

## General properties of elmacik fossil beds and Its importance in view of anatolian paleogeography

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### Abstract

Tefenni Basin, is located in the southwestern part of Burdur Basin. Elmacik village where paleontological excavations was made, is established at the place where Elmacik stream opens to Tefenni basin.

Elmacik fossil beds, were discovered during the geomorphological studies we did in 1997. Lake containing fossil, marsh layers consisting of fillers, are located on the Formation of Burdur.

These layers showing different color and texture features, are tilted 10-15 degrees to the east-southeast direction by tectonic movements affecting region. Due to subsidence and rising as a cause of tectonic reasons, this layer series are located at different altitudes.

Elmacik fossil beds insitu situation have mostly fossil localities. Secondary fossils are also observed in some layer series. Secondary fossil finds, consists of horn and bone oms belonging to various species lived in earlier periods. Elmacik vertebrate fossil bed, is located between the Neogene fossil beds in Tokmacik town of Isparta province and Özlüce village of Muğla province in south west Anatolia., According to these findings, Elmacik fossil bed shows a bed feature where comparisons can be made in view of the spread and migration of the upper Neogene faunal species.

Between 2006 - 2009, excavations were made in five localities in Elmacik fossil beds. Through this excavations, the presence of twelve different macro species were identified in the region, macro proboscidiens being in the first place. Among the excavated fossils, defense tooth of South Mamut, has been the largest ivory ever found in Turkey. Palaeontological findings excavated from the Elmacik beds, will be exhibited in a museum of natural history established in the center of Burdur.

With new work to be done in the Elmacik fossil beds, withdrawal stages of Burdur Pliocene lake, Pliocene tectonic movements affecting the region and new evidence of Quaternary transition period may also be obtained.

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## 1. Introduction

Elmacik village connected to Kemer town is located about 45 miles south of Burdur province. The village is located in the opening of the river with the same name to the Tefenni Basin where it built a valley (Map 1). Starting around Elmacik, the land shows a rather fragmented picture, with rising increasingly sharp ridges in the eastern direction, and advanced notch valleys. These ridges, toggles to the relatively large erosional surfaces in the back like Kocadüz, and Kayıdüz (Figure 1).

Elmacik fossil beds, were revealed during the geomorphological studies we did in the region in 1997. Fossil fragments we collected from villages surrounding hillsides, revealed the existence of a rich faunal community in Elmacik fossil beds in terms of types.

Before beginning any excavation during the summer of 2006, cross-sectional studies were made on the southern slope of Ardiçtekketepe which is to the south of the the village. As a result of these studies fossil-containing layers have been identified and excavations have been carried out in the layer set that is rich in findings.

Clayey, silty, sandy, lake-marsh fills has been named in the scientific literature as "Burdur Formation", this formation is observed in the slope surfaces and is interbedded with fluvial fill, lakes, swamps. Thin-member fillers such as clay and silt, has contributed positively to the fossilization process. Coprolite samples we found during excavations, show that the findings in Elmacik fossil beds are fairly well protected.

Mass movements, soil and mud flow occurred on slopes where fossil beds are, and erosion is strong there as well. Fossils exposed on slope surfaces or are close to the surfaces, suffer from these developments. In addition, damaging the fossil finds by loosening the soil surrounding the roots of plants or excreting sap, cause negative consequences.

## 2. General Tectonic and Geomorphological Features

Older Neogene terrestrial deposits in Anatolia, following the recent tectonic overlays started in Upper Miocene and continued at intervals until the lower Quaternary. Continental fillers at the same age with peneplain developing at Pliocene that forms the upper half of the Neogene, can be found in parts in western Anatolia where they can be protected from erosion and at different elevations. Burdur Basin, is an example of the protection of indicated terrestrial filling and a relatively wide distribution area.

Burdur Basin, began to develop, depending on the prevailing tectonic drawing from the Upper Miocene in the region. The block, gravelly, sandy, yellow, red colour land fill we observe in different parts of the basin is considered as the first traces of basin formation stage. Some sections are equipped with interbedded coal levels with these fillers. The clayey, silty, sandy, gravelly lacustrine sediments on the mentioned filling, sits with an angular unconformity. Above them come the travertine stores showing different thicknesses from place to place (Photo 1).

Layers forming the Burdur Formation, were roughly tilted 10-15 degrees in the east-southeast direction with tectonic movements. As a result of this development that caused tilting on the east side of the Burdur and Tefenni Quaternary basins, rivers coming from the higher parts, splitting the layered series which rose in part that opens to said basin formed relatively narrow and deep gorges. Elmacik stream likewise opens to the Tefenni basin creating a defile.

Between the valley entrance of the establishment of the Elmacık village and the pond 2 miles up the southeast, a graben is formed due to tectonic subsidence. Elmacık stream has developed a meandering bed in this graben base. Between the specified graben and Tefenni basin in accordance with the tectonic line and between the height of 1100-1150 meters, ridges consisting of hills and erosional surface chain such as Ardiçtekte, Gökmen, Akbayırlar, Kayıyokuşu, extends in the NNW-SSE direction in a line (Figure 1). The majority of the Elmacık fossil localities, are found on these ridges and on the slopes of the lower course of Elmacık stream valley.

### 2.1. Properties of the Layer Containing Fossil

Although there are fossils in each level of the Neogene old lake-marsh around Elmacık, two layers includes more fossils of animals of different species (Figure 2). The top level layer resulting on the slopes at the altitude of around 1100 meters, alongside with fine factors such as clay and silt, includes gravel and fragments of volcanic origin sponge stone as well. Pumice stones in the form of blocks that are understood to come from Gölcük volcano in the south of Isparta by being dragged by the rivers, are 15 - 20 cm in size. Fossil fragments contained in the 1100 m level that shows about 1.5 - 2 m of thickness, have been distributed in an irregular manner in ungraded fillers. Specified fossil fragments, transported and stored again in the filling. Found samples, are the hard parts of the skeleton like teeth and bones condyle.

The second level rich in fossils, according to the excavation work we did in Gökmen Tepe, though being approximately at 1070 m of height; both fossiliferous levels, as a result of vertical tectonic movements affecting the region, can be found in different raises in the environment. Fossiliferous layers as in the north slope of Ardiçtekte Tepe, was reduced to different levels in places with mass movements.

1070 m level, occurs in fragmented slopes and flood plains around Ardiçtekte, Gökmen hills and Akbayır Region extending in the south of Elmacık village. Especially on the southern and western slopes of Gökmen Tepe, with the other lake and marsh fillings, it stays in a slope state at 10-15 degrees to east - southeast direction because of tectonic reasons.

On the southern and western slopes of Gökmen and Ardiçtekte hills, fossils were found belonging to different types, in the fillings which weren't well cemented, emerged as a result of the erosion of flood waters from runoff and in different colors and lithology (Figure 3). Fossils we work on are of macro dimensions. As of 1100 m level was observed, two types of fossilization were encountered on these slopes as well.

Although moved and re-stored fossils in fragments are affected by erosion, fragmentation and atmospheric conditions, the overall situation suggests that they are moved from a nearby field. The layer they are found is a filling level of about 1.5-2 m in thickness that contains not well graded, uncommon block, gravel, sand, silt mixture. In some places, clay solidifications can be encountered rarely in fillings seen in ash-color on the exposed grey, khaki slope surfaces. The filling stacked between dense clay on the top, whereas uncemented line at the bottom showing an orange color tone close to 0.5 m in thickness. Second type of fossils in the filling, are fossils in insitu situation belonging to mostly animals in the macro size. These are at the level of 1070 m, as pockets (Photo 2).

The groundbreaking down between the village and Elmacık pond of the valley developed by the Elmacık stream, is bordered by steep slopes where the elevation difference reaches 130 meters between the base and the upper slopes of it. The steep slopes hit the fault escarpments, and the fault line leading to the formation of slopes, separates the ridges from Kayı Düzü in south direction and those in the south of the Elmacık village. Lower course of Elmacık stream, shows a graben feature that has a width of about 750 - 1000 m between the specified fault escarpment and western ridges. Valley floor is covered with alluvium. The defense tooth of the Mammoth Meridionalis we found in Gökyer

district in the southeast of this depression area, also indicates that different types of proboscians lived in Elmacik fossil fauna (Foto 3). This sedimentary sequence at this locality, gives important clues about the climate of the period Elmacik vertebrate fossil beds were formed. Terrestrial fill forming Gökyer localities, starts at the bottom with dense clay and coal level and above that sits the

1.5 m thick level of a clay containing the South Mammoth fossil. There is an evaporite layer varying between 1-2 m over the clayey level (Figure 4).

### 3. The Species Found In Elmacik Fossil Beds

The main types revealed and the pre-determined in Elmacik fossil excavations carried out between 2006 - 2009 with the permission and financial support of the Ministry Culture and Tourism of Turkey, Cultural Heritage and Museums General Directorate are as follows:

*Proboscida sp.*

*Hipparion sp.*

*Gazelle sp.*

*Rhinoceros sp.*

*Artiodactyla sp.*

*Cervidae sp.*

*Castoridae sp.*

*Rodentia sp.*

*Aves sp.*

*Mollusca sp.*

Chitin parts and hair parts detected in the coprolite sample we found in Kaletepe Region, show the presence of scavenger species in Elmacik fauna.

### 4. Significance of Elmacik Fossil Beds In Terms of Anatolian Paleogeography

Elmacik vertebrate fossil beds, are the first macro fossil areas that have been unearthed in Burdur Basin so far. In a long period, besides the richness of species in this region that is dominated by different conditions, well-preserved fossils increase the importance of this bed. With the new examination to be made, Elmacik fossil bed, in geological significance, seems to have properties that shed light on the near term Anatolian paleogeography in the points mentioned below:

- a. Elmacik fossil beds lays between the vertebrate fossil beds of Tokmacik in Isparta on its west and Sazak, Babadağ, Güzelpınar ve Çameli, Muğla'nın Özlüce, Eskihisar ve Akgedik in Denizli on its west. In this regard, Elmacik fossil beds, animal migration for Neogene period in Southwestern Anatolia, offers the opportunity to make comparison in terms of species used to live the period.
- b. Elmacik fossil beds are rich in species. With the new species and subspecies to be revealed by the excavations here, the inclusion of new types to the number of species that lived in Anatolian paleogeography will be provided.
- c. with the aging studies to be made on the found fossils, the dating of geological and tectonic events occurred in both Burdur Basin and western Anatolia, will become more clear.
- d. Swamp and river tanks which are members of the Burdur Formation around Elmacik, shows different color and texture properties. While generally cross-layered series which were dominated by coarse sediments such as block and gravel, indicate the presence of high water energy in the region, layer of series dominated by sediments such as clay, silt, and fine sand, indicate the weakness of the water energy. This situation suggest that the slope values in and around the basin changed due to tectonic reasons.

The presence of coalification level on some layers, constitutes evidence that there was an increase of rainfall in that region in the period when these layers were deposited and the vegetation became dense.

No fossil findings were found in layers showing yellow and orange colour. This case, shows that there were dry periods in the region that affected animal and plant life negatively and occurred in intervals.

- e. Having seen the coprolite samples in the excavations, indicates that Elmacık fossil beds offers very favorable conditions in terms of fossilization process.
- f. At different levels of the lake - marsh fillings sitting in compliance on the Pliocene fluvial lake, pumice fragments derived from Gölcük volcano were observed. This case, indicates that Gölcük volcano was active during the storage of 30 m thick terrestrial filling.
- g. Elmacık fossil beds were the first vertebrate fossil bed discovered on the Fethiye-Burdur fault zone. By aging done through fossils, more reliable results for when the tectonic movement in this zone started can be obtained.
- h. South mammoth found among the proboscidiens in Elmacık, is a type of African descent. This species, which corresponds to the Miocene-end Messiniyen, spread northward by land bridges resulted from water withdrawals that occur in the Mediterranean. In this regard, Elmacık fossil beds will provide significant findings about the plant and animal migration between Anatolian - African lands in the specified period.
- i. Species that form the Elmacık fauna are the types of the same geographic area. It indicates that there was an African savannah-like ecosystem of today in this region.
- j. Many of the species is extinct. Some of them are living in the present Anatolian geography. In this regard, the mentioned fossil region hosting the remains of these well-preserved species has been taken under protection by the Ministry Culture and Tourism of Turkey.
- k. There being methane output in the region between the Akören and Akçaören villages in the near south of Elmacık fossil bed, indicates the presence of significant natural gas formation under these fossil sites.
- l. Finds in Elmacık vertebrate fossil beds, are fossil remains that has a visual attraction that belong to the largest species uncovered in Anatolia until today.

## 5. Conclusion

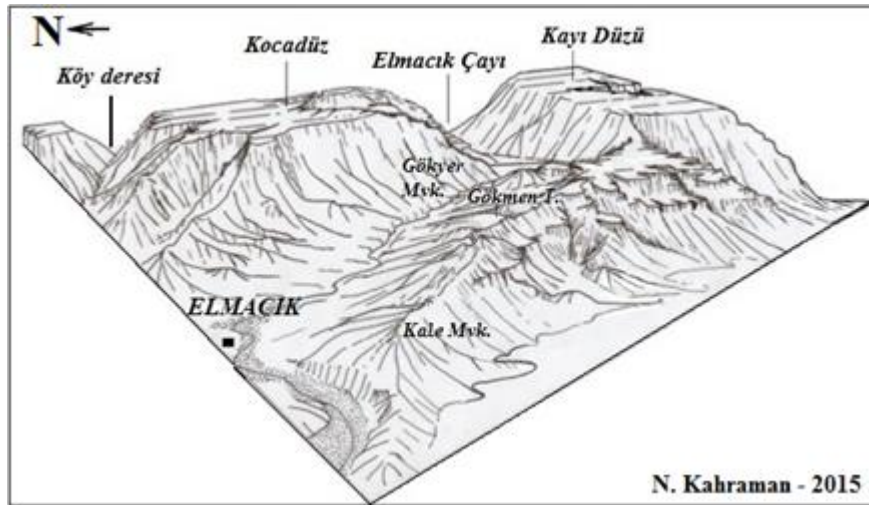
Elmacık vertebrate fossil beds have discovered in 1997. Excavation works of this area had been started on fossil beds in 2006. Studies were conducted on five different areas until 2009. Fossil findings are well-protected on cross-layers of clay. More fossil findings are encountered in the 1070 and 1030 meters levels of these layers. Excavation end with the findings which are belong to *Probocidae*, *Hipparion*, *Gazelle*, *Rhinoceros*, *Artiodactyla*, *Suidae*, *Carnivore*, *Castoridae*, *Rodentia* and *Aves* species. Elmacık vertebrate fossil beds excavation works were terminated in 2009. The fossil findings of the excavation will be exhibiting at the natural history museum which is being established in Burdur.

## MAPS AND FIGURES

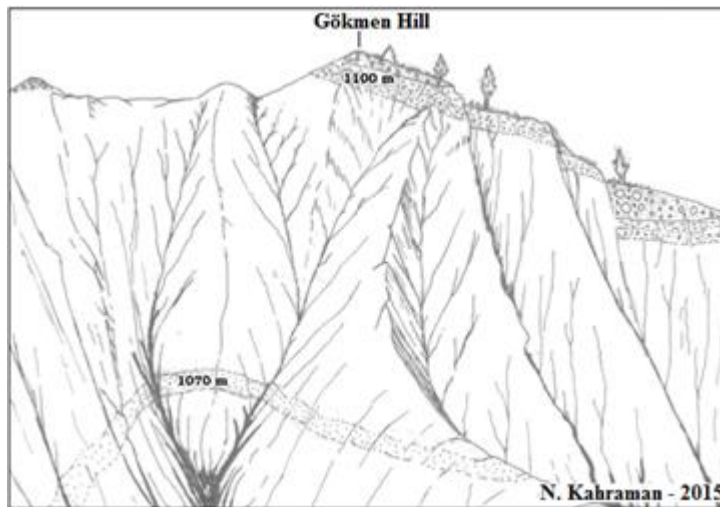


**Map 1:** Location map of the Elmacik fossil beds.

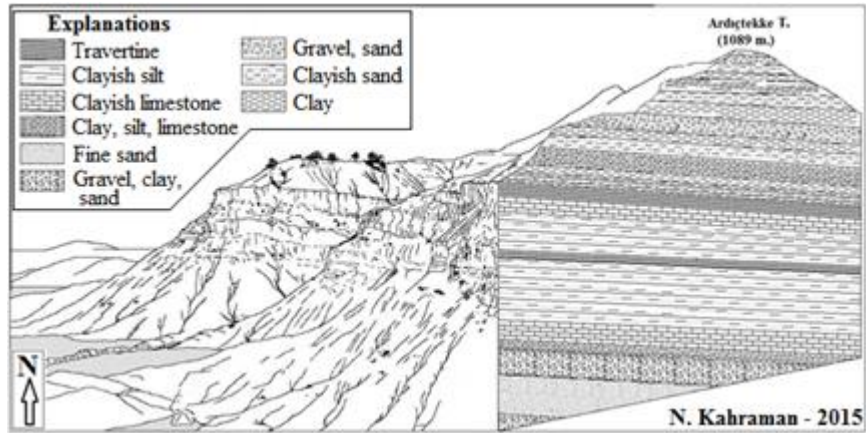




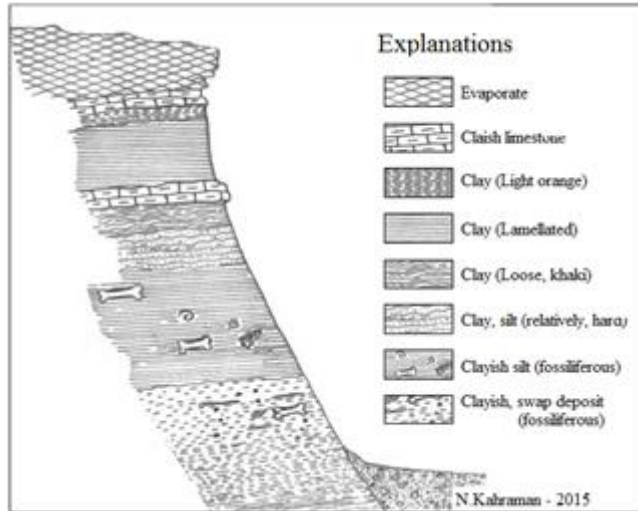
**Figure 1:** Simple block diagram of the field where Elmacik fossil beds are found



**Figure 2:** The order of layer series in the filling focused on fossils in Neogene terrestrial fill around Elmacik.



**Figure 3:** Overview and stratigraphic section of Burdur formation on the west slope of Ardiçtekke Tepe.



**Figure 4:** Section of the terrestrial filling where *Mammoth Meridionalis* in the Gökyar Region fossilised.



## PHOTOS



**Photo 1:** Appearance of the fill slope of Burdur Formation Badarmit River valley, 15 km to the N of the Elmacik fossil beds. Block, gravelly, sandy series below, travertine layer at the top (Photo: N.Kahraman 2007).



**Photo 2:** Find of Mammoth meridionalis which is in insitu condition in the western slope of Gökmen Tepe (Photo: N.Kahraman – 2009).



**Photo 3:** The largest defense tooth in Turkey extracted from the Gökyer locality. The length of the tooth of a southern mammoth (*Mammoth Meridionalis*) is about 3.50 meters (Photo: N. Kahraman 2007).