I	Copper ore (native copper), pyrite. arsenopyrite	18.487	0.8468	2.0935
DHN-38	39s 0342546 . UTM 3736831, Ahmad Jigi II	Arsenopyrite. chalcopyrite, pyrite	18.446	0.8485	2.0928
DHN-42	39s 0343347 . UTM 3737263, Ghara Ghouii	Quartz, chalcopyrite, malachite, azurite, Fe oxides	18.444	0.8484	2.0922
DHN-43	North of the deposit	Oxidized ore (chalcopyrite, pyrite, sphalerite. cassiterite)	18.422	0.849	2.0937
DHN-45	39s 0344246 . UTM 3737047, Close to the ancient settlement	Oxidized copper ore	18.547	0.8438	2.0857
DHN-47	N33° 46.61´. E049° 19.99´, Granodiorite	Oxidized ore (chalcopyrite, arsenopyrite, ferberite)	18.517	0.8453	2.0901
DHN-60	N33° 46.083' . E049° 18.992', Northeast of the prospect	Pyrite, arsenopyrite, sphalerite	18.434	0.8486	2.0935
DHN-76	East of the deposit	Oxidized ore (chalcopyrite, galena, pyrite)	18.447	0.8486	2.0927
DHN-93	39s 0342443 . UTM 3737013, Ahmad Jigi I	Arsenopyrite	18.509	0.8458	2.0950

Table 2 Lead isotope ratios and sample description of the ore samples from Deh Hosein.

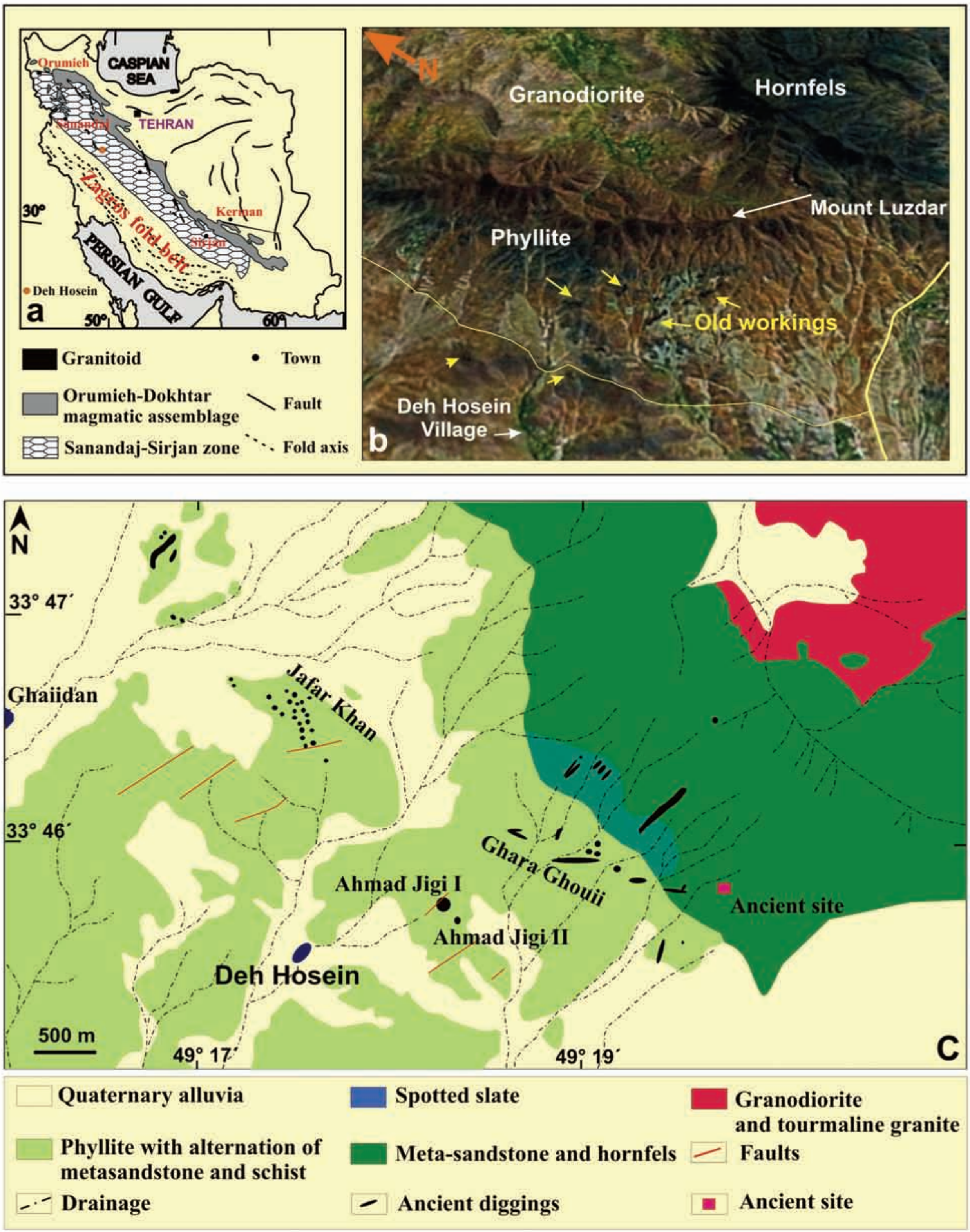

Fig. 1 a) Location of the study area in Iran, b) Satellite map of the Deh Hosein occurrence (Google Earth), c) Geology of the Deh Hosein occurrence (modified after Ojaghi et al. 2002).

Fig. 2 a) An overview of the Deh Hosein ancient mine with part of its ancient diggings, b) The Ghara Ghouii alignment of ancient diggings at Deh Hosein, c) The Ahmad Jigi ancient digging with a large mining dump, d) Hammer stone of silicified phyllite found in the Ghara Ghouii digging, e) Hammer stone of granite found in the Ghara Ghouii digging, f) Granitic grinding stones found in the greater ancient settlement, g) Pottery sherds and granitic grinding stone (top: a piece of depicted pottery sherd).

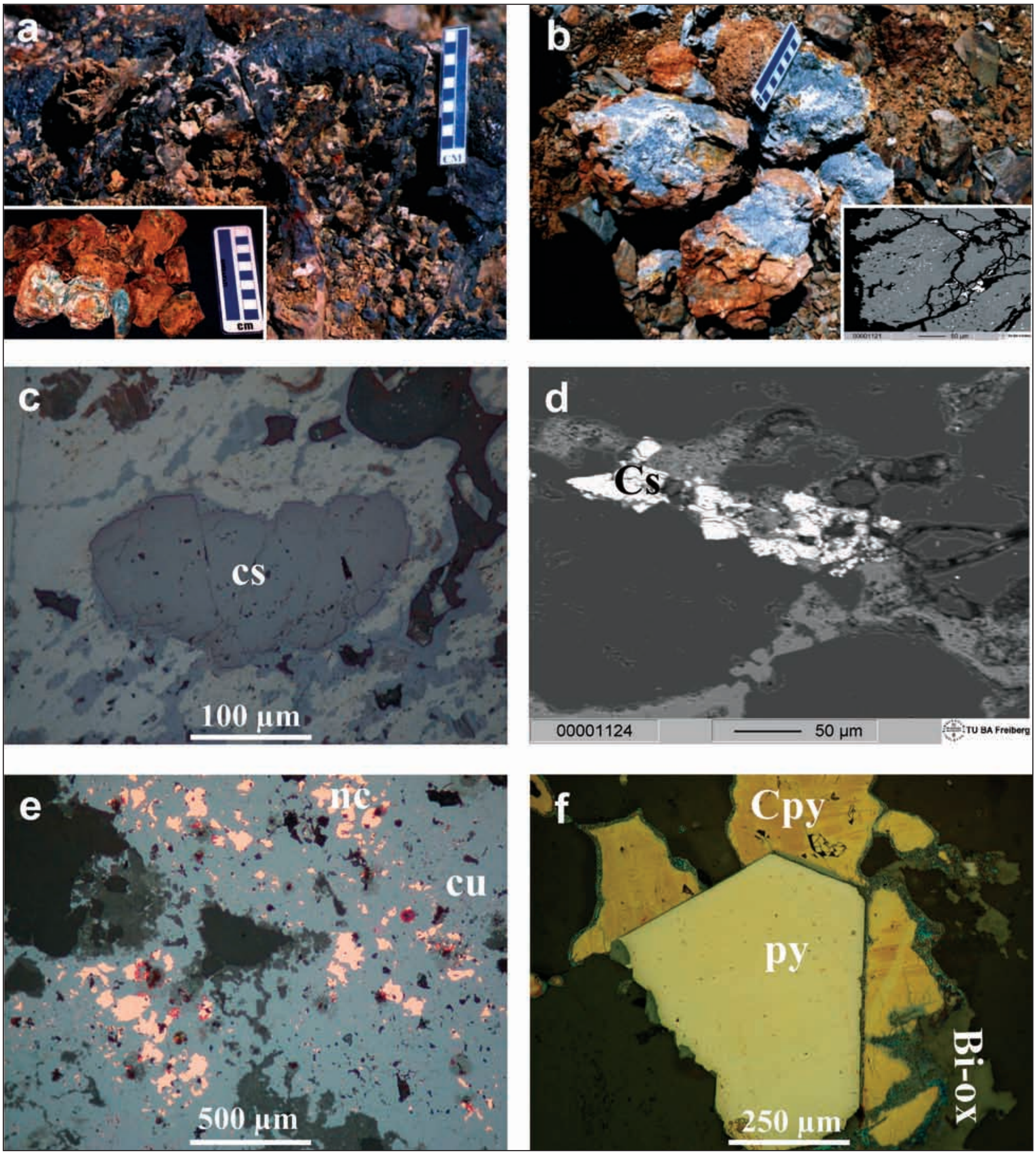

Fig. 3 a) Part of a gossan vein at the Jafar Khan locality (Bottom: Typical oxidized copper ore of the mine), b) Part of an arsenopyrite vein at Ahmad Jigi II (Bottom: Inclusions of bismuth minerals in arsenopyrite), c) Cassiterite in Fe-oxides, d) Back scattered electron micrograph of cassiterite in Fe-oxide, e) Native copper converting into cuprite and tenorite, f) An assemblage of chalcopyrite, pyrite and bismuth oxides.

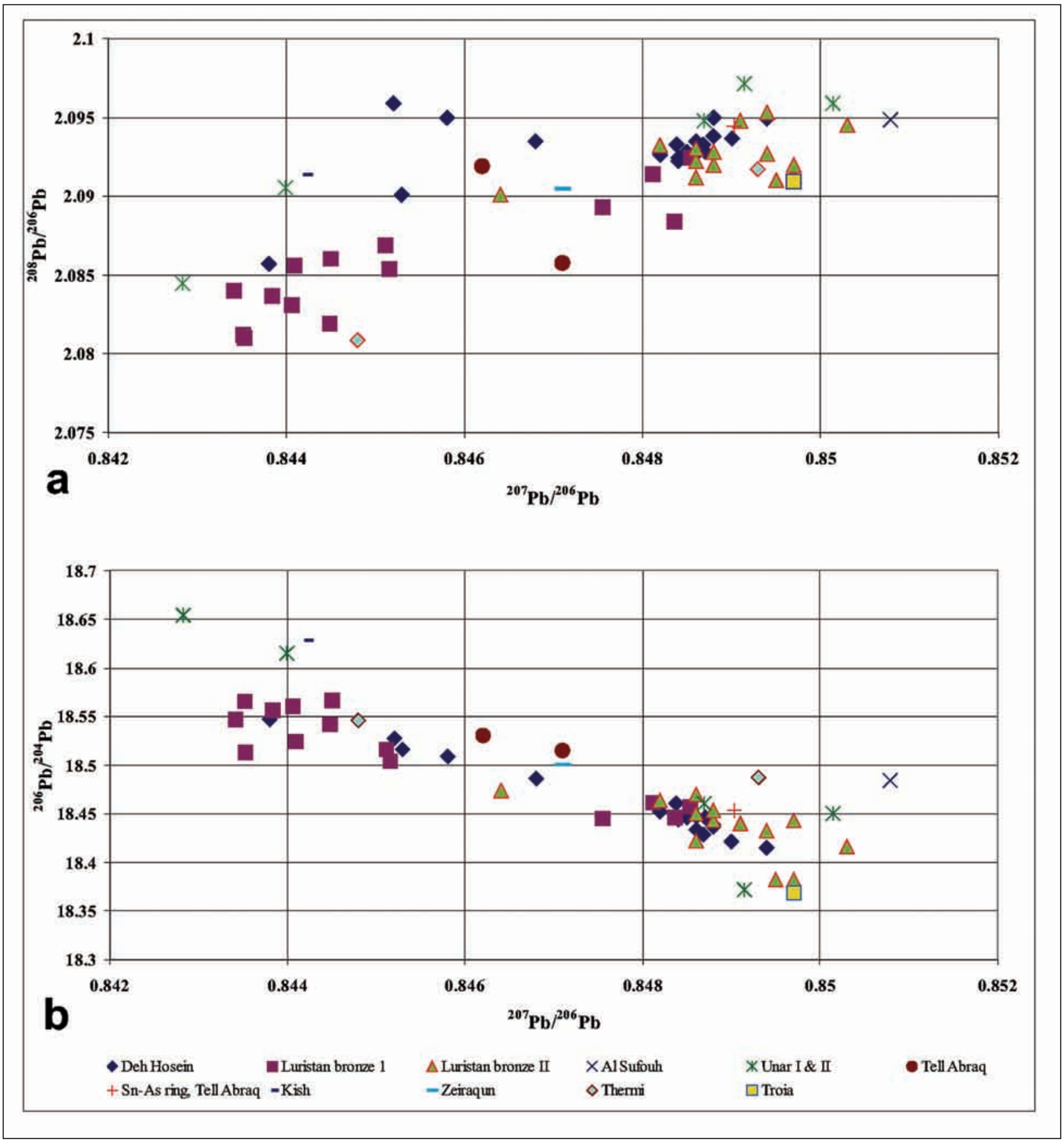

Fig. 4 Isotope plot of lead in ore samples from Deh Hosein in comparison with bronze artefacts from Luristan, UAE, Mesopotamia, and the Aegean (Fig. a and b).Luristan Bronze I refers to the 1st and 2nd millennium BCE artifacts (Nezafati 2006), while Luristan Bronze II refers to the 3rd millennium BCE samples (Begemann et al. 2008). Please note that the scale of the diagrams is greatly expanded.

PRÄHISTORISCHER ZINNBERGBAU IN MITTELASIEN

ORTA ASYA'DA TARİHÖNCESİ KALAY MADENCİLİĞİ

Gerd WEISGERBER

Schlagwörter: Zinn Bergbau und Metallurgie, Bronzezeit, Andronovo Kultur, Mittelasien

Anahtar Sözcükler: Kalay madenciliği, Tunç Çağ, Andronovo Kültürü, Orta Asya

Key Words: Tin mining, Bronze Age, Andronovo culture, Central Asia

ÖZET

Yapılan son dönem araştırmalarından Orta Asya ülkelerinde MÖ 3. ve 2. bin yıldan beri kalay ve bakır madenciliğinin varlığı anlaşılmaktadır. Madencilik ve hammadde ticaretinin, organizasyonu hakkında yeterli bilgiye sahip olmamamıza rağmen, göçebe yaşam tarzı ile doğrudan ilişkili olduğu düşünülebilir. Ancak kapsamlı yeni araştırmalar konuya açıklık getirecektir.

VW ve Gerda-Henkel vakıflarının desteği ile gerçekleştirilen projeler, son 120 yılda Orta Asya ülkelerinde ilk kez Tunç Çağı'na ait kalay ve bakır madenciliğinin araştırılmasını sağlamıştır. Böylece kalay konusu hem yataklar hem de madencilik arkeolojisi açısından son derece sağlam bir temel üzerinde tartışılmaya başlanmıştır. Sınırları yeni açılan ve bu nedenle geçmişte yapılan arkeoloji çalışmalarının iyi bilinmediği Özbekistan, Tacikistan ve Kazakistan'da, özellikle buluntuların tarihlemesi ile ilgili temel araştırmalar gerekmekteydi. Karnab, Muschiston ve Askaraly'da yapılan araştırmalarda madenci yerleşmelerine rastlanması bu açıdan önemlidir. Böylelikle, ilk defa madencilerin yaşamları ve organizasyonu hakkında birçok önemli bilgiye ulaşılmıştır. Bu üç ülkede de Andronovo kültürüne ait toplumların madencilikle uğraştıkları anlaşılmıştır. Oysaki göçebe çoban olarak bilinen Andronovo kültürü toplumlarının metal buluntularının zenginliğine anlam verilememekteydi. Bu sonuçlar Andronovo kültürünü ve dolayısıyla ekonomisini ve özellikle işletmeden izabeye kadar tüm safhalarıyla madenciliğini anlamamıza katkıda bulunmaktadır.

EINFÜHRUNG

Seit einigen Jahrzehnten ist es Mode geworden, das Ende der Rohstoffe nach - in der Zwischenzeit längst vergangenen - 20 oder 40 Jahren zu prophezeien (Meadows 1972; Gruhl 1992). Dieses Jammern offenbart nur das Fehlen jeglichen historischen Bewusstseins, denn der Mangel oder das Ende von Rohstoffen ist keineswegs eine neuzeitliche Erscheinung. Das hat sich viele Male im Laufe der Geschichte wiederholt, und immer hat die Menschheit das Problem gelöst und man Neues erfunden, um die auftauchenden Engpässe zu bewältigen. Die Geschichte des Kupfers ist dafür ein klassisches Beispiel, das hier aber nur in seinen ersten beiden Schritten angedeutet werden kann (Hauptmann and Weisgerber 1985). Sieht man von der Nutzung roter Eisenerze als Farbträger vor weit mehr als 100.000 Jahren ab (Lumley 1966), reicht der Gebrauch von Metall und Metallerzen an sich bis ins 9. Jtd. v. Chr. zurück. Damals begann man in Anatolien neben Malachitperlen auch Stückchen gediegenen Kupfers zu kleinen Perlen und Nadeln zu formen, aber auch zu schweren Keulenköpfen (Yalçın 1998; Yalçın and Pernicka 1999), also natürlich vorhandenes Metall zu verund zu bearbeiten. Die Vorräte dieses natürlichen Kupfers reichten aber nur für vier Jahrtausende. Doch um 5000 v. Chr. wurde es notwenig, das Metall selbst zu erzeugen, d.h. aus Erzen zu erschmelzen. Vor allem eine steigende Nachfrage aus den sich entwickelnden Kulturen im Zweistromland wird den Verbrauch und damit die Entwicklung beschleunigt haben. Der Drang nach Schmuck, Prestige- und Votivobjekten war größer als der nach besseren Gebrauchsgegenständen wie Waffen und Geräten. In Anatolien wurden die ältesten Verhüttungsreste für das 5. Jtd. v.Chr. festgestellt (Yalçın 2000). Legierungen von Kupfer mit Antimon und/oder Arsen setzen sich hier bereits im 4. und 3. Jtd. durch. Deshalb kann in der Geschichte der Metallurgie die Rolle des erzreichen Anatoliens gar nicht überschätzt werden (Yalçın 2000; 2002; 2003; 2005; Yener 2000; 2003). Das gilt auch später noch, als die bekannte Produktion und Nutzung des Eisens im späten 2. Jtd. v. Chr. in Anatolien beginnt, Buntmetalle und ihre Legierungen nach und nach in den Hintergrund zu drängen, besonders bei Waffen und Werkzeugen (Yalçın, 1998b). Der Wert, den man Edelmetallen aber seit dem 5. Jtd. beimaß, bleibt bestehen, ja er wird im 1. Jtd. durch die Erfindung des gemünzten Geldes, ebenfalls in Anatolien, maßgebend.

Vor 3000 v. Chr. sind bereits alle wichtigen Metalle (Kupfer, Blei, Gold, Silber) bekannt, außer Zinn. Es konnte also kaum mehr darum gehen, neue Metalle zu entdecken, sondern „nur“ noch darum, die erkannten schwachen Eigenschaften der bekannten Metalle zu optimieren. So war gerade das Kupfer für manche Zwecke einfach nicht hart genug, und es ließ sich auch nicht besonders gut gießen. Wahrscheinlich aufmerksam geworden durch unterschiedliche Qualitäten des Kupfers, je nach Herkunft und unterschiedlichen natürlichen Beimengungen, begann man mit Zusätzen zu experimentieren – und hatte einen epochalen Erfolg (Pernicka 1995; 1998; 2000). Es zeigte sich nämlich, dass sich sowohl Härte als auch Gießverhalten durch die Beimengung von Zinn zu Kupfer entscheidend verbessern ließen. Diese Kupfer-Zinnlegierung – optimal bei 90% Kupfer und 10% Zinn – nennt man in Europa erst seit etwa 500 Jahren “Bronze”. Produktion und Metallurgie der Bronze riefen so viele technische und gesellschaftliche Veränderungen hervor, dass die Altertumsforschung vor über 170 Jahren eine Epoche danach bezeichnete, die „Bronzezeit“ (Thomsen 1837).

Die Zinnfrage

Da chemische Zusammensetzungen prähistorischer Metallfunde bereits seit der Mitte des 19. Jhs. bekannt sind, stellt sich seither die Frage nach der Herkunft der Metalle Kupfer und Zinn im Allgemeinen und im metallerzlosen Mesopotamien im Besonderen (Riederer 1987: 139-141). Für das Kupfer kommen als Lieferanten Anatolien, Kaukasien, Iran und Oman in Frage. Zwar konnte durch die analytischen und archäologischen Arbeiten des DBM der Oman als das in sumerischen Keilschrifttexten erwähnte Kupferland Magan identifiziert werden (Prange 2001; Prange and Hauptmann 2001), aber bis heute fehlt ein naturwissenschaftlicher Bezug der anderen genannten Regionen zum Fundgut des Zweistromlandes, obwohl zu dieser Zeit auch in den genannten Gebieten Kupfer in großem Umfang aus seinen Erzen reduzierend erschmolzen und wohl auch exportiert worden war.

Da metallisches Zinn gediegen kaum vorkommt, setzt die Metallurgie des Zinns die Kenntnis der Erzreduktion voraus. Der Prozess der Zinnerzreduktion ist, wie ethnographische Beispiele zeigen, in kleinen Öfen leicht durchzuführen (Bartelemy 1938). Als zu reduzierendes Erz kommt hauptsächlich Kassiterit (SnO_2) in Frage, welches noch heute z.B. in Hinterindien vorwiegend aus Sedimentlagerstätten (Seifen) ausgewaschen wird. Für Zinn konnte bislang noch kein Bezug zwischen Geologie und Metallurgie, zwischen irgendeiner Lagerstätte und altorientalischem Verbrauch nachgewiesen werden.

Die Auswertung schriftlicher Quellen zum Zinn zeigt das gleiche Dilemma auf. Es wird z.B. zu Beginn des 2. Jtd. Zinn aus Assyrien nach Syrien und Anatolien geliefert, aber von wo es dorthin gelangt war, bleibt weiter rätselhaft, die Herkunft bleibt unklar (Charles 1975; Crawford 1974; Dercksen 1996; Dossin 1970; Franklin 1978; Muhly 1973; 1985; Stech 1986; Wertime 1978). Dabei wird die Frage nach der Herkunft des Zinns des Alten Orients seit über 130 Jahren gestellt (Baer 1876). Alle Gebirge mit Zinnerzreserven (Abb. 1) von der Cordillera Central in Spanien bis Afghanistan oder von Ägypten (Sabet *et al.* 1976) bis Indien (Chakrabarti 1979; Hegde 1978; Kochhar *et al.* 1999) waren in Betracht gezogen worden. Sie mussten nach geologischen Forschungen schließlich verworfen werden oder sie erwiesen sich als unergiebig oder von zu geringer Reserve oder waren, wie das ägyptische Beispiel, zu jung (für Europa vgl. Roden 1985).

Ein kleines Vorkommen in der Türkei bei Kestel im Taurus ist noch in der Diskussion: Auf dem Siedlungshügel Göltepe im Taurus wurden Gusstiegelbruchstücke mit zinnhaltiger Verschlackung entdeckt. Nachdem sich Kassiterit in benachbarten Flusssedimenten nachweisen ließ, glaubte man in einer nicht weit entfernten kleinen Grube Zinnspuren in den Erzen entdeckt zu haben (Yener *et al.* 1987; 1989; 1992; 1993; Willies 1995). Dem wurde heftig widersprochen (Belli 1991; Muhly 1993; Muhly *et al.* 1991; Pernicka *et al.* 1992). Erzanalysen schienen diese Grube als Goldmine auszuweisen. Das Bergwerk selbst datiert archäologisch und nach Radiokarbondaten ins 3. Jtd. v. Chr. Neueste Forschungen haben aber so viele Gusstiegel mit reinen Zinnablagerungen in den Schlacken nachgewiesen, dass an eine gewerbliche Zinnproduktion gedacht werden muss (vgl. Özbal in diesem Band). Gleichwohl kann die Produktion nicht ausreichend für die Versorgung des Zweistromlandes im 3. Jtd. gewesen sein; sie hatte wohl mehr lokale Bedeutung.

Eine völlig neue Dringlichkeit erhielt die Diskussion zur Herkunft des Zinns durch die seit den sechziger Jahren hauptsächlich an drei Stellen an den Küsten des östlichen Mittelmeeres gefundenen Zinnbarren:

Zwei 1976 im Hafen von Haifa sichergestellte u.a. quaderförmige Barren (rd. 31 x 20 x 3,7 cm, rd. 12 kg Gewicht) werden durch Zeichen zyprisch-minoischer Schrift in die Zeit von 1500 – 1100 datiert. Sie sind der Rest einer größeren Schiffsladung aus Kupfer- und Zinnbarren, welche leider durch den Finder als Schrott verkauft worden waren (Galili and Shmueli 1983; 1986; Galili *et al.* 1986; Maddin *et al.* 1977, Muhly 1985; Raban and Galili 1985; Stos-Gale *et al.* 1998). Ein später dazugekommener Barren zeigt eine als Göttin Arethusa gedeutete Gravur und datiert in die gleiche Zeit (Artzy 1983).

Leider waren die Funde in dem Schiffswrack bei Kap Gelidonia nicht so eindeutig. Neben zahlreichen ochsenhautförmigen Kupferbarren war auch ein weißliches Material gefunden worden, in dem man korrodierte Zinnbarren sah. Wegen ägyptischer Funde konnte der Untergang dieses Handelsfrachters ins 13. Jh. v.Chr. datiert werden (Bass 1986; 1967; Maddin 1989).

Aber erst der sensationelle Wrackfund von Uluburun vor der südwesttürkischen Küste mit mehr als 300 Kupfer- (10 t) und ca. 40 Zinnbarren (1 t) zeigte auf, welche Mengen dieses Metalls in der Spätbronzezeit verfügbar waren (Bass 1989; Gülçur 1995; Hiebert 1994; Kilian 1993, Yalçın *et al.* 2005).

Nachdem sich die in der älteren Literatur für Persien genannten Zinnvorkommen öfter als nicht zutreffend heraus stellten, wurde überraschend eine Lagerstätte in Westiran identifiziert (Momenzadeh *et al.* 2005; Nezafati *et al.* 2006; 2008). Bislang wurden die Pingenbaue dieser Bergbauaktivitäten ins 2. Jtd. v. Chr. datiert und passen damit sehr gut zur üppigen Metallproduktion dieser Zeit in Luristan. Zukünftige Forschungen können vielleicht zu älteren Daten führen.

Allerdings können alle diese Barren-Entdeckungen und das iranische Zinnvorkommen aus deutlich jüngeren Perioden (!) nur als Hintergrundinformation für die Herkunft des mesopotamischen Zinns im 3. Jtd. dienen. Auch, wenn wir für die frühe Periode kaum ahnen können, woher das auf die Schiffe geladene Zinn kam, so war es damals im Zweistromland doch reichlich verfügbar und wurde in großen Mengen und über weite Entfernungen verhandelt.

MITTELASIEN, GEOLOGIE UND MONTANHISTORIE

Seit langem gibt es Hinweise darauf, dass Mittelasien (nicht "Zentralasien"!) eine wichtige Rolle für die Rohstoffversorgung (vor allem Metalle und Edelsteine) der frühen Hochkulturen in Mesopotamien gespielt haben könnte, aber wegen der allgemeinen weltpolitischen Lage war es im 20. Jh. lange Zeit nicht möglich, diese Vermutung durch Geländeuntersuchungen in den entsprechenden Ländern zu überprüfen.

Berichte über Zinnvorkommen in Mittelasien (**Abb. 2**) reichen bis in die Mitte des 19. Jahrhunderts zurück (Baer 1876). Zwar begann die wissenschaftliche Erforschung Mittelasiens, nachdem das Khanat Buchara in das russische Reich eingegliedert worden war, aber systematisch geologisch wurde das Gebiet erst unter der Sowjetunion untersucht. Außerdem dauerte es noch geraume Zeit, bis Anzahl und Umfang von Zinnvorkommen in Afghanistan (Wolfart und Wittekind 1980; Cleuziou und Berthoud 1982) und im südlichen Pamir-Gebirge (Rossovsky *et al.* 1987) bekannt wurden. Nunmehr scheint sich abzuzeichnen, dass Zinn innerhalb von zwei Gürteln auftritt, die einerseits vom Hilmandbecken in Westafghanistan über Kandahar bis nach Pakistan und andererseits von Buchara über das Serafschantal bis zum Issyk-Kul in Kirgisien und darüber hinaus (Materikov 1974) reichen und auch das nördlicher gelegene Kasachstan umfassen.

Vor diesem geologischen Hintergrund gewinnen ältere Berichte über prähistorische bzw. bronzezeitliche Zinngewinnung in Usbekistan und Kasachstan eine besondere Bedeutung. Sie sind im Deutschen Bergbau-Museum seit langem bekannt gewesen und übersetzt worden. Später wurden sie auch in einem umfassenden Buch über Zinn im Altertum (Penhallurick 1986) angesprochen.

INTERKULTURELLER FERNHANDEL

Der Gedanke, dass mittelasiatische Zinnlagerstätten für die Kulturen des Alten Orients im 3. Jtd. durchaus in Frage kommen, ist keinesfalls so abwegig wie es nach den großen Entfernungen scheinen könnte. Frühbronzezeitliche mittelasiatische Importe, z.B. an der südlichen Küste des Persischen Golfes, wie z.B. Steatitschminkbehälter oder Kämme (Potts 2000) zeugen bereits damals von einem unerwartet weiten Netz von Handelsbeziehungen. Seit langem wird z.B. das Lapislazuli-Vorkommen von Badakhschan in Nordostafghanistan als Ursprung der Funde dieses Halbedelsteins in Iran, Mesopotamien, Anatolien, Ägypten und des Indus-Tals angesehen (Casanova 1992; Herrmann 1968; Kuhlke 1976; Pinnock 1988; Sarianidi 1971; Tosi 1974; Tosi und Lamberg-Karlovsky 2003; Weisgerber 2004). Am bekanntesten ist die hervorragend gearbeitete Prunkaxt im Schatzfund A von Troja IIg. Sie stellt eines der größten Objekte aus dem blauen Mineral dar, wenn auch die Farbe nicht besonders intensiv ist. Ähnliche Überlegungen bezüglich der Herkunft des Rohstoffes werden bei Gegenständen aus Nephrit und/oder Jadeit angestellt. Auch hier mögen als Beispiel die drei Prunkäxte aus demselben Schatzfund angeführt werden. Im Gegensatz dazu sind die berühmten tiefblauen Lapislazuli-Skarabäen ägyptischer Pharaonen meist aus armseligen Lapis-Krümeln hergestellt, was Versorgungsprobleme auf dem Weg nach Ägypten belegt.

Steatitgefäße des 3. Jahrtausends v. Chr. aus Sarazm im östlichen Serafschan-Tal (Tadschikistan) haben solch exakte Parallelen mit nahezu identischer Materialzusammensetzung in den Vereinten Arabischen Emiraten, dass an deren mittelasiatischer Herkunft kaum gezweifelt werden kann (Kohl 2004; Vogt 1985; Potts 2000). Elfenbeinkämme aus Baktrien gelangten ebenso auf die östliche Arabische Halbinsel wie Lapislazuliperlen von dort (Potts 1993; 2000). Umgekehrt gelangten aber auch Importgegenstände aus Mesopotamien, dem Iran und dem Indus-Tal nach Mittelasien (Sarianidi 1977; Masson 1992).

Ein Grund für diese weit reichenden Verbindungen liegt sicher bei den wichtigen Fernhandelswegen, die Mittelasien seit frühester Zeit durchziehen und diese Kulturräume miteinander verbinden. Deren Trassen waren und sind durch die starke naturräumliche Gliederung der Landschaften zwischen Kara Kum im Westen und Taklamakan im Osten durch die naturräumliche Gliederung festgelegt. Darüber hinaus ist zu vermuten, dass die Zinn- und Goldlagerstätten im Tienschan und im Pamir zumindest in der Bronzezeit eine wichtige Attraktion gebildet haben. Es ist schon früher darauf hingewiesen worden, dass in Mesopotamien und Anatolien neben seltenen Halbedelsteinen auch Gold und Zinnbronze innerhalb eines relativ kurzen Zeitraumes fast schlagartig und zeitgleich auftauchen (Muhly 1973). Diese Kombination von Rohstoffen (Zinn, Gold, Lapislazuli, Nephrit) existiert auf der eurasischen Landmasse nur in Mittelasien und in der Altai-Region.

PROJEKT: ZINN IN MITTELASIEN

Es war das Ziel eines von der VW-Stiftung geförderten Projektes, das lagerstättenkundliche Potential Usbekistans und Tadschikistans im Hinblick auf die frühe Ausbeutung von Zinnvorkommen zu untersuchen. Neben den geologischen Gegebenheiten sollten sowohl die bergmännische Ausbeutung der Lagerstätten als auch die siedlungsarchäologischen Hinterlassenschaften der Bergbau-Reviere überprüft werden. Das Projekt sollte also nicht nur einen Beitrag zu der wichtigen Frage nach dem Ursprung des Zinns in vorgeschichtlicher Zeit liefern, sondern auch einen wichtigen Schritt in der Erforschung der frühen Kulturen des Zerafschantales darstellen, das zu den bedeutendsten West-Ost-Verbindungsstraßen Zentralasiens gehört.

So schnell wie möglich wurden nach dem Untergang der Sowjetunion in Erkundungsreisen des Deutschen Bergbau-Museums Bochum 1992 und 1994 die Verhältnisse vor Ort in Usbekistan überprüft und Kontakte mit Wissenschaftlern und Institutionen geknüpft, nachdem diese 1991 in Bochum vorstellig geworden und uns eingeladen hatten. 1994 erfolgte ein Hinweis auf eine Zinn-Lagerstätte im Hochgebirge von Tadschikistan, die ebenfalls besucht werden konnte (s.u.).

Für das Projekt schlossen sich das Eurasien-Institut des DAI in Berlin, der Lehrstuhl für Archäometallurgie der Bergakademie TU Freiberg und das Institut für Montanarchäologie des Deutschen Bergbau-Museums Bochum zusammen, um mit dem Archäologischen Institut Samarkand der Akademie der Wissenschaften der Republik Usbekistan (Taschkent) und dem Historischen Institut der Akademie der Wissenschaften der Republik Tadschikistan (Duschanbe) gemeinsam an diesen Problemen zu arbeiten. Bis heute sind einige Publikationen erschienen (Alimov *et al.* 1998; 1999; Boroffka *et al.* 2000; 2003; Cierny *et al.* 2003; 2005; Parzinger 2000; 2002; Parzinger und Boroffka 2001; 2003; Rusanov *et al.* 1999; Weisgerber und Cierny 1999).

ZINNGRUBEN IN USBEKISTAN

KARNAB

In Usbekistan liegen die Zinn führenden Berge südlich der alten Straße Samarkand – Buchara in den Serabulak-Zaijidin-Bergen (39°49'49.50" N 65°31'53.51" E). Von den drei Revieren bei den Dörfern Karnab, Çangali (80 km östlich von Karnab) und Lapas (15 km entfernt) war Karnab bei Navoi am bedeutendsten, weshalb hier die Arbeiten konzentriert wurden (Abb. 2).

Offensichtlich begleitend zu geologischen Prospektionen hatte im Jahre 1946 der Archäologe Boris A. Litvinskij die Spuren alten Bergbaus im Serabulak- und Zaijidin Gebirge untersucht und bald berichtet (Litvinskij 1950a, b; 1954). Damals ging es um die Frage, ob es zu den zahlreichen Kupferlagerstätten auch Zinnvorkommen für die mittelasiatische Bronzezeit und ihre zinnreichen Artefakte gäbe. Aber da man im dortigen Land Rillenschlägel seinerzeit ins Mittelalter datierte, entging vielen die wahre Bedeutung seiner Beobachtungen. Nur Ruzanov wies darauf hin (Ruzanov 1979; 1999; Ruzanov *et al.* 1999).

Das Zinnerz-Revier von Karnab liegt rd. 1,5 km östlich des gleichnamigen quellenreichen Dorfes, geografisch bei N 39°49'43.11" und E 65°32'5.53", in einer flachhügeligen Steppenlandschaft. Diese Berge liegen südlich der Autostraße etwa in der Mitte zwischen Samarkand und Buchara. Im Zentrum des heutigen Dorfes liegt ein Siedlungshügel, der bis zur Oktoberrevolution bewohnt war. Deutlich erhebt sich dieser Tell ca. 6-8 m über das Gelände. Ausgrabungen ergaben, dass er, wie die anderen Siedlungshügel Mittelasiens nicht bis in die hier interessierende Vorgeschichte zurück reicht, sondern um die Mitte des 1. Jtds. beginnt (Parzinger and Boroffka 2001; 2003).

Der Untergrund des Zinnreviers wird von Granit und Kalken gebildet, in deren Kontaktzone die Zinn führenden Quarzgänge eingebettet sind. Diese durchziehen den anstehenden Granit, mit dem sie genetisch verbunden sind. Sie stehen steil bis senkrecht und waren an der Oberfläche gut sichtbar. Die einige Zentimeter bis 1 m starken Quarzgänge streichen in Ost-West-Richtung. Darin sind in den Erzgängen rd. 2% Zinn als fein verteilter Kassiterit (SnO_2) enthalten. Der Bereich mit den alten Gruben erstreckt sich über ein Areal von ca. 1500 m Länge und 500 m Breite zwischen ca. 450 – 500 m Meereshöhe. An zehn verschiedenen Stellen wurden in einem Gebiet von 10 ha alte Abbaue eobachtet. Dabei kommen sowohl Tage- als auch Tiefbaue vor. Beide Abbauverfahren zeichnen sich als Pingen ab. Ein großer, wohl jüngerer Tagebau hat eine Länge von 140 m, bis zu 20 m Breite und noch 3 m Teufe.

Viele prähistorische Objekte und Strukturen wurden durch die Abbauarbeiten der 50er Jahre und neuere Prospektionsarbeiten in den 80er Jahren verschüttet. Nach zur Verfügung stehenden Unterlagen und lokaler, mündlicher Überlieferung, war die Lagerstätte im Jahre 1944 (wieder-) entdeckt worden. Im folgendem Jahr (1945) wurde mit den Prospektionsarbeiten begonnen, der Abbau dauerte von 1951 bis 1958, in dem man die alten Gruben von tieferen Schächte aus unterfuhr. In den ersten Jahren haben die Geologen an die 20 Gruppen mit alten Pingen kartiert und z.T. untersucht. Die Oberfläche des Geländes ist insgesamt sehr stark zerwühlt, neben den aufgeschütteten Abraum- und Aufbereitungshalden wurden damals mehrere Hundert (>300) Prospektionsgräben (1 m breit, 10 bis 300 m lang) angelegt. Dazu kommen noch Bulldozer-Schürfe von 5 m Breite und bis zu 200 m Länge als Zeugnisse der groß angelegten Prospektionsarbeiten der sowjetischen Geologen. Diese kilometerlangen Baggergräben - quer zu den W-O streichenden Erzgängen - sind auf den Satellitenbildern von Google-Earth gut zu erkennen.

Während dreier Grabungskampagnen 1997-99 wurden in Karnab 6 Bergwerke (Gruben 3-1, 3-2, 5-1 (+5-4), 5-2, 5-5 (+5-3) und 6-1) archäologisch untersucht. Bis zur Sohle in 17,50 m Teufe konnte allerdings nur Grube 6/1 ausgegraben werden, bei den anderen stand der Grundwasserspiegel bei 9,5 m unter der Oberfläche an. Wegen der Enge der Grubenbaue, 1 m Breite wurde selten erreicht, gestalteten sich die Räumarbeiten zeitaufwendig, konnten doch nur wenige Mann in den Bauen arbeiten, um das eingewehte und eingeschwemmte Erdreich mittels kleiner Blecheimer zu fördern (Cierny *et al.* 2005; Weisgerber and Cierny 1999; 2002).

Bei den Gruben handelt es sich um Abbauschürfe, welche den am Tage zwischen Granit ausbeißenden senkrechten bzw. steil stehenden Erzgängen in die Teufe folgen. Es wurde immer nur das Gangmaterial ausgebrochen. Die Gänge sind bis zu 1 m mächtig, meist jedoch nur rd. 60 cm breit, die Abbaue folglich sehr eng. Manche Abbaubereiche sind so klein, dass auch in der Vorzeit kein erwachsener Mann darin hatte arbeiten können, Kinder- und Frauenarbeit müssen daher angenommen werden. Für heutige Mitteleuropäer sind sie oft nur mit großer Mühe zu befahren, an ein Arbeiten mit Gezähen ist nicht zu denken. Da die Gruben sämtlich zusedimentiert sind, waren die russischen Untersuchungsbaue oft eine große Hilfe beim Entdecken der alten Grubenbaue.

Stehen gelassene Bergfesten waren besonders interessant, weil sie noch das ursprüngliche Erz - mit Zinngehalten um 2 % - enthalten. Sie waren aber auch bei der Befahrung der Gruben und der Erzförderung als Zwischenstufen hilfreich. Einmal wurde eine Schleifrille vom Förderseil festgestellt im Übergangsbereich von der zweiten zu den tieferen Sohlen.

Die meisten Gruben konnten nicht vollständig ausgegraben werden, da jeweils nach 8 – 15 m Teufe Grundwasser anstand. Lediglich in einem Bau von nur 7 m Teufe wurde die Sohle erreicht. Sie ist unregelmäßig und uneben und zeigt, dass eben nur dort geteuft wurde, wo Erz herein gewonnen werden konnte. Taubes Gangmaterial blieb stehen. Nur an wenigen Stellen konnten Fahrhilfen wie Trittlöcher oder Stufen beobachtet werden. Zum Vortrieb wurde die Feuersetzmethode eingesetzt, als hauptsächliches Gezähe dienten schwere Schlägel aus ortsfremdem Kalkstein (Abb. 3).

Die Grube 3-2 zeichnet sich dadurch aus, dass sie im Schnittpunkt der Scharung von zwei Erzgängen angelegt worden war, da sich in einer derartigen Situation erfahrungsgemäß die stärkste Mineralisation befindet. Die bronzezeitlichen Bergleute bewiesen bemerkenswerte geologische Kenntnisse. Es konnte nur der obere Scharungsbereich näher untersucht werden. Die Stelle lieferte neben einer Vielzahl von Steinschlägeln auch datierbare Keramikfunde, die gut in die Andronovo-Tazabag'jab-Kultur passen.

Die Grube 3-3 liegt unmittelbar am linken Ufer eines Trockentälchens (Abb. 4) und stellt die längste noch offene Pinge des Bergreviers dar, sie war wohl seinerzeit von den Russen frei geräumt worden. 27 m lang, an der Oberfläche 1,8 m breit und 6 bis 7 m tief folgt sie sichtlich dem Verlauf eines Quarzganges. An zwei Stellen in der Sohle wurde sie von einer rezenten Strecke, die ebenfalls in der Richtung des Erzganges vorgetrieben worden war und deren Firste ca. 8 -9 m unter der heutigen Oberfläche liegt, angeschnitten. An diesen zwei Stellen reichte die prähistorische Pingensohle offensichtlich tiefer. Die moderne Strecke selbst stand aber unter Wasser. Das östliche Ende der Pinge bildet der anstehende Fels mit dem (hier tauben) Quarzgang. Am Westende aber befand sich ein ca. 2,5 m langer und 4 m tiefer, ungestörter Pingenteil, dessen unterer Bereich zusedimentiert war (Abb. 4). Nach Freiräumen der Verfüllung kam in 5,9 m Teufe die

Sohle zum Vorschein. Im Profil zeigte sich, dass die Verfüllung vorwiegend aus scharfkantigem Versatz mit Lehm bestand und nur im oberen Bereich ein Lößpaket von bis zu 50 cm Stärke auflag. Bei den Aufräumarbeiten wurden insgesamt 11 Steinschlägel oder deren Fragmente geborgen.

Die Grube 5-1 (Abb. 5) stellte sich in der Mitte als rd. 10 m lange offene Grabenpinge heraus, die dann aber mit dem westlichen Ende höhlenartig unter die Tagesoberfläche reichte. Dort stand in der Firste der Erzgang noch fast 1 m mächtig an. Östlich reichte der Abbau ebenfalls unter die Tagesoberfläche, wo er von einem rezenten Wetterschacht angeschnitten worden war. Dort war ein Teil des Erzganges als Sicherheitspfeiler stehen geblieben. Die Sohle erreicht nirgendwo das Grundwasser, sondern endet stumpf und gerundet im tauben Granit. An einer Stelle war im anstehenden flachen Fels in der Nähe der Sohle, aber noch unter freiem Himmel (wegen des besseren Lichts) eine rundliche Vertiefung durch das Ausschlagen des Erzes entstanden. Die dazu passenden kugeligen Schlagsteine waren in größerer Zahl in der Verfüllung gefunden worden. Zwei Trittstufen im Liegenden erleichterten die Befahrung ebenso wie eine schräg einfallende begehbare Kante der entlang man bis zum heute höhlenartigen Abbauort gelangen konnte. Dieser scheint längere Zeit offen gestanden zu haben. Feuerstellenreste und eine Lanzenspitze des 1. Jahrtausends v. Chr. belegen eine spätere Wohnfunktion dieser praktischen Überwölbung.

Die Gruben 5-3 und 5-5 (Abb. 6. 7) wurden über eine Länge von 45 m in fünf Quadranten untersucht. An ihrem westlichen Ende schart sie sich mit der Grube 5/2. Hier fällt der Erzgang weniger steil ein, so dass der bergmännische Hohlraum sehr schnell unter die Tagesoberfläche gerät. Gleichwohl fällt genügend Licht zum Arbeiten ein. Die Mächtigkeit des Gangs, der an manchen Stellen als vertaubte Sicherheitsbrücke stehen gelassen worden war, konnte sogar 1 m überschreiten. Die Sohle ist mit rezenten Strecken voller Wasser zum großen Teil durchschlägig. In dieser Grube wurden, neben den zahlreichen Steinschlägeln und ihren Trümmern, auch Keramik sowie einige Menschen- und viele Tierknochen gefunden (s. u.). Ein steinernes Zepter oder Idol, belegt einerseits den bronzezeitlichen Abbau, andererseits aber auch, dass im Bergbau außer wirtschaftlichen noch andere Gesichtspunkte wichtig waren (Boroffka and Sava 1998).

Die Grube 6-1 gehört zu einer Pingengruppe am östlichsten Ende des Reviers. Wegen ihrer Lage auf einem Hügel (Abb. 8) bestand Hoffnung, dass dort der Grundwasserspiegel tiefer liegen würde. In der Tat wurde nach mühseligem Räumen Wasser nur im allertiefsten Bereich angetroffen (Abb. 9). Die Grube beutete einen fast senkrechten Gang über eine Länge von rd. 30 m bei einer Teufe von über 17 m aus. Sie ist sehr eng und erreicht an keiner Stelle eine Weite von mehr als 1 m. Taube Gesteinsbrücken bzw. erzhaltige Bergfesten (Sicherheitspfeiler) zwischen dem linken und rechten Stoß hielten die Grube bis heute ohne Verbruch stabil (Abb. 10). Sie war allerdings völlig durch wieder eingeschwemmtes Haldenmaterial und eingewehten Löss verschlossen gewesen. Mit dem Haldenmaterial waren ebenfalls Hunderte von steinernen Schlägeln mit Tausenden von ihnen abgeplatzten Trümmern (Abb. 3) in die Verfüllung geraten.

Diese vollständig ausgegrabene Grube eignet sich zu folgender Berechnung: Bei 30 m Länge und 15 m Teufe und einer durchschnittlichen Breite von 60 cm hat sie einen Hohlraum von 270 m^3, was etwa 730 t Gestein entspricht. Nimmt man eine Erzmächtigkeit von nur 5 cm an, so können mindestens 60 t Erz errechnet werden. Bei einem Zinngehalt von 2% lieferte diese Grube rd. eine Tonne Zinn, was der Ladung des Uluburun-Schiffes entspricht. Es ist von besonderer Pikanterie, dass einige Gruben bei Karnab wie dieses in die zweite Hälfte des 2. Jtd. v. Chr. datieren.

ZUR GEWINNUNGSTECHNIK

Mit Quarz als Ganggestein und Granit als umgebendem Nebengestein sahen sich die prähistorischen Bergleute sowohl in Karnab als auch in Čangali bereits an der Oberfläche mit sehr harten Gesteinen konfrontiert, wenn sie an das Erz gelangen wollten. (Im karstigen Lapas, wo im Kalk Erz in einer Höhle abgebaut wurde, war die Technik ähnlich, jedenfalls wenn man von den zahlreichen Rillenschlägeln dort ausgeht.) Um in Karnab im Erzgang Teufe zu gewinnen, wendete man die Methode des Feuersetzens an. Gerade Granit kann aufgrund seiner kristallinen Struktur gut mit Hitze bearbeitet, d.h. mürbe gemacht werden. Dabei stellt das Teufen mittels Feuersetzen eine besondere Schwierigkeit dar, weil die Hitze von Feuern naturgemäß nach oben wirkungsvoller arbeiten kann. Die prähistorischen Bergleute kannten offensichtlich die, oder ähnliche, Tricks und Wege, welche noch im 19. Jh. zu demselben Zweck eingesetzt wurden.

Tierknochen geben Auskunft einerseits über Fleischproduktion und –verbrauch dieser Nomaden an Schafen, Ziegen und Rindern, andererseits aber auch über einen Teil der Werkzeuge. Die Hörner von Ziegen und Gazellen (*Gazella subgutturosa*) wurden als Gezähe genutzt, wahrscheinlich zum Auskratzen der Erzsplitter aus dem Gang. Ihre Hornzapfen haben gelegentlich in den Gruben überlebt. Außerdem war ein Rinderschulterblatt als Schaber genutzt worden (Doll 2003) (Abb. 12).

Ein weiteres Problem stellt die fehlende Baumvegetation dar. Die Steppe selbst ist zwar dicht mit Wermutbüschen bestanden, aber in der Steppe um Karnab wachsen heute die wenigen Bäume nur an Quellen. Von Herrn J. Cierny durchgeführte Experimente haben aber gezeigt, dass mit trockenen Wermutstauden gemachte Feuer sehr wohl ausreichen, um Granit mittels Feuersetzen zu zermürben. Steinschlägel waren nach dem Erlöschen des Feuers am Granit sehr wirkungsvoll. Der schnell verbrennende Wermut hinterlässt keine Holzkohle sondern nur Asche. In der Tat waren Holzkohle in den Bergwerken von Karnab selten, graue Lagen mit Asche dagegen häufig.

STEINSCHLÄGEL

Die Zahl der gefundenen Steinschlägel geht in die Tausende (Abb. 3. 14). Allein über 3000 wurden in einer Datenbank erfasst. Der größte Teil stammt aus den Bergwerken selbst, wohin sie mit der Rücksedimentation bzw. Rückverfüllung des Haldenmaterials gelangt waren, nur wenige konnten an der Erdoberfläche gefunden werden. Im Gegensatz zu nahezu allen anderen bekannten prähistorischen Bergbauen bestehen die Steinschlägel in Karnab nicht aus Flussgeröllen, die in der Steppe von Karnab ja auch nicht vorkommen. Hier wurden Kalkbrocken in einem nahen Vorkommen wahrscheinlich steinbruchmäßig gewonnen und dort zu Schlägeln zurecht geschlagen. Die Schlägel haben meistens Kerben, seltener eine Rille, manchmal jedoch sogar deren zwei, mit denen eine hölzerne Schäftung befestigt war. Da alle diese Schlägel nicht rund wie Gerölle, sondern kantig sind und eine flache Seite aufweisen, kann von einer so genannten „Knorrenschäftung" ausgegangen werden. Dabei wird das flache Ende von Ästen, die am Stamm abgeschnitten wurden, mittels Bindematerial an der flachen Seite des Steins festgebunden, wobei sich Schnur oder Leder in den Kerben oder Rillen fixieren (Craddock 1990; Rieser and Schrattenthaler 2004: Abb. 8 und 10) (Abb. 13). Wegen ihrer Form und wegen fehlender Kerben oder Rillen ist aber auch sicher, dass manche Schlagsteine einfach mit der Hand geführt wurden.

BEWERTUNG DES BERGBAUS

Stellt sich die Frage nach der Bedeutung der Bergwerke von Karnab. Diese kann nicht überschätzt werden. Rechnet man den Erzgehalt der Grube 6/1 hoch, so hat dieses Grubengebäude rd. 1 Tonne Zinn geliefert (s. o.). Wie ihre außergewöhnliche Enge im Vergleich zu den anderen Bergwerken aber zeigt, gehört sie zu den ärmeren und kleineren Gruben. Wo Gangbreiten von mehr als 1 m vorkommen, muss man von einem Vielfachen des Metallgehalts ausgehen. Angesichts der Hunderte von Bergwerken in Karnab kann man schätzen, dass das Revier während der Dauer seiner Ausbeutung zwischen 500 und 1000 Tonnen Zinn geliefert hat.

Nach kulturgeschichtlicher Aussage der Funde, welche fast ausnahmslos in die Andronovo-Tazabag'jab-Kultur gehören, geschah dies in den Jahrhunderten vor 1400 v.Chr., also in der Mittleren- und Spätbronzezeit. Radiokarbondaten von Holzkohle und Asche erweitern die Produktionsdauer von 1700 bis 800 v.Chr. Mittelalterliche Daten und Keramik belegen den späteren Versuch einer erneuten Nutzung, aber in den von uns freigelegten Bergwerken kann diese Aktivität nicht bedeutend gewesen sein, es wurden keinerlei Spuren von Metallwerkzeugen entdeckt. Lediglich keramische Scherben zeigen, dass die Gruben geöffnet bzw. zumindest begangen (Wohnhöhlen?) worden waren. Möglicherweise gibt es aber doch Gruben, die größtenteils mittelalterlich sind.

DIE SIEDLUNG KARNAB SIČKONČI

Im Bereich des Karnab-Reviers, nur 1 km von den Gruben entfernt, wurden, wie Keramikfunde zeigen, Siedlungsreste aus der Andronovo-Kultur entdeckt und ganz ausgegraben (Parzinger und Boroffka 2001; 2003). Die Siedlung Karnab-Sickonci war unter einer 1 m dicken Lössschicht begraben und nur zufällig am Profil eines Geologenschnitts zu erkennen gewesen. Sie liegt oberhalb des heute ausgetrockneten Sickonci-Saj

Tälchens. Kleine Metallfunde kamen in Grubenhäusern und Herdstellen zu Tage. Vor allem die für Karnab so typischen Steinschlägel mit zwei Rillen stellen eine direkte Verbindung zwischen Siedlung und Bergbau her. Keramik und Radiokarbondaten datieren zwischen dem 18. und 14. Jh. v. Chr., was auch den Daten aus dem Bergbau entspricht. Zahlreiche Feuerstellen fielen auf, die gleichzeitig in Betrieb waren. Ofen 2 hat einen analytisch festgestellten hohen Zinngehalt, was auf seine metallurgische Funktion hinweist. Ein kleiner Kupferbarren und Gusstropfen aus Zinnbronze belegen die Verarbeitung von Metall. Mahlsteine, Hammersteine und Anhäufungen von Quarzsplittern stammen möglicherweise von der Erzaufbereitung.

Zumindest bei der heutigen Bewuchslage wäre eine Verhüttung aber auch nur durch Holzimport möglich gewesen. Wie die Vegetation zur Bronzezeit aussah, ist weitgehend unbekannt. Tatsache ist aber, dass der heute die Landschaft prägende, und vor allem die meisten archäologischen Zeugnisse 1 m hoch überdeckende Löss erst nach der Bronzezeit abgelagert wurde. Eventuell vorhandene Verhüttungsüberreste mögen deshalb überdeckt sein.

ČANGALI

Bei den Dörfchen Kotschkarly und Çangali liegen jeweils Zinnlagerstätten (N 39°48'26.13" E 66° 00' 33,36") (Abb. 1). Auf den Satellitenbildern sind gleichfalls die sowjetischen Baggerschnitte in der Umgebung gut auszumachen. Noch heute zeichnen sich viele der abgebauten Erzgänge durch nicht mehr sehr tiefe Graben- oder Trichterpingen im Gelände ab. In Kotschkarly ziehen sie den Hang eines Granitberges hinauf und setzen sich auf der Höhe fort. Gewinnung fand als Tagebau in 0,70 bis 1,20 m breiten Verhauen statt, deren Länge 20 und mehr Meter bei Teufen von bis zu 12 m betragen konnte, wie einzelne Sondagen ergaben. An einer Stelle wird der Kamm eines Hügels durchschnitten, der entstandene Verhau ist bis heute offen geblieben. Bei den Grabungen wurden viele hammerartige Steinwerkzeuge angetroffen, wie sie für prähistorischen Bergbau typisch sind (Abb. 14). Aber es wurden auch mittelalterliche Scherben angetroffen.

Von besonderem Interesse war zunächst, dass 800 m westlich des heutigen Dorfes am Nordufer des dortigen Baches ein Siedlungshügel auf einer 10 m hohen Düne liegt (Abb. 15) mit einem Durchmesser von 40-50 m an der Basis, 22 m auf dem Gipfel und 6 m Kulturschichten. Die Siedlungsreste auf der Oberfläche gehen bis ins 10. Jahrhundert n.Chr. zurück. Prähistorische Besiedlung wurde aber weder hier noch sonst im Gelände festgestellt. Aber in dem vorbei fließenden Bach wurden Zinnschlacken entdeckt.

ZINNGRUBEN IN TADSCHIKISTAN

Unter Geologen liegt der gute Ruf des Serafschantales (Abb. 16) an seinem Mineralreichtum begründet (Chernykh 1992; Kuzima 1991), vor allem wegen seiner Goldlagerstätten (der Name des Flusses lautet übersetzt "Goldbringer"). Aber die Kombination von Zinn und Gold im Verein mit den Zugängen zu den Lapislazulivorkommen in der südlichen Pamir-Region weisen diese Landschaft als möglichen Ausgangspunkt des oben erwähnten Materialtransportweges von Luxusgütern aus (Anon 1954).

1992 hatte man uns in der Sammlung der Tadschikischen Geologischen Expedition in Pendjikent u.a. Erzproben mit Zinn und Kupfer gezeigt und überlassen, die genaue Herkunft aber nicht mitgeteilt. Erst 1994 konnte nach einem Hinweis tadschikischer Geologen und mit deren Hilfe der Berg Muschiston besucht werden. Obwohl völlig überprägt von modernen Prospektionsschürfen konnten doch verschiedene alte Mundlöcher von Stollen festgestellt werden. Bei der Befahrung eines modernen Stollens (N 39°18.650' E 67°58.742) konnten Spuren alten Bergbaus auch im Innern des Berges ausgemacht werden. Erst die Ausgrabungen von 1997 und 1999 konnten diese als prähistorisch identifizieren. Außerdem war noch die Wolfram und Zinn führende Lagerstätte von Takfon besucht worden.

MUSCHISTON

Im August 1994 konnte nach Gesprächen mit dem Chefgeologen Gorshkow eine große Zinnlagerstätte in 3000 bis 3300 m Höhe bei Muschiston in einem Seitental des Serafschan besucht werden (Abb. 1). Sie wurde vor mehreren Jahren von der Geologischen Expedition Tadschikistans durch Bohrungen und Prospektionsarbeiten erschlossen. Sie wird auf eine gesamte Erzreserve von etwa 70 Millionen Tonnen geschätzt. Die hydrothermalen Erzgänge liegen zwischen devonischen Kalken und Schiefer. Sie streichen mit 310° und fallen mit 50-80° nach Westen ein.

Das Besondere an dieser Lagerstätte ist aus archäometallurgischer Sicht, dass hier Kupfer und Zinn gemeinsam vorkommen. Alle Bergwerke gehen in der Oxidationszone um. Neben Kassiterit (SnO2) als wichtigstem Erzmineral tritt auch Zinnkies (Stannit, Cu2FeSnS4)), ein Zinn-Kupfer-Sulfid, auf. Hinzu kommt noch Muschistonit (Cu Zn Fe)Sn(OH)6, erst 1984 entdeckt und nach dem Fundort selbst benannt, außerdem Varlamoffit (Sn,Fe)(0,OH)2. Aus diesen Mineralien entstehen bei der Verwitterung grün gefärbte Oxidationsprodukte, die von gewöhnlichen oxidischen Kupfererzen kaum zu unterscheiden sind (Abb. 17). Die Verhüttung eines solchen Erzes würde zwangsläufig zu einer "natürlichen" Zinnbronze führen.

Darüber hinaus haben die rezenten Prospektionsarbeiten auch alte Grubenbaue angeschnitten (Cierny 1995). Nach Aussage der Geologen befinden sich in diesem Revier weitere 150 alte Gruben- und Verhüttungsreste. Die Beschreibung der Lagerstätte erfolgte durch russische Geologen vorwiegend in internen Berichten. Aber eine weitere Untersuchung mit dem Schwerpunkt Geochemie erscheint unumgänglich.

Vor der Prospektion unter dem Einsatz von Großmaschinen (Abb. 18) sollen mehr als 40 Mundlöcher am Berghang sichtbar gewesen sein. Jetzt konnten am Berghang nur noch 11 Gruben ausgemacht werden. Ihre Untersuchung ergab, dass Stollen vom Hang aus in den Berg vorgetrieben worden waren (Abb. 19). Die Stollenform wurde nach den Gewinnungsmöglichkeiten sogleich aufgegeben, wenn man seitlich Erz gewinnen konnte. Dadurch entstanden Weitungen. In einem Falle befand sich in der Sohle ein Abhauen in ein tieferes Niveau, wo ebenfalls in einer Richtung eine Abbauweitung entstand. Zur anderen Seite ging der Stollen weiter in den Berg hinein. Die Zeit reichte nicht aus, um alle Stollen bis zum Ende freizulegen. Allerdings ergibt sich aus der Vermessung, dass offensichtlich die Gruben im Berginnern von den Stollen am Berghang aus zugänglich gewesen sein müssen.

Die besondere Situation, dass die bronzezeitlichen Gruben im Berginnern heute durch einen modernen Stollen zugänglich sind, erlaubte deren leichtere Untersuchung vor Ort (Abb. 20). Es stellte sich heraus, dass sie ebenfalls im vererzten Quarz bauen, der reichlich Zinnminerale enthält. Hier hat man ebenfalls mit Rillenschlägeln gearbeitet, wenn sie auch in wesentlich geringerer Zahl vorkommen als in Karnab. Die für Feuersetzen typischen rundlichen Stoßstrukturen wurden nirgends beobachtet. Gelegentliche Spuren metallener Werkzeuge deuten auf deren Verwendung. Jedenfalls sehen Stöße und manche fast rechtwinkligen Durchhiebe deutlich nach Metallwerkzeugen aus. In Muschiston wurden in der Bronzezeit wegen der Größe der Weitungen und wegen des brüchigen Nebengesteins aus Sicherheitsgründen Holzstempel gesetzt (Abb. 21). Das dazu nötige Holz lieferten die auch heute noch bis in 3000 m Höhe vorkommenden Wacholderbäume. Scherbenfunde stammen, wie in Usbekistan, ebenfalls aus der Andronovo-Tazabag'jab-Kultur. Aber Radiokarbondaten ergaben auch höhere Alter als für Karnab, nämlich vorwiegend den Anfang und die erste Hälfte des 2. Jtds. v.Chr. Dieses hohe Alter, zusammen mit frühen Siedlungen wie Sarazm und deren Metallreichtum, gibt einer frühen Bedeutung dieser Lagerstätte ihr besonderes Gewicht.

Da ein gemeinsames Schmelzen der Minerale wie sie in Muschiston vorkommen, eine natürliche Bronze ergibt, kann die Kenntnis über diese Legierung durchaus auf empirische Weise entstanden sein (Cierny 1995).

ZINNGRUBEN IN KASACHSTAN

Das Serafschan-Tal bringt einerseits die Mittelasien so kennzeichnenden kulturellen Gegensätze zwischen Nomadengruppen und frühstädtischen Oasen, also zwischen Nord und Süd, andererseits aufgrund seiner verkehrsstrategischen Bedeutung aber auch zwischen West und Ost deutlich zum Ausdruck. Und gerade im Serafschan-Tal liegen bedeutende Zinnlagerstätten (Materikov 1970).
Das erzreiche Vorland des Altai-Gebirges liegt im Osten Kasachstans (Abb. 1) und steigt von 600 m über d. Meer auf bis zu 2700 m zum Berg-Altai an. Wegen seines Erzreichtums heißt es auch Rudnyj Altai (=Erzaltai) (Ermolaeva et al. 1998; Nechroschev 1966; Scherba et al. 1984). Bereits die ersten Völkerkundler berichten von Spuren alten Bergbaus, dachten aber, er gehe auf die einheimischen Nomaden zurück (Pallas 1971). Im Mittelalter hatten die Mongolen sogar deutsche Bergleute und Metallurgen in den Altai verschleppt (Weisgerber 1986).

In den Granitoiden sind die Zinn- und Goldvererzungen an Intrusionen gebunden. Ein Zentrum ist das Revier Askaraly im Gebirgsmassiv des Delbegetej im Oblast Vostocnyj (Askaraly I: E 505392,480, N 5523756,415; Askaraly II: E 503127,000, N 5529077,000). Auch hier zeichnet sich eine Intensivierung der Gewinnung in der Andronovo-Kultur ab, entwickelt sich also neben der Nomadenkultur eine Abteilung von Spezialisten mit dem Schwerpunkt Metallproduktion.

Seit dem Jahre 2003 gibt es ein gemeinsames Projekt des Deutschen Bergbau-Museums und des Archäologischen Instituts am Ministerium für Bildung und Wissenschaft der Republik Kasachstan, das den prähistorischen Montanaktiviäten gewidmet ist. Es wird ermöglicht durch die Förderung der Gerda-Henkel-Stiftung.

Besiedlungsspuren seit der frühen Mittelbronzezeit unterstreichen die Bedeutung und Nutzbarkeit der Region, für die der Irtysch als Kulturscheide aber auch als Transportweg eine Bedeutung hatte (Berdenov 1998; 2002a, b; Koutznetsova et al. 1988; Kyzlasov 1965). Mehr als 100 Plätze mit alten Schächten und Pingen waren bereits in den 1970er Jahren festgestellt worden. Pingenzüge folgen den Erzgängen und zeigen diese an (Abb. 22).

Auch die Nomadenwirtschaft des Westaltai gewann metallische Rohstoffe. Besonders Zinnvererzungen im Kalba-Narim Gebirge lockten den frühen Bergbau an. Das Metall findet sich bereits in den Bronzen der sibirischen Okunev-Kultur in den Jahrhunderten um 2000 v.Chr. bevor es im Andronovo-Fedorovka-Kulturkomplex üblich ist.

Bei einem ersten Besuch in 2003 im Gebiet des Delbegetej-Berges wurde die Bedeutung derartiger Grubenreviere deutlich. Lohnend war die Zinnerzlagerstätte Kalai Topkan (Çernikov 1949). Neben Zinnerz führenden Seifen, in denen noch in den 1950er Jahren gewaschen wurde, fielen vor allem die Pingen in der Zinnerz führenden Gangvererzung auf. Dort gab es auch kleine, feuergesetzte oberflächennahe Gruben. Bronzezeitliche Gewinnung ist bewiesen.

Desweiteren wurden in Novaja Schulba, 180 km nordwestlich von Ust-Kamenogorsk, wo man schon in den 1980er Jahren montanarchäologische Spuren festgestellt hatte, Kupferbergbau, aber auch Schlackenstreuungen samt zugehörigen Siedlungen kartiert. Mit Holzkohle konnten die Befunde ins 3. Jtd. datiert werden.

An der Zinnlagerstätte Kalai Topkan bei Belaja Gora wurden zwei untertägige Gruben untersucht. Klopfsteine sowie Holzkohle weisen auf eine spätbronzezeitliche Ausbeute hin (Stöllner 2009).

An der Fundstelle Askaraly I wurden an die dreißig Pingen in elf Gruppen gezählt. Davon konnten viele kleinere an ihren kleinstückigen Abraumhalden und den Steingeräten (Schlägel, Hacken, Keile, Klopfsteine, Scheidplatten) als prähistorisch angesprochen werden. Beim Freilegen wurden Hunderte von Steinschlägeln geborgen, die in den Typen und der Art ihrer Befestigung an den Stielen denen von Karnab sehr gleichen. Große und bis zu 7,50 m tiefe Untersuchungsschnitte stellten fest, dass es wegen des mürben Nebengesteins nicht nötig war, auf die Feuersetzmethode zurück zu greifen. Interessant, dass man an den Sedimentations- und Verfüllungsschichten der Grabenpingen erkennen kann, dass die Abbaue bewusst wieder verfüllt worden waren. Dies ist ein in der Völkerkunde mehrfach beobachtetes Vorgehen, um den Frieden mit den Erdgöttern wieder her zu stellen.

An der Stelle Askaraly II wurde eine Pinge geräumt (Abb. 23) und in einer Teufe von 9 m Holzkohle gefunden. 2006 wurde eine weitere Grube in einem Erzgang fast vollständig frei geräumt: Feuersetzen und zermalmende Gewinnung durch Steinschlägel waren die Abbaumethoden. Der Fund eines hölzernen Schäftungsgriffes ist als Sensation zu bewerten. Keramik sowie Holzkohle erlaubten eine Datierung ins 2. Jtd. v. Chr. In der Nähe lag auch das Gräberfeld Tschernogorka. Steinhämmer in den Grabmauern und als Beigaben können evtl. Bergleute identifizieren. Deshalb sind die Untersuchungen von Siedlungen und Gräbern der Bergleute bei den Zinn- und Kupfergruben für die Erforschung der Gesellschafts- und Organisationsstrukturen vor dem Hintergrund weiträumiger Verflechtungen von besonderer Bedeutung.

ZUSAMMENFASSUNG

Dieser summarische Überblick macht deutlich, dass in Mittelasien im 3. und 2. Jtd. v. Chr. sowohl bronzezeitlicher Zinn- als auch Kupferbergbau umgingen. Die nomadischen Kulturverhältnisse in den verschiedenen Teilen Mittelasiens bilden deren Hintergrund, ohne dass bereits eine klare Vorstellung herrscht über die Organisation der Arbeit durch die, welche diese schwere Arbeit zu schultern hatten. Ebenso wenig kennt man die Art und die Wege des Transportes. Hier können nur weitere Erkenntnisse vor allem zur chronologischen Differenzierung weiter helfen.

Mit dem von der VW Stiftung und der Gerda-Henkel-Stiftung geförderten Projekten ist es erstmals seit 120 Jahren gelungen, bronzezeitlichen Zinn-Bergbau nachzuweisen und zu beschreiben. Damit ist die Diskussion zur Herkunft des Zinns zwar nicht beendet, sie hat aber zum ersten Mal einen konkreten Hintergrund bekommen, sowohl lagerstättenmäßig als auch bergbauarchäologisch. Da dies in drei archäologischen Entwicklungsländern geschah, die erst kürzlich zugänglich wurden, galt es viel Grundlagenarbeit zu leisten, wo es um Fragen der Datierung archäologischer Funde und Befunde ging. Dabei war es ein besonderer Glücksfall, dass sowohl in Karnab als auch in Muschiston und in Askaraly die Siedlung der Bergleute angetroffen und teilweise ausgegraben werden konnte. Damit sind zu mindest in Ansätzen Aussagen zu Struktur und Organisation der Arbeit möglich. Dabei stellte sich heraus, dass an allen Plätzen in den Ländern Träger der Andronovo-Kultur den Bergbau betrieben (Sarianidi *et al.* 1977; Litvinskij and Pjankova 1992). Dies ist insbesondere deshalb erstaunlich, weil man sich bislang Andronovo-Leute als nomadische Hirtenvölker vorstellte, deren Metall-Reichtum schon immer schwer zu erklären war. Nachdem sie jetzt selbst als Metallproduzenten vom Bergbau bis zur Verhüttung (letztes zumindest, was das Kupfer betrifft) fassbar werden, wird man sich ein völlig neues Bild ihrer Ökonomie machen müssen, bei dem Spezialarbeiter wie Bergleuten, Hüttenleuten und Metallhandwerkern sicher eine größere Bedeutung zukommen wird.

REFERENCES

Alimov, K. et al. 1998
"Prähistorischer Zinnbergbau in Mittelasien", *Eurasia Antiqua* 4: 137-199.

Alimov, K. et al. 1999
"Research at Karnab", *Usbekistan. Istorija Material'noj Kultury Uzbekistana* 30: 80-87.

Anon, 1954
Drevnejschie stranicy istorii gornoga dela Tadschikistana i drugich respublik Sredney Azii (Die älteste Geschichte des Bergbaus Tadshikistans und anderer Republiken Mittelasiens). Populärwissenschaftliche Bibliothek 10, Stalinabad.

Artzy, M. 1983
"Arethusa of the tin ingot", *Bulletin of the American Schools of Oriental Research* (BASOR) 250: 51-55.

Baer, K.E. von 1876
"Von wo das Zinn zu den ganz alten Bronzen gekommen sein mag?", *Archiv f. Anthropologie* 9: 263.

Bartelemy, R.E. 1938
"Primitive Tin Metallurgy in Laos", *Mining and Metallurgy* 19: 244-246.

Bass, G.F. 1967
Cape Gelidonya, A Bronze Age Shipwreck. Transact. American Philosophical Society NS 57, part 8, Philadelphia.

Bass, G.F. 1986
"A Bronze Age Shipwreck at Ulu Burun (Kaş). 1984 Campaign", *American Journal of Archaeology* 90: 269-296.

Bass, G.F. 1989
"Das Wrack von Ulu Burun", *Geo H*. 1: 84-98.

Belli, O. 1991
"The problem of tin deposits in Anatolia and its need for tin, according to the written sources", A. Çilingiroğlu and D.H. French (eds.) *Anatolian Iron Ages* (The Proceedings of the Second Anatolian Iron Ages): 1-9. British Institute of Archaeology at Ankara, Oxbow Books, Oxford.

Berdenov, S.A. 1998
"Kazachstanskaja gorno-metallurgičeskaja oblast", *Voprosy Archeologii Kazachstana* 2: 180-190.

Berdenov, S.A. 2002a
Drevnie istotschniki dobytschi medi i olova v Kazachstane. Potgotovka specialista novoj formacii: nauka, metodika, praktika. Taldykorgan, Institut Zhetysu. Materialy mezhdunarodnoj konferencii. Almaty.

Berdenov, S.A. 2002b
Drevnee gornoe delo Kazachstana. Drevnejschie etapy gornogo dela i metallurgii v Severnoj Evrazii: Kargalinskij kompleks. Materialy simpoziuma. Moskva.

Boroffka, N. and Sava, E. 1998
"Zu den steinernen "Zeptern/Stößel-Zeptern", "Miniatursäulen" und "Phalli" der Bronzezeit Eurasiens", *Archäologische Mitteilungen aus Iran und Turan* 30: 17-113.

Boroffka, N. et al. 2000
"Issledowanija rajone drewnich rasrabotok olowa w sewernom Tadtschikistane (Muschiston i Takfon)", *Archeologitscheskije Rabotij w Tadtschikistane* XXVII: 71-120.

Boroffka, N. et al. 2003
"Bronze Age Tin from Central Asia: Preliminary Notes", K. Boyle, C. Renfrew and M. Levine (eds.) *Ancient interactions: east and west in Eurasia*: 135-159. McDonald Institute Monographs, Oxford.

Casanova, M. 1992
"The Sources of the Lapis-lazuli found in Iran", C. Jarrige (ed.) *South Asian Archaeology*: 49-56. Monograms of World Archaeology No 14, Prehistory press, Madison.

Chakrabarti, D.K. 1979
"The problem of tin in Early India - a preliminary survey", *Man and Environment* 3: 61-74.

Charles, J.A. 1975
"Where is the tin?", *Antiquity* 49: 19-24.

Chernykh, E.N. 1992
Ancient Metallurgy in the USSR. Cambridge University Press, Cambridge.

Cierny, J. 1995
"Die Gruben von Muschiston in Tadschikistan - Stand die Wiege der Zinnbronze in Mittelasien?", *Der Anschnitt* 47/1-2: 68-69.

Cierny, J., Th. Stöllner and G. Weisgerber 2005
"Zinn in und aus Mittelasien", Ü. Yalçın, C. Pulak and R. Slotta (eds.) *Das Schiff von Uluburun*: 431-448. Deutsches Bergbau Museum, Bochum.

Cierny, J. and G. Weisgerber 2003
"Bronze Age Tin Mines in Central Asia", A. Giumlia-Mair and F. Lo Schiavo (eds.) *Le problème de l´étain à l´origine de la métallurgie*: 23-31. Âge du Bronze en Europe et en Méditerranée, BAR International Series 1199, Oxford.

Cleuziou, S. and T. Berthoud 1982
"Early tin in the Near East. A reassessment in the light of new evidence from western Afghanistan", *Expedition* 25: 14-19.

Craddock, B.R. 1990
"The Experimental Hafting of Stone Mining Hammers", P. Crew and S. Crew (eds.) *Early Mining in the British Isles*: 58-74. Plas Tany Bwlch.

Crawford, H.E.W. 1974
"The problem of tin in Mesopotamian bronzes", *World Archaeology* 5-6: 242-247.

Černikov, S.S. 1949
Drevnaja metallurgija I gornoje delo zapadnogo Altaja. Alma-Ata.

Dercksen, J.G. 1996
The Old Assyrian Copper Trade in Anatolia. Nederlands Historisch Archaeologisch Instituut, Leiden.

Doll, M. 2003
"Animals and Men in Mines – the BoneAssemblages from Karnab and Mušiston", *Der Anschnitt* 16: 113-125.

Dossin, G. 1970
"La route de l'étain en Mésopotamie au temps de Zimri-lim", *Revue d'Assyriologie* 64: 97-106.

Ermolaeva, A.S., L.N. Ermolenko, E.F. Kuznetsova and T.M. Teplovodskaja 1998
"Poselenie drevnich metallurgov VIII-VII vv. do n. E. na Semiplatinskom pravoberesche Irtyscha", *Voprosy Archeologii Kazachstana* 2: 39-46.

Franklin, A.D., J.S. Olin and T.A. Wertime (eds.) 1978
The Search for Ancient Tin. U. S. Government Printing Office, Washington.

Galili, E. and N. Shmueli 1983
The International Journal of Nautical Archaeology 12, (Israel). 178.

Galili, E. and N. Shmueli 1986
"Metal from the Depth of the Sea", *IAMS Newsletter* 1: 4-6.

Galili, E., N. Shmueli and M. Artzy 1986
"Bronze Age ship's cargo of copper and tin", *The International Journal of Nautical Archaeology* 15.1: 25-37.

Gruhl, H. 1992
Himmelfahrt ins Nichts. Der geplünderte Planet vor dem Ende. Langen Müller, München.

Gülçur, S. 1995
"Das bronzezeitliche Wrack von Uluburun bei Kaş", *Antike Welt* 26: 453-461.

Hauptmann, A. and G. Weisgerber 1985
"Vom Kupfer zur Bronze: Beiträge zum frühesten Berg- und Hüttenwesen", H. Born (ed.) *Archäologische Bronzen, Antike Kunst, Moderne Technik*: 16-36. Staatl Museen Press Kulturbesitz, Berlin.

Hedge, K.T.M. 1978
"Sources of ancient tin in India", A.D. Franklin, J.S. Olin and T.A. Wertime (eds.) *The Search for Ancient Tin*: 39-42. U. S. Government Printing Office, Washington.

Herrmann, G. 1968
"Lapis lazuli, the early phases of its trade", *Iraq* 30: 21-57.

Hiebert, F.T. 1994
"Production evidence for the origins of the Oxus Civilization", *Antiquity* 68/259: 372-387.

Kilian, I. 1993
"Überlegungen zum spätbronzezeitlichen Schiffswrack von Ulu Burun (Kaş)", *Jahrb. Röm. Germ. Museum* 49: 333-352.

Kochhar, N., R. Kochhar, S. Chakrabarti and K. Dilip 1999
"A New Source of Primary Tin Ore in the Indus Civilisation", *South Asian Studies* 15: 115-118.

Kohl, Ph. 2004
"Chloritgefäße und andere steinerne Behältnisse und ihr Austausch im Gebiet des Iranischen-Zentral-Plateaus und jenseits davon", T. Stöllner et al. (eds.) *Persiens antike Pracht*: 282-289. Deutsches Bergbau Museum, Bochum.

Kouznetsova, E.F., N.F. Pchenitchnaia and E.N. Soulei-Menov 1988
"Études pysico-chimiques: des matières premières et production métallurgique à l'âge du Bronze au Kazachstan central", *Paléorient* 14/1: 49-55.

Kulke, H. 1976
"Die Lapislazuli-Lagerstätte Sare Sang (Badakhshan). Geologie, Entstehung, Kulturgeschichte und Bergbau", *Afghanistan Journal* 1: 43-56.

Kuzmina, E. 1991
"Die urgeschichtliche Metallurgie der Andronovo-Kultur. Bergbau, Metallurgie und Metallbearbeitung", *Zeitschrift für Archäologie* 25: 29-48.

Kyzlasov, L.R. 1965
"Drevnejšie orudija gornogo dela na Altaje. Mat. i. Issled", *Arch. SSSR* 130: 165-168.

Litvinskij, B.A. 1950a
"K istorii dobytschi olova v Uzbekistane. Trudy Sredneaziatskogo Gosudarstvennogo Universiteta", *Archeologija srednej Azii* N.S. 9: 51-67.

Litvinskij, B.A. 1950b
"Towards a history of tin-mining in Uzbekistan", *Arbeiten der Mittelasiatischen Staatsuniversität* 11: 56-68.

Litvinskij, B.A. 1954
Drevnejschie stranicy istorii gornoga dela Tadschikistana i drugich respublik Srednej Azii. Geschichte des Bergbaus Tadschikistans und anderer Republiken Mittelasiens, Stalinabad.

Litvijnskij, B.A. and L.T. Pjankova 1992
"Pastoral Tribes of the Bronze Age in the Oxus Valley (Bactria)", A.H. Dani and V.M. Masson (eds.) *History of Civilisations of Central Asia* I: 374-394. UNESCO Publ., Paris.

Lumley, H. de 1966
"Les fouilles de Terra Amata à Nice", *Bulletin du Musée d'Anthropologie et de Préhistoire de Monaco* 13: 29-51.

Maddin, R. 1989
"The copper and tin ingots from the Kas shipwreck. Archäometallurgie der Alten Welt - Beiträge zum Internationalen Symposium 'Old World Archaeometallurgy', Heidelberg 1987", *Der Anschnitt* 7: 99-105.

Maddin, R., T. Stech Wheeler and J.D. Muhly 1977
"Tin in the ancient Near East, old questions and new finds", *Expedition* 19/2: 35-47.

Masson, V.M. 1992
"The Bronze Age in Khorasan and Transoxania", A.H. Dani ve V.M. Masson (eds.) *History of the Civilisations of Central Asia* I: 225-246. UNESCO Publ., Paris.

Materikov, M.P. 1970
"Tin International, Jan. 1970", S. 20 für Tien Shan Gebirge; 1970 Juni, S. 165 für Kasachstan.

Materikov, M.P. 1974
"Tin deposits - patterns of tin ore deposits of Tien-Shan", *Soviet Geology* 8: 74-90.

Meadows, D. 1972
The Limits to Growth- a report for the Club of Rome's project on the predicament for mankind. Universe Books, New York.

Momenzadeh, M., N. Nezafati and E. Pernicka 2005
"First indication of tin at the ancient mining site near Deh Hosein", H. Kars and E. Burke (ed.) *Proceedings of the 33rd International Symposium on Archaeometry*: 116-117. Vrije Universiteit, Amsterdam.

Muhly, J.D., 1973 und Suppl. 1976
"Copper and Tin", *Trans. Connecticut Academy of Arts and Sciences* 43: 155-535 und 46, 77-136.

Muhly, J.D. 1985
"Sources of tin and the beginnings of bronze metallurgy", *American Journal of Archaeology* 89: 275-291.

Muhly, J.D. 1993
"Early bronze age tin and the Taurus", *American Journal of Archaeology* 97: 239-253.
Muhly, J.D. et al. 1991
"The Bronze Metallurgy in Anatolia and the Question of Local Tin Sources", E. Pernicka and G.A. Wagner (eds.) *Archaeometry* '90: 209-220. Proceedings of the 27th Symposium on Archaeometry held in Heidelberg, Basel.

Nezafati, N., E. Pernicka and M. Momenzadeh 2006
"Ancient tin: Old question and a new answer", *Antiquity* 80/308.http://antiquity.ac.uk/ProjGall/nezafati%20et%20al/index.html

Nezafati, N., E. Pernicka and M. Momenzadeh 2008
"Iranian Ore Deposits and Their Role in the Development of the Ancient Cultures", *Anatolian Metal* IV (Der Anschnitt, Beiheft 21): 77-90.

Pallas, P.S. 1971
Reise durch verschiedene Provinzen des Russischen Reiches. Bd. 2, St. Petersburg 1771-1776, Nachdruck Graz.

Parzinger, H. 2000
"Zinn für Mesopotamien. In: Archäologische Entdeckungen", *Die Forschungen des Deutschen Archäologischen Instituts im* 20. Jh., Bd. 2: 247-251.

Parzinger, H. 2002
"Das Zinn in der Bronzezeit Eurasiens", *Anatolian Metal* II (Der Anschnitt, Beiheft 15): 159-177.

Parzinger, H. and N. Boroffka 2001
"Woher stammt das Zinn der Bronzezeit in Mittelasien?", *Archäologie in Deutschland* 17/3: 12-17.

Parzinger, H. and N. Boroffka 2003
Das Zinn der Bronzezeit in Mittelasien I. Die siedlungsarchäologischen Forschungen im Umfeld der Zinnlagerstätten, Archäologie in Iran und Turan 5, Mainz.

Pernicka, E. 1996
"Gewinnung und Verbreitung der Metalle in prähistorischer Zeit", *Jahrbuch des Römisch Germanischen Zentralmuseums Mainz* 37: 21-129.

Pernicka, E. 1998
"Die Ausbreitung der Zinnbronze im 3. Jahrtausend", B. Hänsel (ed.) *Mensch und Umwelt in der Bronzezeit Europas*: 135-148. Abschlusstagung: Die Bronzezeit: das erste goldene Zeitalter Europas, FU Berlin 1997, Kiel.

Pernicka, E. 2000
"Das Rätsel des Zinns", *Spektrum der Wissenschaft* November 2000: 88-89.

Pernicka, E., G.A. Wagner and J.D. Muhly 1992
"Comment on the discussion of ancient tin sources in Anatolia", *Journal of Mediterranean Archaeology* 5: 91-98.

Pinnock, F. 1988
"Observations on the Trade of Lapis Lazuli in the 3rd Millennium B.C.", H. Hauptmann and H. Waetzoldt (ed.) *Wirtschaft und Gesellschaft von Ebla*: 107-110. Akten der Internationalen Tagung Heidelberg, Heidelberg.

Potts, D.T. 1993
"A new Bactrian find from southeastern Arabia", *Antiquity* 67: 591-596.

Potts, D.T. 2000
Ancient Magan - The Secrets of Tell Abraq. Trident Press, London.

Prange, M. 2001
"5000 Jahre Kupfer in Oman, Bd. 2. Vergleichende Untersuchungen zur Charakterisierung des omanischen Kupfers mittels chemischer und isotopischer Analysenmethoden", *Metalla* 8/1-2: 1-126.

Prange, M. and A. Hauptmann 2001
"The Chemical composition of Bronze Objects from Ibri/Selme", P. Yule and G. Weisgerber (eds.) *The Metal Hoard from Ibri/Selme, Sultanate of Oman*: 75-84. Prähistorische Bronzefunde XX, Bd. 7, Stuttgart.

Raban, A. and E. Galili 1985
"Recent maritime archaeological research in Israel – A preliminary report", *International Journal of Nautical Archaeology* 14/4: 321-356.

Riederer, J. 1987
Archäologie und Chemie – Einblicke in die Vergangenheit. Staatl Museen Preussischer Kulturbesitz, Berlin.

Rieser, B. and H. Schrattenthaler 2004
"Prähistorischer Kupferbergbau im Raum Schwaz/Brixlegg (Nordtirol)", *Der Anschnitt* 17: 75-94.

Roden, Ch. 1985
"Montanarchäologische Quellen des ur- und frühgeschichtlichen Zinnerzbergbaus in Europa", *Der Anschnitt* 37: 50-80.

Rossovsky, L.N., V.V. Mogarovsky and V.M. Chmirev 1987
"The metallogeny of tin and rare metals in the eastern part of the Mediterranean folded belt", S. Jankovic (ed.) *Mineral deposits of the Tethyan Eurasian metallogenic belt between the Alps and the Pamirs* (selected examples): 170-177. UNESCO/ICCP Project no. 169.

Ruzanov, V.D. 1979
"About some ancient tin sources on the territory of Uzbekistan (in Russisch)", *The history of material culture in Uzbekistan* 15: 98-104.

Ruzanov, V.D. 1999
"Zum frühen Auftreten der Zinnbronzen in Mittelasien", *Der Anschnitt* 9: 103-105.

Ruzanov, V., J. Cierny and G. Weisgerber 1999
"Ob itogach raboty meshdunarodnoj usbeksko-nemeckoj ekspedicii v 1997-1998 godach po archeologitscheskomu obsledovaniju drevnich istotschnikov olova v Zirabulak-Ziaetdinskich gorach (Ergebnisse archäologischer Untersuchungen der usbekisch-deutschen Expedition in den Jahren 1997/98 in den alten Zinnerz-Abbaurevieren der Zirabulak-Ziaetdin-Berge)", *Obschtschestvennye nauki v Uzbekistane* 7-8: 68-72.

Sabet, A.H. et al. 1976
"The Placer Tin-Deposits of Igla, Abu Dabbab and Nuweibi", *Annals of the Geological Survey of Egypt* 6: 169-180.

Sarianidi, V. 1971
"The Lapis Lazuli route in the ancient Near East", *Archaeology* 24: 12-15.

Sarianidi, V., N.N. Terekhova and E.N. Tchernykh 1977
"The beginning of metalworking in ancient Bactria", *Sov. Ark.*: 35-42.

Scherba G.N., B.A. Djatschkov and G.P. Nachtigal 1984
Metallogenija Rudnogo Altaja i Kalby. Alma-Ata.

Stech, T. and V. Pigott 1986
"The Metals Trade in Southwest Asia in the Third Millennium B.C.", *Iraq* 48: 39-64.

Stos-Gale, Z.A. et al. 1998
"The Copper and Tin Ingots of the Late Bronze Age Mediterranean: New Scientific Evidence", *Proceedings of the Fourth International Conference on the Beginning of the Use of Metals and Alloys* (BUMA-IV): 115-126. Kuniibiki Messe, Matsue, Shimane, Japan.

Stöllner, Th. 2009
"Zinnbergbau in Kasachstan", *Damals* 2009/6: 43-44.

Thomsen, Ch.J. 1837
Leitfaden zur nordischen Altertumskunde. Copenhagen.

Tosi, M. 1974
"The Lapis Lazuli Trade across the Iranian Plateau in the 3rd Millennium B.C.", *Gururajamanjarika* (Festschrift Guiseppe Tucci Vol. 1): 3-22. Instituto Universitario Orientale, Napoli.

Tosi, M. and C.C. Lamberg-Karlovsky 2003
"Pathways across Eurasia", J. Aruz (ed.) *Art of the first Cities. The Third Millennium B.C. from the Mediterranean to the Indus*: 347-350. Katalog Metropolitan Museum of Art, New York.

Vogt, B. 1985
Zur Chronologie und Entwicklung der Gräber des späten 4. – 2. Jtsd. v. Chr. auf der Halbinsel Oman. Diss, Göttingen.

Weisgerber, G. 1986
"Deutsche Bergleute im Mongolenreich - Bergmännisches bei Wilhelm von Rubruck vom Jahre 1255", *Der Anschnitt* 38/3-4: 147.

Weisgerber, G. 2004
"Schmucksteine im Alten Orient (Lapislazuli, Türkis, Achat, Karneol)", T. Stöllner et al. (eds.) *Persiens antike Pracht*: 64-74. Deutsches Bergbau Museum, Bochum.

Weisgerber, G. and J. Cierny 1999
"Ist das Zinnrätsel gelöst? Auf den Spuren der Bronzezeit in Zentralasien", *Oxus* 4: 44-47.

Weisgerber, G. and J. Cierny 2002
"Tin for Ancient Anatolia?", *Anatolian Metal* II (Der Anschnitt, Beiheft 15): 179-186.

Wertime, Th.A. 1978
"The search for ancient Tin, the geographic and historic boundaries". A.D. Franklin, J.S. Olin and T.A. Wertime (eds.) *The Search for Ancient Tin*: 1-6. U. S. Government Printing Office, Washington.

Willies, L. 1992
"Kestel Tin Mine, Turkey. Interim Report 1995", *Bulletin of the Peak District Mines Historical Society* 12/5: 1-11.

Wolfart, R. and H.P. Wittekind 1980
Geologie von Afghanistan. Beiträge zur regionalen Geologie der Erde 14, Berlin/Stuttgart.

Yalçın, Ü. 1998a
"Der Keulenkopf von Çan Hasan (TR): Naturwissenschaftliche Untersuchung und neue Interpretation", *Der Anschnitt* 8: 279-289.

Yalçın, Ü. 1998b
"Frühe Eisenverwendung in Anatolien", *Istanbuler Mitteilungen* 48: 79-95.

Yalçın, Ü. 2000
"Anfänge der Metallverwendung in Anatolien", *Anatolian Metal* I (Der Anschnitt, Beiheft 13): 17-30.

Yalçın, Ü. (ed.) 2002
Anatolian Metal II. Der Anschnitt, Beiheft 15, Bochum Bergbau Museum, Bochum.

Yalçın, Ü. 2003
"Metallurgie in Anatolien", *Der Anschnitt* 16: 527-536.

Yalçın, Ü. (ed.) 2005
Anatolian Metal III. Der Anschnitt, Beiheft 18, Bochum Bergbau Museum, Bochum.

Yalçın, Ü. and E. Pernicka 1999
"Frühneolithische Metallurgie von Aşıklı Höyük", *Der Anschnitt* 9: 45-54.

Yalçın, Ü., C. Pulak and R. Slotta 2005
Das Schiff von Uluburun – Welthandel vor 3000 Jahren. Katalog zur Ausstellung des Deutschen Bergbau Museums Bochum (Veröffentlichung aus dem Deutschen Bergbau Museum Bochum Nr. 138), Bochum.

Yener, K.A. 2000
The domestication of metals: the rise of complex metal industries in Anatolia. E. J. Brill, Leiden.

Yener, K.A. and H. Özbal 1987
"Tin in the Turkish Taurus mountains: the Bolkardag mining district", *Antiquity* 61: 220-26.

Yener, K.A. and M. Goodway 1992
"Response to Mark E. Hall and Sharon R. Steadman, Tin and Anatolia. Another look", *Journal of Mediterranean Archaeology* 5: 77-90.

Yener, K.A. and P. Vandiver 1993
"Reply to J.D. Muhly, 'Early Bronze Age Tin and the Taurus'", *American Journal of Archaeology* 97: 255-262.

Yener, K.A., A. Adriaens, B. Earl and H. Özbal 2003
"Analyses of Metalliferous Residues, Crucible Fragments, Experimental Smelts, and Ores from Kestel Tin Mine and the Tin Processing Site of Göltepe, Turkey", P.T. Craddock and J. Lang (eds.) *Mining and Metal Production Through The Ages*: 181-197. The British Museum Press, London.

Yener, K.A. et al. 1989
"Kestel: an early Bronze Age source of tin ore in the Taurus Mountains", *Science* 244: 200-203.

Abb. 1: Karte Eurasiens mit den bekanntesten Zinnvorkommen. Dabei handelt es sich bei den nachgewiesenen Bergbaurevieren 1-3 und 5 um große bronzezeitliche Gewinnungsstätten, während 4 noch nicht genug untersucht ist. Die mittelasiatischen Plätze liegen an den alten Verbindungswegen gen Westen.

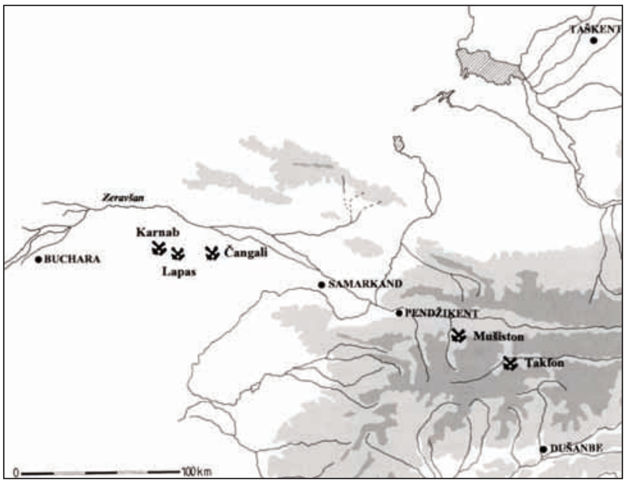

Abb. 2: Lage der Reviere Karnab, Lapas und Čangali in Usbekistan entlang des Flusses Amu-Darja, dem antiken Oxus, und Mushiston in Tadschikistan in der Nähe des Zerafshan.

Abb. 4: Karnab, Grube 5-3-II. Blick auf das östliche Grabungsende der Grabenpingen. Gut sichtbar ist die Löss-Sedimentabdeckung im oberen Teil.

Abb. 3: Karnab, Grube 6. Blick über den abgebauten Erzgang mit einer Auswahl der dort geborgenen kantigen Steinwerkzeuge. Man beachte ihre unregelmäßige Form.

Abb. 5: Karnab, Grube 3-2. Blick über den frei geräumten, nahezu senkrechten Gangverlauf.

Abb. 6: Karnab, Grube 5-3. Blick aus dem Inneren nach oben, wo die stehen gelassene Bergfeste mit dünnen Gangresten (Pfeil) seit Jahrtausenden die Sicherheit garantiert.

Abb. 7: Karnab, Grube 5-1. Auch im tieferen Bereich des Bergwerks schützten Bergfesten die Bergleute (Pfeil: Reste des Erzgangs).

Abb. 8: Karnab, Grube 6-1. Der senkrechte schmale Erzgang wurde bis zum Grundwasser frei geräumt.

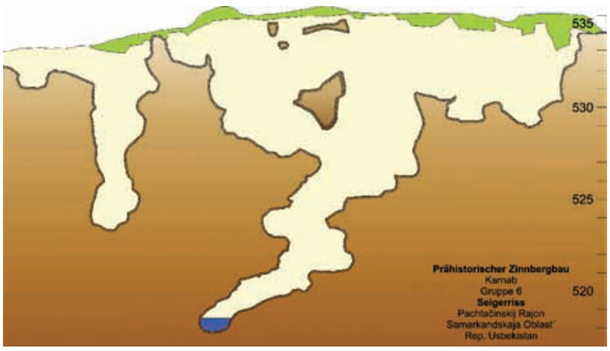

Abb. 9: Karnab, Grube 6-1. Seigerriss des Bergwerks.

Abb. 10: Karnab, Grube 6-1. In der Bergfeste an der Tagesoberfläche hat sich ein Rest des Erzgangs erhalten, der zwecks Analysen beprobt werden konnte (Pfeil: Reste des Erzgangs).

Abb. 11: Karnab-Sičkonči. Ausschnitt aus der Siedlung von Bergleuten und Metallurgen.

Abb. 12:Mushiston. Ziegenhörner wurden ehedem als Werkzeuge benutzt, sie sind bis auf die Hornzapfen vergangen.

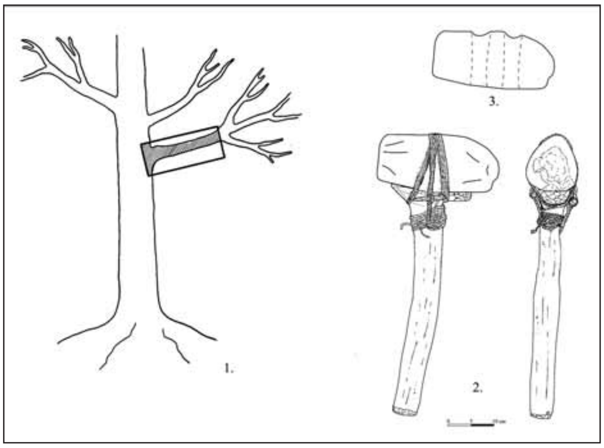

Abb. 13: Schäftungsvorschlag für Steinschlägel mit einer flachen Seite, die sog. “Knorrenschäftung” (Nach Rieser und Schrattenthaler 2004, Abb. 8 und 10, Umzeichnung J. Garner).

Abb. 14: Čangali. Der schwere Rillenschlägel hat die für eine Knarrenschäftung nötige flache Seite.

Abb. 15: Čangali. Hinter den Häusern des Dorfes erhebt sich der mittelalterliche Siedlungshügel.

Abb. 16: Vom Aufstieg zu den Bergwerken von Mushiston Blick zurück ins Tal des Zerafshan (2007).

Abb. 17: Mushiston. In der Mineralprobe sind neben weißem Quarz und schwarzem Stannit weiter grüne und blaue Kupferminerale sichtbar, auch Muschistonit.

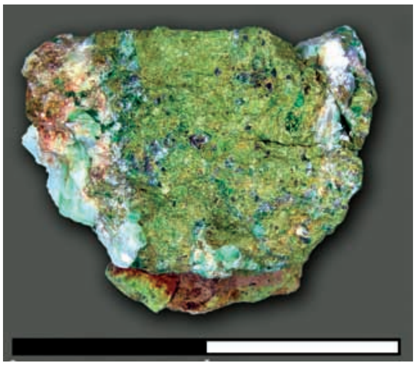

Abb. 18: Mushiston. Blick auf den Berg mit den prähistorischen Bergwerken auf dem Hang. Heute ist diese Hangseite gekennzeichnet von den zahlreichen Prospektionsschürfen sowjetischer Geologen, welche viele alte Baue verschütteten oder zerstörten. Einige konnten vom Tage aus untersucht werden. Auf die graue Halde wurde der Abraum des rezenten sowjetischen Bergbauversuches gekippt. Durch dessen Stollen waren manche alten Baue für uns auch aus dem Berginneren her zugänglich. Sie reichten vom Stollenmundloch ca. 80 m schräg in den Berg.

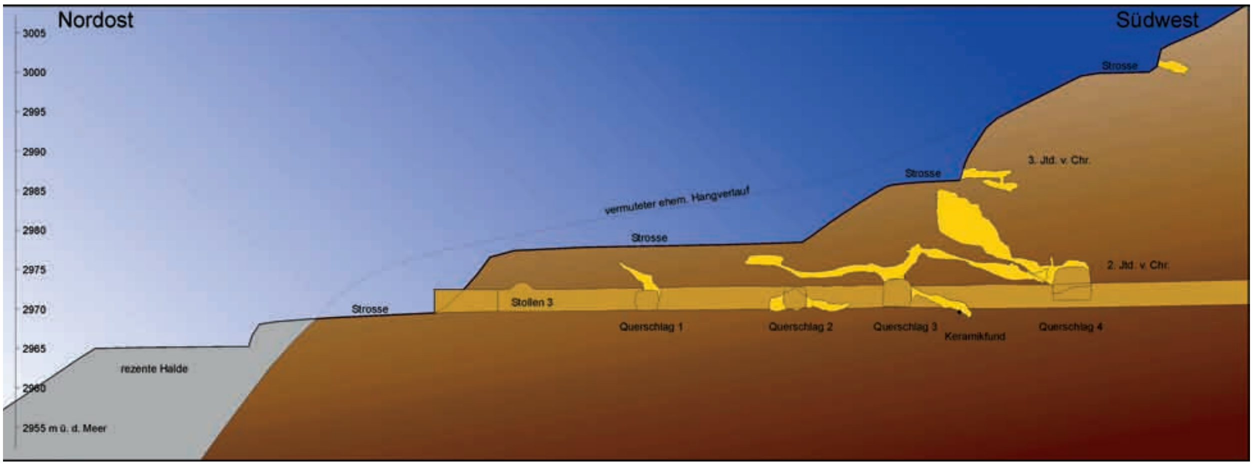

Abb. 19: Mushiston, Stollen 3. In den Seigerriss des rezenten horizontalen Stollenverlaufs wurden alle bekannt gewordenen bronzezeitlichen Abbaue projiziert, die vom Hang aus freigelegt worden waren.

Abb. 20: Mushiston, Stollen 3. Vom rezenten Querschlag 3 aus war der obere Teil des bronzezeitlichen Abbaus nur schwierig zu erreichen. Die grüne Mineralisation zeigt, dass beide Baue satt in der Vererzung stehen.

Abb. 21: Mushiston, Stollen 3. Eine Weitung war mit einem hölzernen Stempel gesichert. Später wurde sie mit Abraum verfüllt. Der bronzezeitliche Holzstempel ist über 3200 Jahre alt.

Abb. 22: Askaraly, Michaelovka. Zwischen den Felsen hat sich eine Grabenpinge gut erkennbar erhalten.

Abb. 23: Askaraly II. Die Grube baute einen steil stehenden Zinnerzgang ab.

YAZARLAR / AUTHORS

Yar.Doç. Dr.Erhan AKÇA
Adıyaman Üniversitesi, Meslek Yüksek Okulu, Adıyaman.

Doç.Dr. Engin AKDENİZ
Adnan Menderes Üniversitesi, Fen-Edebiyat Fakültesi, Arkeoloji Bölümü, Aytepe-Aydın

Yard. Doç. Dr. Metin ALPARSLAN
Istanbul Universitesi, Edebiyat Fakültesi, Hititoloji Anabilim Dalı, İstanbul

Yard. Doç. Dr. Meltem DOĞAN-ALPARSLAN
İstanbul Universitesi, Edebiyat Fakültesi, Hititoloji Anabilim Dalı, İstanbul

Prof.Dr. Nurettin ARSLAN
Çanakkale 18 Mart Üniversitesi, Fen-Edebiyat Fakültesi, Arkeoloji Bölümü

Erkan ATAY
Ilısu Barajı İnşaat Sahası Koordinasyon Merkezi, Müze Müdürlüğü, Mardin.

Dr. Norbert BENECKE
Deutsches Archäologisches Institut-Zentrale, Berlin.

Dr. James H. BURTON
Laboratory for Archaeological Chemistry, Department of Anthropology, University of Wisconsin, Madison.

Murat EROĞLU
Ilısu Barajı İnşaat Sahası Koordinasyon Merkezi, Müze Müdürlüğü, Mardin.

Yard. Doç. Dr. Nurullah HANİLÇİ
İstanbul Üniversitesi, Jeoloji Mühendisliği Bölümü, Avcılar Kampüsü, İstanbul

Prof. Dr. Horst KLENGEL
Kölnische Str. 34a, 12439 Berlin, Germany

PD Dr. Barbara HELWING
Deutsches Archäologisches Institut, Eurasien Abteilung, Berlin,

Prof.Dr. Selim KAPUR
Çukurova Üniversitesi, Zıraat Fakültesi, Toprak Bölümü, Balçalı Yerleşkesi, Adana.

Prof.Dr. Joseph W. LEHNER
Cotsen Institute of Archaeology, University of California, Los Angeles.

Dr. Morteza MOMENZADEH
Director, Zarneh Research Group, Tehran.

Assist. Prof. Dr. Nima NEZAFATİ
Islamic Azad University, Science and Research Branch, Department of Geology, Tehran.

Prof.Dr. A.Tuba ÖKSE
Kocaeli Üniversitesi, Fen-Edebiyat Fakültesi, Arkeoloji Bölümü.

Prof. Dr. Hadi ÖZBAL
Boğaziçi Üniversitesi, Kimya Bölümü, Bebek, İstanbul

Prof. Dr. Hüseyin ÖZTÜRK
İstanbul Üniversitesi, Jeoloji Mühendisliği Bölümü, Avcılar Kampüsü, Avcılar, İstanbul.

Prof. Dr. Ernst PERNICKA
Institut für Ur- und Frühgeschichte und Archäologie des Mittelalters, Eberhard Karls Universität Tübingen.

PhD Dr.Felix PIRSON
Alman Arkeoloji Enstitüleri İstanbul Şubesi Başkanı, İstanbul.

Assoc. Prof. Cemal PULAK
Institute of Nautical Archaeology at Texas A&M University.

Prof.Dr. John RYAN
International Center for Agricultural Research in the Dry Areas (ICARDA), Aleppo.

Yeliz TAN
Ilısu Barajı İnşaat Sahası Kazı Projesi, Müze Müdürlüğü, Mardin.

Prof. Dr. Gerd WEISGERBER
Deutsches Bergbau-Museum Bochum.

M.A. Gönül YALÇIN
Meisenweg 1, 44807 Bochum, Germany.

Prof. Dr. Ünsal YALÇIN
Deutsches Bergbau-Museum Bochum.

Prof. Dr. Aslıhan YENER
Koç Üniversitesi, Arkeoloji ve Sanat Tarihi Bölümü, İstanbul.

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