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CONTENTS

NEOGENE STRATIGRAPHY OF THE İZMİR -OUTER- BAY ISLANDS

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ABSTRACT

The volcaniclastics, derived from calcalkaline acidic-intermediate volcanism in the region during late Early Miocene, and lacustrine deposits of Middle Miocene and alkaline volcanics are exposed on Uzun Island, Hekim Island, Çiçek Island and Karantina Island in the Outer Gulf of Izmir. Kocadağ volcaniclastics derived from Kocadağ volcanism, by extruding mainly calcalkaline andesitic-dacitic products during Late Early Miocene, represents the exposed oldest rock unit. The volcaniclastic succession extending in the north of Uzun Island is composed of pyroclastics in ignimbrite and blocky ash flow facieses, and epiclastics in volcanic mass flow (lahar) facies. Foça tuff, represented by rhyolitic ignimbrites, originated from an area around Foça and moving to an area around Uzun Island, emplaced onto the Kocadağ volcaniclastics in two main explosive stages. The Değirmentepe Member alluvial deposits composed of coarse volcanic detritus were deposited during a inactive period between the explosion stages. A K/Ar age of 16.0 Ma was obtained from a rhyolite dome, which shows lateral relationship with the correlant ignimbrites in Foça Peninsula, and so it is considered that Foça tuff emplaced onto the region at the end of late Early Miocene. Lacustrine-dominated Middle Miocene succession, which overlies the Foça tuff unconformably, differentiated as the Urla group. Urla group consists of alluvial Beşiktepe Formation, the Pırnallı Island volcaniclastics, which is composed of sublacustrine volcanic density-flow deposits and felsic ignimbrites, Hekim Island basalt comprising basic volcanics and lacustrine Urla limestone, respectively from bottom to top. Beşiktepe formation only exposed on Uzun Island, overlies the Foça tuff with an unconformity indicating a basin margin deposition during the Middle Miocene. Pırnallı Island volcaniclastic succession, which its lower boundary does not expose within the area on Hekim Island and Çiçek Islands, is mainly composed of epiclastics deposited by the dynamics of sublacustrine gravity flow and includes trachytic ignimbrite layers in various welding degrees. The main lithologic components of Pırnallı Island volcaniclastics derived from alkaline trachytic volcanism, which was active during the Middle Miocene in Menteş Peninsula. The eruption center of Hekim Island basalt intruding as a sill to the bottom of Urla limestone succession is on Hekim Island. Along the upper contact of the basalt intruding backshore deposits at the bottom of Urla limestone, the peperites occurred reflecting the interaction between molten lava and unconsolidated sediment. A K/Ar age of 14,8±0,8 Ma is obtained from the basic lavas called as trachybasalt and basaltic trachyandesite according to the major element composition. Hekim Island basalt, which exposed at the center of Foça Depression, can be correlated with both the Ilıpınar basalt in Foça Peninsula and the Ovacık basalt in Urla basin with respect to chrono- and lithostratigraphy. Urla limestone succession, which transgressively overlies Hekim Island basalt, begins with backshore mudstones, continues with foreshore deposits comprising stromatolitic oncoids and algal bioclasts and lasts with cherty limestones.

1. Introduction

This study is towards the stratigraphy of the Neogene rock units outcropping in the İzmir outer bay islands of Uzun Island, Hekim Island, Çiçek Islands and Karantina Island and their correlation with the units in the Foça Depression (Kaya, 1979, 1981). The Foça Depression mainly represents continuous lake sedimentation all along Miocene-Early Pliocene and it is known that with the development of İzmir Bay the Foça Depression has lost its unity. (Figure1A). Foça and Urla parts and eastern shore section of Karaburun are the parts of the Foça Depression, which is above the sea level to day. The rock units in the islands group had not been studied in the concept of correlating them with the Foça Depression. So it was considered that the islands group would be a good place to study the rock units to correlate them with the Foça depression (Figure 1 B). Summaries of proposed Neogene stratigraphies for different parts are given in (Figure 2). Stratigraphy of the study area, relative sizes have been

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studied in the Uzun Island and Hekim Island as they are high enough from the sea level and provide good outcrops to study. Volcanoclastic facieses described in the text have been classified according to Cas and Wright (1987).

2. Stratigraphy

Main rock units cropping out in the islands group are continental Miocene sediments and volcanics. Stratigraphic succession consists of Early Miocene felsic-mafic-intermediate volcanoclastics and dominant Middle Miocene lake sediments and laterally associated felsic-mafic volcanics. Andezitic-dasitic Kocadağ volcanoclasticks are associated with the Kocadağ volcanics (Türkecan et al., 1998). Rhyolitic Foça tuffs generated from the Foça volcanic centre (Kaya, 1979, 1981). Kocadağ volcanics and Foça tuffs are the units of Early Miocene calk alkali volcanisms outcropping in the study area. Middle Miocene sedimentation has been studied within the Urla group. Foça tuffs mainly consist of lake sediments overlie the Middle Miocene sediments with an unconformity starting with alluvial fan deposits Between Urla basin and Hekim Island bimodal Middle Miocene volcanisms were active (Helvacı et al., 2009; Göktaş, 2011). They are represented with felsic volcanoclastics participating with lake sedimentations and mafic volcanics (Figure 3).

2.1. Kocadağ Volcanoclastics

The succession consisting of mainly andeziric, less dacitic volcanics origin sediments is considered to be related to the Kocadağ volcanics. The farthest away extended unit of the Kocadağ volcanics crop out only in Uzun Island (Figure 4). Göktaş (2011) reported the presence of volcanoclastics in Uzun Island generated from the Kocadağ volcanic complex.

The succession consists of pyroclastic and epiclastic sediments displaying typical scarlet-brown colour on the alteration surfaces. Pyroclastic flow sediments consist of ignimbrite and blocky ash flow facieses mainly of andesitic-dacitic volcanic origin. Ignimbrites consisting with different size lava blocks of the same origin differ from blocky ash flow levels. Epiclastic sediments in the blocky volcanic flow (lahar) facieses consist of andesitic, dacitic coarse fragments (Figure 5A). Levels represented

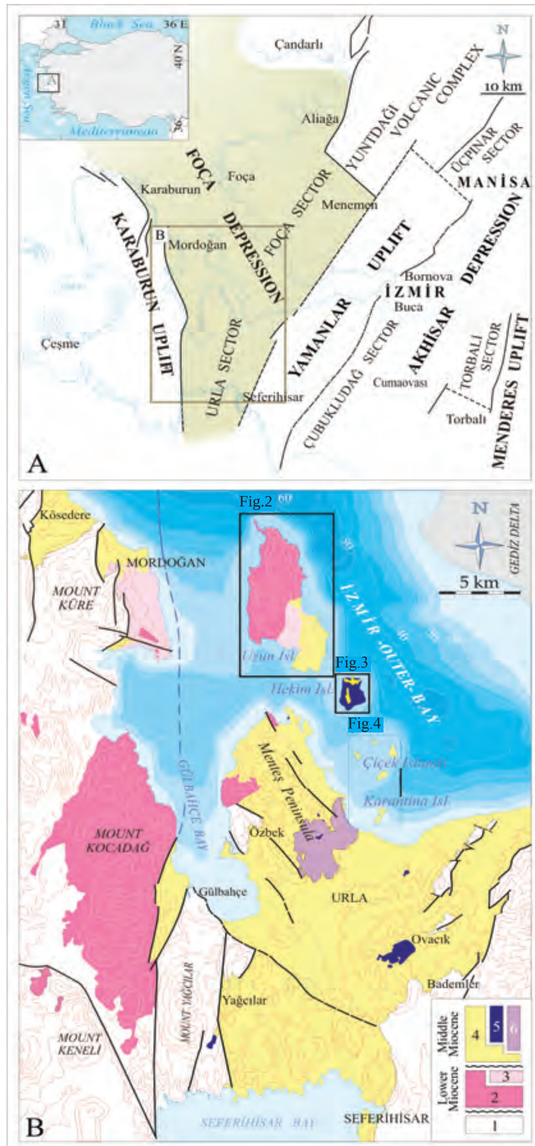

Figure 1- Position of the study area within the Foça Depression (modified from Kaya, 1979) (A) and in the Outer Gulf of Izmir (B). 1. Pre-Neogene basement, 2. Kocadağ volcanics, 3. Foça tuff, 4. Middle Miocene deposits, 5. Alkaline basic volcanics, 6. Alkaline acidic volcanics (“Menteş trachyte”: Kaya, 1979). Bathymetry of the Outer Gulf is taken from Sayın (2003).

with matrix supported inhomogeneous pebble stones and pebbly sandstones are massive. Size rate of most of semi rounded pebbles and blocks (most 90 cm) vary vertical and lateral directions. Matrix is made of badly graded coarse-very coarse grained volcanic sands and mainly consists of granules of volcanic materials. In the succession thickness of felsic tuff interlayer’s consisting base surge and/or ash fall facieses materials are most 12 m thick. Centimeter-decimeter thick parallel tuff layers

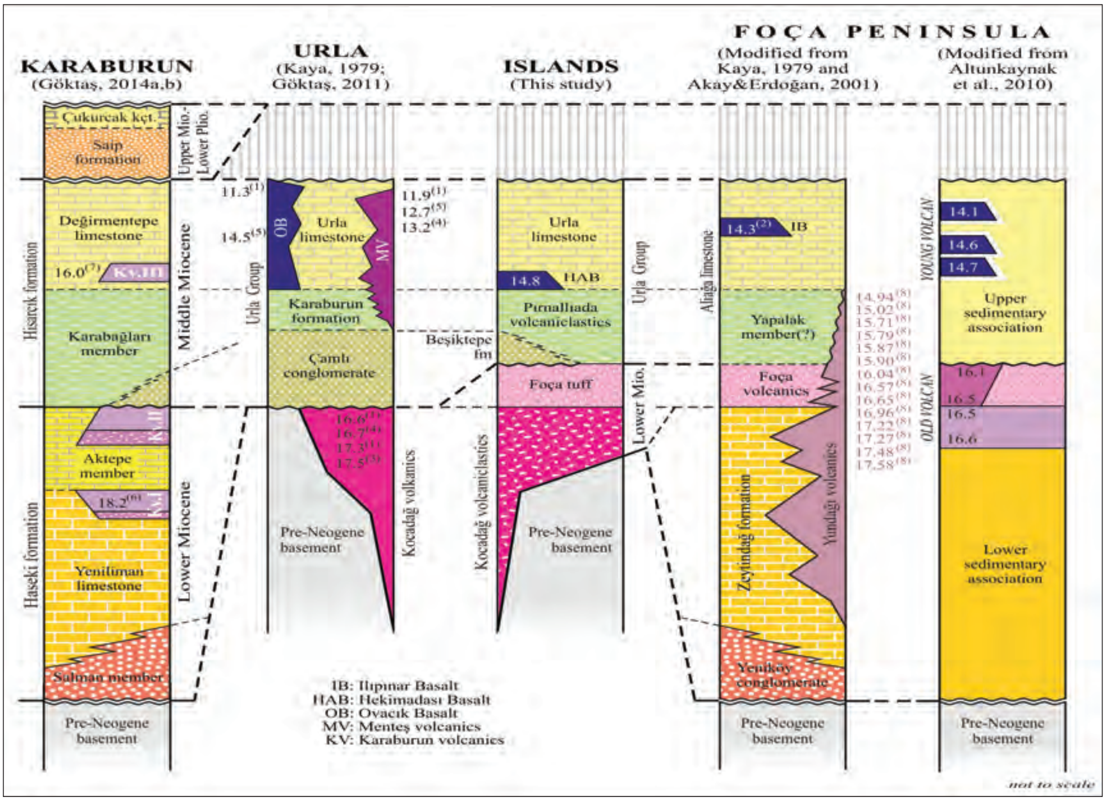

Figure 2- Correlation of proposed stratigraphic sequences for different parts of Foça depression basin. (1)Borsi et al. (1972), (2) Ercan et al. (1996), (3)Helvacı et al. (2009), (4)Karacık et al. (2013), (5)Göktaş (2011), (6)Göktaş (2014*a*), (7) Göktaş (2014*b*), (8) Seghedi et al. (2015).

seldom are made of accretionary lapillies. Within the succession there are laterally discontinuous lacustrine sediment intercalations (Figure 5B). Carbonate containing clay stone and fine-medium size grained sandstone are the units of the temporary lake sediments consisting of volcanic materials. Massive or normal graded sandstone intecalations have characteristic fossils indicating local bio turbulences. Some of the typically parallel thin bedded/laminated claystones-siltstones have been subjected to soft sedimentary deformation (Figure 5C).

2.2. Foça Tuff

Pyroclastic successions represented with rhyolitic ignimbrites in the Foça Peninsula have been described first time by Kaya (1979). Since Kaya (1979) the ignimbrites in the Foça Peninsula have been studied by Kaya, 1981, Kaya and Savaşçın, 1981; Akay, 2000; Altunkaynak and Yımaz, 2000; Akay and Erdoğan, 2001, 2004; Altunkaynak et al., 2006, 2010; Agostini et al., 2010 and indicated that their extensions in the study area are represented by ignimbrites. Within the succession presence of discontinuous alluvium fan intercalations have been described as Değirmentepe member. The succession crops out only in Uzun Island and with the Değirmentepe member the thickness is maximum about 250 metres.

Whitish, light gray unwelded ignimbrites show exfoliations (Figure 6A). Main body of metric scale thick ignimbrites has centimeter-decimeter thick parallel tuff beds with ash falls and/or pyroclastic surge levels. With the overlying flows they have been mostly reduced and the succession in general has been protected only in some local areas (Figure 6B). Centimetric scale juvenile clasts, found in the main body of ignimbrites are represented by round cornered-semi round pumice and lava fragments of same origin. Same origin lithic rhyolites are mainly bluish dark gray and burgundy coloured and have aphyric or porphyritic textures.

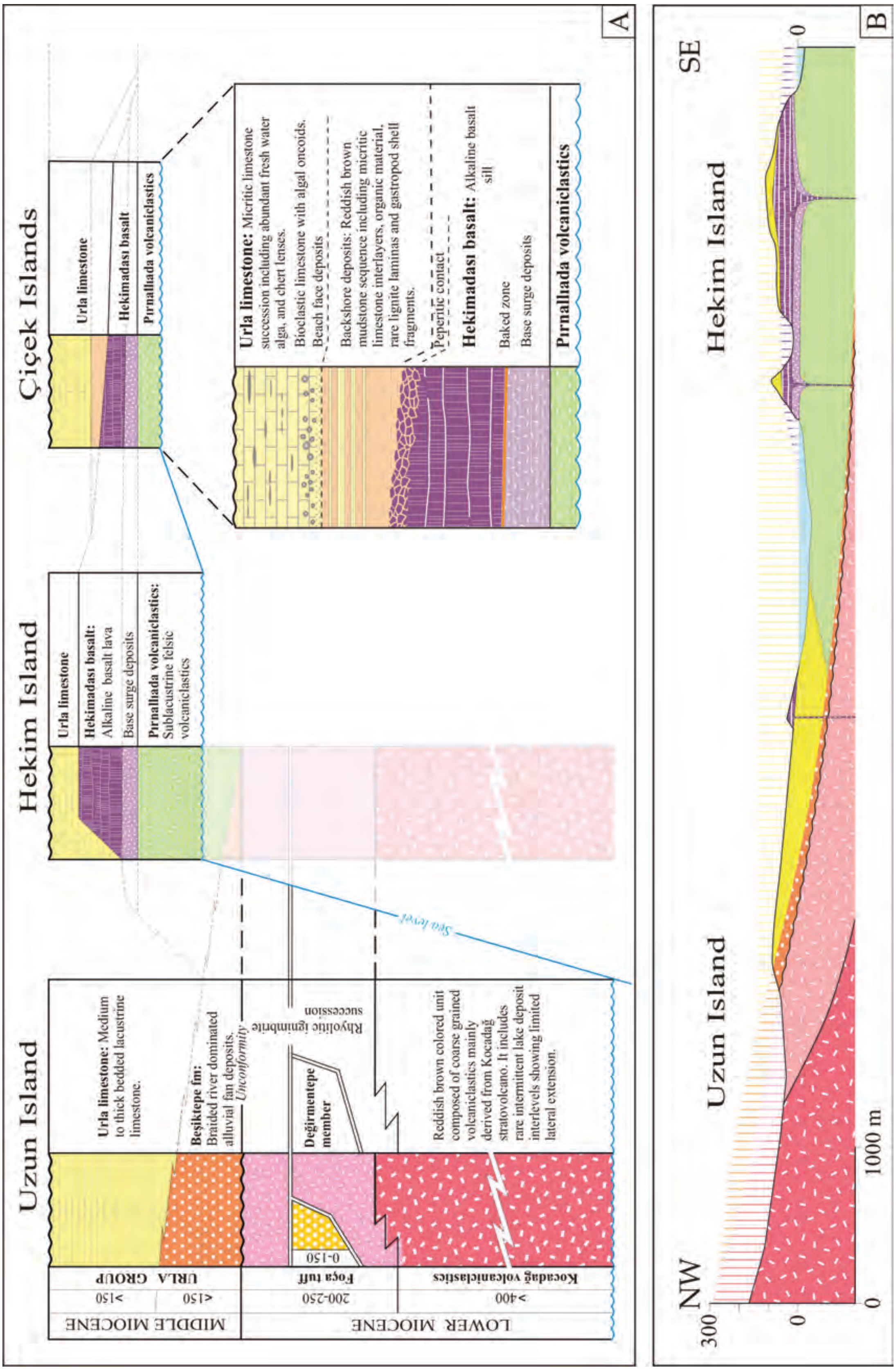

Figure 3- Vertically (A) and laterally (B) stratigraphic arrangement of the litho-units exposed on Uzun Island and Hekim Island.

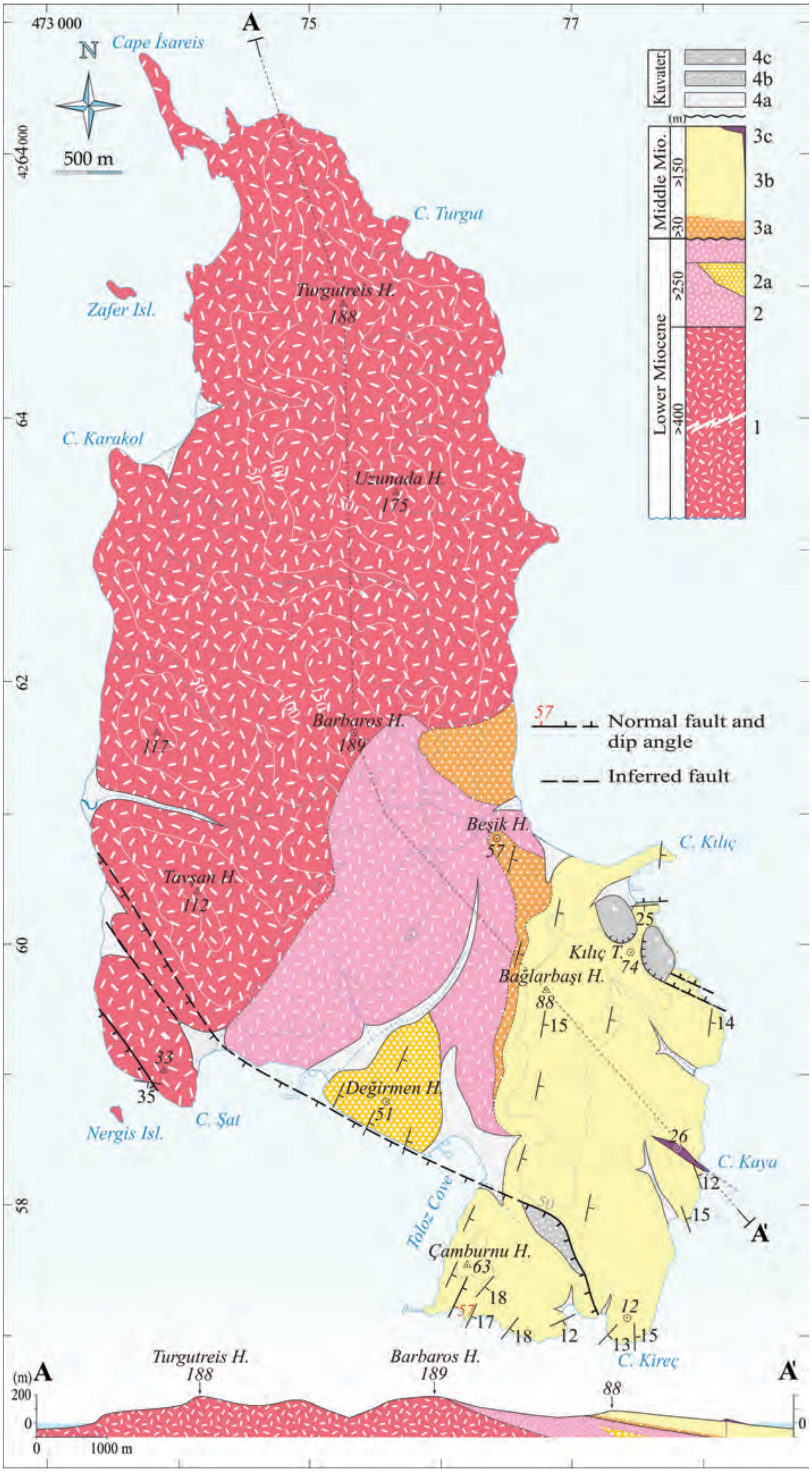

Figure 4- Geological map of Uzun Island. 1. Kocadağ volcaniclastics, 2. Foça tuff (a: Değirmentepe member), 3. Urla group (a: Beşiktepe fm., b: Urla limestone, c: Hekim Island basalt), 4. Quaternary deposits (a: Alluvium, b: Slope debris, c: Landslide debris).

Figure 5- A) Volcanic mass flow (lahar) levels. B) Planar parallel thin bedded-laminated lacustrine deposits. C) Green coloured laminated claystone level within the lacustrine succession was fluidized and subjected to a ductile deformation by flexural flow probably as a result of seismic shocks of a volcanic explosion.

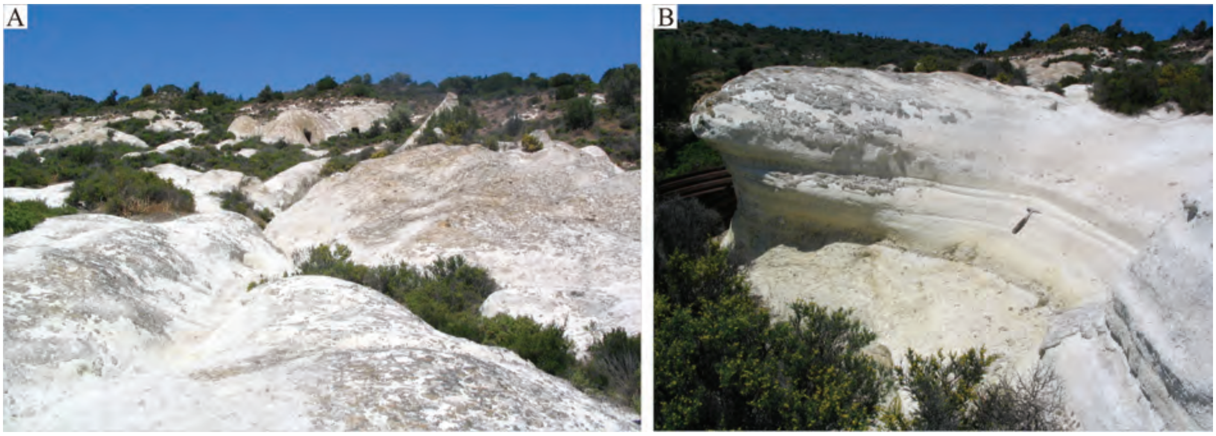

Figure 6- Foça tuff. A) General view. B) Ignimbrite units distinguished by possible base surge levels.

2.2.1. Değirmentepe Member

Volcanic pebble stone–pebbly sandstone succession present within the Foça tuffs as an interlayer has been named as Değirmentepe member (Figures 3 and 4). The thickness is maximum 150 metres.

Sedimentary succession mainly consists of blocky pebble stones with large pebbles. The beds are decimetre-meter thick, basal contacts in many places are eroded and are irregular. Pebbles are matrix supported of coarse-very coarse fragmented volcanic sand and granule matrix. In places where percentage of pebble fragments is increased, matrix material is still present in between the pebble fragments. Rock types present have been generated from the Kocadağ volcanoclastics. Rickety felsic pyroclastites derived from the Foça tuffs have mostly been ground and they are mostly seen in the matrix. They are mainly scarlet-burgundy coloured and are porphyrithic andesitic-dacitic lava pebbles and blocks and are in general semi rounded or rounded. Degree of roundness has been inherited from the original rocks. Volcanic sandstones are faded yellow coloured and are not well graded, have small pebbles, with the decimetre thick massive levels, they separate multiple bedded pebble stones or they are laterally discontinuous intercalations.

Sedimentary succession represents block flow dominated alluvium fan deposition. Levels with high pebble-block rates display disorganized texture and it is mainly related to the debris flow facieses. Massive sandstones have also been sedimented by block flow dynamics.

2.3. Urla Group

Urla group was first defined by Göktaş (2011) in the Urla basin. The group includes Miocene dominantly lake sedimentation and laterally associated alkali volcanics. In the study area The Urla group is represented by alluvial Beşiktepe formation, Pırnallı Island lake volcanoclastics, Hekim Island basalts and Urla lake limestones (Figure 3)

2.3.1. Beşiktepe Formation

The succession consisting of pebblestone-sandstone has first time been studied in detail within the formation level. Known thickness of the succession cropping out in the Uzun Island is about 50-150 metres (Figure 3, 4).

The succession is orange coloured and consists of laterally discontinuous pebblestones and mainly sandstones. Materials mainly derived from the Kocadağ volcanoclastics and Foça tuffs. Pebbles of the pebblestones are within the limits of small round-semi round pebbles and have coarse volcanic sand matrix support. In places coarse sandstones containing small pebbles and granules display cross bedding. Sandy mudstone levels are rare in the succession and are not well graded.

The unit represents sedimentation of alluvium fan deposits where plaited running water dynamics were dominantly effective. The unit defines the sedimentation of the Urla group in the Middle Miocene basin at the edge of Uzun Island.

2.3.2. Pırnallı Island Volcanoclastics

Volcanoclastic succession consisting intercalations of epiclastics of felsic pyroclastics which developed in sublacustrine conditions and fed by eruptions and sedimented by gravity flows has been studied in detail and for the first time in this study defined in the formation level. Upper sections of the succession can be seen above sea level in some of the islands; in Hekim Island and Çiçek Island, namely in İncirli Island and Pınarlı Island (Figure 7A, 7B). The thicknes of the succession is about 50m and extensive outcrops are in the Hekim Island .

Epiclastic sediment facieses form the largest portion of the succession. They have regular parallel beddings consisting sandstones with massive or graded felsic volcanic materials and with less pebble stone levels. In Pırnallı Island along the NE coast, coarse grained, normal graded metric scale thick beds are laterally followed in the order of tens of metres (Figure 8A). Matrix supported beds starting with coarse pebbles grades down to sand size through small size pebbles. Base of the beds are either planer or eroded. Main elements of the rock types are trachytic lava clasts. In the NW coast of the Pırnallı Island a 2 m thick blocky pebblestone level has same rock type clasts (Figure 8B-b, 8C-b). The base is sharp and planer. Coarse clasts consist of porphyritic trachte lavas with coarse feldsphat phenocryst show reverse grading at the base but normal grading at the top. Rreverse grading starting from the boundary of coarse sand-granule size ends at the base with 60 cm coarse blocks. Matrix supported coarse clasts are semi rounded, less with blunt corners. Matrix consists of coarse-very coarse sand and also has granule size materials. Below the pebble stone level, 2m thick part observable a suspended sediments level is present (Figure 8B-a, 8C-a). The succession with centimeter thick planer bedded siltstone-claystone alternations has most 1 cm size rim-type lapillies containing fine-medium size volcanic sandstone and 1-3 cm thick micritic limestone interbeds. The epiclastic succession outcropping in the Hekim Island from base to the top consists of sandstones with volcanic elements and also less amount claystone-siltstone intercalations (Figure 8D-b). Centimeter-desimeter thick planer beddings are typical. Beddings are laterally continuous and thickness does not vary much. Coarse-very coarse grained sandstone beds are decimetre thick, massive or normal graded. They have matrix support of reverse graded sandstones with coarse ash, rare lapilli size white pumice and trachytic lava fragments. Reverse grading developed from fine sand to coarse sand form centimetre-decimetre thick parallel undulated bedding groups (Figure 8E, F, G). In rare cases Enlarged lapillies and sandstone interlayers with charred wood pieces are observed (Figure 8H).

Each of the pyroclastic interlayers marked with trachytic ignimbrite units in the epiclastic succession are the products of one volcanic (explosion) activity (Figure 9). 2-4 m thick separate levels of welded ignimbrite facieses can be seen in the western coastal part of the Hekim Island (Figure 8D-a, 9A, B, C). At the bottom two levels of the unit, dark scarlet-brown colour representing operative thermal oxidation is typical (Figure 8D-a). Third level is yellowish light brown coloured (Figure 9B). Coarse pumices containing sanidine phenocryst are centimetre, locally decimetre thick. Pumices of first two layers are dark coloured. Apart

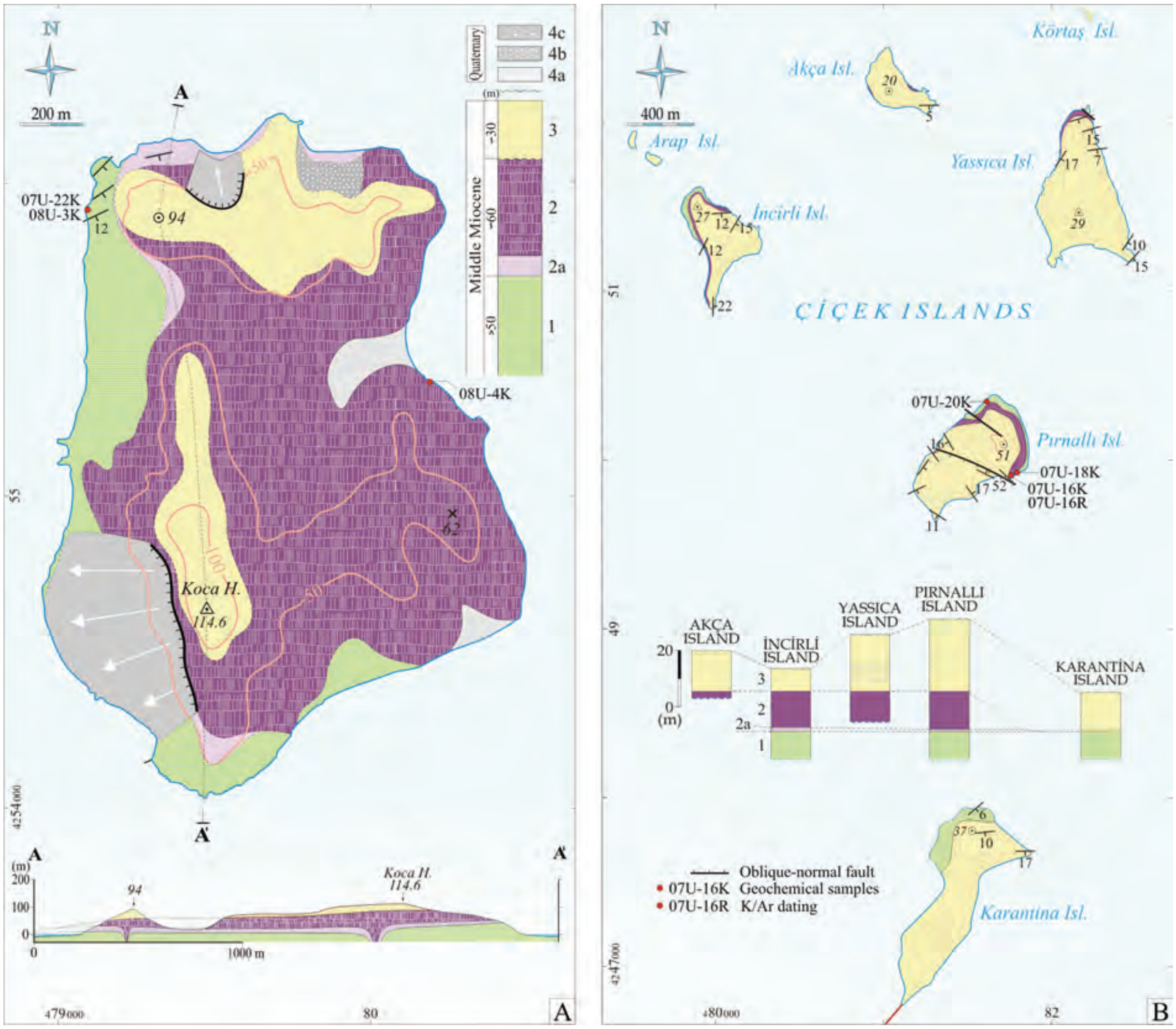

Figure 7- A) Geological map of Hekim Island. 1. Pırnallı Island volcaniclastics, 2. Hekim Island basalt (a: Base surge deposits), 3. Urla limestone, 4. Quaternary deposits (a: Alluvium, b: Slope debris, c: Landslide debris). B) Geological map of Çiçek Islands and Karantina Island. 1. Pırnallı Island volcaniclastics, 2. Hekim Island basalt (a: Base surge deposits), 3. Urla limestone.

from the second level from the bottom (Figure 10A) elongation and orientation of the elements in the pumices are not noticeable. Thin section study of the matrix of the pumices indicated elongation of the elements and less noticeably development of fiyam (?) structure. Lithic fragments are made of trachytic lava clasts. At the base, below the fourth level there are big mammal fossils remains. At this part in a zone where white pumices becomes more showing less distinct elongations (Figure 9C, D). Following the route of the ignimbrite flow planer bedded turbiditic succession developed at the bottom of the turbititic succession cross bedded volcanic sandstone facieses is present. Small pebbles and granule containing coarse grained sandstone succession is several metres thick and is discontinuous laterally (Figure 10E). In the Hekim Island, İncirli Island and Pırnallı Island unwelded trachytic ignimbrite facieses are located on the upper most part of the succession. It is maximum 8 m thick, is laterally continuous and is represented by a flow unit. Tafone (?) development on the whitish light gray coloured weathered surfaces is typical (Figure 9F). Homogenous lithics marked with centimetre size blint cornered trachyte fragments in general are either irregularly dispersed or form pebble clusters as seen in the İncirli Island. Three levels have been identified at the base of the same ignimbrite unit outcropping in the Pırnallı Island, lowest two of these levels are laterally discontinuous. I) on average 35 cm thick lowest part is marked

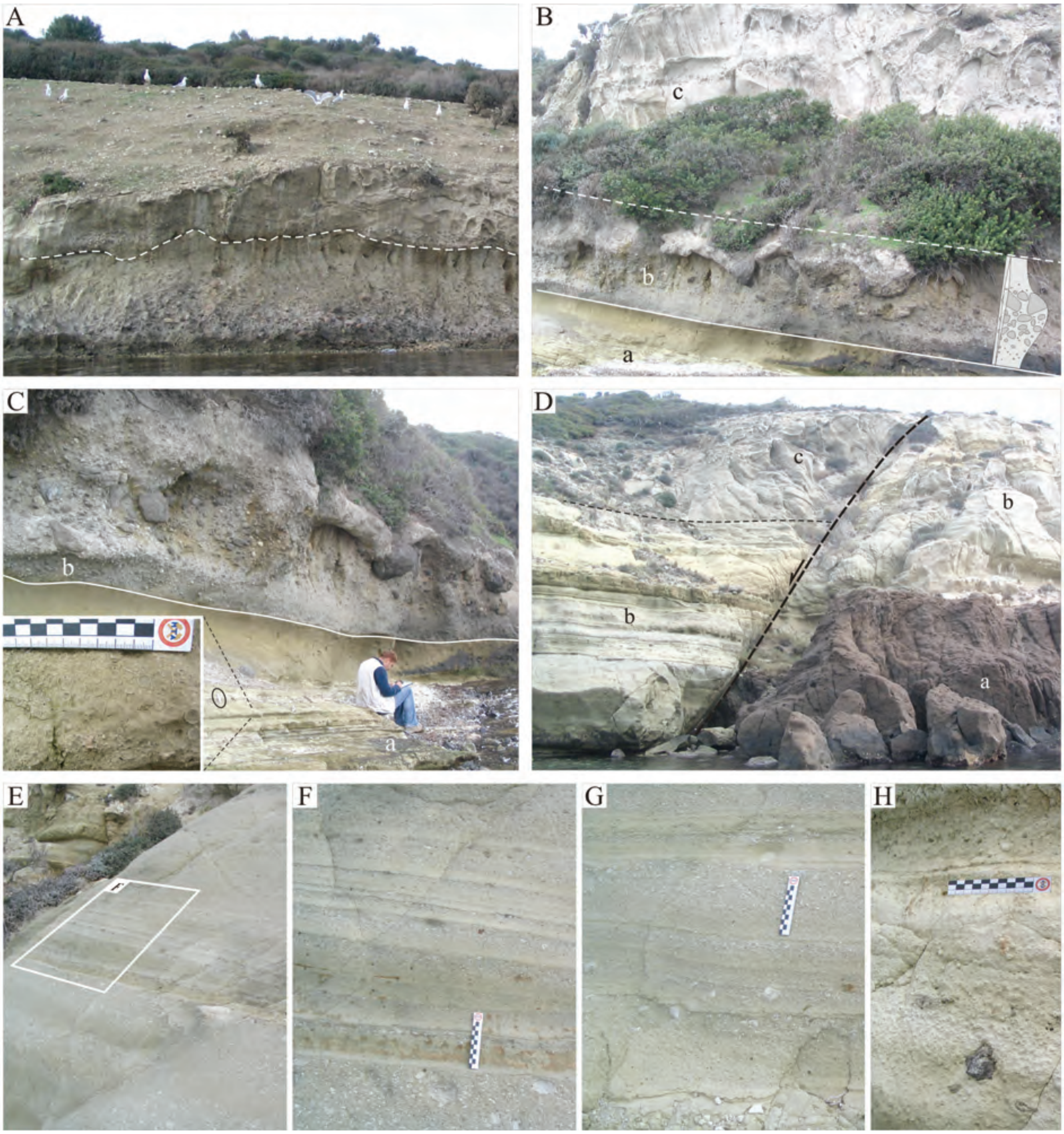

Figure 8- Some of epiclastic sedimentary facies observed within Pırnallı Island volcaniclastics. A) Proximal (?) turbidite facies with high-sediment concentration which coarse components are normally graded. Cut-and-fill deposits are observed in the lowermost part of the upper level (Pırnallı Island). B) a: Planar parallel bedded-laminated suspension deposits, b: High-density turbidite level, c: The weathering surface of unwelded ignimbrite level originated from trachytic volcanism has a tafoni form (Pırnallı Island), C) a: The suspension deposit succession is built from a planar parallel bedded-laminated claystone, siltstone and micritic limestone intercalation with turbiditic sandstone interbeds. Fine-medium grained volcanic sandstone levels comprise 'rim-type' accretionary lapillis, most of which are 1 cm in size (The scale is 10 cm in large photo), b: close-up view of the lahar level in B-b (Pırnallı Island). D) a: welded and thermally oxidized -first- ignimbrite unit in the lowermost part of Pırnallı Island volcaniclastic succession, b: The part of Pırnallı Island volcaniclastics represented by epiclastic distal turbidites, c: The lateral continuation of trachytic ignimbrite unit viewed in B-c (NW coasts of Hekim Island). E,F,G) Reverse graded volcanic sandstone beds in which white pumice fragments are particularly prominent (NW coasts of Hekim Island), H) Carbonized wood fragments within one of the turbiditic layers which indicate the hot origin of pyroclastic flow (NW coasts of Hekim Island).

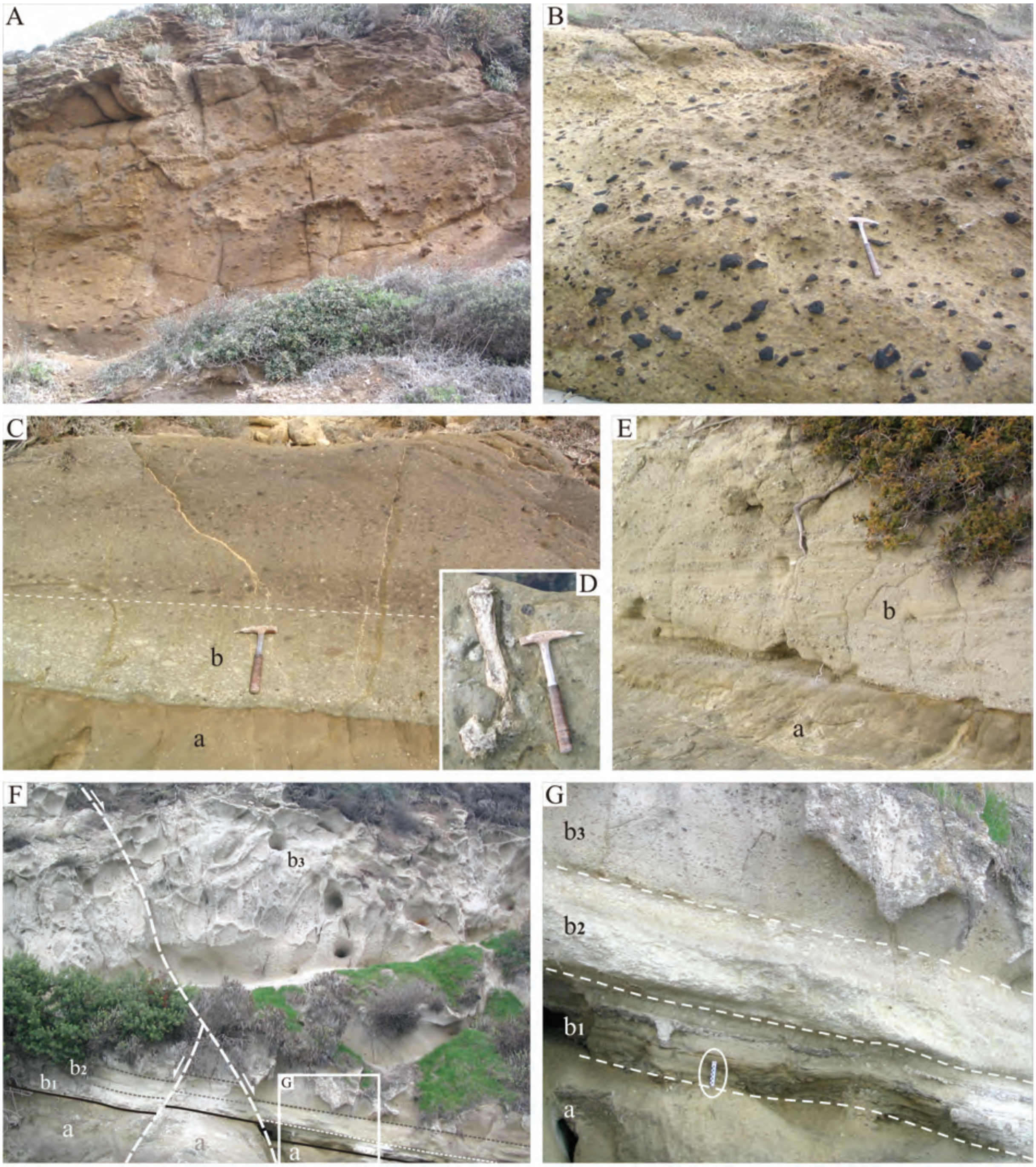

Figure 9- Ignimbrite units within the epiclastic succession of Pırnallı Island on Hekim Island. A) View of the second one from the bottom of four welded ignimbrite levels exposed on Hekim Island. Pumices are partly elongated and oriented. B) Third ignimbrite unit including black amorphous pumices (Hammer length is 33 cm). C) The fourth ignimbrite unit bearing white pumices in its lower part. a: Epiclastic turbidite level, b: The part in which partly oriented pumices increase (Reverse grading occurred at the bottom). D) Remains of a limb bone for a large mammal within the same horizon. E) Beach deposits (b) resting on fourth ignimbrite level (a). F) General view of unwelded trachytic ignimbrite level (Pırnallı Island). a: lahar level shown in figure 8B-b, b1: Bottom of flow unit, b2: Pumice lapilli level, b3: Main ignimbrite body. G) The lower part of trachytic ignimbrite level. a: Upper massive part of the lahar level, b1: The planar/wavy parallel thin bedded lower part, b2: Reverse graded pumice lapilli level, b3: Main ignimbrite body in which cognate lithic clasts are reversely graded in its lower part.

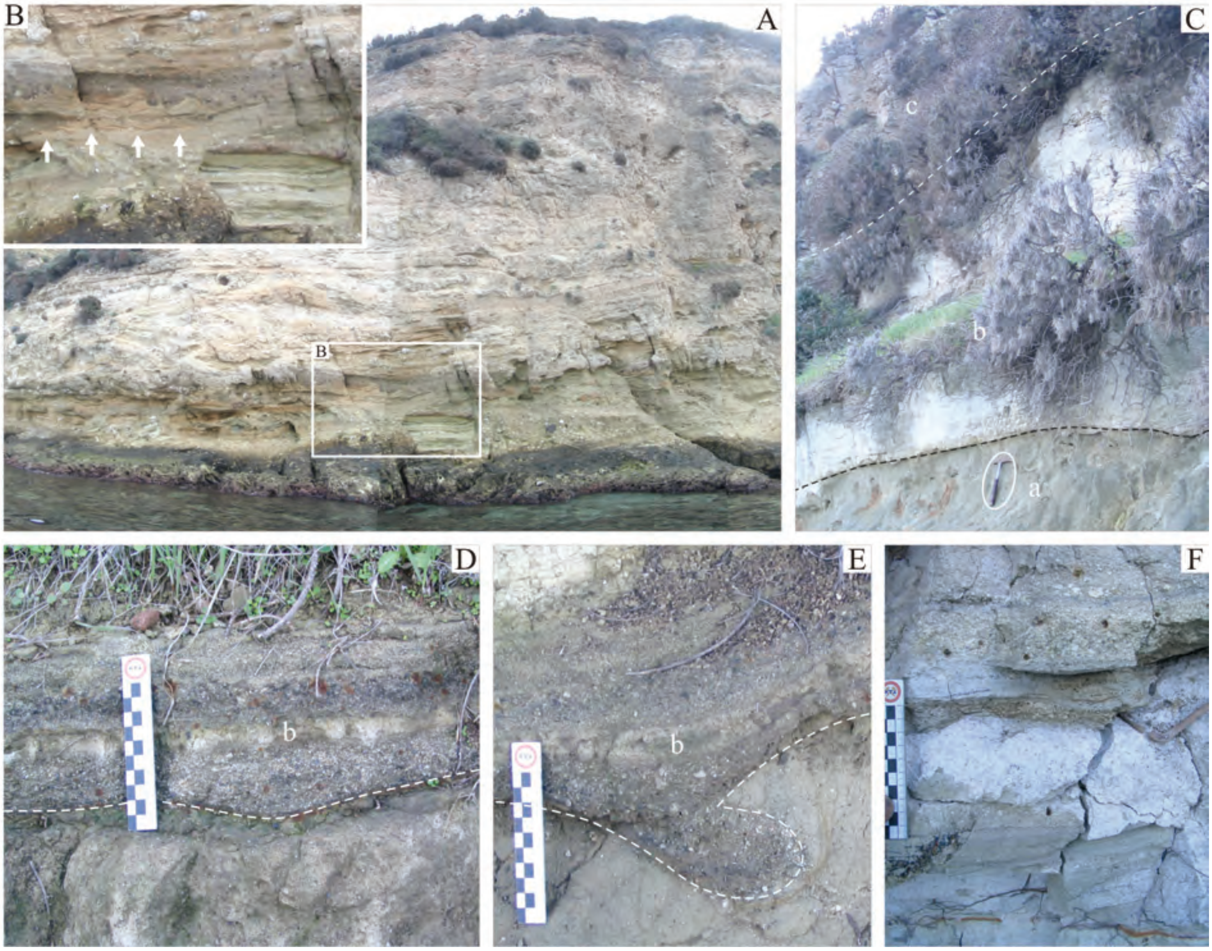

Figure 10- A) The base surge succession emplaced on a subaqueous environment in the beginning of Hekim Island basic volcanism. B) At the bottom, the base surge level changed into a debris flow because of undergoing to brittle deformation during lateral displacement. At the top, the flame structures, which reflect the moving of base surge in subaqueous environment (NW cliffs of Hekim Island). C) Basic pyroclastics emplaced on the sandy turbidites of Pırnallı Island volcaniclastic succession (İncirli Island). a: Sandy turbidite level, b: Basic pyroclastics, c: Basalt lava (Hammer length is 33 cm). D) Basic pyroclastic succession initiates with scoria fall deposits (İncirli Island). E) A load cast at the bottom of scoria fall deposit over unconsolidated turbidite level. (İncirli Island). F) Planar parallel laminated base surge deposits observed together with scoria fall beds (İncirli Island).

with vertically grain size differentiation has planer/undulated millimetre-centimetre scale beddings. In general coarse sand size volcanic elements are matrix supported and are well graded. Homogeneous granule size lava fragments are scarce (Figure 9G-b1). II) 40-60 cm thick white coloured pumice lapillies show thickness variations laterally and display reverse grading (Figure 9G-b2). III) Third part of the flow is the main part and is massive. At the lower 1 m part the homogeneous lava clasts have reverse grading (Figure 9G-b3). Locally small pebble size trachyte pebbles with blint corners form clusters and pumice lapilli accumulations are encountered.

Outside of the ignimbrite parts of the Pırnallı Island succession, lacustrine shoreface fillings of epiclastic flow sediments are dominant. From Pırnallı Island towards Hekim Island average grain size and thickness of the beds of the sediments reduce and along the same direction it shows changes from coarse trachyte clasts containing dense proximal turbidites to less dens distal turbidites. Fed by trachytic volcanisms (Menteş trachyte: Kaya, 1979; Menteş volcanics: Göktaş, 2011) in the Menteş peninsula, changes along lateral direction show the development of turbiditic processes northwards. Pırnallı Island is located nearest to the volcanic centre. In the NE shore of the island (Pırnallı Island), the unit with coarse trachytic lava clasts forming normal graded levels has been considered to be the high density paroxysmal turbidites. In the NW part of the island the pebble stone level, at the bottom is reversely and at the top normally graded and has a non erosive base is also a same type turbidite. Reversely graded bottom part is at debris flow facieses, developed with laminar flow. In the normally graded top part, materials settled from the suspension of turbulent flow (Postma et al., 1988). Both of the pebble stone litho facieses consist of coarse trachytic lava fragments. Nearest source for these coarse materials is the block flows developed at the slopes of the Menteş volcanic centre.

In the Hekim Island low density distal turbidite facieses is dominant. Reversely graded sandstone beds with volcanic materials might be the distal extension of the material changed into grain flow as a result of basal underwater turbulent flow of sediments (Figure 8E, F, G). Charred woods remains (Figure 8H) in the beds with transported enlarged lapillies indicate that flow was hot and sub aerial. A big mammal bone fossil remains found in one of the welded ignimbrite level indicate that source area of the Menteş volcanics was above lake level. Lithic extent of same origin ignimbrites have same source and are marked by porphyritic trachytes. The lateral extent of the coarse grained sandstone level sedimented on top of the fourth welded ignimbrite level is limited with the extent of the ignimbrite flow. Based on the pebble bearing sandstone succession, development of teams of large scale-low angle cross beddings, fragment supported textures and litho stratigraphic position it was concluded that it was a beach face sedimentation. With the emplacement of ignimbrites lakes became locally shallow and following local shallowings, turbiditic sedimentations continued.

2.3.3. Hekim Island Basalt

The unit has basic pyroclastics at the bottom and less distinct alkali basic lavas on the top. It was for the first time defined in this study. Volcanics generated in the Hekim Island, their outcrops in the Çiçek Islands are 10-20 m thick. Basalt dyke cutting the Urla limestone in the Kaya Burnu, Southeast shore of Uzun Island is considered to have the same origin (Figure 4).

Volcanic activity started in lacustrine environment, first products were pyroclastics, they were mainly basal turbulent and scoria air-fall facieses. Pyroclastics developed in the marine environment are very thick (>50 m) and crop out in the Northern slopes of Hekim Island (Figure 10A). Their bottom under the sea is not observable. The beds developed near to the outlet centre of the basal turbulent succession have mostly lost their original positions because of the volcanic tremors and they were subjected to gentle (soft) sedimentary deformations. Laterally displaced beds have been subjected to brittle deformation along the flow direction and were broken (Figure 10B). Some flame structures observable at the bottom of some beds are the products of advancing pyroclastic turbulent in water environment (Figure 10B). Pyroclastics outcropping in the İncirli Island are located in between sandy turbitites of Pırnallı Island pyroclastics and basalt lavas (Figure 10C). The unit is most 4 m thick and starts with beds of slag falls and mainly consists of base turbulent sediments. Black coloured slag fall levels, marking the start of the volcanic activity developed in two explosion stages and are 10 cm thick. At the bottom soft deformation features like load mould. Millimetre size lithics (with vesicles-without vesicles) of same origin forming massive and weakly compacted face are fragment (grain) supported (Figure 10D, E). At the top overlying light gray basal turbulent succession has centimetre thick planer/undulated parallel bedded-laminated. Poorly developed cross beddings are rarely encountered (Figure 10F). Slag fall interlayer's containing lapillies with millimetres scale growth are commonly encountered in the basal turbulent succession.

Blackish dark gray coloured lavas are heavily fractured and display flow foliations In the Northern part of Yassıca Island a lava block with a discontinuous spatter lava level may indicate at least two episodes of lava extraction (Figure 11A). About a10 m thick thick lava overlying the spatter level has decimetre scale flow foliations and alteration feature of exfoliations. Lavas came out from the secondary lava extraction channels in the northern part of the Hekim Island have polygonal joint patterns and entablature cooling columns commonly developed (Figure 11 B). Lava flow outcropping in the Çiçek Island has vesicles, peperites developed extensively on the surface of the in contact with water containing sediments (Figure 12).

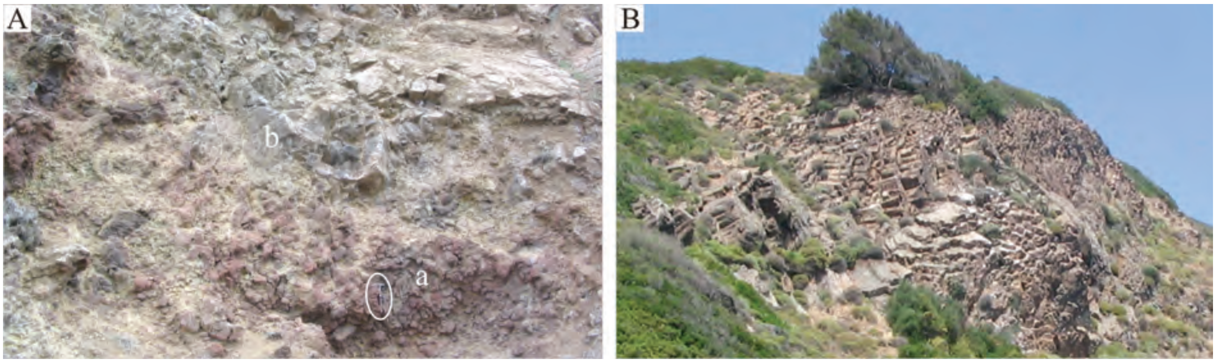

Figure 11- Hekim Island basalt. A) A Spatter level with no lateral continuity between two lava flows on Yassıca Island. a: Spatter, b: Lava. (Hammer length is 33 cm). B) Entablature cooling columns observed in the north of Hekim Island.

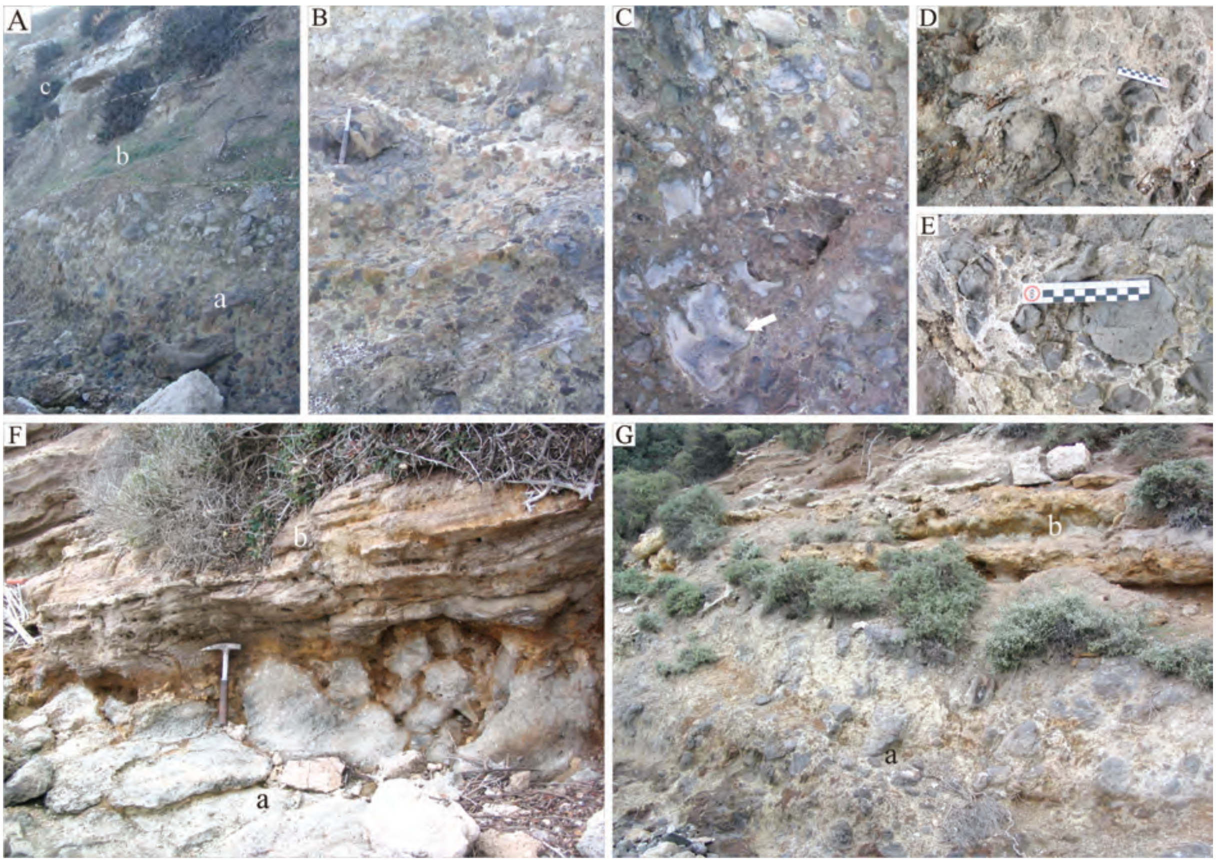

Figure 12- Peperites observed along the upper contact of Hekim Island basalt sill. A,B) Peperite zone with a thickness up to 3 meters on İncirli Island. a: Peperite zone, b: Backshore mudstones in the lowermost part of Urla limestone succession, c: Urla limestone. C) Hydrothermal alteration belts developed rapidly cooling walls of some fluid-shaping lava fragments by contact with unconsolidated sediment in the peperite zone on İncirli Island. D,E) Poorly developed jigsaw-fit texture is observed in some parts of the peperites on Pırnallı Island (Scale is 10 cm). F,G) Peperitization between the upper backshore mudstones and the lower intruding basalt sill on Yassıca Island. a: Basalt, b: Backshore mudstones (Hammer length is 33 cm).

2.3.4. Urla Limestone

Lacustrine limestones succession is the last unit of the Urla group. It was for the first time named by Kaya (1979) and has been defined at formation level. The unit crop out in the entire islands group and has thickest (>100m) succession is in the Uzun Island.

In the Çiçek Islands Urla limestones lie on top of the basalt lava. At the bottom of the limestone there is a scarlet-brown colour thinly bedded-laminated mudstone succession which is the dominant unit in this part (Figure 14A). The thickest succession (~10 m) is in Yassıca Island (Figure 13 B, C, D).

The mudstone upwards with centimetre-desimeter scale thick intercalations goes into micritic limestone or like in the Pırnallı Island overlain by limestone with a sharp contact (Figure 13 E). With maximum 70 cm, thickest limestones containing mudstone beds-laminas intercalations are in Yassıca Island. Within the mudstone succession there are 1-3 cm thick laterally discontinuous charcoal bands. The thickness of the thin bedded-laminated mudstone with charcoal bands is up to 30 cm in Yassıca Island (Figure 13 D). In general and in the parts near to the overlying limestone, along the bedding planes development of laminated-nodular $CaCO_3$ concentrations caliches could be seen (Figure 13 F).

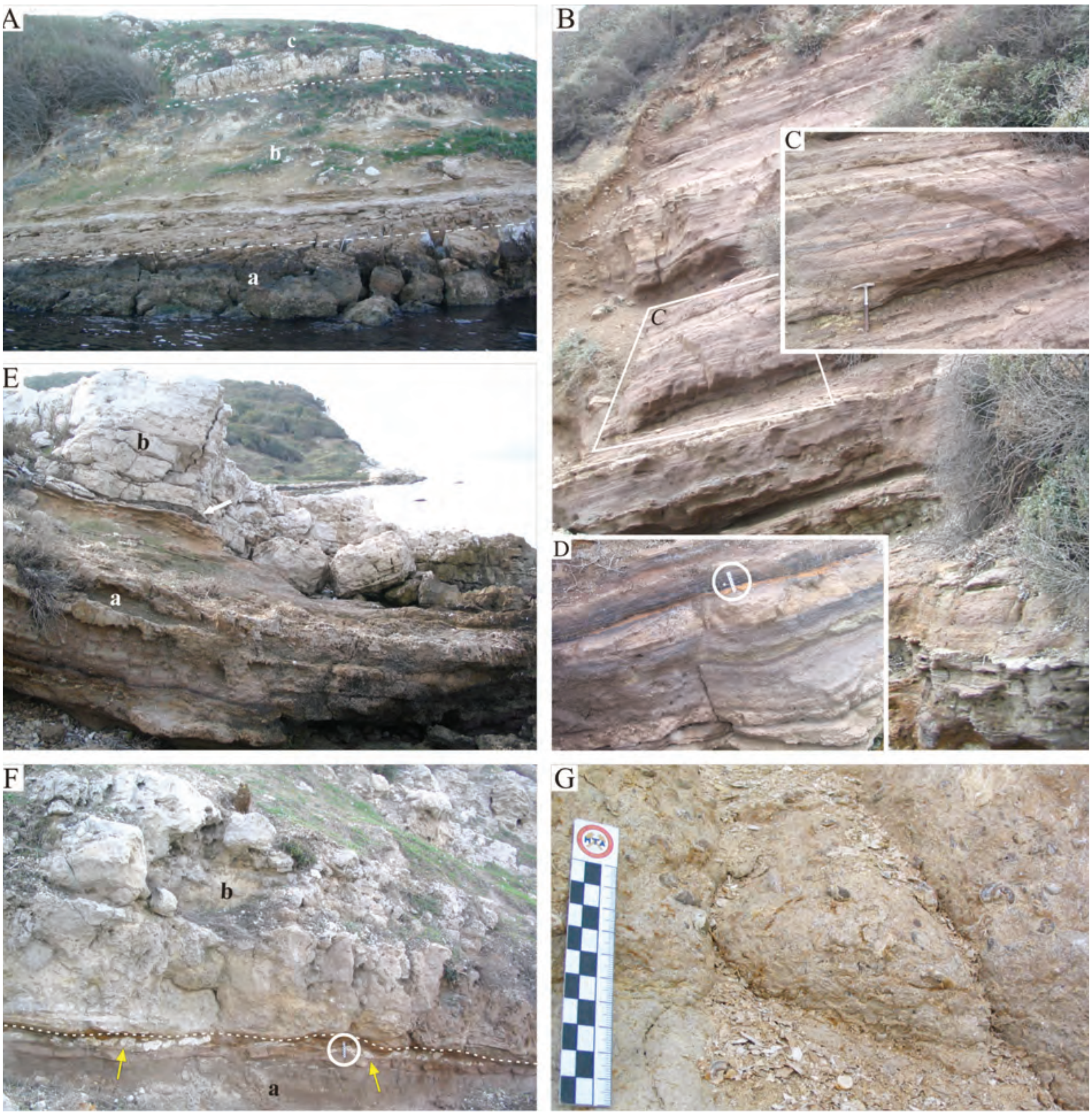

Figure 13- Mudstone-dominated backshore deposits exposed at the lowermost part of Urla limestone on Çiçek Islands. A) Basalt sill (a) overlain by backshore deposits (b) and algal limestones (c) on Akça Island. B,C) Planar parallel thin bedded-laminated mudstone succession observed on Yassıca Island. D) Detailed view from the coal seams intercalated with the mudstones bearing gastropod shell fragments in the same succession (Scale is 10 cm). E) a: Mudstones bearing gastropod shell fragments and coal laminae, b: Limestones with chert lenses (white arrow) (Pırnallı Island). F) a: Massive mudstone with caliche nodules (yellow arrows) and laminae, b: Algal limestones (Pırnallı Island) (Scale is 10 cm). G) Carbonate-rich mudstone bearing relatively well-preserved (cm sized) gastropods (Pırnallı Island).

Figure 14- Litho-facies observed in the beginning at the deposition of Urla limestone. A) Planar cross-bedded algal biosparite-biosparrudite facies with algal oncoids and bioclasts (Yassıca Island). B) The low-angle planar cross-stratified biosparite-biosparrudite facies composed of algal bioclasts (Pırnallı Island). C) Close view of grain-supported biosparite-biosparrudite facies. D) Close-up view of bioturbated limestone with algal oncoids and hemispheroidal-ovoidal stromatolites included (Pırnallı Island). E) Poorly developed medium-thick bedded and cherty (white arrow) biogenic limestone (b), overlying red-brown massive mudstone succession with a sharp contact (a) (Pırnallı Island). F) Thick bedded micritic limestone with chert nodules and fenestral voids (Pırnallı Island). G) Planar cross-bedded, grain-supported and well-sorted coarse sandstone and fine conglomerate sequence, overlying sandy turbidites of Pırnallı Island unit (a) (Akça Island). H) Wave ripple cross-laminated thin-medium sandstone in the lower part, and planar cross-stratified coarse sandstone and granulestone at the top (Karantina Island).

White coloured shell fragments of gastropod remains are seen from top to bottom in all parts of the mudstone succession but parts with more organic materials are particularly rich. In Pırnallı Island centimeter scale thicker gastropod shells appear to have relatively better protected (Figure 13 G).

Apart from Uzun Island in entire islands group mudstone succession or transgressive limestone sedimentation overlying Pırnallı Island, sandy turbitites of the volcanoclastics start with algal bioclastics with low angle planer cross beddings. I) In Yassıca Island and Pırnallı Island the allochemical composition lithofacies has been identified as Biosparrit-biosparrudit (Folk, 1962), columnar branched stromatolite fragments are the bioclasts and locally are algal nkoids (Figure 14 A, B). Less found coarse sand-granule size transported volcanoclasts in general have blunt corners. Algal oncolites (?) (onkoid) are mostly ovoid shape and their long axis rarely reach 10 cm. Main structural elements of biosparit-biosparrudit with algal oncolite lithofacies are bioclasts which are in 0.5-15 mm dimensions and are well cemented with mostly well graded, fragment supported, packed and tightly cemented with spar calcite cement (Figure 14 C). Following these levels, the Lower levels of these limestones particularly are algal-biogenic. Allochem context is marked by blue-green algal (Cyanophyta) stromatolites. Beddings differ depending upon the growth geometry of stromatolites. In places where Hemispheroidal/Ovoidal stromatolites accumulated in different bioturbation rates with massive underdeveloped thick bedded bioclastic parts in most places this kind of accumulations reflects beginning of limestone sedimentation (Figure 14 D). In Pırnallı Island limestones formed by laminated stromatolites directly overlie mudstone succession. In places where medium-thick beddings become noticeable, on the bedding planes centimetre thick laterally discontinuous chert bands and concretions with fenestras (fenestral boşluk) become noticeable (Figure 14 E, F). ii) A low angle planer cross bedded sandstone-pebblestone accumulations is present at the bottom of the Algal limestone outcropping in Akça Island . About 2 m thick clastic succession has sedimented on to the Pırnallı Island turbitites. Light gray coloured succession with coarse grained sandstone and fine pebblestones is made of volcanic fragments transported from underlying sandy turbidites. Maximum 1 cm size algal oncolites (onkolid) bearing sandstones are grain supported, well graded and is weakly compacted (Figure 14 G). In Karantina Island similar succession is also present outside the extension of Hekim Island basalts. Algal oncolite bearing bioclastic limestone sedimentation starts with planer cross beded and ripple cross laminated sandstones, developed on the Pırnallı Island turbidites. In the planer cross bedded sets consisting coarse-very coarse sand and granule size volcanic components, small pebbles and algal bioclasts are present (Figure 14 H).

At the bottom of the limestone succession shore/beach sediments are located. The mudstones forming the bottom of the limestone succession around Çiçek Island have sedimented in the back shore mud plain which developed in a limited area as a result of emplacement of Hekim Island pyroclastics on to the Pırnallı Island volcanoclastics. Paleo oxidation associated scarlet-brown colour distribution, lateral discontinuous charcoal occurrences which points out temporary swamps, pedogenic caliche occurrences, gastropod shell fragments the food remains of the small mammals, all indicate that sedimentation developed behind the shore line. Like Karantina Island outside the extension of the Hekim Island pyroclastics where back shore sedimentation did not develop well, algal limestones, with the foreshore/beach face sediments directly covered Pırnallı Island volcanoclastics. Low angle planer cross bedded sets, with well developed textures, biosparites-biosparrudites and epiclastic sandstone lithofacieses have been deposited in the fore shore/beach face environment. Allocthonuous microbial (?) (mikrobial) oncolites with spheroidal stromatolites (wrapped products) mostly reflect wave related high energy environment conditions. Overlying limestones have developed by autochthon growing stromatolites under low energy conditions.

3. Petrography

In Uzun Island rhyolitic ignimbrites of the Foça tuffs have same type lithics. General characteristics of these lithics are the same with the rhyolites of the Foça volcanics studied by Akay ve Erdoğan (2001). Rock samples with aphyric, porphyritic textures mainly have phenocrysts of quartz and K-feldspath in glassy matrix.

In the Pırnallı Island volcanoclatics succession, lava clasts in coarse grained turbidites have porphyritic texture and phenocrysts are plagioclase, biotite and sanidine. In the hand specimens' sanidins with Carlsbad twinings and zoned plagioclases are larger than 2 cm.

Lavas of the Hekim Island with porphyritic texture mainly have olivine, pyroxene and plagioclase phenocrysts. Black coloured filotaksitik (?) (phyllotaxy?) matrix, consist of plagioclase microlites, olivine and pyroxene microcrystals. Ksenoquartz phenocrysts, are encircled by clinopyroxene microlits-microcrystals representing magma mixing.

4. Main Elements Oxide Geochemistry

Samples Fo-3, O8U-03 and O4 have been analysed in the ACME Analytical Laboratories LTd in Vancouver, Canada. The samples were first subjected to fusion with Lithium metaborate/tetraborate then dissolved in nitric acid. Following these the samples were analysed by using ICP-emission spectrometer. Samples 07U-16, 18, 20, 22 have been analysed in the 'Mineral Analyses and Technology Department' laboratories of MTA. Samples were (crushed) powdered down to below 75 µ, then dried at 105ºC. 3 gr powdered sample from each specimen have been taken and mixed with 0.9 gr cellulose binder and mixed and powdered again to achieve homogeneous mixing, then samples were pressed under 40 ton pressure. Following all these processes the samples were analysed by using Panalytical, Axios XRF instrument and results have been evaluated with IQ-program.

Coordinated and analyses are given in table 1. After subtracting the H_2O values from the analyses, main elements oxide values of the samples have been normalized to 100% and Le Bas et al., (1986) total alkali (Na_2O-K_2O) and silica (SiO_2) have been plotted on to the diagram (Figure 15 A, B).

Table 1- Major element oxide compositions of volcanic rock samples.

Sample	Coordinate	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	SrO	BaO	LOI
Fo-3	*79.845E-80.340N*	79.14	12.15	0.34	0.04	0.22	1.91	4.22	0.08	0.03	<0.01	--	--	1.9
07U-18K	*81.790E-49.940N*	66.7	17.7	1.6	0.4	1.7	5.9	4.4	0.4	0.2	<0.1	0.03	<0.01	0.55
07U-20K	*81.600E-50.350N*	63.5	16.7	3.1	0.6	2.2	5.2	4.7	0.4	0.2	0.1	0.03	<0.01	1.95
07U-22K	*79.100E-56.225N*	53.3	16.2	4.6	1.7	1.1	5.0	5.5	0.2	0.1	0.2	<0.01	<0.01	8.25
08U-03K	*79.115E-56.210N*	60.13	17.72	2.71	0.36	1.86	5.08	6.76	0.22	0.08	0.07		--	4.90
07U-16K	*81.775E-49.915N*	48.40	17.20	10.10	4.40	9.20	3.80	1.70	1.60	0.50	0.20	<0.01	<0.01	2.70
08U-04K	*80.210E-55.673N*	48.47	16.84	9.84	3.58	8.30	3.76	2.40	1.59	0.44	0.16	--	--	4.30

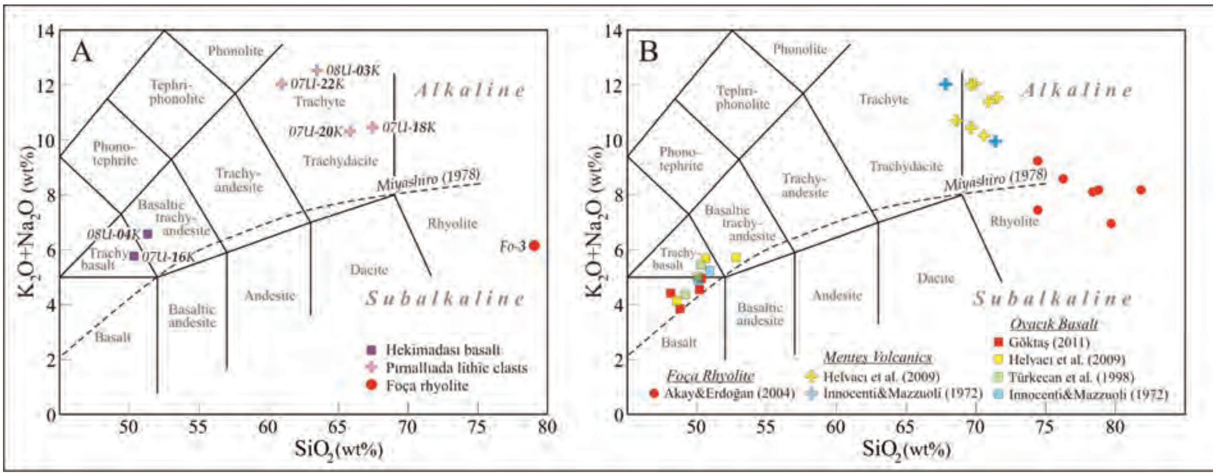

Figure 15- According to the major element oxide content of volcanic rock samples total alkali-silica (TAS) classification diyagram suggested by Le Bas et al. (1986). A) This study. B) Previous studies (Innocenti and Mazzuoli, 1972; Türkecan et al., 1998; Helvacı et al., 2009; Göktaş, 2011).

Results of main oxide analyses of volcanic lithics of epiclastic and pyroclastics of Pırnallı Island volcanoclastics have been classified in the TAS diagram. Coarse lava components of the Pırnallı Island volcanoclatics (Figure 15 A: 07U-18K and 20K) and black coloured pumices of welded ignimbrite (Figure 15A: 07U-22K and 08U-03K) are in the trachyte field (Figure 15A). Menteş volcanic centre is considered to be the main source of the volcanoclastics. Lava samples collected from the Menteş Volcanic center by Mazzuoli (1972) and by Helvacı et al. (2009) have been evaluated together in figure 15B and genetic connection between the acidic products of volcanisms have been studied.

Results of main oxide element analyses of the two lava specimens collected from the Hekim Island basalts in this study together with the Ovacık basalt specimens collected from the Urla depression in the early work have been evaluated in the TAS diagrams. Hekim Island basalts plot (07U-16K and 08U-04K) in the 'trachybasalt', 'basaltic trachandezit' fields, on the other hand Ovacık basalts plot in the 'basalt', 'trachybasalt', 'basaltic trachyandezit' fields and they are shown to be the products of the same volcanisms (Figure 15A, B).

5. K/Ar Geochronology

Radiometric K/Ar analysis of the Foça rhyolite has been carried out in the ACME Analytical Laboratories LTd in Vancouver, Canada. K concentration has been analysed by ICP, Argon analysis has been conducted by isotope dilution procedure on to the noble gases mass spectrometer.

Foça tuff is an important reference base as it is forming the base of the Urla group succession accumulated in the Foça depression province in general. Because of this age determination of the calc alkaline acidic volcanism considered to be essential, so during the field work in 2008 specimens were collected for K/Ar analysis from a rhyolite dome claimed to be laterally connected with the ignimbrites by Akay and Erdoğan (2001). K/Ar analysis indicated 16.0 ±0.6 Ma age (Table 2). Specimens collected from similar lava domes in the area also gave 16.6 Ma and 16.1 Ma (Altunkaynak et al., 2010). Age data shows that in the Foça Peninsula pyroclastics of the same kind and laterally connected rhyolite domes were emplaced 16.6-16.0 Ma ago.

In Pırnallı Island a specimen (07U-16R) was collected from the extension of Hekim Island basalts. Location of the specimen is given in Figure 7B and K/Ar analysis is given in Table 2. Hekim Island basalt gave 14.8±0.8 Ma. whole rock age and 14.5±0.5 Ma. Age reported by Göktaş (2011) for the Ovacık basalts could chrono-stratigraphicaly be correlated.

6. Time-Rockstratigraphy Connections and Regional Correlation

Kocadağ volcanoclastics have been defined in the scope of Kocadağ volcanics are the oldest unit in the defined Neogene stratigraphy in the islands group. Correlated sediments around the study area mostly crop out in the Kocadağ volcanic complex and also locally in the NW of Menteş Peninsula (Figure 1B). Succesion's bottom is not observable in Uzun Island, it is overlain with a sharp contact by ignimbrites of the Foça tuff. Felsic pyroclastic intercalations within the succession could be the early stage explosion products of the rhyolitic fiorite magmatism which produced The Foça Tuff. In the Kocadağ volcanic complex volcanoclastic sediment group has been cut by andesite-dacite lavas of 16.6-17.3 Ma (Borsi et al., 1972, 17.5 Ma (Helvacı et al., 2009) and 16.7 Ma (Karacık et al., 2015) age. Geochronological data indicate that in a general sense Kocadağ volcanoclastics are Early Miocene age.

Rhyolitic ignimbrites overlying the Kocadağ volcanoclastics in Uzun Island are the extension of the Foça tuffs defined in the Foça Peninsula. In the Foça volcanic centre the age of the rhyolites laterally related with the ignimbrites is 16.6-16.0 Ma. (Altunkaynak et al., 2010 and this study). Data may show that

Table 2- K/Ar analysis of volcanic rock samples.

Sample	Materyal	K (%)	$^{40}Ar_{rad}$	$^{40}Ar_{rad}$ (%)	Age (Ma)
Fo-3	K-spar	2.27	1.392 (nl/g)	87.5	16.0±0.6
07U-16R	whole rock	1.382	7.985×10^{-7} (ccSTP/gr)	31.5	14.8±0.8

ignimbrites, constituting Foça tuffs, emplaced in the Uzun Island area in Early Miocene. Foça tuffs in North of Çandarlı were first identified as dacitic tuffs by Öngür (1972). Demirtaş felsic pyroclastics defined by Ejima et al. (1987) and Aliağa pyroclastics around Menemen-Aliağa area Eşder et al. (1994) are also the equivalence of Foça tuffs. Akay (2000) and Akay ve Erdoğan (2001, 2004) studied rhyolitic pyroclastics in the Foça Peninsula within the scope of the Foça volcanics.

Değirmentepe member within the Foça tuff is the equivalent of 'Mordoğan lower unit' which was first defined as to be the same stratigraphic position in the southern part of Mordoğan by Kaya Kaya (1979). In the distribution area alluvial succession which separates the Foça tuffs into upper and lover parts represents the calm period of the fiorite magmatism which produced the rhyolitic ignimbrites and shows that ignimbrite flows emplaced to the area mainly in two explosion stages.

Urla groups sedimentation starts with an unconformity on the Foça tuffs outcropping in the Uzun Island. Göktaş (2014 *a,b*) defined the Hisarcık Formation. "Hisarcık Formation"is in the eastern side of the Karaburun peninsula which forms the western side of the Foça depression. Hisarcık formation is considered to be the stratigraphic equivalent of the Urla group.

Within the Urla group, alluvial Beşiktepe formation reflects beginning of Middle Miocene sedimentation. Foça tuffs form the base of the Middle Miocene basin in the Uzun Island and Beşiktepe formation sedimented on to the Foça tuffs with an unconformity. Urla limestone outcropping in Uzun Island with vertical and lateral transitions overlies Beşiktepe formation. Although relationships with the Pırnallı Island volcanoclastics can not be observed but it is considered that Beşiktepe forrmation lies at the bottom (Figure 3). Time-rock stratigraphy correlations of the alluvial succession have been completed in the western side of the Foça depression and in Urla part. Hacıhüseyintepe member has been defined and around Karaburun town center (Göktaş, 2014*a,b*) and Alibey member (Göktaş 2011) in the west of Gülbahçe are known examples.

Bottom contact of the Pırnallı Island volcanoclastic succession reflects lacustrine shore face sedimentation but at present as it is under the sea it can not be observed. In the synthesized stratigraphy, it transitionally overlies Beşiktepe alluvial sediments amd in Uzun Island direction, it was assumed that it missed the Urla limestone with lateral interfingering (Figure 3). Beyond Uzun Island, in the islands group the unit is overlain by pyroclastics of the Hekim Island basalts. Karantina Island is outside the extension of the Hekim Island volcanics. In the Karantina Island through sand face sediments it is overlain by the Urla limestone. Relative geological age of the unit sedimented before Hekim Island volcanisms (14.8 Ma) is Middle Miocene. In the Foca depression province correlation of the successions has been made defining Early Middle Miocen lacustrine shoreface sediments. Karaburun formation (Kaya, 1979) which has been defined in the Urla part and the fine fractions of the 'Güvenlik Member' (Göktaş, 2011) are in the same stratigraphic position with the Pırnallı Island volcanoclastics. In the Foça part, possible equivalence of the fine grained lacustrine sediments are in the southern part of Maltepe (Dönmez et al., 1998). Lacustrine 'Karabağlar Member' (Göktaş 2014*b*) defined in the western edge of the Foça depression is the stratigraphic equivalence of the unit (Figure 2). Upper contacts of the Hekim Island basalts are observed outside Uzun Island and Karantina Island in the island group. Bottom contacts crop out in Hekim Island, İncirli Island and Pırnallı Island. Pyroclastics defining beginning of explosive stage of the volcanic activity sedimented on to the sedimenting turbidites of the Pırnallı Island volcanoclastics (Figure 16A). In the effusive stage lavas flowing on the its own pyroclastics, as it is recognizable in the Pırnallı Island and part of İncirli Island developed a weak heat effected cooked zone. Turning south lava flow developed sills within the same origin pyroclastics as well as within the back shore mudstones settling on the pyroclastics (Figure 16B). Lavas getting in contact with watery sediments caused excessive vasiculation and peperite development, typically seen in the İncirli Island, Pırnallı Island and Yassıca Island. Hekim Island basalts outcropping in the islands group in the central part of the Foça depression could be correlated with the previously defined alkali mafic volcanics in Urla, Foça parts. In Urla and Foça parts Ovacık Basalts (14.5 Ma; Göktaş, 2011) described by Kaya (1979), Ilıpınar basalts (14.3 Ma; Ercan et al., 1997) and within the alkali volcanics context Akay ve Erdoğan (2004) described basic lava series in Foça Considering their time-rock stratigraphic position and volcanogenic character they could be correlated with the Hekim Island basalts.

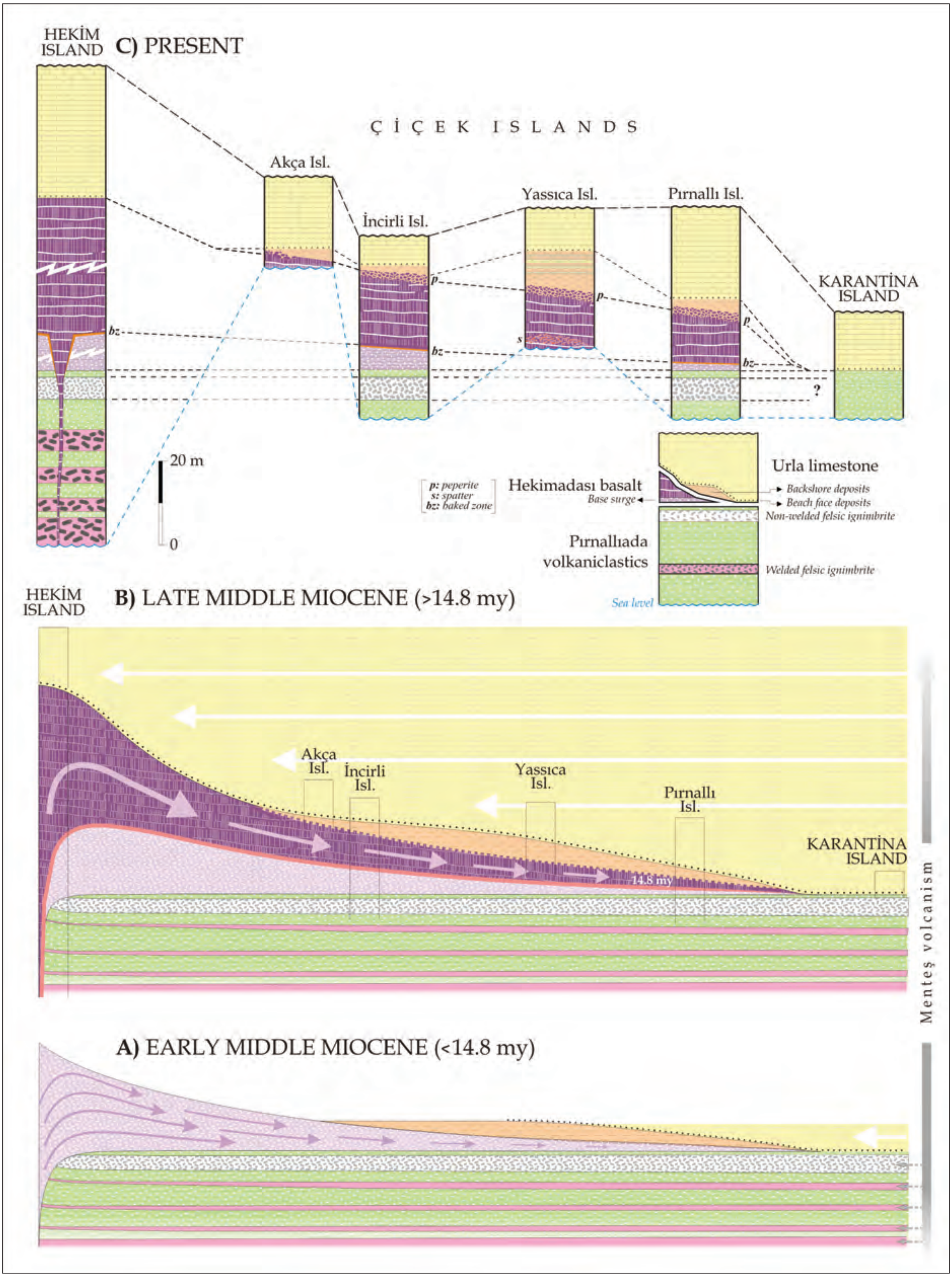

Figure 16- The palinspastic evolution of Middle Miocene sedimentation and volcanism represented by the Urla group.

Urla limestone outcropping in Uzun Island with lateral-vertical transitions they overlay Alluvial sediments of the Beşiktepe formation (Figure 3). On the other hand in the Çiçek Islands they mostly sedimented following back shore mudstones (Figure 16 B). The lava-water reaction developed between Hekim Island basalts and mudstone succession. Sill intrusion took place 14.8 Ma ago, this shows that sill intrusion is at the same age with the sedimentation. Following intrusion of the sill transgression of the Urla limestone continued and Hekim Island basalt were covered in all of their extension areas (Figure 16 B). Like in the shore lane area between Menteş Peninsula and Karantina Island outside the extension area of the basic volcanics, Urla limestone overlay the Pırnallı Island volcanoclastics through shore face sediments. In the study Urla limestones top contact is marked with Quaternary erosion.

"Değirmentepe" limestone defined in the NE part of Karaburun Peninsula (Göktaş, 2014), 'Urla limestone' (Kaya, 1979; Göktaş, 2011) in Urla and 'Aliağa limestone' (Kaya, 1979, 1981; Akay and Erdoğan, 2004) in Foça Peninsula and 'Çamdağ limestone' (Eşder et al., 1994) are the defined equivalents of Urla limestones in the Foça Depression.

7. Conclusions

In this work Early Miocene volcanoclastics and Middle Miocene sediments and alkali volcanics outcropping in the outer bay islands group in İzmir have been studied. In the study area Late Early Miocene calc alkaline volcanisms have been represented by Kocadağ volcanoclastics and Foça tuffs. Dominant Middle Miocene lacustrine sediments and laterally connected alkali volcanics have been defined within the Urla group context.

Kocadağ volcanic complex produced mainly andesitic volcanoclastics and less dacitic pyroclastics and epiclastics constituting the Kocadağ volcanoclastics. They were generated from the N-NE slopes of the Kocadağ volcanic complex centre which was capable of producing these kinds of products and were emplaced in the area.

It was concluded that weakly welded ignimbrites overlaying the Kocadağ volcanoclastics with sharp contacts are the extension of the tuffs in the area, as defined Foça tuff in the Foça Peninsula .

In Foça Peninsula Akay (2000) described the lateral connection of the ignimbrites with an underwater rhyolite dome. In this study age determination of this underwater rhyolite dome has been carried out. The age is 16.0 Ma. According to this age it was suggested that ignimbrites of the Foça tuff emplaced to the area during towards the end of Early Miocene.

Alluvial Değirmentepe member is mainly consists of coarse materiels derived from the Kocadağ volcanoclastics. It has been described as a discontinuous interface within the Foça tuff. Alluvium fan succession sedimented in the calm period of rhyolitic fiorite magmatism (?) shows that rhyolitic ignimbrites emplaced to the area mainly in two explosive period.

Sedimentation of the Urla group started with the alluvial Beşiktepe formation which was defined in the in the Uzun Island. Alluvian fan succession representing Middle Miocene basin edge sedimentation overlies Foça tuff with an unconformity and itself with vertical, lateral transitions is overlain by Urla limestones.

Pırnallı Island volcanoclastic succession is mainly consists of volcanic turbidites and is sedimented in lacustrine environment has weakly welded trachytic ignimbrite interfaces. Chemical and petrographic studies show that pyroclastic and epiclastic sediments consist of materials from trachytic origin. Pyroclastic and epiclastic sediments were generated from the volcanic centres in the Menteş Peninsula which produced alkali felsic prodcucts during Middle Miocene.

Extrusion centre of the Hekim Island basalts is in the Hekim Island, Hekim Island basalts have been distinguished for the first time in this study and volcanic facieses have been defined. Lavas main oxide elements compositions have been correlated and evaluated with the previous data of the basalts prior to the Ovacık basalts in the Urla Depression; the data show distribution in the basalt-trachybasalt-basaltic trachyandesit composition area. This distribution shows that these weakly alkali lavas all have same magmatic origin. In the lacustrine environment while Pırnallı Island volcanclastics were sedimenting at the early stage of the explosive volcanic activity produced pyroclastics.

Pyroclastics lying on the sandy turbidites of the Pırnallı Island volcanoclastics consist of basal turbulent sediments with some slag fall intercalations. Following the emplacement of pyroclastics, part of the lava flows coming out from Hekim Island take a south turn and intrudes into the bottom of the back shore mud of the lake where Urla limestones were sedimenting, forming sills there. Along the contact peperites development indicate lava-water interaction and 14.8 Ma K/Ar age determination shows that intrusion was about the same age with the Early Middle Miocene sedimentation. Hekim Island basalt in Foça depression in general is included within the small volume lava of extrusions of the Early Middle Miocene alkali basic series.

In Çiçek Islands and Karantina Island back shore and shore face/sandy sediments outcropping at the bottom of the Urla limestone indicate that shore/sand sedimentations have developed. In the Karantina Island turbidites of the Pırnallı Island volcanoclastics have been overlain by the limestone transgression through sand face sediments. Around the Çiçek Islands the limestone transgression covered back shore sediments and the outlet of the Hekim Island basalts and continued advancing towards, the end it totally covered the Foça Depression region. Sand facieses marked with Algal biosparit-biosparrudite or epiclastic coarse grained sandstone marking sand face facieses consist of detritus material with high textural maturity(?), have low angle planer cross beddings and have various amounts of algal oncolits (hemispheroidal-ovoid stromatolites). Particularly lower part of the limestone succession, sedimented on the sand facieses is biogenic and kinds of beddings show variations depending upon the growing type of the stromatolites. In the high energy parts of the lake, sedimented bioclastic limestones have less distinct beddings on the other hand micritic limestones developed by laminated stromatolites have middle-thick beds with ellipsoidal cherts and fenestrate voids.

8. Discussion

A connection has been drawn between rhyolitic pyroclasdtics present as interface in the Kocadağ volcanoclastics, under Foça tuffs and the plinian eruptions prior to the caldera sinking(?) which produced Foça tuffs, lateral connection has been proposed between early stage of rhyolitic Foça volcanism and Kocadağ volcanism. In Foça Peninsula a similar lithostratigraphic correlation has been shown between Foça tuffs and andesites of the Yunt Mountain volcanics (Akyürek and Soysal, 1983) by Akay and Erdoğan (2004). Geochronology and lithostratigraphy data indicates that during Late, Early Miocene while Kocadağ volcanism continued developing along with it, rhyolitic fiorite (freat) magmatism producing Foça tuff became active.

The Foça tuff extends mainly in the Foça Peninsula. It is made of the materials from the product of fiorite (freto?) magmatizm which was active in the Late Early Miocene lake where Zetindağı group (Kaya et al., 2007) was sedimenting. In the area between Foça Peninsula and Yunt Mountain, ignimbrite lava flows generated from a possible underwater caldera development flowing westwards, past over the Kocadağ volcanoclastics and around Uzun Island leaned at the west side of the Foça Depression (East side of the Karaburun Peninsula).

Reflecting Middle Miocene basin development (Kaya, 1979, 1981; Göktaş, 2011, 2014*a,b*) in the Urla region defined Urla group sedimentation in the west side of Foça Depression, and in the islands group in İzmir bay, it starts with sediments of the alluvium fan deposits. Lacustrine part of the Urla group is likely to be correlated with the Aliağa limestone; previous work carried out in the depression's Foça region (Figure 1A) did not mention presence of alluvial sediments at the bottom of the Aliağa limestone, reflecting an unconformity. According to the stratigraphic observations Aliağa limestone lies concordantly and transitionally on the Foça tuff (Kaya, 1979, 1881; Eşder et al., 1994; Akay and Erdoğan, 2004). All these data may indicate that while Foça Depression was extending W-SW direction and forming the Urla basin at the beginning of Middle Miocene, in the Foça region, in the remaining Late Early Miocene basin lacustrine sedimentation continued following the emplacement of the Foça tuff.

The Urla group lies with an unconformity on the Foça tuffs, according to the geochronological data of the Foça tuff; lowest age boundary of the Urla group is considered to be the beginning of Middle Miocene. Intrusion of Hekim Island basalt into the lower part of the Urla limestone 14.8 Ma ago, supports this suggestion. In the Foça depression in general, although there has not been any reliable data on the upper age limit of the Urla group, in the Urla basin, based on the 11.3 Ma. age of the Ovacık basalt (Borsi et al., 1972) intruding the Urla limestone it may be suggested that sedimentation process continued until the end of Middle Miocene.

Late Miocene unconformity is not observable in the study area but göktaş (2014 *a,b*) described it in the west side of the Foça depression. It was suggested that prior to the Late Miocene extension which effected Western Turkey, the Urla group sedimentation ended with short lasting compression phase (Yılmaz, 2000; Yılmaz et al., 2000).

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