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FIELDTRIP TO KIZILCAHAMAM-ÇAMLIDERE GEOPARK PROJECT GUIDEBOOK

Nizamettin Kazancı and Yaşar Suludere

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Birleşmiş Milletler Eğitim, Bilim ve Kültür Kurumu : UNESCO Türkiye Millî Komisyonu

Katkılarıyla...

With contribution of...

Welcome

to

The Kızılcahamam-Çamlıdere Geopark Project

The first geoconservation and geoheritage project of Turkey is in Ankara, about 70 km northwest of the city centre. It covers ca. 23 designed and some non-designed geosites ca in 2000 km^2 (Figs. 1, 2). The main théme of the geopark is volcanism, palaeogeography and erosive landforms. The vegetation of the area changing from semi-aride climate in central Anatolia to wet Black Sea region is so typical that it is the reason of the existed Soğuksu National Park.

The logo above of which was selected within from 48 candidates of a competition in 2011 symbolized columnar basalts, thermal and mineral waters, fish and leave fossils and green andcapes of the region.

Central Anatolia and thus the geopark area have been already of interest since ancient times, when it was the land of Hitites, Phrygians, and Galatians. Particularly, Galatians lived here, just on the geopark area (Fig. 1). The towns Kızılcahamam and Çamlıdere and/or the whole geopark area are placed geographically on a transition zone between semi-arid central Anatolian plateau and mountainous and wet northern Anatolia; therefore, plant cover and morphology change from bushes to pine forest and from large plains to deep valleys-high summits with altitudes of 2100 m respectively. In addition, Erosional landforms are apparent dependent on lithological differences of the volcanic rocks. So, the area has become popular recently for picnicking, trekking, cycling and hunting. The geopark project and its geosites have been introduced previously in some scientific and popular documents (Kazancı et al. 2007; 2010; Kazancı, 2010, 2012). The information here is summarized from the literature existed.

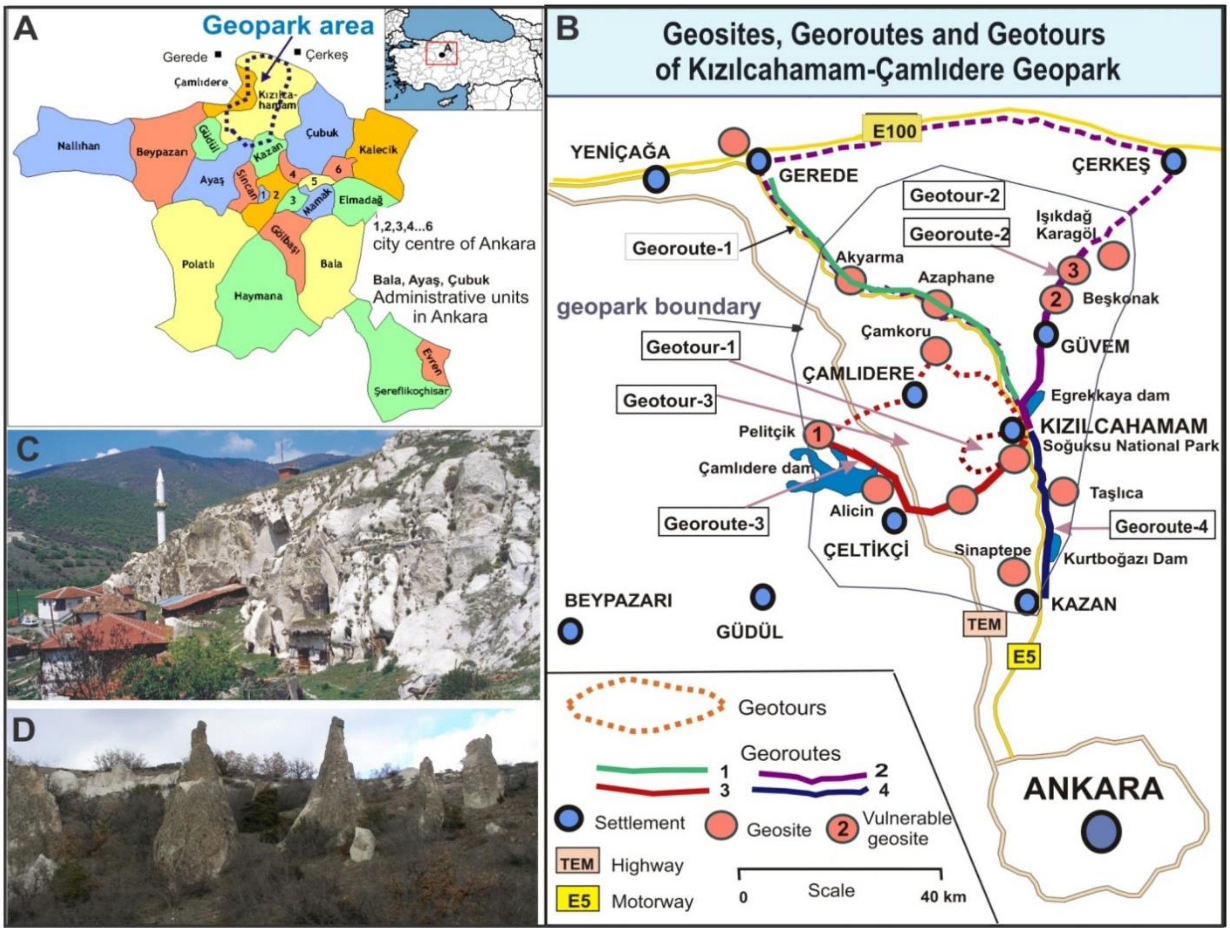

Figure 1. Location and geotours map of the geopark initiative. A municipalities, B General info about geosites and geotours, C, D two examples of geosites to be visited (modified from Kazancı et al., 2012).

Turkish geoconservationists are happy now as the Kızılcahamam-Çamlıdere Geopark was registered by the Turkish Patent Institute as name and content in October of 2011, in addition to registration of eight geosites as “natural monument” by the General Directorate for Nature Conservation and National Parks of Turkey, in 2011. The Ankara Governorship, the largest local authority of the region has been already one of the partners and the leaders of the geopark project since the initiation. By these registrations and leaderships it is possible to say that the first geopark of Turkey was realized officially, even though it has neither an international status nor a geopark has been cited within national legislation (Kazancı et al. 2012). In fact, it is a formal management plan for the determined area covering two moderate-size towns (Kızılcahamam and Çamlıdere), a municipality (Çeltikçi) and 55 villages with over 40 000 inhabitants at ca. 2000 km square (Figs. 2, 4). Ankara, the capital and also the second largest city of Turkey with five millions of inhabitants increases geotourism potential of this project. A coordination office with four staff at town Kızılcahamam and an executive committee formed by the representatives of the project partners are working for the targets of the geopark. Presently, they have been preparing the relevant documents for membership applications to the international networks (i.e. GGN and EGN).

The area and Kızılcahamam Volcanics

Geological evolution of Turkey and the Middle East can be divided broadly in palaeotectonic and neotectonic periods by termination of Alp-Himalayan orogenesis. Morphology of Anatolia and surrounding areas commenced to initiate in Late Oligocene-Early Miocene and later it progressed during the neotectonic period (Şengör and Yılmaz 1981). Thus, it is possible to say that neotectonic period in Turkey covers whole Neogene and Quaternary. Volcanism is one of main characteristics of the neotectonic period and the Kızılcahamam volcanics are good example of that evolution.

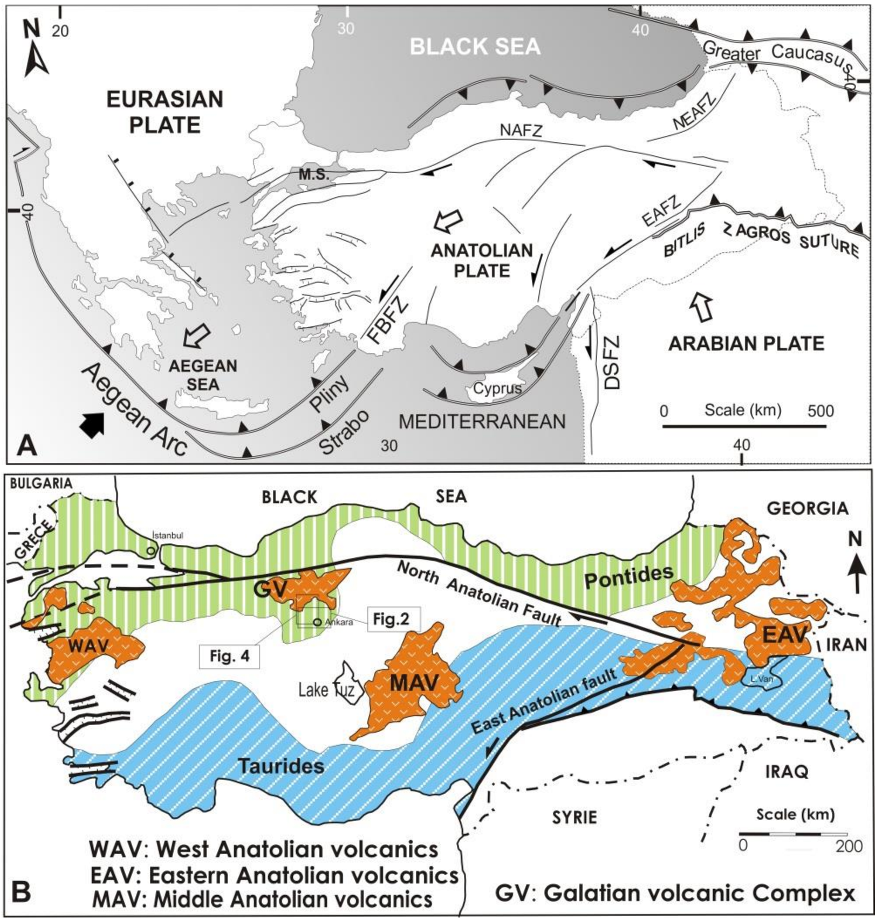

Figure 2. Tectonic elements (A) and basic volcanic provinces (B) of Turkey and the Middle East (modified from Toprak et al. 1996).

The Galatian Volcanic Complex (GV; sometime called Kızılcahamam volcanics, Kızılcahamam volcanic complex, Köroğlu volcanics), one of the four main Neogene and Quaternary volcanic fields of Turkey covers an area of ~12,500 km^2 in the northwest region of Anatolia, at ~70 km north of Ankara and is bounded by the North Anatolian fault (Fig. 2). The other volcanic provinces are eastern, central and western Anatolian fields and the last activity point of view they all become broadly younger from west to east (Fig. 2). Previous literature says that not only Kızılcahamam volcanics but also other Anatolian volcanic provinces are related to collision of African and Eurasian continents resulting the Hellenic arc, Cyrus arc and Bitlis suture (Ercan et al. 1986; Wilson et al. 1997; Tankut et al. 1998; Koçyiğit et al. 2003) (Fig. 2A, B). However, rock types and stratigraphies of these volcanic provinces differ from each other, for example, rocks of the GV change from basalts to andesites and rhyolite (Ercan et al., 1986).

One of the characteristics of the GV is the absence of any typical eruption centre, despite the volcanic complex occupies large areas of western Pontides (Fig. 2). A topographic high, called Işıkdağı is interpreted as a stratovolcano based on only morphology (Türkecan et al. 1991).

According to Öngür (1976) and Gevrek et al (1986), the Kızılcahamam volcanics were produced from linear volcanic centers, probably from large and long fractures and thus, present-day blanket-like field morphology of the volcanics was initiated from their primary emplacements. The other characteristic of this field was the long duration of the volcanism from early Miocene to Pliocene.

Geological background

The Kızılcahamam Volcanics or the GV of the Late Tertiary rest on a bedrock which consists of different lithological composition in places from Triassic to Eocene in age; however, only small part of them are seen in Figs. 3 and 4 as Pre-Oligocene. The oldest unit of the substratum is composed of quartzites, schists, marbles, and recrystallized limestones. They form a group of rocks of Triassic called *Karakaya mélange*. This group includes also a good deal of Permian limestone blocks exposed mostly in the southeast of the GV (Figs. 3, 4). The second older unit of rocks in the map area is pelagic limestones of the Late Jurassic–Early Cretaceous, and they were overlain by an ophiolitic mélange of Late Cretaceous. The latter is composed of mainly ophiolites (spilites, basalt dikes, and chert), turbiditic sandstones, Jurassic limestone blocks (olistolites), and matrix-supported conglomerates (olistostromes). Paleocene clastics and early and middle Eocene redbeds and limestones are the youngest part of bedrocks (Fig. 3). As a matter of fact, the fossiliferous limestones of Eocene (= Lutetian) represent the last marine transgression on central Anatolia. After late Eocene regression, any marine incursion could never reach to this region; instead, large fluvio-lacustrine basins became dominant during Neogene and early Pleistocene forming thick continental successions (Erol, 1954; Erişen and Ünlü 1980).

The volcanic rocks (Kızılcahamam volcanics) form the largest geological unit in the area, from towns Kazan to Gerede and from Uruş-Güdül to Çerkeş, ca. 12,500 km^2 (Fig. 4). They covered bedrocks like a blanket in some places (mostly to south), while forming high summits (stratovolcanoes?) in the north called Işıkdağı and Köroğlu mountain ranges (Figs. 3, 4). Lithology of the unit is consisted of andesitic-basaltic-dasitic lavas, volcanic breccias, agglomerates, tuff, and laharic formations; however, they intercalate with sedimentary deposits in some localities (Toprak et al. 1996; Tankut et al. 1998). Radiometric dates and fossil-based stratigraphy display that they formed three-partite volcanic assemblage within a time span of 23–11 Ma (Türkecan et al. 1991; Wilson et al. 1997; Koçyiğit et al. 2003). A generalized columnar section could be suggested as shown in Figure 5 emphasizing first, second, and third volcanic phases (Kazancı 2010, 2012).

The rocks of the Phase I Volcanism are mainly basalts (lava flows) and minor basaltic pyroclastics. These dark colored volcanics are less than products of the second and third phase volcanism. According to few radiometric dates, they had been emplaced here in early Miocene (21–20.6 Ma; Wilson et al., 1997).

The rocks of the Phase II Volcanism are mostly andesitic and they are interlayered with lacustrine sediments (Fig. 5). They form main lithology of the whole Galatian Volcanics by andesitic-rhyolitic-dacitic lava flows and medium- and fine-grained pyroclastics (Fig. 2). White colored, pumice-rich tuff is common. Radiometric dates showed a wide formation-time interval from 20.6 Ma to 10.6 Ma for these rocks (Wilson et al., 1997). Moreover, plant and insect fossils in the lacustrine marls which are intercalated and mostly covered rocks of this phase show ages of early and middle Miocene (Fig. 5). Presence of some signs of stratovolcanoes and pyroclastic cones and also abundance of pyroclastics may indicate that explosive eruptions are characteristics of volcanic centers during this phase (Toprak et al. 1996; Tankut et al. 1995; 1998; Wilson et al. 997).

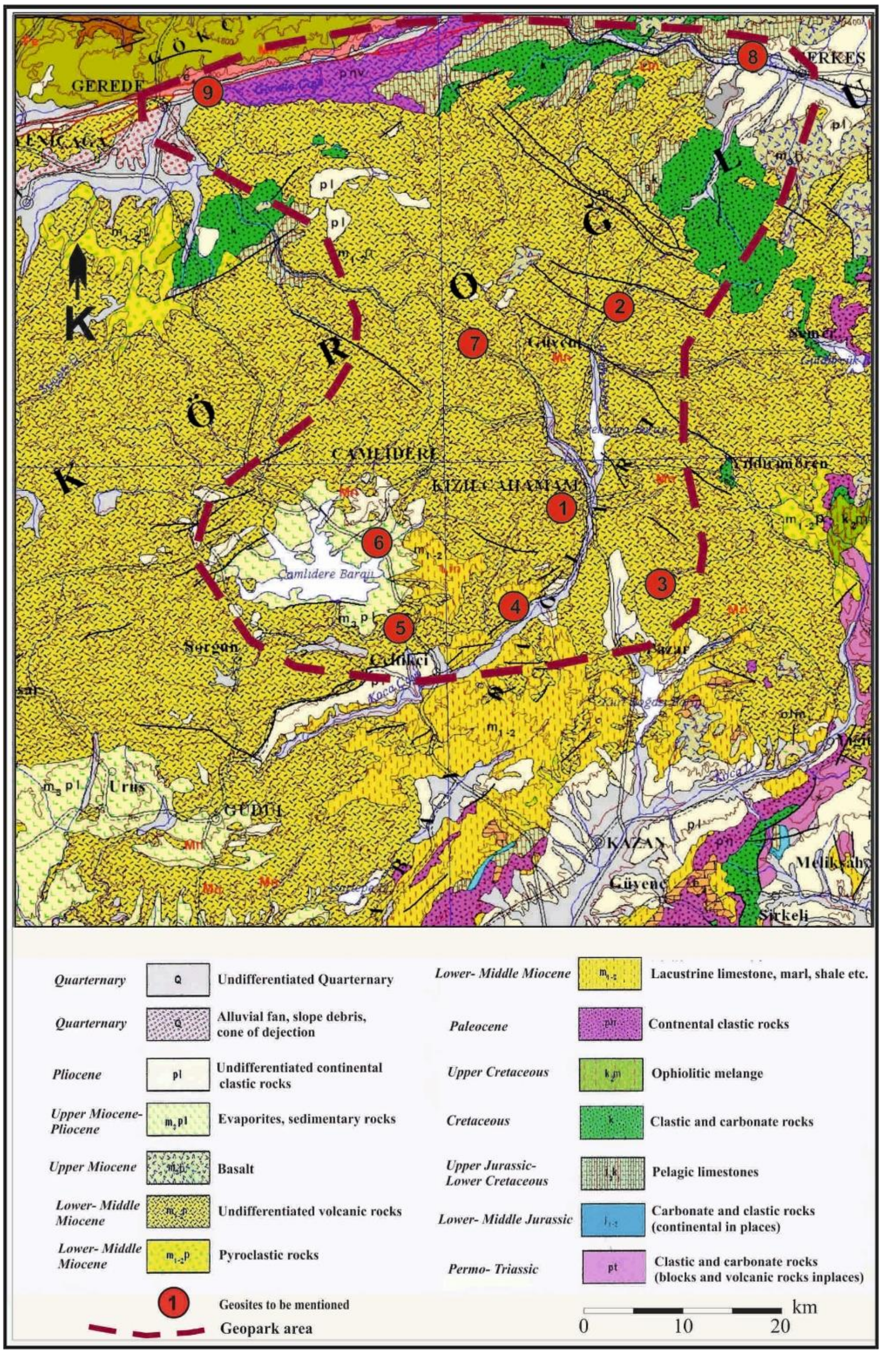

Figure 3. Geological map of Kızılcahamam and geopark area (from MTA, 2002)

Following the Phase II Volcanism, extensive lakes and related wet environments became dominant not only in this region but also in whole central Anatolia as separate basins (i.e., Beypazarı basin, Çankırı-Çorum basin) (Fig. 4b). The Phase III Volcanism of the Galatian complex area produced mainly basaltic lavas dated as 10.6–9.6 Ma (Wilson et al. 1997). Their areal distributions are relatively limited compared to previous andesitic rocks, and all are covered by Pliocene clastic deposits (Fig. 5). The latter are composed of mudstones, sandstones and minor conglomerates. It is worth noting that Quaternary deposits in this region are not much and not varied. They are typically old and recent alluvium, colluviums, and terraces. Most likely, deep valleys and gorges were created during this time period (Quaternary), but eroded materials were transported to the Black Sea directly instead of local deposition here.

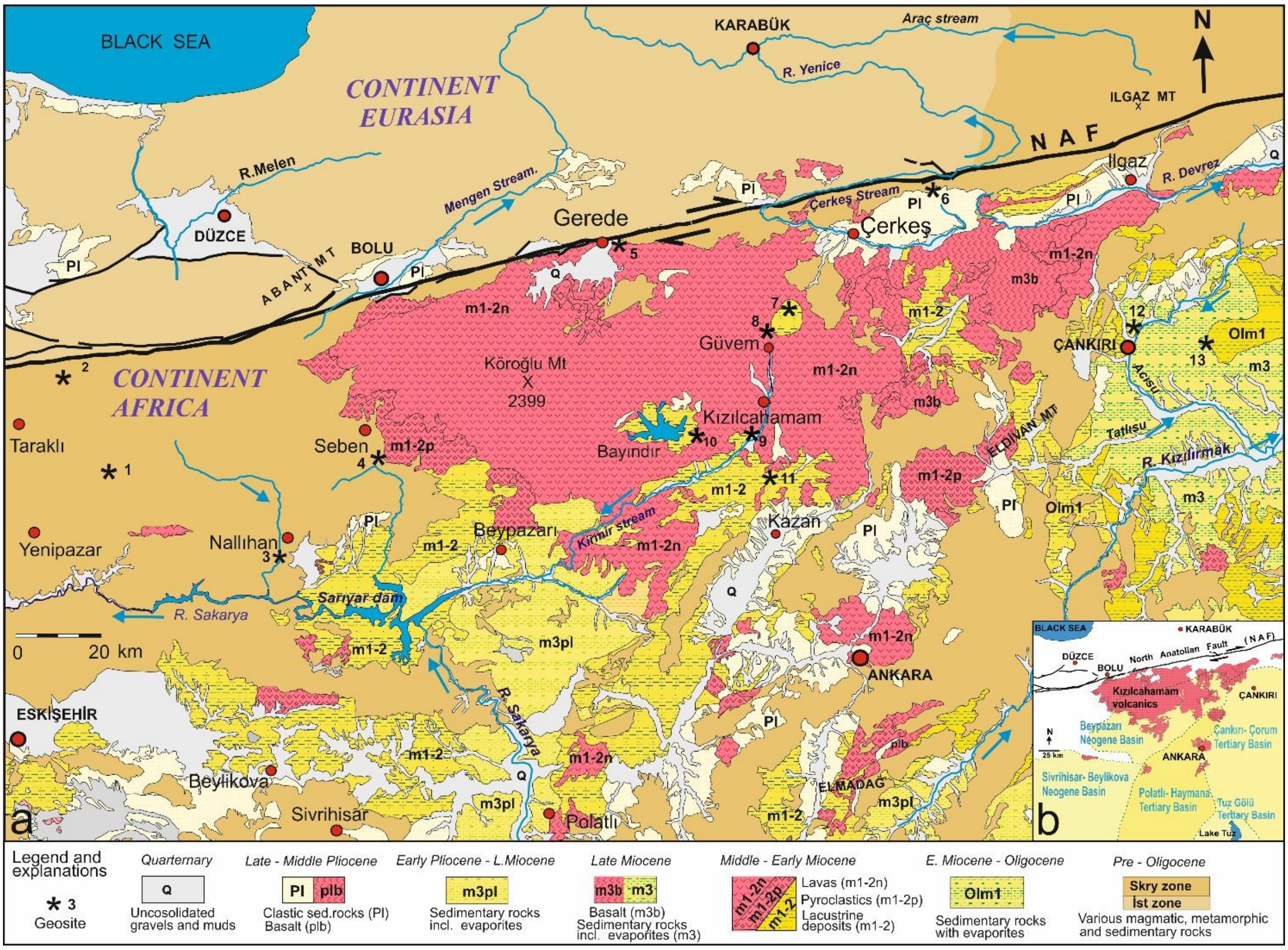

Figure 4. Relations of the Kızılcahamam volcanics, NAF and diffrent Neogene units (a). Note that there is not significant exposures of volcanics behind the North Anatolian Fault (NAF). The figure inset (b) shows diffrent Tertiary sedimentary basins fed partly by Kızılcahamam volcanics. Compare the figure with Figs 2 and 3.

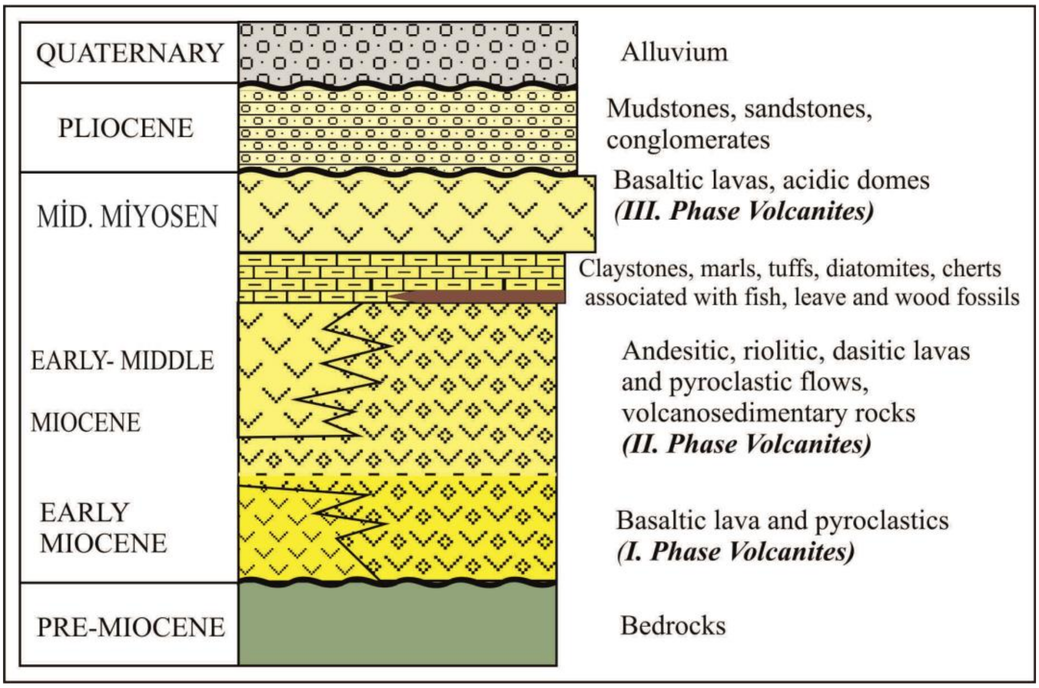

Figure 5. The generalized stratigraphy of the volcanic rocks in the Kızılcahamam area (modified from Gevrek et al., 1986)

Geosites to be visited / Stops

Despite presence of several geosites in the geopark, only few of them which are easy accessible by bus will be visited in that fieldtrip. The itinarary will be the georoute-3 in Fig. 1 working on vulnerable geosites 1-3 (They are 6, 4, 2 in Fig. 3).

Stop 1: Pelitçik-Yahşıhan Petrified Forest

This is the geosite- 1 in Fig. 1. Also 6 in Fig 3, and 10 in Fig. 4.

This stop includes thousands of silicified trees -a real fossil forest-. According to a recent study, the preserved wood indicates that the forest was composed almost exclusively of *Taxodium* and *Sequoia* in addition to trunks of oak, juniper, pine, and cypress woods (Akkemik et al. 2009). Tankut et al. (1995) proposed an age range of 18.2–16.9 million years for the fossil forest based on their own study about the volcanics in this region. It corresponds to the Phase II Volcanism in Figure 5.

This site is 6 km south of Ankara-İstanbul highway and 80 km from Ankara city center (Figs 1, 3, 4). Access to the geosite is easy and so it causes to increase threats by collectors and fossil hunters. It was introduced first by Atabey and Saraç (2004) as a site of geoscientific value; however, the presence of silicified trees here and in the vicinity was reported previously (Erol 1954; Erişen and Ünlü 1980; Gevrek et al. 1986; Türkecan et al. 1991; Saraç 2003). Later it has been popular and even the subject of a dissertation (Gümüş 2007; Kazancı et al. 2007; 2010).

Figure 6 shows stratigraphic position and geological map of the Pelitçik-Yahşıhan geosite. The Petrified forest is in a narrow, ca 3-km-long layer (Fig. 6). Woods here are from silicified trunks, branches, and roots (Fig. 7). Sizes of fossils vary from a few centimeters to 3 m. Their abundance gives visitors a sense that they face a forest made from rocks. Silicified trees have also been found in adjacent areas (Bolu, Çerkeş, Kurşunlu, Ilgaz, Çankırı, Şabanözü, Beypazarı, Kazan, Çubuk areas), but they are not as rich as at this locality (Saraç 2003; Kazancı et al. 2007; Hatipoğlu and Türk 2009).

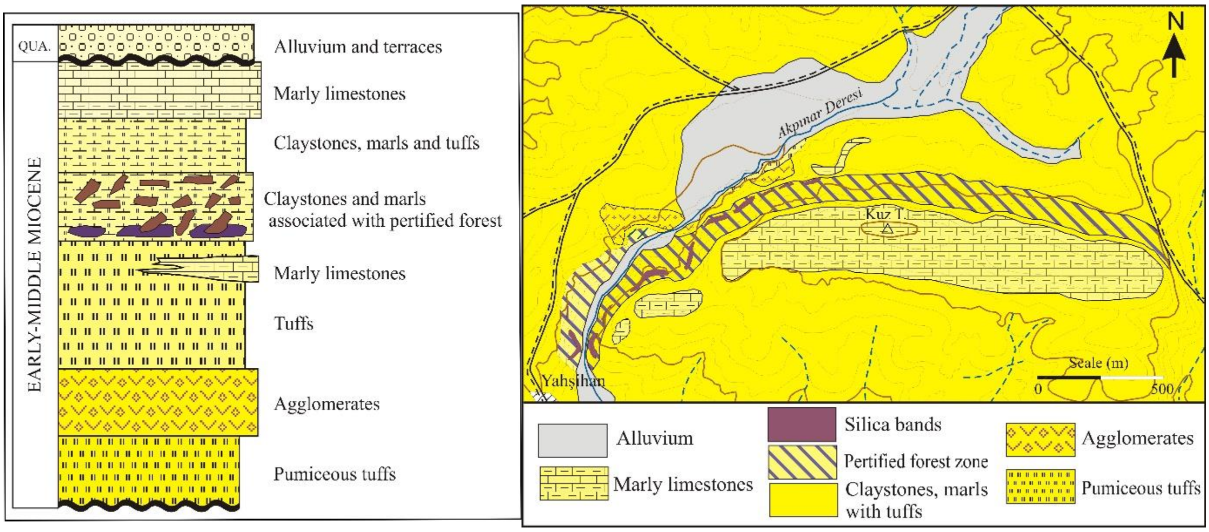

Fig. 6. Stratigraphy and areal distribution of the fossil forest (from Kazancı et al. 2010)

The silicified fossil layer is 15–20 m thick but not every area of the layer is filled with fossils. The layer forms the middle part of a volcano-sedimentary succession (Figs 5 and 6). Stratigraphically, at the relative base of the succession, pumice-rich tuff is typical. They were overlain by a thin agglomerate layer and then upwardly change to clayey tuff and marl (Fig. 6). Marly limestones that underlay the silicified zone appear and disappear laterally in a short distance. A continuous silica-rich band composed of mostly chert and opal occurs at the base of Petrified Forest layer. The succession terminates with a 5-m-thick marly limestone sequence. The latter covers the top of the section, Kuz Tepe (Fig. 6). Characteristics of the sequence described here are a fine-grained, clay-rich lithology, indicating that this probably plays an important role in fossilization and in preserving fossil woods (Fig. 7A-H).

It is believed that fossilization of trunks and other wooden parts were related directly to the presence of silica band (Selmier 1990; Hatipoğlu and Türk 2009). Silica-related minerals in this layer support this idea (i.e., Süzen and Türkmenoğlu 2000). Beyond, silicification steps of wood textures have been previously introduced by microscope and experimental studies proving ion by ion change (Scurfield and Segnit 1984; Akahane et al. 2004). In the early-middle Miocene, the Kızılcahamam region was volcanically active, and as a result of one volcanic eruption, pyroclastics flows felled many of the trees that carpeted the vicinity, typically displacing their trunks and leaving only the stumps behind (Fig. 6). Clouds of fine ash then (partially) buried the forest, and it became entombed (Türkecan et al. 1991, Koçyiğit et al. 2003, Akkemik et al. 2009).

Individual petrified trees or trunks are not rare in the geological record; however a fossil forest is unique formation and its occurrence needs specific environmental conditions. Consequently, there are big efforts to conserve them as as “nature monument” or “geological heritage” (i. e. Selmier 2001; Velitzelos 1996; Artabe et al. 2007; Kazmer 2008; Erdei et al. 2009; Zouros 2009). The Pelitçik-Yahşıhan Fossil Forest of the Kızılcahamam-Çamlıdere Geopark can be easily compared with Lesvos in Greece and Bükrabrany in Hungary from point of species richness and abundance of trunks.

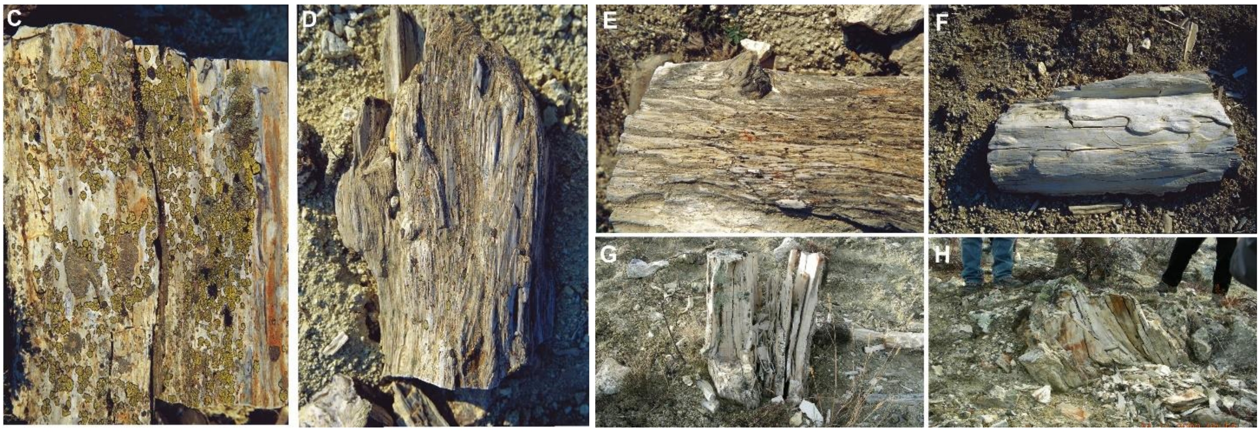

Figure 7. Examples of trunks, roots and branches of the fossil forest

Stop 2. Abacı fairy chimneys

It is marked as 4 in Fig. 3, and 9 in Fig. 4.

The site is 3 km and 20 km away from Ankara-İstanbul highway and Kızılcahamam town respectively (Fig. 1, 5 in Fig. 3). It consists of ignimbritic tuff dissected deeply by erosion forming peculiar landforms (Fig. 8, 9). The Kirmir river plays an important role as base-level on the development of the erosion (Fig. 8). The geosite is more or less equivalent of the Pelitçik-Yahşıhan fossil forest hosted in tuffs which are 16-11 million years old.

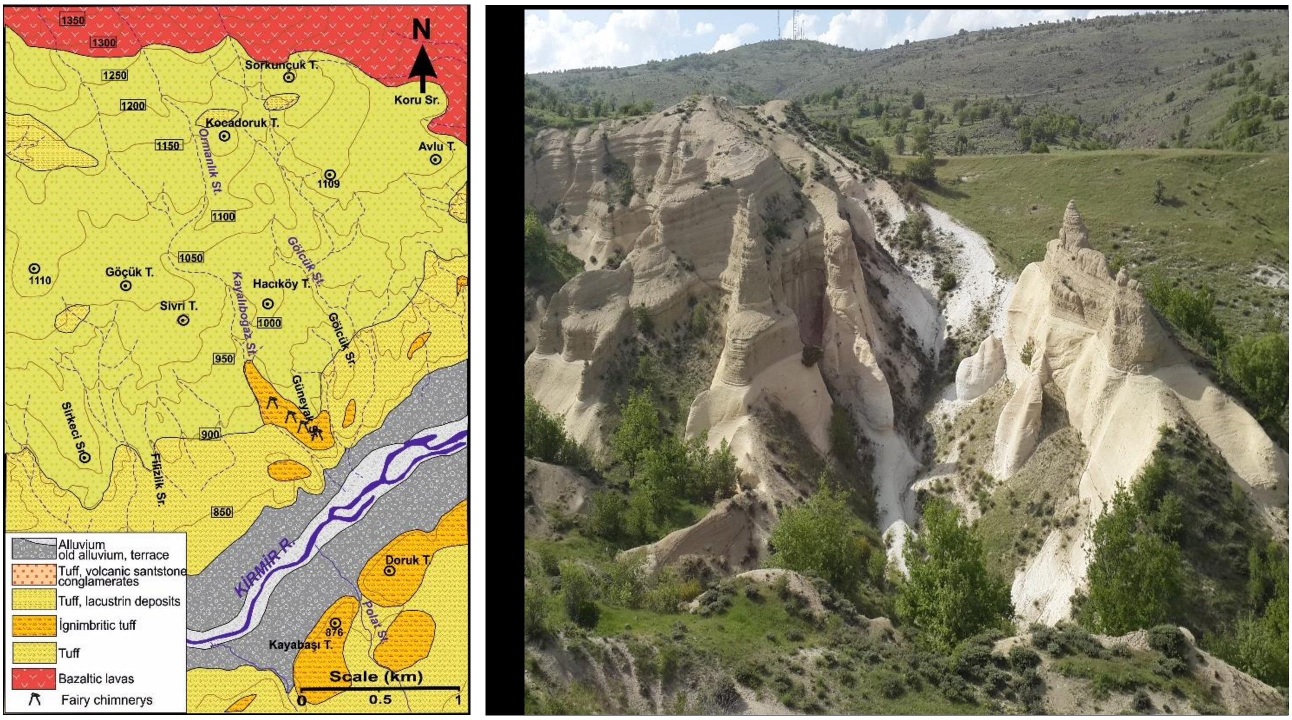

Figure 8. Location and typical lithology of stop 2; Ignimbritic tuff.

Figure 9. Close views of the chimneys

Stop 3. Mahkeme Ağacin Cultural Geosite

It is marked with same number in maps as very closed to stop 2.

This stop is at ca 3 km northeast of the Abacı fairychimneys (Stop 2) and it is on the same lithology, the ignimbritic tuff (Fig. 10). Significance of the geosite is from a four-storey underground settlement included ca 45 houses caving in ignimbrites. Their design is completely different from underground cities in central Anatolia. Archaeology says that they were used effectively in Galatian and early Byzantine times. The walls of the houses have been strengthed by a special technique. Natural erosion is a big threat on that site.

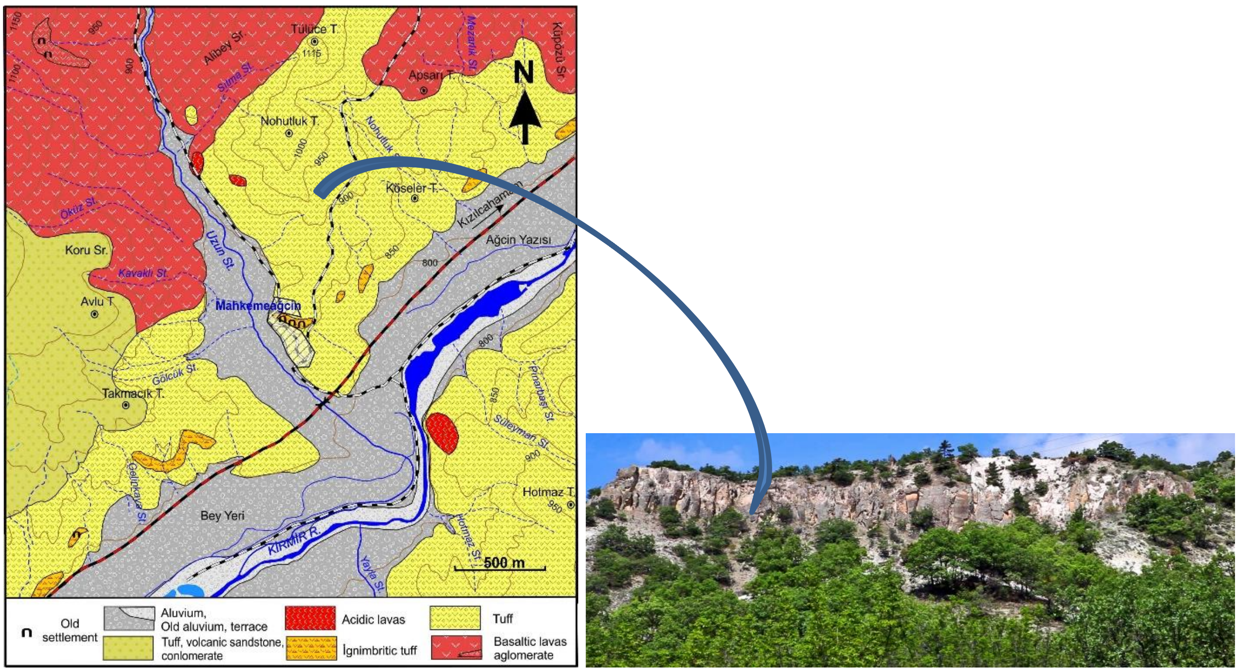

Figure 10. Geological map of the area and Mahkemağcin tuff in where a multi-storey settlement was emplaced

Figure 11. Entrance of a house and a chapel

Stop 4: Güvem Columnar Basalts

It is marked as 2 in Figs. 1 and 2, and 8 in Fig. 4a.

This site provides a nice section to examine flood basalts and basalt columns. In fact, they are common and typical features of some silica-poor lava flows (Spry 1962). The importance of the geosite is the presence of two types of columns; one can observe regular and irregular joints in the same section at this locality (Fig. 12). Throughout the site, regular or colonnade basalts were overlain by the irregular or entablature basalts. The latter is dark colored, and it creates a picturesque landscape (Figs. 13, 14). The color difference between the two basalts is due to different alteration along the column-maker joints. The columnar basalt geosite is located 1.5 km north of village Güvem, just on Sabunkaya Gorge along the road of towns Kızılcahamam-Çerkeş (Figs. 1, 3, 4). Columns are very apparent at two sides of the Sabunsuyu creek because of natural erosion and anthropogenic activities. Regular (colonnade) features have 4–5 edges at transversal sections; moreover, some have 6 edges. Dimensions are homogenous within regular (colonnade) and irregular (entablature) features. Lengths of columns are not measurable due to exposure limitations, but their widths are 10–30 cm and 3–12 cm for colonnades and entablatures respectively (Fig. 13). The boundary between the two types of columnar basalts is sharp but not horizontal. Moreover, the irregular columns orient to different directions and consequently they appear to be structurally deformed (Fig. 14).

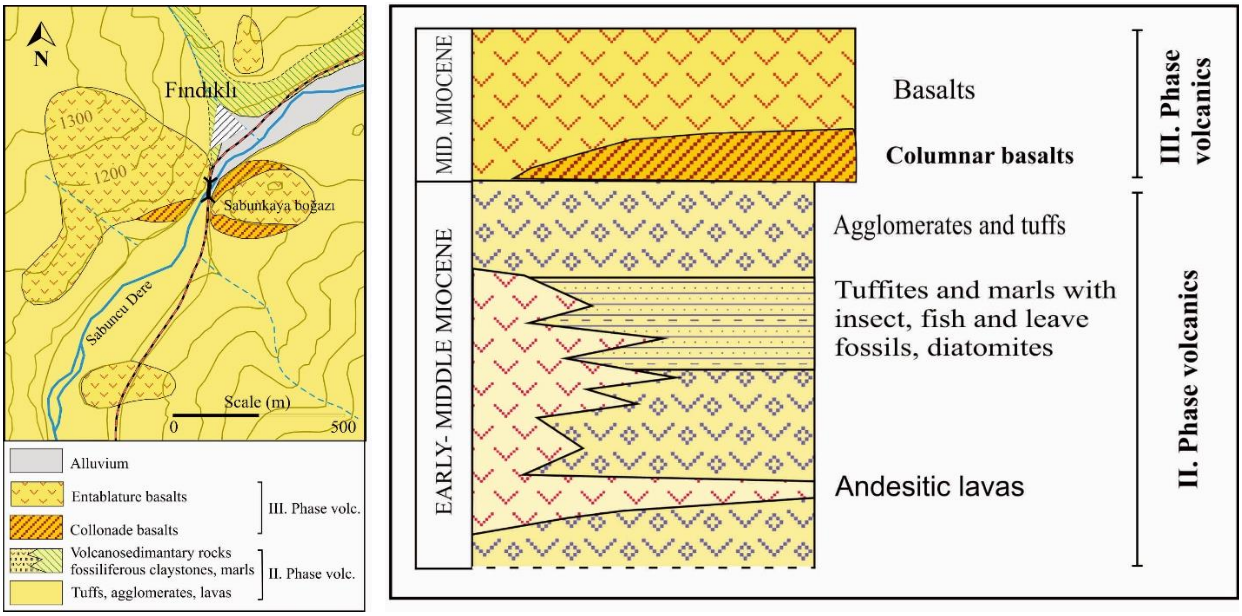

Figure 12. Location and stratigraphy of the columnar basalts

As noted previously, the Kızılcahamam volcanics and particularly rocks in the Güvem area have been studied in detail as the Kızılcahamam-Çerkeş route provided a good road-cut section (Gevrek et al. 1986; Türkecan et al. 1991; Workneh 1993; Tankut et al. 1995; 1998). In addition, the volcanic complex is very high and covers all volcanic phases at this locality, forming two huge Işıkdağ and Köroğlu Mountains up to 2000 m asl. However, only rocks of Phases II and III could be detected in the Güvem area (Kazancı et al. 2007; 2010). The basaltic lava flows included columnar basalts dated 10.6–9.6 Ma (Tankut et al. 1995). This result shows that rocks of the columnar basalt were a part of the Phase III Volcanics.

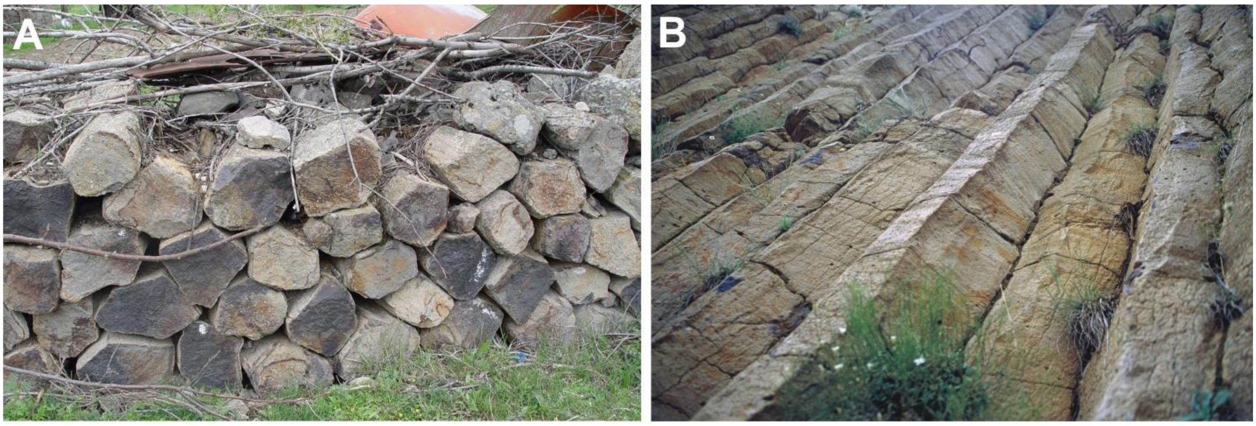

Figure 13. Close views to the columns

Figure 14. general views to the basalt columns. Note that irregular columns are short and thin relatively

Figure 12 summarizes geographic and stratigraphic position of the column-bearing basalts. They were placed on top of the volcanic succession. However, basalts are usually seen on the lacustrine units of the Phase II Volcanics in the field. It must be related to palaeotopography during the explosions.

The most well-known example of the columnar basalts is Giant's Causeway in Ireland. In fact, basalt columns and Giant's Causeway itself became popular following the introduction by Tomkeieff (1940). As it is accepted classically, occurrences of basalt columns are directly related to cooling, as volume of hot lava diminishes up to 15% when it cooled and then vertical joints start to initiate (Spry 1962; Guy and Le Coze 1990; Boiron et al. 2010). Slow cooling produced the colonnade or regular columns, while rapid cooling has created irregular/entablature basalts. Surface water and ordinary climatic circumstances of the relevant time were likely causes of relatively fast cooling. As result, if a basaltic lava lake changed to solid rock by cooling from the ground over a long period of time, regular columns would occur. In contrast, if it started from the upper surface and realized rapidly, irregular columns would appear (Fig. 14).

As it is mentioned above, columnar basalts are common features in volcanic settings and they have been known since sixteen century at least (Tomkeieff, 1940). However, examples which include regular and irregular columns (columnar and entablature basalts) together are rare in the geological records. Hence, the Güvem geosite increases popularity and scientific interest of the local Kızılcahamam-Çamlıdere Geopark.

Stop 5: Beşkonak Leave and Fish Fossils

It is marked as 3 in Fig.1; 2 in Fig.3 and 7 in Fig4

The village of Beşkonak, the locality of the geosite is ~5 km north of columnar basalts described previously as stop 4. It includes a typical geosite of fragile fossils known as the "Güvem fossil bed" in the literature (Figs 1, 2 and 4) (Kazancı 2010). It was discovered and introduced first by Kasaplıgil (1977) and then studied in detail (Paicheler 1978; Ruckert-Ülkümen 1980; Rückert-Ülkümen et al. 2002). The fossil assemblage consisted of different leaf, fish, and insect species hosted in a clay-dominated lacustrine sequence (Figs 12, 15 and 16). Unfortunately it is one of the most disturbed geosites in Turkey particularly by fossil hunters, even it has been a nature conservation site since 1985 (Kazancı et al. 2007, 2010). Presently, after setting of the geopark, the gendarme is taking care of the geosite.

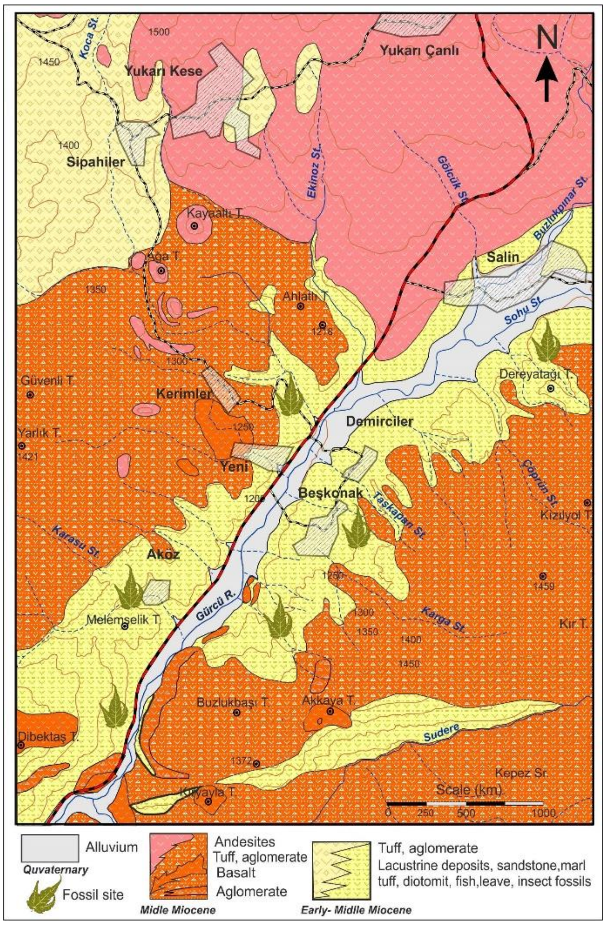

Figure 15. Geological map of the area. See Fig. 12 for stratigraphy.

Figure 16. Laminated mudstones and marl of Miocene and their fossils (insect, fish and leaves)

The fossil-bearing lacustrine deposits are parts of volcanosedimentary units intercalated with andesitic volcanic rocks all of which formed the Phase II Volcanics (Figs. 5, 12). Thickness of the fossiliferous layers is not known because of syn- and postdepositional deformations. In addition, the lithology changes laterally and vertically from fine-grained sandstones to siltstones, claystones and marls. Thin tuff layers and coal seams are common. Limestone beds, diatomite layers, and silica bands are also observed. Fossils are usually found within laminae of lacustrine claystones and marls. Based on fossils, the sequence and related volcanics were first described as Miocene in age (Kasaplıgil 1977; Paicheler 1978). Later pollen analyses, micromammals, and correlations with volcanic rocks dated radiometrically indicate that these lacustrine sequences and their fossil content were deposited during the early-middle Miocene, around 16–15 Ma (Tankut et al. 1995; Saraç 2003).

General stratigraphy of the region shows clearly columnar basalts and/or Phase III Volcanics cover the Beşkonak fossiliferous lacustrine deposits as a basalt lake. As a matter of fact, this cover protected the fossils and host sediments from natural erosion like an envelope up to the Early Pleistocene.

Sedimentary deposits (marl and limestone), limnic coal seams, and fish fossils show that a large lacustrine environment emplaced the region in early Miocene and some parts of it became swamps from time to time. Insect, leaf, and pollen fossils indicate that extensive forests surrounded the lake. According to descriptions, woods had been mainly *carpinus*, *pinus*, *fagus*, *taxus*, *abies*, *acer*, *taxinus*, *zelkowa*, *querqus*, *juglan, diospyros,* and *tilia* (Kasaplıgil 1977). The area must have been as fascinating as it is today with its rocks, landscapes, and endemic living things (Fig. 16).

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TMMOB
JEOLOJİ MÜHENDİSLERİ ODASI
CHAMBER OF GEOLOGICAL ENGINEERS OF TURKEY
Hatay Sokak No: 21 Kocatepe/ANKARA
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