Sandıklı (Afyonkarahisar) Havzası Hidrojeoloji İncelemesi – Ön Araştırmalar

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Özet - Bu araştırmada Sandıklı (Afyonkarahisar) havzasının genel hidrojeolojik ve hidrojeokimyasal değerlendirmelerinin yapılarak havzadaki optimum yeraltısuyu yönetim planlarının düzenlenmesi hedeflenmektedir. Sandıklı havzası, Ege bölgesinin İç Batı Anadolu bölümünde yeralan ve Büyük Menderes havzasına açılan önemli havzalardan biridir. Sandıklı Kuruçay ovası ve Küçük Sincanlı ovası olmak üzere iki ovanın birleşmesinden oluşan Sandıklı havzası, yaklaşık olarak 1556 km^2'lik bir alanı kapsamaktadır. Sandıklı havzası yarı kapalı bir havza özelliğine sahiptir. Havzanın içinden doğan Kestel çayı, havza dışında Büyük Menderes nehrinin sularına karışmakta ve Ege denizine dökülmektedir. Havzanın önemini artıran diğer bir unsur ise içerisinde 72 ^0C sıcaklığa ulaşan Hüdai sıcak ve mineralli kaynağının boşalımının bulunmasıdır. Hüdai jeotermal suları tektonizma ve volkanizma ile ilişkili olarak açığa çıkmaktadır.

Çalışma alanı içerisinde Kuvaterner alüvyon, Pliyosen çökeller ve Kretase kireçtaşları önemli akifer ortamları oluşturmaktadır. Havzada Eylül-2008 ve Mayıs-2009 dönemlerinde yapılan yeraltısuyu seviye ölçümlerine göre, havzanın genel yeraltısuyu akım yönünün Büyük Menderes Nehri'ne doğru olduğu belirlenmiştir. Çalışma alanında yaklaşık 1072 adet sondaj kuyusu bulunmaktadır. Bu kuyulardan içme ve yoğun olarak sulama amaçlı kullanım mevcuttur. Bölgede aşırı su çekimi nedeniyle yeraltısuyu seviyesinde düşümler (ortalama 10 m/yıl) gözlendiği için, günümüzde yeni sondaj kuyularının açılmasına izin verilmemektedir. Bu durum Hüdai jeotermal sularını da olumsuz etkilemekte olup, havza bazında ayrıntılı hidrojeolojik araştırmaların gerekliliğini ortaya çıkarmaktadır.

Herhangi bir su kaynağının kullanım koşullarını sınırlayan en önemli etken suyun hidrojeokimyasal özellikleridir. Bu çalışmada havzadaki yeraltısularının genel hidrojeokimyasal değerlendirmelerinin yapılabilmesi için temsili seçilen lokasyonlardan analizler yapılmıştır. Elde edilen sonuçlar yeraltısularının Ca-HCO_3'lı sular fasiyesinde olduğu belirlenmiştir. Hüdai sıcak ve mineralli su kaynağı ise Na-Cl 'lü su sınıfındadır.

Anahtar kelimeler : Sandıklı (Afyonkarahisar) havzası, hidrojeoloji, hidrojeokimya

Hydrogeological Investigations Of Sandikli Basin (Afyonkarahisar)-Preliminary Studies

Abstract - The aims of this research are to determine hydrogeological and hydrogeochemical investigations of Sandıklı (Afyonkarahisar) basin and to plan of optimum groundwater management of the basin. The Sandıklı basin is situated in the west of the Aegean region and discharge to the Büyük Menderes Basin. The research area is occurred from Sandıklı Kuruçay and Küçük Sincanlı basins. It has 1556 km^2 recharge area. The basin has a semi-closed basin property due to discharge to Kestel River. The river is appear from the Sandıklı basin and discharge to the Aegean Sea via the Büyük Menderes River. Furthermore, Hüdai geothermal waters (72 $^{\circ}C$) located in Sandıklı which emerge as result of the tectonics are one of the most important geothermal areas of the country.

In the research area, Quaternary alluvium, Pliocene sediments and Cretaceous limestones are important aquifer units. According to groundwater level measurements of September-2008 and May-2009 terms, general groundwater flow direction of the basin is towards to the Büyük Menderes River. 1072 pumping wells are located in the research area. These wells are utilized to drinking and irrigation purposes densely. Decreasing of groundwater (average 10 m/year) has

observed due to overexploitation of groundwater in the research area. Therefore, a new well dugging has not been given permission by governmental associations nowadays. In addition, Hüdai geothermal water is also influenced negatively by overexploitation of the waters. It is shown that the hydrogeological investigations in detail must be made in the Sandıklıbasin.Hydrogeological properties which are controlled to using conditions of water sources are the most important factors. Representative locations were selected to general hydrogeochemical evaluating of groundwater in the basin and, physical and chemical analyses of groundwater were made. According to the classification of the waters, cold groundwaters have Ca-HCO_3 facies and Hüdai thermal and mineral waters have Na-HCO_3 facies.

Key Words : Sandıklı (Afyonkarahisar) Basin, hydrogeology, hydrogeochemistry

1. INTRODUCTION

The Sandıklı basin is located to the southeast of Afyonkarahisar, Turkiye. Some studies have been carried out the geological and hydrogeological features of the area by different researchers [1,2,3,4].

Study area is one of the plains which has problem related to sustainable safely water yield in our country (Fig. 1). Safe yield is commonly defined as the attainment and maintenance of a long-term balance between the amount of groundwater withdrawn annually and the annual amount of recharge [5,6]. Continued pumping in excess of recharge may eventually deplete the aquifer. Therefore, the Sandıklı basin has especially controlled due to negatively originated from usage unplanned of groundwater. Kestel Creek which is the most important surface flow of the basin has discharge to Büyük Menderes River in out of the basin.

Hüdai geothermal area is located in middle of the Sandıklı basin. Nowadays, thermal water is benefit with natural thermal springs discharged from different locations and wells digging in 1994 and 2001 years. The springs/wells have 57-72 $^{\circ}$C temperature and 90 l/s total yield. Hüdai thermal and mineral water springs are discharged from intersection points of N-S and E-W trending faults [3,7]. Those have used for balneology and house heating since 1998 in Sandıklı residential area.

2. MATERIALS AND METHODS

It is presented the relationship among geology, hydrogeology and hydrochemistry in the study area. In this connection, geologic map of the region is prepared and aquifer features of lithological units and groundwater flow have been discussed. In addition to the water samples from groundwater in the vicinity of Sandıklı basin were collected and analyzed. The results ofchemical analysis of water samples are evaluated in Piper diagram (Fig. 2).

3. RESULTS AND DISCUSSION

3.1 GEOLOGY

3.1.1 *Paleozoic*

Precambrian aged Kestel formation (Pk) which is composed of metamorphic rocks is foundation in the study area. The metamorphic foundation is composed of quartz, sericite schist, albite, quartzite, calc-schist, phyllite and metabasalt. Cambrian aged Hüdai quartzite (Pzh) is composed of quartzite and schist, Çaltepe formation (Pzç) is composed of dolomite and limestone, Seydişehir formation (Pzs) is composed of siltstone. Permo-Triassic aged Karatepe formation (P-TRk) which is composed of sandstone, gravelstone and siltstone is discordant with the Seydişehir formation. Jurassic aged Derealanı formation (Jd) which is composed of sandstone, siltstone, claystone and clayey limestone is harmonic on the Karatepe formation. Akdağ formation (Cra) which is consists of limestone, reef limestone and sandy limestone is also harmonic the Derealanı formation. Paleocene aged Bozoğlan formation (Pb) which is consists of marly limestone, conglomerate, sandstone, siltstone and shale is crop out on the Akdağ formation. Oligocene conglomerate (To) is situated on the Bozoğlan formation. The Sandıklı Lava (Tsl) is composed of andesite, trachyandesite and basalt. The Soğucak pyroclastic (Tsp) is also composed of tuff, tuffite and agglomerate. Miocene aged the Sandıklı Lava is crop out as discordant on the Oligocene conglomerate formation. Pliocene aged Hamamçay formation (Plh) is harmony on the Sandıklı Lava. The Hamamçay formation is intercalated sandstone, claystone and conglomerate. The youngest units are Quaternary aged Travertine (Qtr) and Alluvium (Qal). Alluvium which is composed of uncemented clay, sand, silt and gravel levels overlie above another units [1,2,3], (Fig.1)

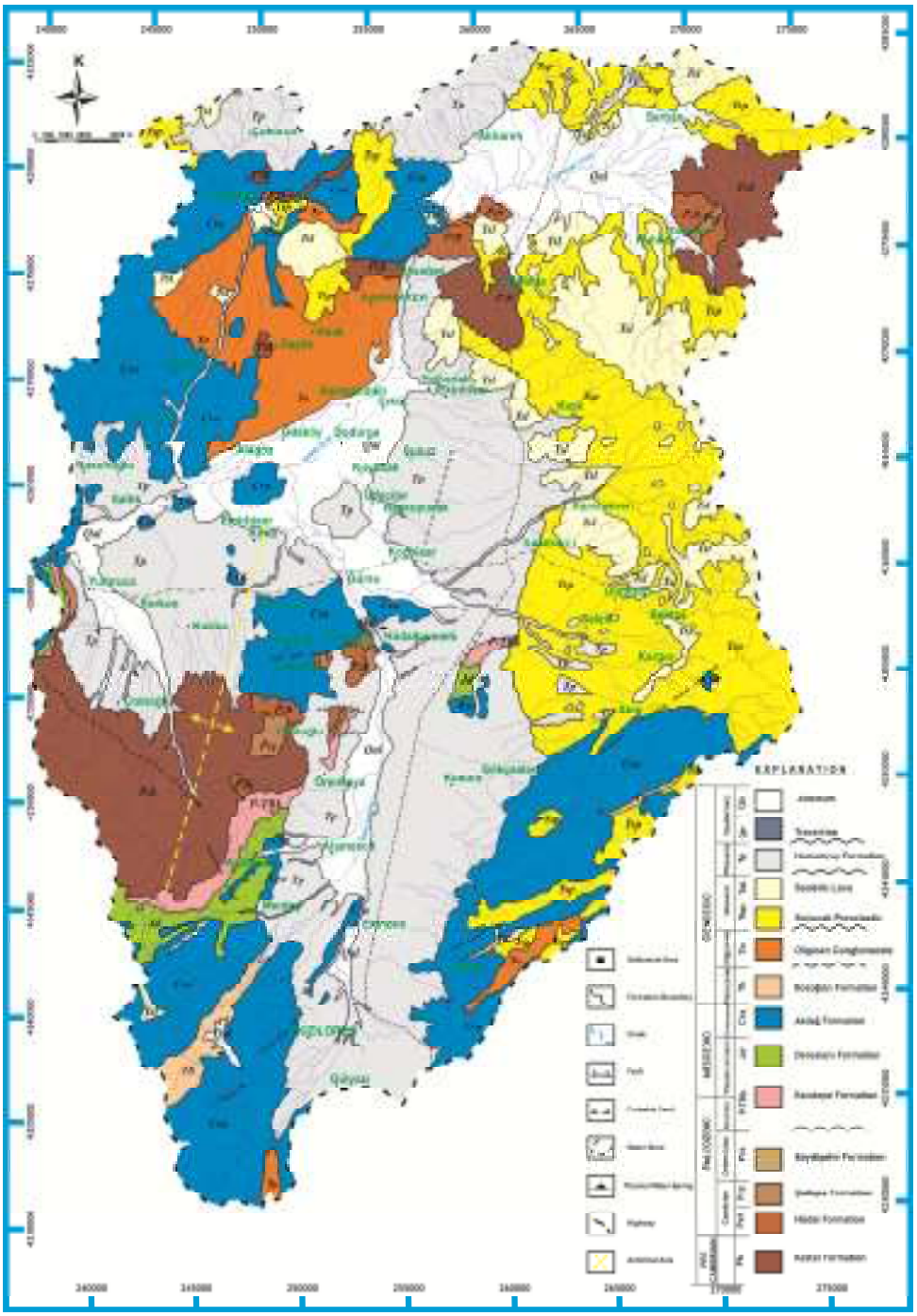

Figure 1. Geological map of the study area [1,2,3,8].

3.2 AQUIFER MEDIUMS

3.2.1 *Porous Aquifer*

In the study area, two type aquifer mediums are determined according to hydrogeological properties of the lithological units. Firstly, Quaternary alluvium and Pliocene aged the Hamamçayı units are porous aquifers The alluvium which is composed of loosely gravel, sand, silt, clay materials and the Hamamçayı unit is also composed of conglomerate having loose tissue, sand and clay levels have a good aquifer character. The alluvium is covered an area of 174 km^2 and the Hamamçay formation is also covered 366 km^2. The results of well logs indicate that the thickness of the alluvium aquifer is between 200 and 300 m, and yields are changed between 4.78 and 51.1 l/s, respectively. In addition, according to Jacob method, the transmissibility and permeability values vary from $1.16\ x10^{-1} - 2.71x10^{2}$ m^3/day, and $3.11x10^{0} - 1.66x10^{-3}$ m/day for the porous aquifer, respectively.

Clay levels within these units are constituted locally confined aquifer under suitable hydraulic conditions. The ratio of recharge from precipitation of units is low in clayey levels and is high sandy levels [3].The general groundwater level direction of the basin is towards to Büyük Menderes River according to groundwater level measurements in September-2008 and May-2009 terms.

3.2.1 Karstic Aquifer

The Akdağ formation which is composed of limestone has karstic properties due to melting cavities and secondary porosity which is developed along intersection of fault, cracks and discontinuity levels. The limestone levels are determined in Saltık, Emirhisar, Sorkun, Akın, Gökçealan and Kızılören regions in the well logs (Fig. 1). These yields of wells are changed between 20 and 50.28 l/s.

3.2.2 Aquitard Mediums

The Karatepe, Oligocene conglomerate and Sandıklı formations and travertine units grouped as semi permeable properties. Stratified levels of the Karatepe formations have a good aquifer properties because of weakly cemented. Siltstone units which are located in upper level of the Karatepe formation are also impermeable unit. Some springs discharged with 0.5-1 l/s yield from discontinuity levels and contact boundaries.

The conglomerates when is fractured and fissured may include groundwater related to thickness and surface area of its. The Akdağ limestone is situated in base of the conglomerates which have 200 m thickness. Leakage waters percolated from conglomerates feed to the Akdağ limestone aquifer.

Closed porosity is increased due to gas gaps which are located in tuff, tuffite and agglomerate levels of the Sandıklı formation. Because of secondary porosity developed with tectonic events and cooling cracks developed in andesite and basalts, permeability is gradually increased. In addition, the permeability is decreased levels which are changed to clay of andesites related to chemical process [3].

The travertines have secondary porosity and permeability because of hydrothermal karstification [3]. Furthermore, travertines which are formed with discharging to surface of thermal water springs have not aquifer characteristics because of unsuitable recharge conditions, thickness and surface area in the region.

3.2.3 Aquifuge Mediums

The Kestel, the Derealanı and the Bozoğlan formations describing as aquifuge medium are impermeable units in the study area. The geological formations have not interconnected openings and can not hold or transmit water.

3.4 HYDROGEOCHEMISTRY

The chemical water analyses have been performed to general hydrogeochemical evaluations of groundwater for representative selected locations from wells in the study area. Two hydrochemical facies have been identified as forming through the interaction between rock and water along groundwater flow paths (Fig. 2). According to analyses results, cold groundwaters discharging from alluvium and karstic aquifers (W1, W2, W4, W5, W6) are determined as Ca-HCO_3 facies. The Hüdai thermal and mineral water springs (W3) are Na-HCO_3 facies (Fig. 2). Meteoric waters while are filtering towards depths are heated by geothermical gradient. The main reservoir rocks of the thermal water are quartzite and limestones. The major anion, HCO_3 of the groundwaters in the research areas is formed through the dissolution of $CaCO_3$ by CO_2 rich meteoric water infiltrating along groundwater flow paths. Furthermore, the dissolution of the carbonate rocks enriches the water in Ca^{+2} and Mg^{+2} ions. All waters in the Sandıklı basin except thermal springs are suitable for conditions irrigation and industrial purposes [3,4]

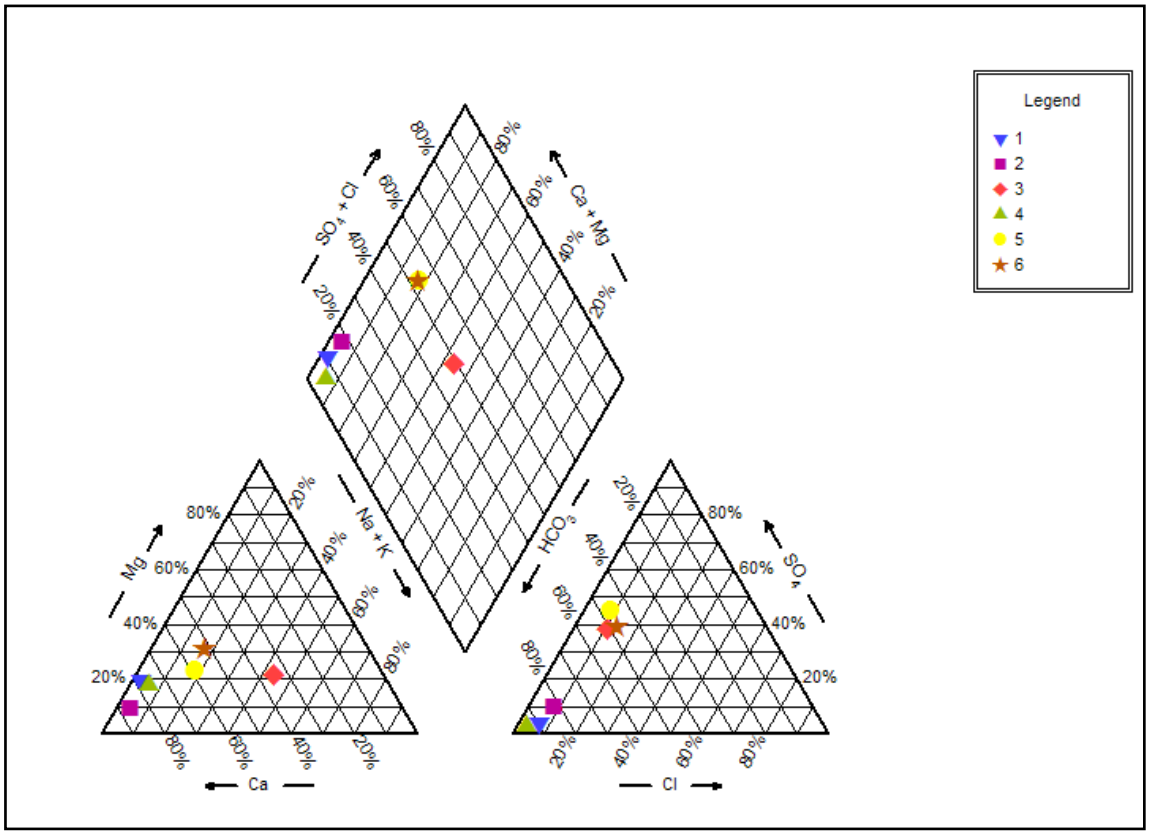

Figure 2. Distribution of thermal and cold groundwater from the study area in Piper diagram

4. CONCLUSIONS

Nowadays, the study area is one of the regions which observed several problems because of water usage as unconscious and unplanned in our country. According to previous hydrogeological investigations, geological formations are occurred aquifer, aquitard and aquifuge mediums. Aquifer medium is determined as porous and karstic aquifers.

In this study, the locations and general hyrochemical properties of the cold and thermal waters are investigated. According to the results of hydrochemical analysis; cold waters have Ca-HCO_3 facies, thermal waters have Na-HCO_3 facies, respectively. The detailed sustainable cold water aquifer potential and usage conditions will be made in the following researches. Furthermore, benefit conditions from thermal water springs will also investigated.

5. REFERENCES

[1] T. Öngür, "Sandıklı (Afyon) jeotermal araştırma bölgesine ilişkin jeolojik durum ve jeotermal enerji olanakları" Maden Tetkik ve Arama Genel Müdürlüğü Rapor No;5520, Ankara, (yayımlanmamış), 1973.

[2] A. Çakmakoğlu, "Çivril-Banaz-Sandıklı-Dinar Arasındaki Bölgenin Jeolojisi (K23-c1,c2,c3,c4d3; K24-d3,d4; L23-a2,a3,b1,b2,b3,b4; L24-a1,a2,a3,a4)" MTA Rap. Derleme No: 8062, Ankara, 1986.

[3] M. Afşin, "Afyon Sandıklı Kuruçay ovası ve Hüdai kaplıcasının hidrojeoloji incelemesi" Ankara Üniversitesi, Doktora tezi, yayımlanmamış, Ankara, 1991.

[4] M. Afşin, "Hydrochemical evolution and water quality along the groundwater flow path in the Sandıklı plain" Afyon, Turkey, Enviromental Geology, 31, ¾, Springer-Verlag, 1996.

[5] M.A. Sophocleous, "From safe yield to sustainable development of water resources the Kansas experience" Journal of Hydrology 235; 27- 43, 2000.

[6] M.A. Sophocleous, R.S. Sawin, "Safe yield and sustainable development of water resources in Kansas" Kansas Geological Survey, Public Information Circular, 9, 6p. Also available at http://www.kgs.ukans.edu/Publications/pic 9/pic 9_1.html/,1997.

[7] AİÇDR, Y. Gürman, T. Kantarcı, "Afyonkarahisar İli Çevre Durum Raporu" Afyonkarahisar Valiliği İl Çevre ve Orman Müdürlüğü, Afyonkarahisar, 2007.

[8] http://www.afyonkarahisar.gov.tr (15/03/2009)

[9] A.,M. "Piper, A graphic procedure in the geochemical interpretation of water analyses" US Geol. Surv. Ground Water Note 12, 1953.