

Geological Background and Three Vulnerable Geosites of the Kızılcahamam–Çamlıdere Geopark Project in Ankara, Turkey

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Received: 8 August 2011 / Accepted: 5 June 2012
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Abstract Country-scale geological events of Neogene and Quaternary age are called neotectonism and so this is known as the neotectonic period in Turkey, where it was responsible for initiating and molding the present-day geomorphology of Anatolia. The neotectonism of the northwestern Anatolia (=western Pontides) are mainly represented by volcanic rocks called the Galatian Volcanic Complex (GVC) which consists of a series of andesites, basalts, and their pyroclastics. Rock sequences of the GVC indicate that volcanism took place abundantly in early and middle Miocene times as three separate phases intercalated by long-term fluviolacustrine environmental conditions. Therefore, the GVC consists of not only volcanics but also volcano sedimentary and pure sedimentary units. It blankets the various rock units from late Palaeozoic to Oligocene in age (=the Anatolian continent, substratum). As a result, rock units of the substratum here and the GVC together represent the whole record of the geological past of the western Pontides. Meantime, this region has been watched daily by thousands of travelers due to presence of highways, bringing a very colorful landscape with many erosional features to the public's attention. In 2011, a 2,000 km² part of the Galatian Volcanic Complex was registered as a geoconservation area called the Kızılcahamam–Çamlıdere Geopark Project by the authorized Turkish institutions. The general geology of the area and three geosites are introduced here. These geosites include (a) a petrified forest, (b) columnar basalts, and (c) a lacustrine

sequence with leaf, fish, and insect fossils. These three geosites are the best representatives for demonstrating the Miocene environmental circumstances and sedimentary responses to a long-term, large-scale volcanism during the neotectonic period.

Keywords Geosite · Geoheritage · Petrified wood · Columnar basalts · Kızılcahamam–Çamlıdere geopark · Galatian Volcanic Complex · Ankara

Introduction

The geology of Turkey and the Middle East can be divided broadly into palaeotectonic and neotectonic periods by the termination of the Alpine–Himalayan orogenesis. The development of the geomorphology of Anatolia and the surrounding areas commenced in Late Oligocene–Early Miocene times and later it progressed during the neotectonic period (Şengör and Yılmaz 1981). Thus, it is possible to say that the neotectonic period in Turkey covers the whole of Neogene and Quaternary times. Volcanic provinces and the Galatian Volcanic Complex (GVC) to be described in this study are important products of this neotectonic period in Turkey (Fig. 1).

The GVC, sometimes called the Kızılcahamam volcanic, Galatian Volcanic Province, Kızılcahamam volcanic complex, Köroğlu volcanics are one of the four main Neogene and Quaternary volcanic fields of Turkey (Fig. 1). It covers an area of ~12,500 km² in the northwest region of Anatolia, ~70 km north of Ankara, and is bounded by the North Anatolian fault (Fig. 1). The other volcanic provinces are eastern, central, and western Anatolian fields and in terms of the last activity, they all become broadly younger from west to east (Fig. 1). Previous literature suggests that not only Kızılcahamam volcanics but also the other Anatolian

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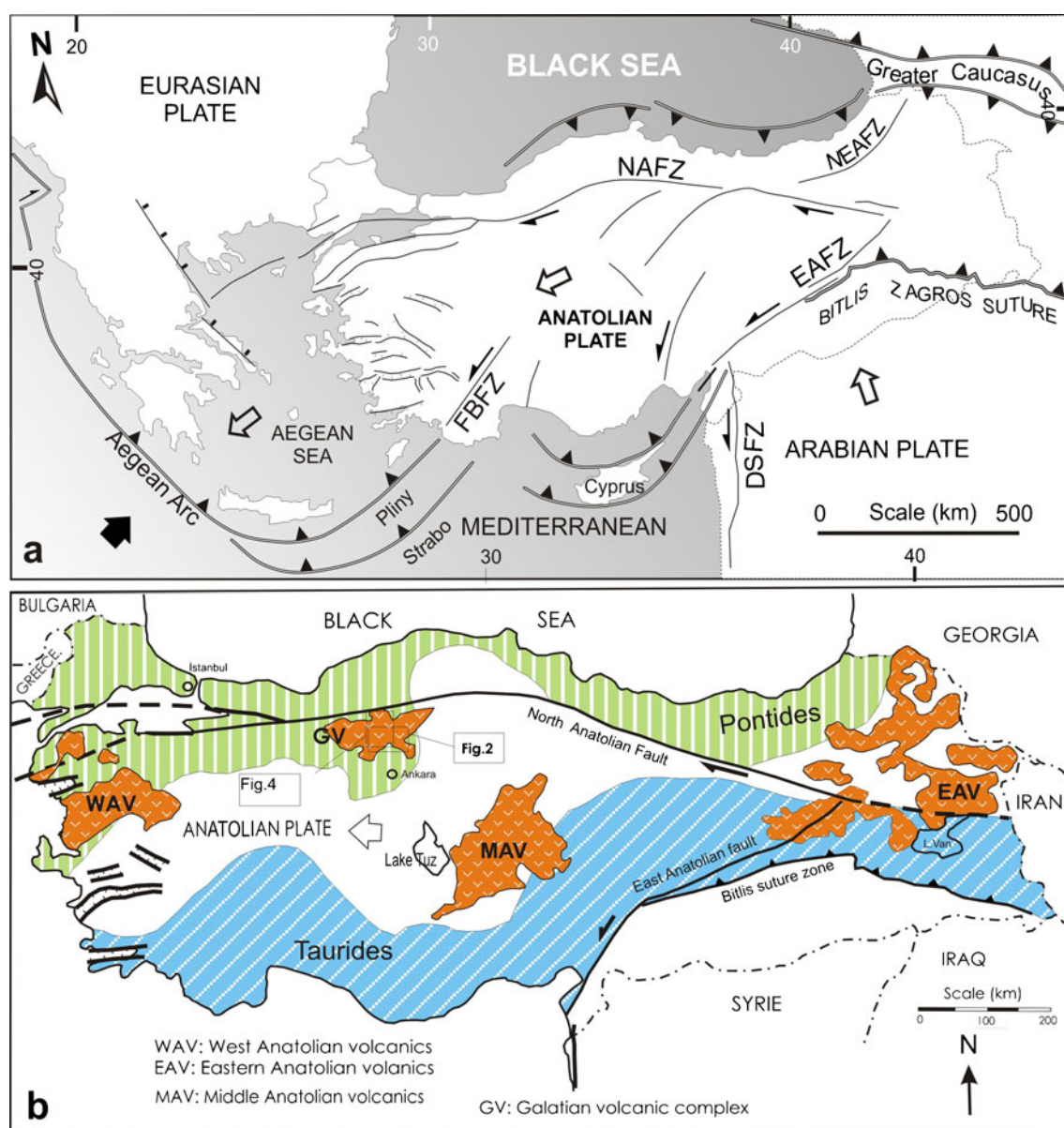


Fig. 1 Geological setting of Turkey. **a** Neotectonic elements of eastern Mediterranean area and surrounding. *Arrows* relative tectonic movements, *black arrow* African plate, *MS* Marmara Sea, *DSFZ* Dead

Fault Zone, *NAFZ* North Anatolian Fault Zone, *EAFZ* Eastern Anatolian Fault Zone. **b** Paleotectonic units and Neogene volcanic provinces of Anatolia (modified from Toprak et al. 1996)

volcanic provinces are related to the collision of the African and Eurasian continents resulting in the Hellenic arc, Cyprus arc, and Bitlis suture (Ercan 1986; Wilson et al. 1997; Tankut et al. 1998; Koçyiğit et al. 2003) (Fig. 1a, b). However, rock types and stratigraphies of these volcanic provinces differ from each other (Ercan 1986). For example, rocks of the GVC change from basalts to andesites and rhyolites.

One of the characteristics of the GVC is the absence of any typical eruption center, despite the volcanic complex occupying large areas of western Pontides (Figs. 1 and 2). A

topographic high called Işıkdagi is interpreted as a strato-volcano based only on morphology (Türkecan et al. 1991). According to Öngür (1976) and Gevrek et al. (1986), the Kızılcahamam volcanics were produced from linear volcanic vents, probably from large and long fractures, and thus the present-day blanket-like field morphology of the volcanics was initiated from their primary emplacement. The other characteristic of this field was the long duration of the volcanism from early Miocene to Pliocene times. As a result, the GVC has some distinctive geological characteristics (a volcanic province, fossiliferous formations, etc.)

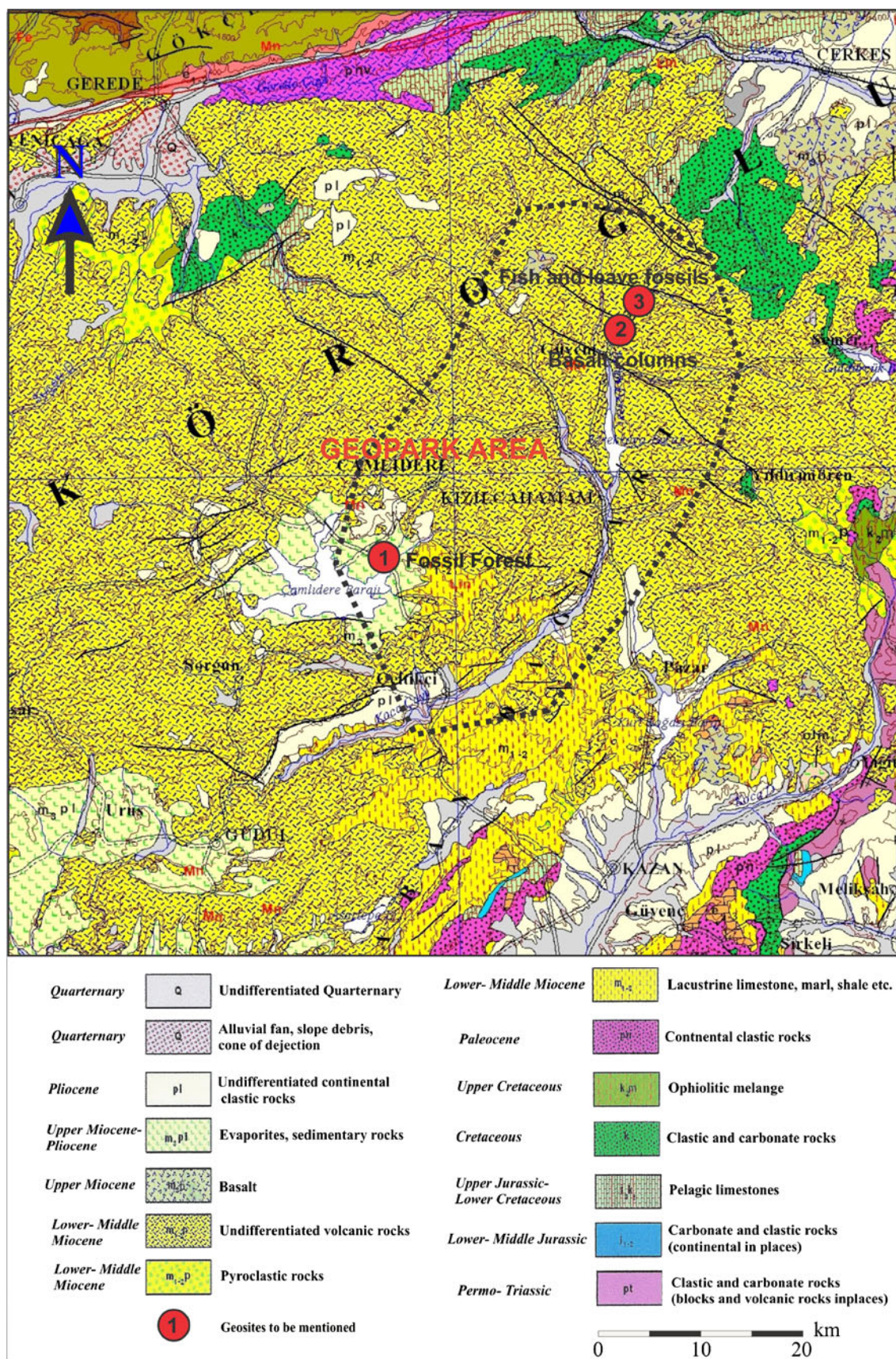


Fig. 2 Geological map of Kızılcahamam area (from MTA 2002). 1–3 in red circles show locations of geosites to be presented. See Fig. 1 for the map area

and some volcanological peculiarities (extensive areal distribution but skin-like geometry, absence of an eruption center). A group of earth scientists suggested that at least a part of this area must be conserved and introduced to local, national, and international communities.

The region has been of interest since ancient times, when it was the land of Hitites, Friges, and Galatians. Galatians in particular lived here, just on this volcanic province (Fig. 1). The towns Kızılcahamam and Çamlıdere and/or the whole volcanics are placed geographically on a transition zone between the semi-arid central Anatolian plateau and the 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 2,100 m, respectively. Erosional landforms are apparently dependent on lithological differences of the volcanic complex. So, the area has become popular recently for picnicking, trekking, cycling, and hunting, particularly with efforts having been made to develop a geopark there since 2005 (Erdoğan 2010; Kazancı 2010).

Turkish geoconservationists are happy now as the Kızılcahamam–Çamlıdere Geopark Project is on the way of realization. It was registered by the Turkish Patent Institute as name and content in October of 2011, in addition to the 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 leaders of the geopark project since its initiation. By these registrations and leadership, it is possible to say that the first geopark of Turkey was realized officially, even though it has neither international status nor been cited within national legislation (Kazancı et al. 2012). It has nevertheless 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. 2,000 km² (Figs. 2 and 4). Neighboring Ankara, the capital and also the second largest city of Turkey with five million inhabitants, increases the geotourism potential of this project.

A coordination office with four staff at Kızılcahamam and an executive committee formed by the representatives of the project partners are working to achieve the targets of the geopark. Presently, they have been preparing the relevant documents for applications to join the international geopark networks (Global Geoparks Network and European Geopark Network). It is hoped that geosites there will be safe from human impact (Kazancı et al. 2005). The first six geosites of the geopark were opened to visitors in July 2010 and the other 18 will be prepared by middle of 2012. Details of the Kızılcahamam–Çamlıdere geopark are outside of this study, but the geological background and three vulnerable geosites of it are presented here as they are typical examples

of the interrelations between sedimentary environments and long-lived volcanism in this area.

Geological Setting

The Kızılcahamam volcanics (or the GVC) of late Tertiary age, rest on a bedrock which consists of different lithological composition in places from Triassic to Eocene age (Öngür 1976; Türkecan et al. 1991; Kazancı 2010); however, only a small part of them is shown in Fig. 2. The oldest unit of the substratum comprises quartzites, schists, marbles, and recrystallized limestones. They form a group of rocks of Triassic age called the *Karakaya mélangé*. This interval includes also a good deal of Permian limestone blocks exposed mostly in the southeast of the GVC (Fig. 2). The second, older unit of rocks in the map area consists of pelagic limestones of Late Jurassic–Early Cretaceous age, and they were overlain by an ophiolitic mélangé of Late Cretaceous age. The latter is composed of mainly ophiolites (spilites, basalt dikes, and chert), turbiditic sandstones, Jurassic limestone blocks (olistolites), and matrix-supported conglomerates (olistostromes). Palaeocene clastics and early and middle Eocene redbeds and limestones are the youngest part of bedrocks (Fig. 2). These Eocene (=Lutetian) fossiliferous limestones represent the last marine transgression of central Anatolia (Türkecan et al. 1991) and thereafter large fluvio-lacustrine basins became dominant, forming thick Neogene and early Pleistocene continental successions (Kazancı et al. 2007).

The volcanic rocks (Kızılcahamam volcanics) form the largest geological unit in the area, covering ca. 12,500 km² between Kazan to Gerede, and Uruş-Güdül to Çerkeş, (Fig. 2). In some places (mostly to the south), they blanketed the bedrocks, while forming high summits (stratovolcanoes?) in the north called the Işıkdagi and Köroğlu mountain ranges (Fig. 2). The lithology of this unit consists 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 biostratigraphy indicate that they formed a tripartite volcanic assemblage with a time span of 23–11 Ma (Türkecan et al. 1991; Wilson et al. 1997; Koçyiğit et al. 2003).

A generalized columnar section (Fig. 3) shows that there were first, second, and third volcanic phases (Kazancı et al. 2007). The rocks of the phase I volcanism are mainly basalts (lava flows) and minor basaltic pyroclastics. These dark-colored volcanics are less than the products of the second and third phase volcanism. According to a few radiometric dates, they had been emplaced here in early Miocene age (21–20.6 Ma).

The rocks of the phase II volcanism are mostly andesitic interlayered with lacustrine sediments (Fig. 3). They form

the main lithology of the whole Galatian Volcanics with andesitic–rhyolitic–dacitic lava flows and medium- and fine-grained pyroclastics (Fig. 2). White-colored, pumice-rich tuff is common. Radiometric dates show a wide formation time interval from 20.6 to 10.6 Ma for these rocks (Wilson et al. 1997). Moreover, plant and insect fossils in the intercalated lacustrine marls indicate early and middle Miocene ages (Fig. 3). The presence of some signs of stratovolcanoes and pyroclastic cones, and also the abundance of pyroclastics, may indicate that explosive eruptions are characteristics of the volcanic centers during this phase (Toprak et al. 1996; Tankut et al. 1995; 1998; Wilson et al. 1997). Following the phase II volcanism, extensive lakes and related wet environments became dominant, not only in this region but across the whole of central Anatolia as separate basins (i.e., Beypazarı and Çankırı–Çorum basin).

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 the older andesitic rocks, and all are covered by Pliocene clastic deposits (Fig. 3). The latter are composed of mudstones, sandstones, and minor conglomerates. It is worth noting that Quaternary deposits in this region are limited 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 being locally deposited here.

From stratigraphic and geochemical points of view, the Kızılcahamam or Galatian volcanics roughly resemble the western Anatolian volcanics as they were mostly emplaced in Miocene times and volcanic activities were ended before Pliocene times (Wilson et al. 1997; Fig. 1). Both volcanics were also entered into palaeolakes and so were intercalated with lacustrine units, helping the formation of some valuable deposits like trona, diatomites, borax, and other boron minerals. Moreover, these regions have important geothermal

energy potential. On the other hand, the eastern Anatolian volcanics and middle Anatolian volcanics are much more widespread aurally than those of the previous provinces (Fig. 1), and they have still recent activity (explosions and lava flows have ceased, but heated gases still come from craters; e.g., Hasandağ and Nemrut Dağ). However, all Anatolian late Tertiary volcanics were related to the same tectonic evolution that resulted from the collision of the Afro-Arabian and Eurasian plates (Koçyiğit et al. 2003; Fig. 1). Geochemical studies also show that they were the result of a large continental arc development on the Anatolian plate, and that generally magma chambers were close enough to the surface for explosive volcanism (i.e., Ercan 1986; Türkecan et al. 1991; Tankut et al. 1998), despite the fact that some say that this volcanicity was a result of extensional tectonism rather than collision (Wilson et al. 1997). The Bitlis Suture was the structural equivalent of the continental arc development, and it caused the initiation of the North Anatolian and East Anatolian transform faults, which created and/or controlled the present-day morphology of Turkey (Fig. 1).

Vulnerable Geosites of the Kızılcahamam–Çamlıdere Geopark Project

Under the scientific leadership of Ankara University, local authorities, and a nongovernmental organization (Association for Conservation of Geological Heritage, Jemirko) efforts have been made over the last 7 years to create the first formal geopark of Turkey on a small part of the Galatian Volcanic Province with the name “Kızılcahamam–Çamlıdere Geopark” and at last it was registered by the national authorized institutions in 2011. The geosites to be presented here are the most vulnerable elements of this area. However, the potential geopark covers a surface area of ca. 2,000 km² with at least 23 individual sites. Most of the geosites have been grouped in four georoutes (linear itineraries) and three geotours (circular itineraries) using the high quality of roads in the area in order to encourage both visitors and also local people for geotourism (Fig. 4). Apart from the earth science values, the geopark includes many thermal springs, old and new baths, cold and hot mineral waters, and endemic fauna and flora, together with many cultural sites (an ape locality, an underground city, ancient ovens for hand tools, a monastery). The significant sites are Sey Hamamı (Sey Bath), Güvem basalts and lava flows, Beşkonak fossils, Işıkdagi stratovolcano (?), Karagöl, man-made caves (=an underground city) at Mahkemeagcin village and early Roman period’s chapels, fairy chimneys at Abacı village, Alicin Monastery, Kirmir Canyon valley, normal fault at village Kızık, petrified (silicified) forest at Pelitçik-Yahşihan villages, Kızılcahamam hot water springs, andesites in Soğuksu National Park, petrified wood trunk and volcanic

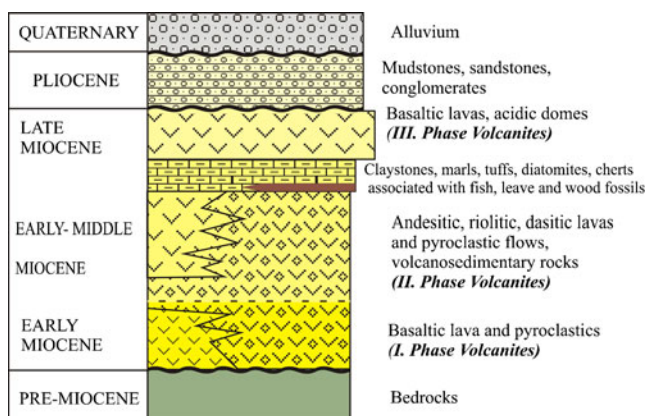


Fig. 3 Generalized stratigraphy of the Kızılcahamam area (Kazancı et al. 2007)

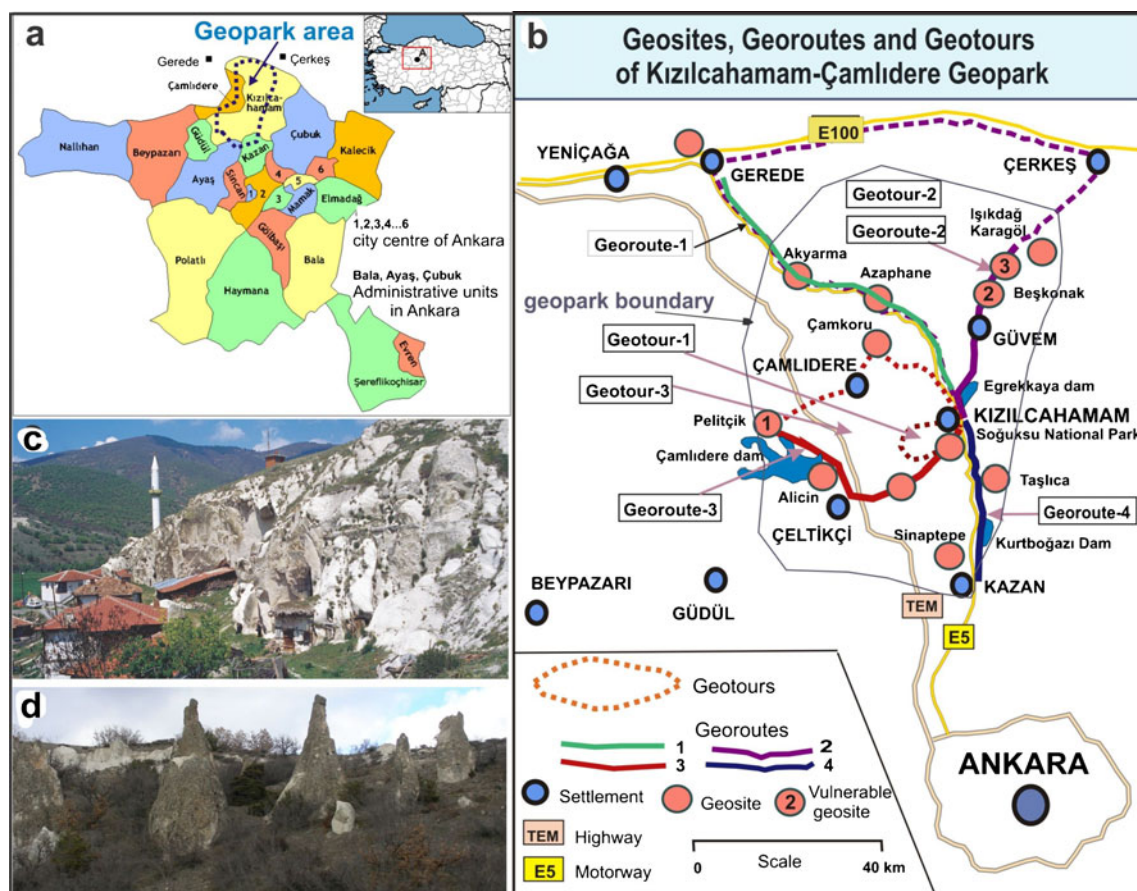


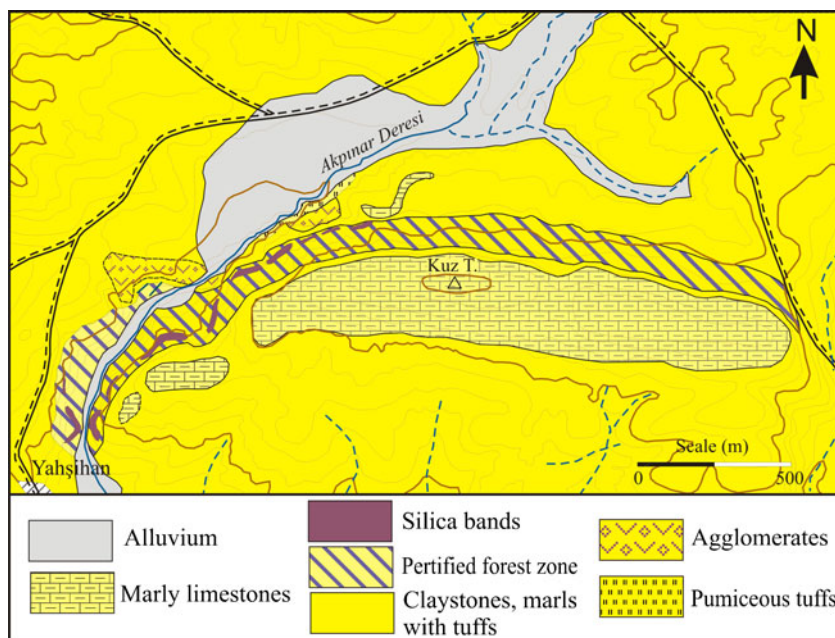
Fig. 4 **a** Administrative units of Ankara and area of the geopark. **a** Ankara inset, **b** locations of significant and vulnerable geosites of the Kızılcahamam-Çamlıdere Geopark project together with geotourism

alternatives as as georoutes (linear itinaeraries) and geotours (circular itinaeraries), **c** Mahkemagcin tuff and Galatian underground city, and **d** Abacı fairy chimneys on tuff

baked zone in Soğuksu National Park, Kızılcahamam mineral water, and travertines, Rocky bride silhouette at Taşlıca

village, rocky “Turtle Brothers” at Taşlıca village, mammalian fossils at Sinaptepe of town Kazan, Çamlıdere tuffs,

Fig. 5 Detail map of the petrified forest area (Kazancı et al. 2007)



Azaphane volcanics, Akyarma tuffs, Özdere volcanics etc. (see <http://www.jeoparkankara.com> for photographs of the geosites). However, the basic need is still for more scientific research in the region. The following geosites demonstrate the interrelations between sedimentary environments and volcanism.

Geosite 1: Pelitçik–Yahşıhan Petrified Forest

This geosite 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*, with subsidiary oak, juniper, pine, and cypress (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 of the volcanics in this region, which corresponds to the phase II volcanism in Fig. 3.

This site is 6 km south of the Ankara–İstanbul highway and 80 km from Ankara city center (Figs. 2, 4 and 5). Access to the geosite is easy and this has caused increased threats from collectors and fossil hunters (Kazancı et al. 2005). Atabey and Saraç (2004) first confirmed the geoscientific value of the site, although the presence of silicified trees here and in the vicinity had been reported previously (Erol 1954; Erişen and Ünlü 1980; Gevrek et al. 1986; Türkecan et al. 1991; Saraç 2003). Later, it has been a popular site and has even been the subject of dissertations (e.g., Gümüş 2007; Kazancı et al. 2007, 2010).

Figure 5 shows a 10-m detail topographical and geological map of the Pelitçik–Yahşıhan geosite. The Petrified Forest is in a narrow, ca 3-km-long layer. Woods here are from silicified trunks, branches, and roots (Fig. 6). 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 the adjacent areas of 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).

The silicified fossil layer is 15–20 m thick but not every part 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, changing upwards into 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 (Figs. 5 and 6). The succession terminates with a 5-m-thick marly limestone sequence. The latter covers the top of the section at Kuz Tepe (Fig. 5). Characteristics of the sequence described here are a fine-grained, clay-rich lithology, indicating that

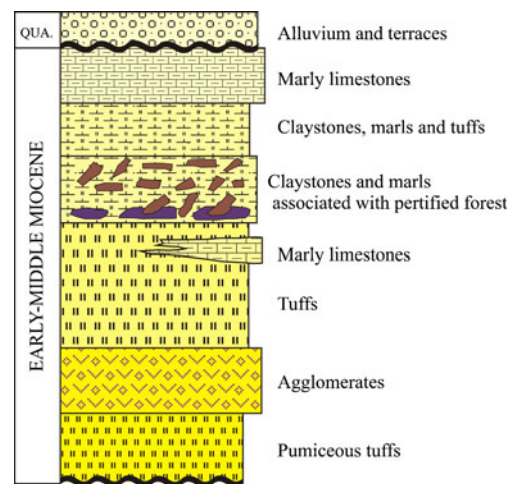


Fig. 6 Lithostratigraphy of the Pelitçik–Yahşıhan area and position of the petrified forest zone (Kazancı et al. 2007)

this probably plays an important role in fossilization and in preserving the fossil wood (Fig. 7a–h).

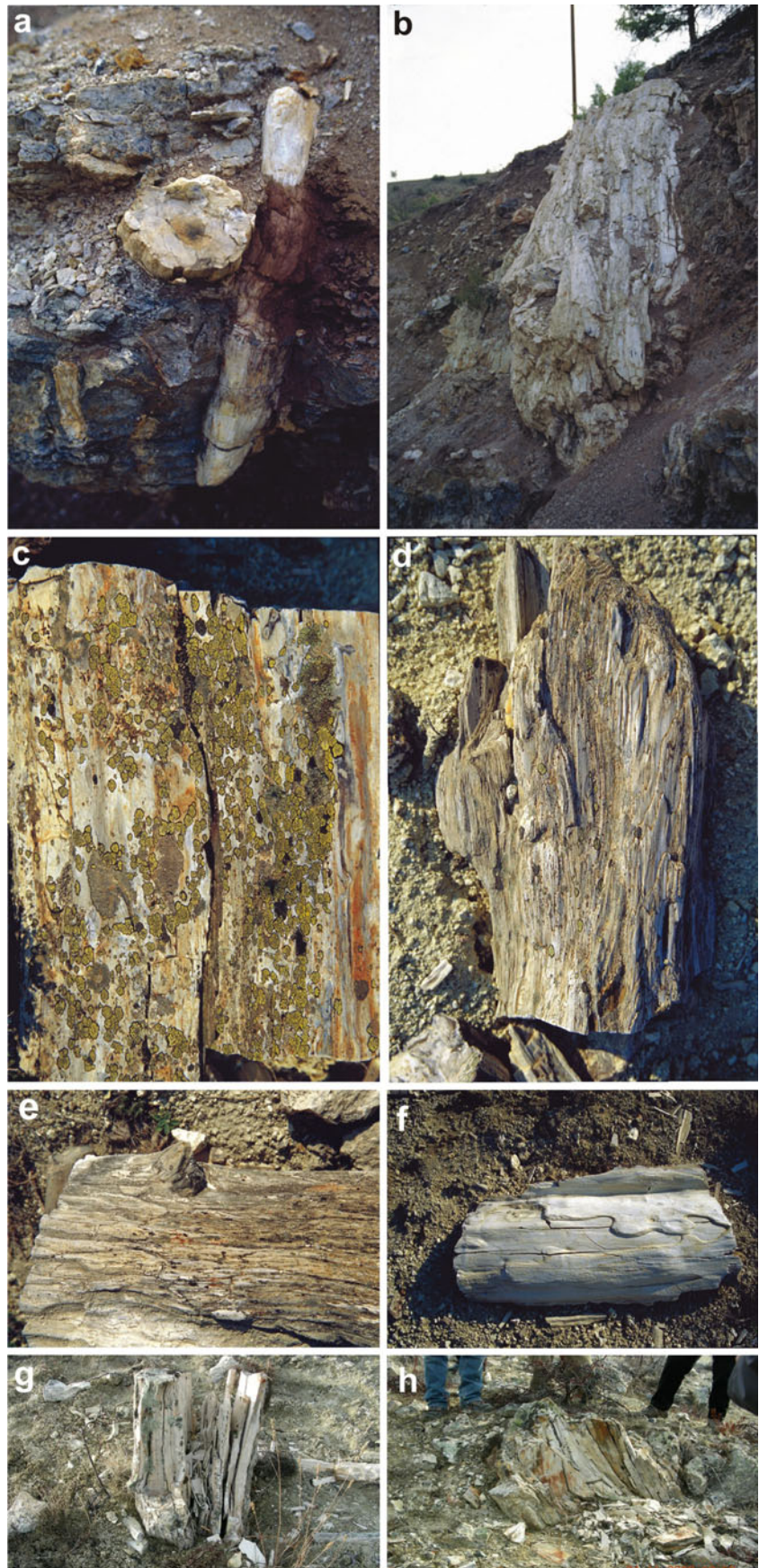
It is believed that the fossilization of the trunks and other wooden parts was related directly to the presence of a band containing silica-related minerals (Selmeier 1990; Süzen and Türkmenoğlu 2000; Hatipoğlu and Türk 2009). It has been demonstrated by microscope and experimental studies that silicification of the wood textures happened by ion by ion change (Scurfield and Segnit 1984; Akahane et al. 2004). In early–middle Miocene times, 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 (Türkecan et al. 1991; Koçyiğit et al. 2003; Akkemik et al. 2009).

Individual petrified trees or trunks are not rare in the geological record, but fossil forests are much rarer and need specific environmental conditions. Consequently, there are big efforts to conserve them as a “nature monument” or “geological heritage” (i.e., Selmeier 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 the point of species richness and abundance of trunks.

Geosite 2: Güvem Columnar Basalts

This site provides a fine section to examine flood basalts and basalt columns, which are common here and show typical features of some silica-poor lava flows (Spry 1962). The scientific importance of the geosite is the fact that it has two types of columnar basalts; one can be observed with regular and irregular joints in the same section at this locality

Fig. 7 a–h Various examples of petrified trees



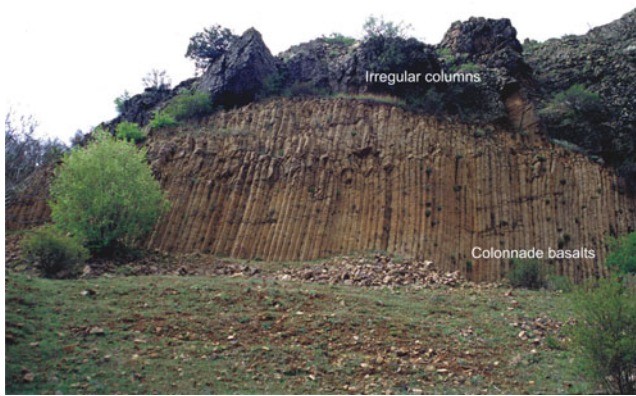


Fig. 8 Regular columns (*below*) and irregular columns (*above*, dark colored) of the Güvem geosite

(Fig. 8). Throughout the site, regular or colonnade basalts were overlain by the irregular or entablature basalts. The latter are dark colored and create a picturesque landscape (Fig. 8). 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 Güvem village, just on the Sabunkaya Gorge along the road of the towns Kızılcahamam–Çerkeş (Figs. 2 and 4). Columns are very apparent along two sides of the Sabunsuyu creek because of natural erosion and anthropogenic activities. Regular (colonnade) features have four or five, or sometimes six edges in transverse sections. Dimensions are homogenous within regular (colonnade) and irregular (entablature) features. Lengths of columns are not measurable due to limitations of exposure, but their widths are 10–30 and 3–12 cm for colonnades and entablatures, respectively (Fig. 9). The boundary between the two types of columnar basalts is sharp but not horizontal. Moreover, the irregular columns are oriented in different directions and consequently they appear to be structurally deformed (Fig. 8).

As noted previously, the Kızılcahamam volcanics and particularly rocks in the Güvem area have been studied in detail as the Kızılcahamam–Çerkeş route provides 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 Işıkdag and Köröglü Mountains up to 2,000 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 as 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 10 summarizes the geographic and stratigraphic position of the column-bearing basalts, which were placed on top of the volcanic succession. However, basalts are usually seen in the lacustrine units of the phase II volcanics in the field. It must be related to palaeotopography during the explosions.

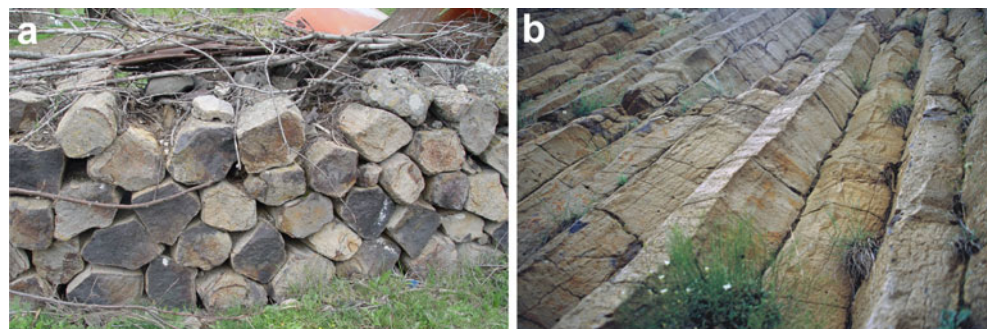
As it is accepted classically, occurrences of basalt columns are directly related to cooling, as the volume of hot lava shrinks by up to 15 % when it cools and then vertical joints start to appear (Spry 1962; Guy and Le Coze 1990; Boiron et al. 2010). Slow cooling produced the colonnade or regular columns, while rapid cooling has created irregular/entablature basalts. Surface water and ordinary climatic circumstances of the relevant time were likely causes of the 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. 8).

Columnar basalts are common features in volcanic settings and they have been known since the sixteenth century at least (Tomkeieff 1940). However, examples which include regular and irregular columns (columnar and entablature basalts) together are rare in the geological record. Hence, the Güvem geosite increases the popularity and scientific interest of the local Kızılcahamam–Çamlıdere Geopark.

Geosite 3: Beşkonak Leave and Fish Fossils

The village of Beşkonak, the locality of this geosite, is ~5 km north of the columnar basalts described previously (Figs. 2 and 4). It includes a typical geosite of fragile fossils known in the literature as the “Güvem fossil bed” (Kazancı

Fig. 9 **a** Different sections of basalt columns, **b** close views of colonnade basalts



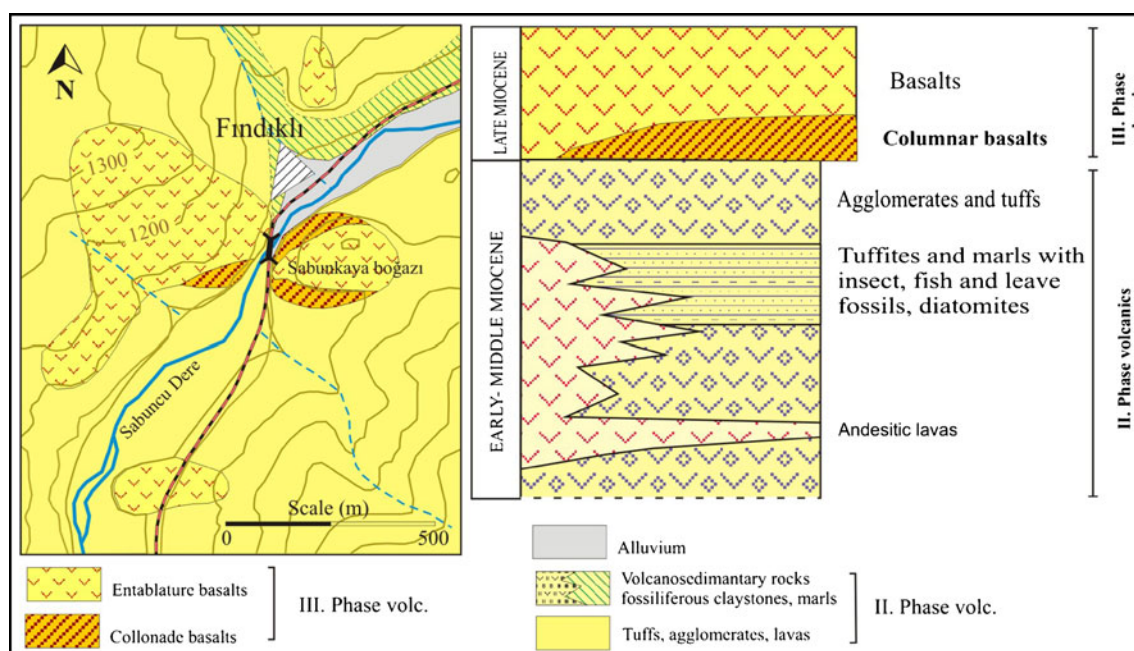


Fig. 10 Areal and stratigraphic positions of basalt columns (Kazancı et al. 2007)

2010). It was discovered and described first by Kasaplıgil (1977) and then studied in detail (Paicheler 1978; Ruckert-Ülkümen 1980; Ruckert-Ülkümen et al. 2002). The fossil assemblage consisted of different leaf, fish, and insect species hosted in a clay-dominated lacustrine sequence (Figs. 11 and 12). Unfortunately, it is one of the most disturbed geosites in Turkey particularly by fossil hunters, despite having been a nature conservation site since 1985 (Kazancı et al. 2005). Presently, after the establishment of the geopark, the gendarme is taking care of the geosite.

The fossil-bearing lacustrine deposits are parts of volcano sedimentary units intercalated with andesitic volcanic rocks all of which formed during the phase II volcanics (Fig. 11). The thickness of the fossiliferous layers is not known because of syn- and postdepositional deformation. 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 the 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 the columnar basalts and/or phase III volcanics covering the Beşkonak fossiliferous lacustrine deposits as a basalt lake

(Fig. 10). This cover in fact enveloped and protected the fossils and host sediments from natural erosion up to Early Pleistocene times.

Sedimentary deposits (marl and limestone), limnic coal seams, and fish fossils show that a large lacustrine environment was emplaced in the region in early Miocene times 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*, *Zelkova*, *Quercus*, *Juglan*, *Diospyros*, and *Nilia*

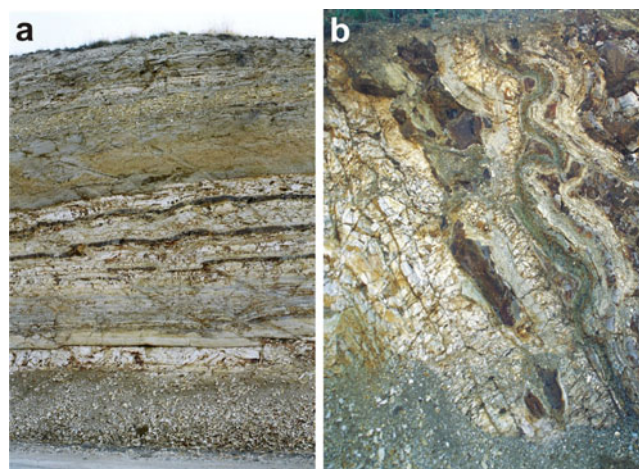


Fig. 11 a, b Lithology of the fine-grained, silica-bearing, and laminated lacustrine deposits of the Beşkonak geosite

Fig. 12 Fossils collected from the Beşkonak geosite. They all are now at the MTA Museum



Fig. 13 **a** Alicin monastery, **b** Turtle brothers (erosional feature on andesites), **c** a rare and endangered bird species; Kızılcahamam Black Vulture, **d** Endemic Kızılcahamam Tulip



(Kasaplıgil 1977). The area must have been as fascinating as it is today with its rocks, landscapes, and endemic living things (Fig. 13).

Concluding Remark

In some places, different types of rock, picturesque landscape, and rich wildlife come together as a natural wonder. The northwest of Ankara is just such a place; however, the rural area has been depopulated because of migration to the cities. On the other hand, some important geosites have been destroyed by visitors or collectors. As geotourism could be an easy solution for the development of towns and villages, administrators have accepted the formation of “the local Kızılcahamam–Çamlıdere Geopark” as an official management plan. Even geoconservation is a secondary purpose for local people and others; the geopark will serve not only geotourism but also awareness, education, and research on geosites and geoheritage. We are lucky that this first local geopark of the country has a great scientific value as it includes different types of stratigraphic, petrographic, structural, and geomorphological geosites, as well as cultural sites. The main tectonostratigraphic unit of the region is the Neogene Galatian Volcanic Complex. However, it is only one of the geological results of the collision of the African and Eurasian plates (Fig. 1). Other geowitnesses of the plates and the collision which are still active are found in the region. The Quaternary was mostly a time of erosion and/or landscape evolution period in Turkey.

A group of Earth scientists have managed to convince people that through the attractiveness of geotourism, rock, and landscape can be used to tell the long past story of the Earth. Up to now, geosites have been physically bounded by simple wooden fences or stones just to define the geological features and they were enriched by adding two 130×90 cm explanatory boards in Turkish and English, together with the construction of parking areas and resting facilities. Symbols, labels, and boards with specific color in brown have been placed along motorways and at crossroads for both advertisement and direction. Many booklets have been published and distributed freely. Training courses, seminars, and conferences for different groups (students, teachers, and local people) are still continuing. First results are extremely satisfying as local people have recognized that the project will be useful for themselves. Geoconservationists are also happy as the local people have become volunteer guards of the geosites. It is hoped that the geopark will achieve its targets for years to come. Visitors and researchers from everywhere to Kızılcahamam and even to other geoparks would make distinguished contributions to the joint “geoconservation” idea.

Acknowledgments Members of Turkish Association for Conservation of Geological Heritage–Jemirko, particularly Yaşar Suludere, helped with the preparation of early version of these notes. Gürol Seyitoğlu read the text and added some comments. Cemal Taluğ Rector of Ankara University, deans of Engineering Faculty, Head of the Kızılcahamam Municipality Coşkun Ünal, Kaymakams Bilal Çelik, Mustafa Çit, and Kaymakam of Çamlıdere Aydın Erdoğan gave full support during the geopark studies. Yaşar Suludere, Muzaffer Eker, Sevim Tuzcu, Hamdi Mengi, Necip Mülazımoğlu, Sonay Boyraz, Nurten Mercan worked in the field for the description of the geosites. In addition many local people and undergraduate students Özgür Yedek, Onur Yücel of Ankara University spent considerable effort to develop public awareness. Excursion participants of the Tectonic Crossroad Congress at Ankara in 2010 visited the geopark and gave new sights on the interpretation of the geosites. Valuable comments of the reviewers Alexandru Andrasanu and an anonymous one and José Brilha the journal editor provided significant contributions for the final version of the manuscript. They all are acknowledged with great pleasure.

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