Türkiye Jeoloji Bülteni
Geological Bulletin of Turkey
64 (2021) 253—266
doi:10.25288/tjb.927117

Holocene Palynology and Pollen-Based Palaeoclimate Reconstruction of Lake Erçek (Eastern Anatolia); Short-Term Climatic Fluctuations and their Relation with Global Palaeoclimatic Change; Results of Cores E1 and E10

Erçek Gölü'nün Holosen Palinolojisi ve Polene Dayalı Paleoiklim Yapılandırması (Doğu Anadolu, Türkiye); Kısa Dönem İklim Salınımları ve Global Paleoiklim Değişimleri ile İlişkisi; E1 ve E10 Karotlarının Sonuçları

Güldem Kamar

Van Yüzüncü Yıl Üniversitesi, Mühendislik Fakültesi, Jeoloji Mühendisliği Bölümü, 65080, Tuşba, Van, Türkiye

• Geliş/Received: 24.04.2021 • Düzeltilmiş Metin Geliş/Revised Manuscript Received: 04.07.2021 • Kabul/Accepted: 05.07.2021
• Çevrimiçi Yayın/Available online: 06.08.2021 • Baskı/Printed: 25.08.2021

Research Article/Araştırma Makalesi *Türkiye Jeol. Bül. / Geol. Bull. Turkey*

Abstract: This study is a palynological and stratigraphical investigation of E1 and E10 core samples from the southern part of Lake Erçek (Eastern Anatolia, Turkey). Core samples were taken by a gravity corer from different water depths. Deposits in the core samples include mostly laminated rhythmic sediments, massive and graded layers and a tephra layer from E10 core, representing different time spans because of the faulted ground of the lake. Tentative time scales of the core samples are based on pollen and tephra correlation with Lake Van deposits. According to the palynological investigations, palaeovegetation of Greenlandian is represented by Amaranthaceae-dominant halophytic vegetation and semi-arid palaeoclimate conditions based on pollen analysis around Lake Erçek. The Meghalayan stage is mainly characterized by Poaceae-dominated steppe vegetation and increasing human impact according to anthropogenic pollen indicators. The Meghalayan palaeoclimate of Lake Erçek was more humid than Greenlandian and is represented by maximum deciduous *Quercus* expansion in recent times around the Lake Erçek area.

Keywords: Greenlandian, Holocene, Lake Erçek, Meghalayan, palaeoclimate, palynology.

Öz: *Bu çalışma Erçek Gölü'nün (Doğu Anadolu, Türkiye) güney kesiminden alınan E1ve E10 sediment karotlarının palinolojik ve stratigrafik incelenmesini kapsamaktadır. Karot örnekleri farklı su derinliklerinden gravite karot örnekleyici kullanılarak alınmıştır. Karot örneklerinin litolojisi çoğunlukla laminalı ritmik sediman, masif ve tabakalı seviyeler ile E10 karotunda bulunan tefra seviyesi içermekte ve göl tabanının faylı oluşundan dolayı farklı zaman aralıklarını temsil etmektedir. Karot örneklerinin yaşlandırılması Van Gölü örneklerinin polen ve tefra seviyeleriyle korelasyonuna dayandırılarak belirlenmiştir. Palinolojik inceleme sonuçlarına göre, Erçek Gölü'nün, Grönlandiyen paleovejetasyonu Amaranthaceae familyası baskın halofitik vejetasyon ve yarı kurak paleoiklim koşulları ile temsil edilmektedir. Meghaliyen katı ise Poaceae familyası baskın step vejetasyonu ve antropojenik pollenlere göre artan insan etkisi ile karakterize edilmektedir. Erçek Gölü çevresinde Meghaliyen paleoiklimi Grönlandiyen'den daha nemlidir ve günümüze doğru gelindikçe maksimum yaprak döken Quercus yayılımı ile temsil edilmektedir.*

Anahtar Kelimeler: *Erçek Gölü, Grönlandiyen, Holosen, Meghaliyen, paleoiklim, palinoloji.*

Correspondence / *Yazışma:* guldemkamar@yyu.edu.tr

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INTRODUCTION

Lake deposits act as a palaeoclimate archive with well-preserved deposits rich in palynomorphs. Holocene sediment deposits such as in small lakes suggest short-term climatic fluctuations from local to regional and global. These closed and small sediment basins like Lake Erçek have stored climatic records and lake level fluctuations on a time scale varying from thousands of years to tens of years. Investigations of ~50 globally-distributed palaeoclimate records show six periods of significant rapid climatic change during the periods 9000–8000, 6000–5000, 4200–3800, 3500–2500, 1200–1000, and 600–150 cal yr BP. These are characterized by polar cooling, tropical aridity, and major atmospheric circulation changes (Mayewski et al., 2004) including two main dry phases during Holocene.

Climate variability during Holocene has been recorded in Anatolia and also closer locations to Lake Erçek such as Lake Sevan (Armenia) and Lake Urmia (Iran) (Ülgen et al., 2012; Eriş, 2013; Ocakoğlu et al., 2013; Çağatay et al., 2014; Dean et al., 2015; Talebi et al., 2016; Ön et al., 2017; Hayrapetyan et al., 2018; Ön & Özeren, 2018). In northwest Anatolia, positive shifts in $\delta^{18}O$ of early Holocene indicate a mean summer temperature rise and increased aridity (Ocakoğlu et al., 2013). Deposits in Lake İznik points to arid periods and a lowered lake level for late Holocene at 4.2 and 3 ka BP (Ülgen et al., 2012). The Medieval Climatic Anomaly and more humid conditions around 1110 BP then drought and humid periods after this period have been defined respectively in northeastern Anatolia (Kılıç et al., 2018). In Eastern Anatolia, multiproxy data results from Lake Hazar indicate warm and humid climate conditions at the onset of Holocene (Biltekin et al., 2018) and a dropping water level about 3ka BP due to cold and dry conditions (Eriş, 2013). Palaeoclimate changes of the Quaternary period in Lake Van have been investigated in detail (van Zeist & Woldring, 1978; Wick et al., 2003; Litt et al., 2009; Kaplan & Örçen, 2011; Kaplan, 2013a; Kaplan, 2013b; Litt et al., 2014; Pickarski et al., 2015; Kamar, 2018). The 600 ka BP pollen record of Lake Van covers several glacial and interglacial periods (Litt et al., 2014). Almost all the palynological and palaeoclimatic data based on pollen analysis in Eastern Anatolia have been mainly focused on the Lake Van deposit. There are several smaller and high altitude lakes located on Eastern Anatolia Plateau and Lake Erçek is one of them. This study aims to investigate the palynology and carry out a pollen-based palaeoclimate reconstruction of Holocene deposits in Lake Erçek to identify short-term palaeoclimate and palaeoflora changes.

STUDY SITE

Lake Erçek is a soda lake and is located in Eastern Anatolia east of Lake Van at about 1815 m above sea level with a surface area of 92 m^2 and water depth of 40 m (İpek & Sarı, 1998). Several geological units ranging from pre-Cenozoic to Quaternary occur around Lake Erçek, which is situated at the intersection of the Afro/Arabian Plate to the south and the Eurasian Plate to the north and east (Figure 1). The continental collision between these two plates along the Bitlis-Zagros Suture Zone (~13 Ma) gave rise to the crustal shortening and uplift of the East Anatolian region (Şengör & Yılmaz, 1981; Şaroğlu & Yılmaz, 1986; Yılmaz et al., 1987; Koçyiğit et al., 2001). Gürpınar, Everek and Alaköy faults are the main faults that have been formed, and they control the eastern part of the Lake Van basin as a result of the collision (Okuldaş & Üner, 2013; Sağlam Selçuk, 2016).

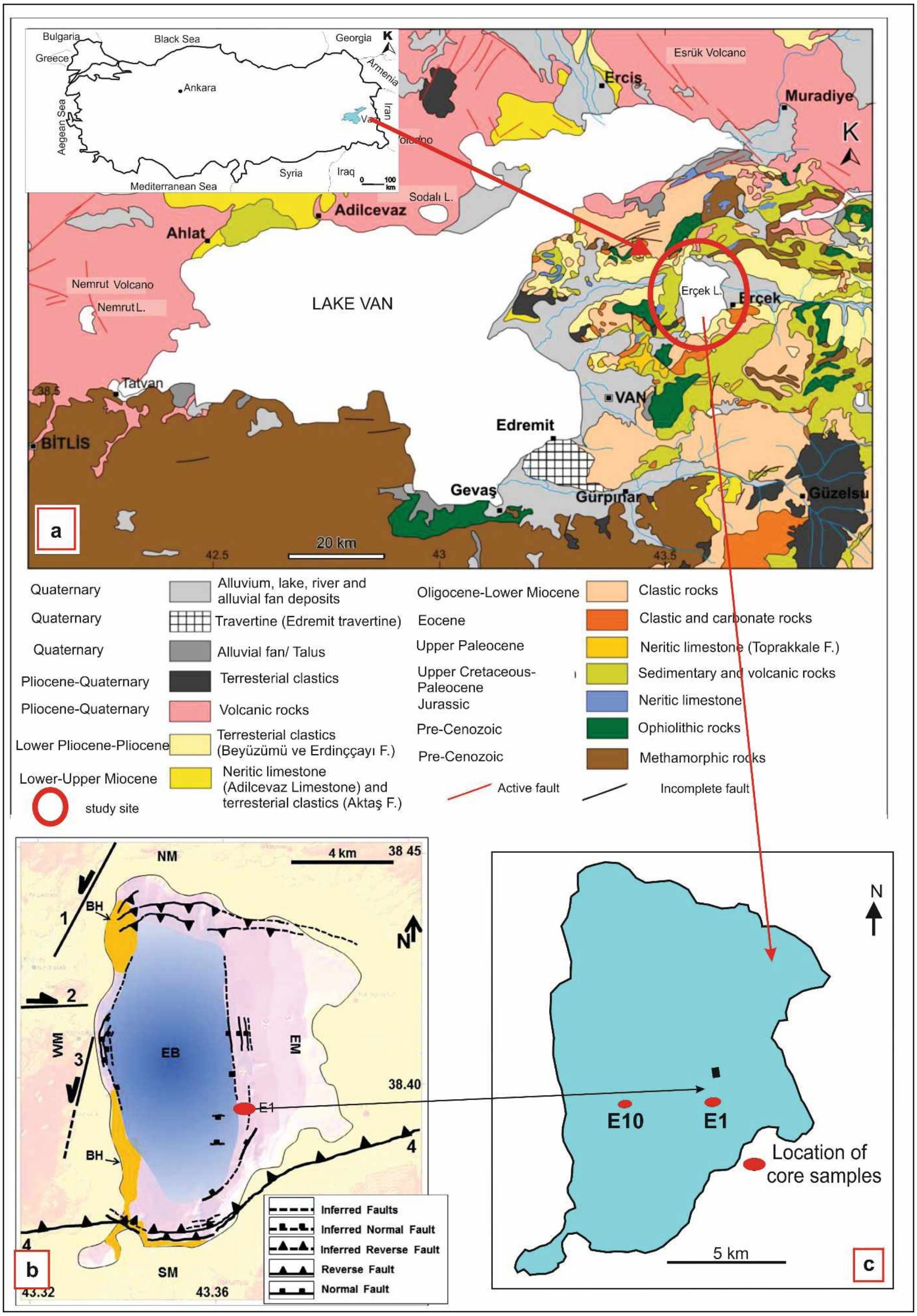

Figure 1. a) Location and geology map of surroundings of Lake Erçek (geological map taken from Alan et al., 2011), **b**) Detailed deformational elements and main faulting patterns of Lake Erçek (taken from Toker et al., 2017), **c**) Locations of E1 and E10 core samples.

Şekil 1. a)*Erçek Gölü'nün lokasyonu ve çevresinin jeoloji haritası (jeoloji haritası Alan ve diğ., 2011'den alınmıştır),* ***b)****Erçek Gölü'nün ana fay sistemleri ve detaylı deformasyonal elemanları (Toker ve diğ., 2017'den alınmıştır),* ***c)*** *E1 ve E10 karot örneklerin lokasyonları.*

The bathymetry and seismic features of Lake Erçek have been published (İpek & Sarı, 1998; Toker et al., 2017; Toker & Tur, 2018). Reverse normal and inferred normal fault systems have been identified at the bottom of Lake Erçek (Figure 1) (Toker et al., 2017; Toker & Tur, 2018).

The surroundings of Lake Erçek are covered by eastern Anatolian lowland steppe and the southern part of the lake is dominated by Eastern Anatolia high mountain steppe (Figure 2) (Eken et al., 2006). *Limonium meyeri, Tamarix parviflora, Carex divisia, Typha latifolia, Salix alba, Hippophae rhamnoides, Plantago lanceolata, Prunella vulgaris, Polygonum bistorta, Ephedra distachia,* and *Ephedra major* plants comprise the lowland steppe vegetation of Eastern Anatolia. Plants such as *Acantholimon kotschyi, Artemisia tauriaca, Centaurea virgata*, etc. have been observed in the high mountain steppe up to 2600-2700 m. *Rumex scutatus* and *Centranthus longiflorus* assemblages widely cover the valley borders up to 1300-2200 m (Tatlı, 2004).

The lowest mean annual temperature is 3.7 °C and the highest mean annual temperature is 14.9 °C for the Van region, according to the last eighty years climate data of the Turkish State Meteorological Service (https://www.mgm.gov.tr/veridegerlendirme/il-ve-ilceler-istatistik.aspx?k=A&m=VAN). In accordance with the Thornthwaite method, semi-dry and semi-humid climatic conditions prevail in Van province (Şensoy, et al., 2021).

MATERIAL AND METHODS

Core samples were collected in 2014 with a gravity corer from different water depths from 9 m to 39 m (Figure 1). The stratigraphical and palynological aspects of two core samples, E1 and E10, are investigated in this study. With a length of 111 cm, the E1 core was taken from a water depth of 18 m at an altitude of 1826 (±5) m above sea level. The 140 cm long sample E10 was taken from a depth of 36 m at an altitude of 1815 (±5) m above sea level (Figure 1). Samples were taken from 3-5 cm intervals for palynological investigation and prepared according to the standard palynological sample preparation method, treated with HCl, HF and $ZnCl_2$ (Ediger, 1986). A minimum of 450 pollen grains were counted per sample. The pollen descriptions, plates and illustrations of Wodehouse (1935), Erdtman (1943), Faegri & Iversen (1989), Moore et al. (1991) and Beug (2004) were used for pollen identification. Pollen diagrams were plotted using Tilia computer program (E. C. Grimm, Springfield, Illinois, USA).

RESULTS AND DISCUSSION

Palynology, Palaeoclimate Reconstruction, Lithology and Stratigraphy of Core E1

The 111 cm-long core sample E1 contains laminated sediments and massive layers up to 2 cm thick. Almost all of the core samples were composed of thin laminated seasonal sediments with light to dark colors. Laminated layers were interrupted by massive layers in a few levels of the core.

The fault systems have been identified in detail by seismic profiles from different directions of Lake Erçek (Figure 1) (Toker et al., 2017; Toker & Tur, 2018). According to those results, many of the normal faults, reverse faults, tectonic uplifts, erosional unconformity and subsequent erosion have been described from the seismic profiles of the bottom sediments of the lake (Toker et al., 2017; Toker & Tur, 2018). Lake Erçek core samples have different depositional time spans because of different sampling locations, such as from the hanging-footwall of the faults or deposits with eroded upper levels (Figure 1).

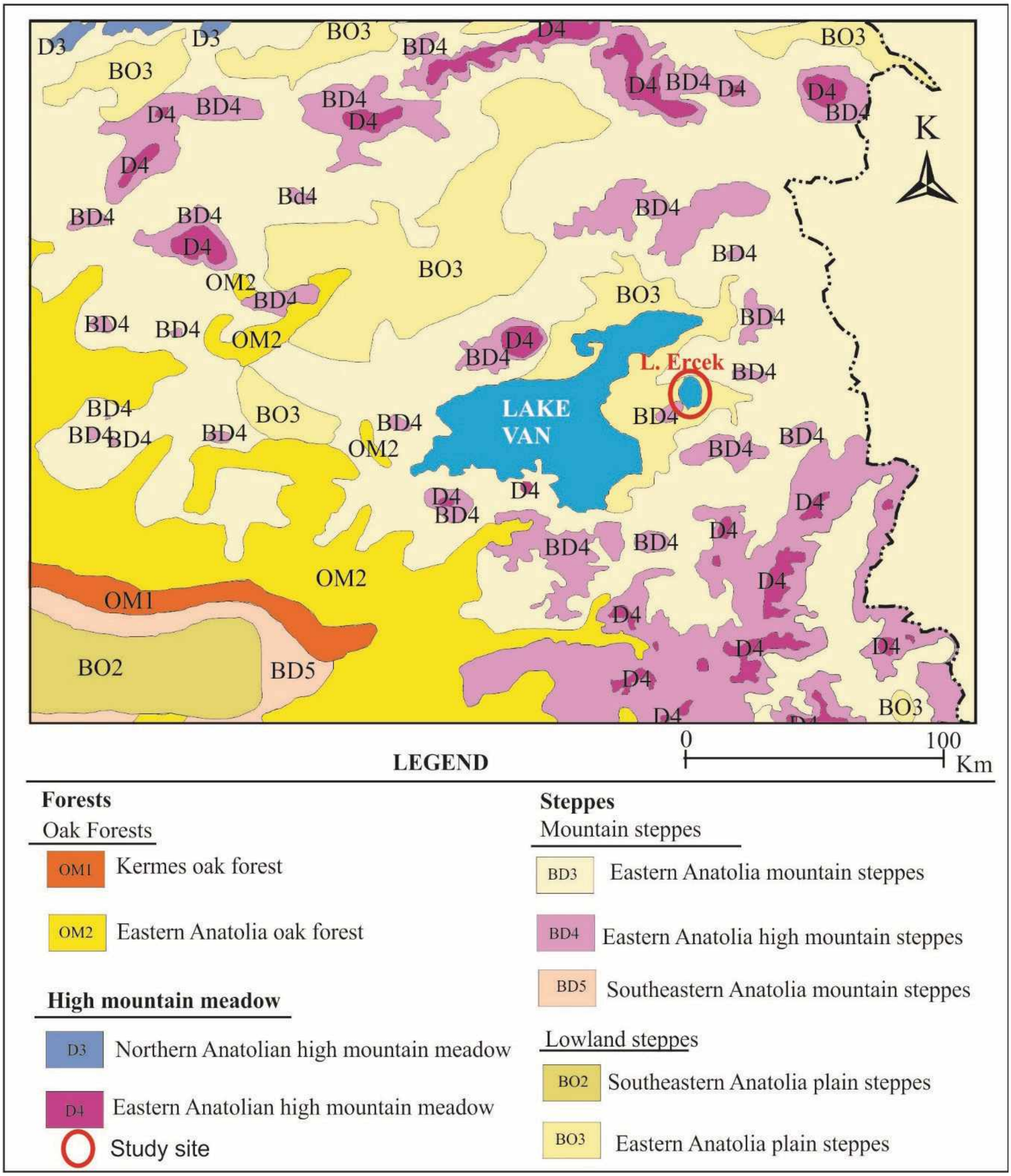

Figure 2. Vegetation map of surroundings of Lake Erçek and Eastern Anatolia (modified after Eken et al., 2006).

Şekil 2. *Doğu Anadolu ve Erçek Gölü çevresinin vejetasyon haritası (Eken ve diğ., 2006'dan düzenlenerek).*

The pollen diagram of the E1 short core samples has uncommon peaks of some taxa, incompatible with the Meghalayan stage. The high amount of pollen grains from semi-arid and halophytic plants such as Amaranthaceae in the samples indicates another time span of Holocene for the E1 core sample. Two scenarios can be suggested for the deposition age of E1 core; one may be a result of sampling from the footwall of the normal faulted system of the lake bottom, with missing upper levels; and the second scenario is slumping of the uppermost levels. Also, both scenarios may have been at work together. The remarkable peaks of some pollen curves in the E1 pollen diagrams are favorable for correlation with Lake Van pollen diagrams and the key points are shown with red dots on the pollen diagram of E1 (Figure 3). According to the correlations, the core sample has paraconformity in some levels (Figure 3). Younger sediments continued deposition after erosion or the downward move of the hanging wall of the fault, and hereby a paraconformity was formed between the upper and lower part of the core.

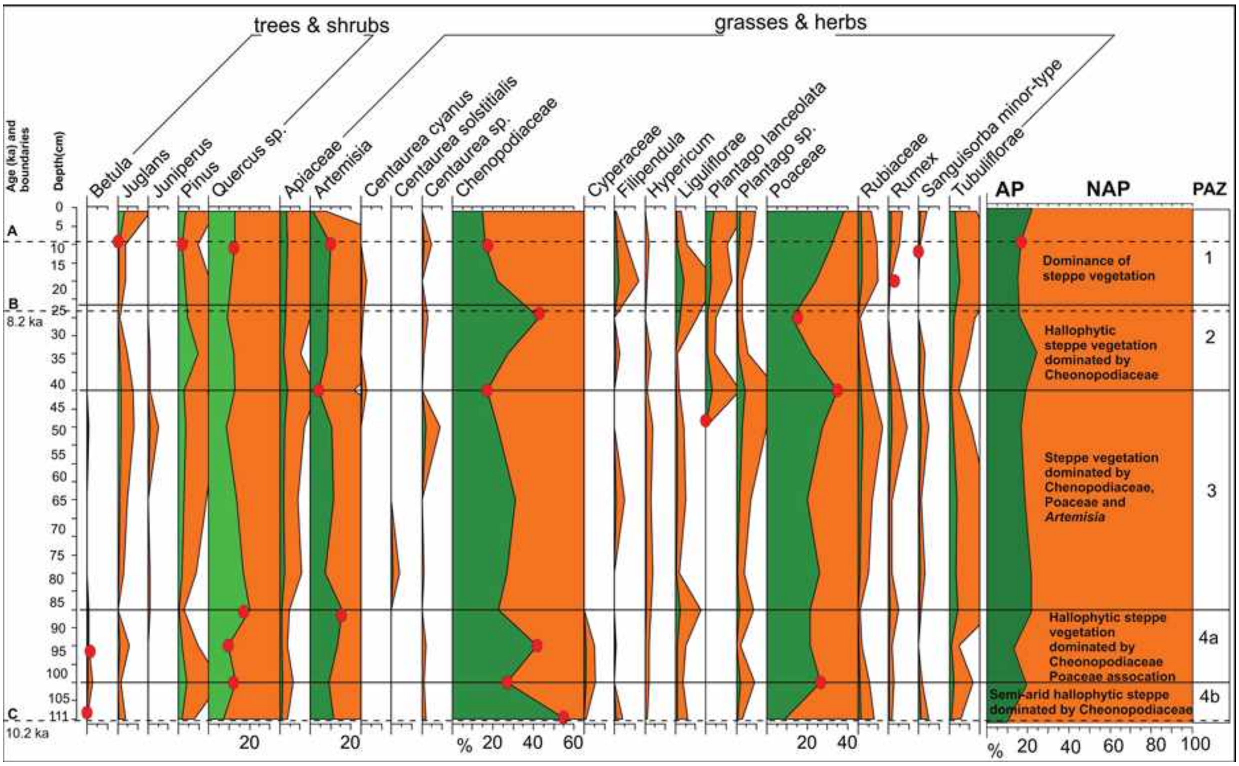

Figure 3. Simplified pollen diagram of E1 core samples (exaggeration value 5). A is the paraconformity boundary of Greenlandian and Meghalayan, B and C are tentative time scales of E1 core, PAZ is Pollen Assemblage Zone and red dots are correlation tie points with Lake Van pollen diagram samples (Wick et al., 2003; Litt et al., 2009, Kaplan, 2010).

***Şekil 3.** E1 karot örneklerinin sadeleştirilmiş polen diyagramı (abartı değeri 5'dir). A; Greenlandian ve Meghalayan parakonformite sınırıdır, B ve C E1 karotunun değişebilir yaşları, PAZ; polen topluluk zonudur ve kırmızı noktalar Van Gölü polen diyagramları (Wick vd., 2003; Litt vd., 2009, Kaplan, 2010) ile yapılan karşılaştırma noktalarıdır.*

E1 core sample revealed a very rich palaeoflora, with eighty-eight taxa. Some of these rich palaeofloral elements were observed just in several samples and have limited values under 1%; therefore, only pollen grains which have a continuous curve and meaningful values are shown on the pollen diagram of E1 core samples (Figure 3). According to the pollen diagram of E1, nonarboreal pollen grains (NAP) represented by Amaranthaceae, Poaceae and *Artemisia* are defined as the predominant and main elements of the palaeoflora (Figure 3). The pollen grains (AP) have a low ratio: deciduous *Quercus* are the main element of the trees and shrubs, with less than 18% value, while the second most dominant AP element *Pinus* curve value is less than 5% (Figure 3). *Juglans* is one of the most important AP elements in Lake Van Basin as an anthropogenic indicator but has a very limited value on the uppermost part of the diagram (Figure 3).

According to the abundance of the taxa, four different pollen assemblage zones (PAZ) may be distinguished in the pollen diagram of E1 (Figure 3). The ratio of arboreal/nonarboreal (AP/NAP) pollen grains changes between 8% minimum in the lowest part and 25% maximum in the upper part of the diagram. Changes in the AP are mainly due to differences in the deciduous *Quercus* values. Amaranthaceae reach their maximum value at the bottom of the diagram with about 60% and show a minimum of 15% at the top of the diagram. Poaceae reach maximum value at the top of the diagram with about 40% and the minimum at the bottom of the diagram with about 10%. Poaceae values increase, whereas Amaranthaceae values decrease. The pollen diagram has been separated into four different pollen assemblage zones (PAZ) according to distinct changes in the amount of AP and NAP pollen (Figure 3). PAZ4 is characterized by a maximum amount of Amaranthaceae and a minimum amount of *Quercus* and Poaceae pollen. The significant decrease of Amaranthaceae and increase in *Quercus* and Poaceae curves at the middle of PAZ4 suggest a short-term climate and also regional change around the study site. PAZ4 was separated into two subzones named as 4a and 4b. PAZ3 is characterized by the dominance of Amaranthaceae, Poaceae and *Artemisia* steppe. In the upper part of PAZ3, Amaranthaceae reach their minimum value whereas Poaceae have a peak value in the same zone. The boundary between PAZ3 and PAZ2 has been defined according to the maximum and minimum values of those taxa. The PAZ2 is represented by a distinct increase of Amaranthaceae and a decrease in Poaceae pollen grains. Dominance of halophytic steppe vegetation is characteristic for PAZ2. In PAZ1, the curve of Poaceae increases, whereas the curves of Amaranthaceae and Artemisia prominently decrease. PAZ1 is characterized by steppe vegetation.

All the taxa changes in the E1 pollen diagram indicate alternating arid (halophytic) and relatively humid phases during the deposition of core E1 sediments. The increase of halophytic indicator pollen grains such as Amaranthaceae and *Artemisia* and the decrease of humid pollen grains such as *Quercus* are in concordance with each other. When Amaranthaceae pollen grains increase on the pollen diagram, the *Quercus* curve decreases. Because of the overall changes in the palaeoflora, peak points of main taxa on the E1 diagram indicate palaeoclimate change rather than local palaeoflora changes.

The high amount of Amaranthaceae pollen grains (about 60%), Poaceae, *Quercus* and the other curves such as *Artemisia*, the Compositae tubulifloreae type, *Rumex*, *Pinus*, *Juniperus*, *Sanguisorba Minor* on the pollen diagram are in accordance with the Greenlandian stage of Holocene and are comparable to the pollen data of Lake Van (Wick et al., 2003; Litt et al., 2009). A high quantity of Amaranthaceae (about 60%) is typical for the early Holocene (Greenlandian) in the pollen diagram of Lake Van (Litt et al., 2009). According to the tentative time scale of E1 core, PAZ 4 and 3 of core E1 may correspond to the Greenlandian stage based on similarities with the pollen curves of Lake Erçek and Lake Van. Upwards in the E1 pollen diagram, a distinct increase of Amaranthaceae and a decrease of Poaceae and *Quercus* pollen grains indicate short term climate change, with a cooling event arising from the evaporative period during PAZ 2.

The semi-arid-dry phase of Lake Erçek is comparable with several areas such as Anatolia, the Near East, Cyprus, Greece, Bulgaria, Poland, etc. An abrupt arid event has been identified from the Dead Sea (Migowski et al., 2006). Results from Anatolia, Cyprus, Greece and Bulgaria provide concrete evidence for 8.2 BP cold events and central Anatolia is the best recognized of all those regions (Weninger et al., 2006). This cooling event was also reported on coastal East Asia (Park et al., 2018) and in Poland (Filoc et al., 2017). The Greenlandian stage of Holocene is characterized by halophytic semi-arid steppe vegetation in the Lake Erçek region according to the palynological and stratigraphical results and comparisons with nearby of E1 samples.

Palynology, Palaeoclimate Reconstruction, Lithology and Stratigraphy of Core E10

The core sample E10 contains thin laminated sediments from light to dark grey and light to dark brown in color, thin massive layers, normal graded layers and tephra layers (Figure 4). Lake Van basin has many volcanic centers such as Nemrut and Süphan, etc. producing tephra material (Figure 1). Tephra deposits in Lake Van basin have been investigated from Lake Van core samples and also well-exposed stratigraphic sections (Litt et al., 2009; Kaplan, 2010; Landmann et al., 2011; Sumita and Schmincke, 2013; Schmincke et al., 2014; Makaroğlu et al., 2018). Tephra layers in the Lake Van sediments mainly originate from the Nemrut and Süphan volcanoes (Landmann et al., 1996b; Landmann et al., 2011; Sumita and Schmincke, 2013; Schmincke et al., 2014). The regional variety of the thickness of the plinian fall deposits from Nemrut volcano indicate that the fallout fan extends to the east (Karaoğlu et al., 2005). Different grain-sized tephra layers (fallout deposits) extending to the east were deposited at the bottom of Lake Van in different subbasins during the Meghalayan stage. Tephra 2 of Lake Van Northern Basin (Figure 4) (Kaplan, 2010), tephra 3 of Ahlat Ridge (Figure 4) (Litt et al., 2009), tephra layer A (ash layer) of Tatvan Basin (Landmann et al., 1996b) and Tephra T1 of the Eastern Fan of Lake Van (Makaroğlu et al., 2018) correspond to each other. Varve based dating of the tephra layers of Lake Van is 2.6 kyr (Landmann, et l., 1996a; Landmann et al., 1996b). The Lake Erçek tephra layer is numbered T1 in this study (Figure 4). Pollen dating and tephra layer correlation between Lake Erçek, Lake Van Ahlat Ridge and Lake Van Northern Basin indicate the same tephra layer (Figure 4). The tephra layer was also sampled and investigated for pollen analysis but neither pollen nor any other palynomorphs or organisms were found.

E10 core samples are mainly dominated by NAP pollen grains with values between 67% and 83% (Figure 5). Poaceae pollen grains are dominant in the NAP with the values ranging between 20% and 38%. Amaranthaceae, Apiaceae, Asteraceae and *Artemisia* pollen grains are the other dominant taxa on the pollen diagram of sample E10 (Figure 5). Other NAP elements such as *Hypericum*, *Plantago lanceolata*, *Plantago* sp., *Rumex*, *Sanguisorba minor* and Cyperaceae pollen grains display a continuous curve on the pollen diagram with maximum 5% values.

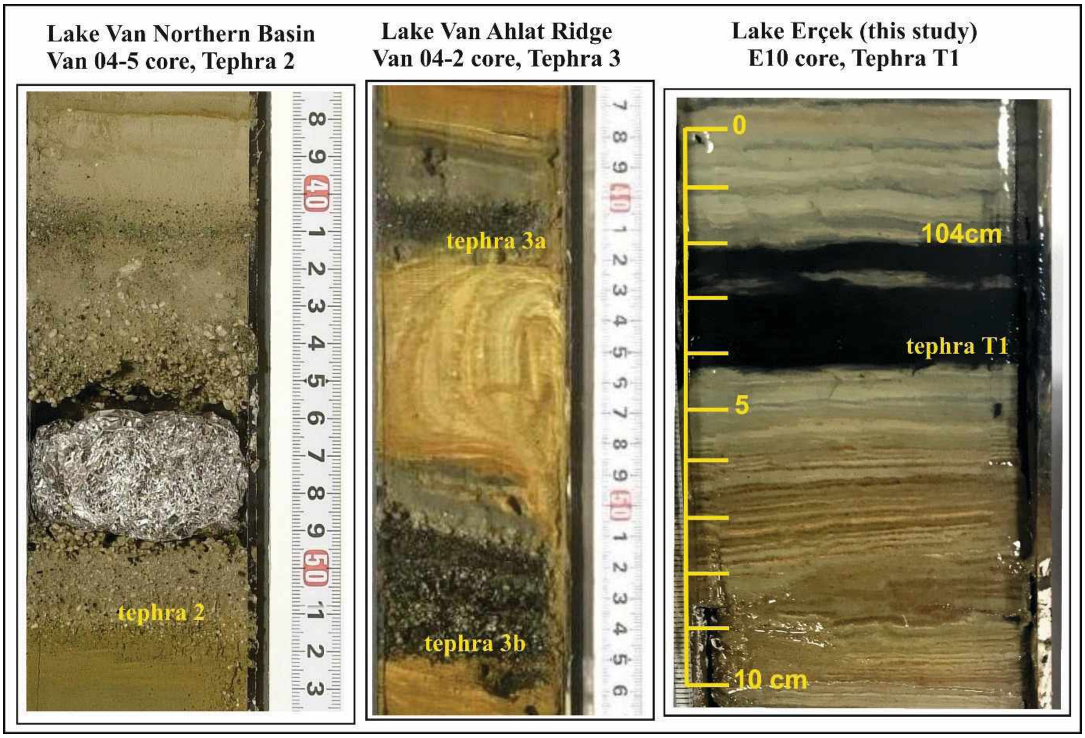

Figure 4. Tephra layers of Lake Van Northern Basin, Ahlat Ridge and Lake Erçek core E10 (tephra photos of Northern Basin and Ahlat Ridge modified from Kaplan, 2010).

Şekil 4. *Van Gölü Kuzey Havzası, Ahlat Sırtı ve Erçek E10 karotunun tefra seviyeleri (Kuzey Havzası ve Ahlat Sırtı'nın tefra fotoğrafları Kaplan, 2010'dan değiştirilerek alınmıştır).*

The maximum AP pollen grain value is 27% and most of the value is represented by *Quercus* pollen grains, at 25% (Figure 5). The second dominant taxon of AP is *Pinus* with a maximum value of 5%. *Juglans*, *Juniperus* and *Betula* pollen grains are the other main AP elements with uncontinuous curves of less than 3% (Figure 5).

The core sample E10 on the pollen diagram was separated into two pollen assemblage zones (PAZ) according to the distinct increase and decrease of Poaceae, *Quercus*, and Amaranthaceae and the onset of continuous *Juglans* pollen curves (Figure 5). The tentative time scale of E10 is mainly based on pollen correlations (correlation points are shown with red dots on Figure 5 and 6) of the main palaeofloral elements of AP and NAP between this study and Lake Van pollen diagrams (Wick et al., 2003; Litt et al., 2009; Kaplan, 2010; Kaplan and Örçen, 2011). Onset of the continuous *Juglans* curve has been dated to about 2-2.1 ka BP in the Lake Van sediments (Wick et al., 2003; Litt et al., 2009; Kaplan, 2010; Kaplan & Örçen, 2011). The continuous *Juglans* curve corresponds to a depth of about 65 cm in the E10 core (Figure 5). That level also indicates increasing human impact in the Lake Van Basin (Wick et al., 2003; Kaplan & Örçen, 2011).

PAZ2 (between 110-145 cm depth) at the bottom side of the pollen diagram is characterized by the dominance of NAP pollen grains with about 80% value (Figure 5) and has also been separated into two subzones, 2a and 2b, according to the increase of Amaranthaceae and decrease of Poaceae, *Quercus* and Cyperaceae pollen grains. Subzone 3b is represented by relatively more halophytic, semi-arid conditions than subzone 3a (Figure 5). The uppermost level of PAZ3 is dated to about 2.6 ka years, based on the tephra layer.

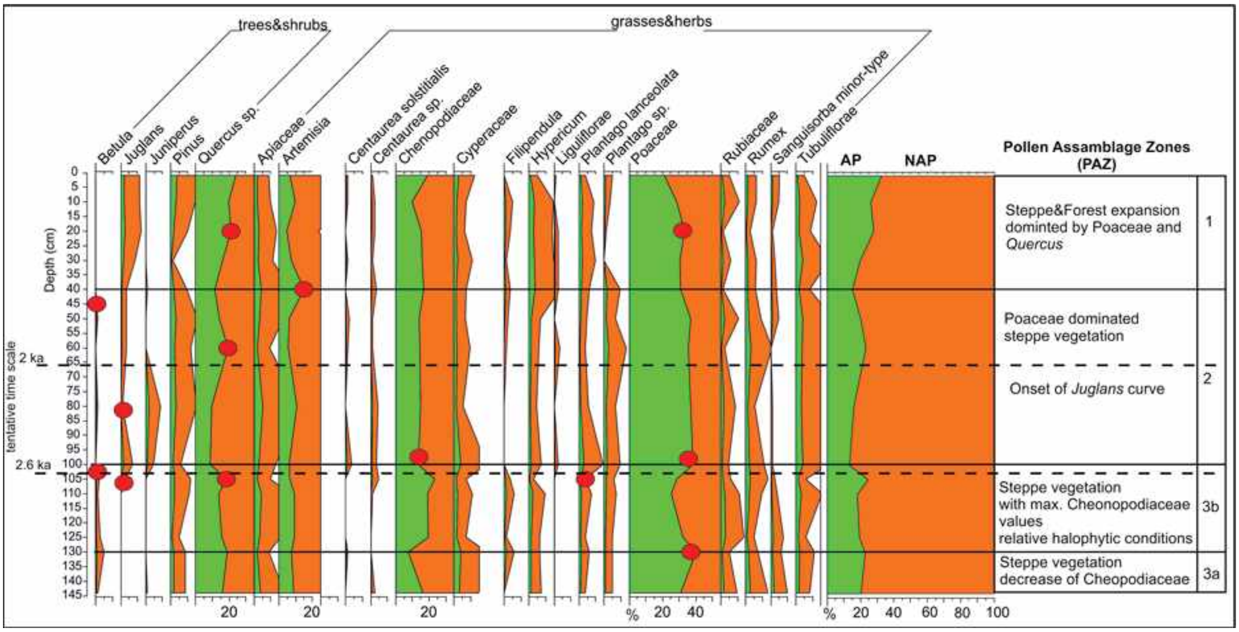

Figure 5. Simplified pollen diagram of E10 core samples (red dots shows tie points for tentative dating, exaggeration value is 5).

Şekil 5. *E10 karot örneklerinin sadeleştirilmiş polen diyagramı (kırmızı noktalar değişebilir yaş için bağlantı noktalarıdır ve abartı değeri 5'dir).*

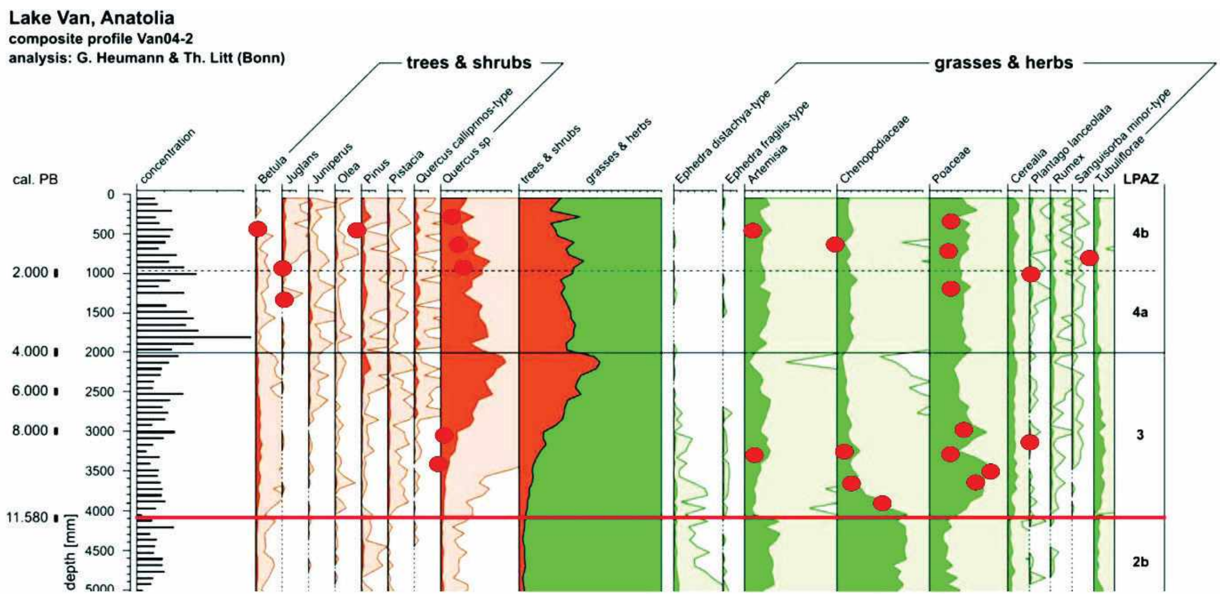

Figure 6. Pollen correlation tie points (red dots) between Lake Van pollen diagram (Litt et al., 2009) and this study.

Şekil 6. *Van Gölü polen diyagramı (Litt ve diğ., 2009) ve bu çalışma arasında yapılan polen korelasyonu noktaları (kırmızı noktalar).*

PAZ1 (between 110-0 cm depth) is characterized by a dominance of NAP pollen grains such as Poaceae, Amaranthaceae and *Artemisia* (Figure 5). The boundary of the PAZ1 and PAZ2 zones is mainly separated by the onset of the continuous *Juglans* curve. *Juglans regia* is a very important anthropogenic plant in the Lake Van Basin around Ahlat and Adilcevaz (Bitlis) regions in the present day and *Juglans* has commonly been cultivated in Lake Van Basin prevalently and economically from past to present (Muradoğlu & Balta, 2010). *Juglans* is also reported as an anthropogenic indicator at Lake Urmia (Talebi et al., 2016) in the Caspian Sea region from 2300 BP to present (Ramezani et al., 2016) and the semi-continuous curve of *Juglans* pollen grains for Lake Almalou was dated to cal 1500 BP as a fruticultural indicator (Djamali et al., 2009). *Rumex* and *Plantago lanceolata* have also been identified as anthropogenic indicators. In contrast to Europe, cereal type pollen grains have a limited importance in the Near East because of their natural occurrence and also cultivation (Behre, 1981). Both *Rumex* and *P. lanceolata* have a continuous curve on the pollen diagram of the E10 core of less than 5% and without showing any significant increase (Figure 5).

PAZ1b (between 40-0 cm depth) is characterized by steppe elements such as Amaranthaceae, Poaceae and *Artemisia* but in this zone Poaceae and *Artemisia* curves decrease while Amaranthaceae increase (Figure 5). The main AP elements *Quercus*, *Juglans* and *Pinus* pollen grains also increase in this zone and reach their maximum values (Figure 5). From the lower to the upper part of the zone, AP pollen grains increase by about 15% (Figure 5).

GENİŞLETİLMİŞ ÖZET

Bu çalışmada, Erçek Gölü'nden alınmış olan E1 ve E10 karot örneklerinin palinolojik, litolojik ve stratigrafik ilk inceleme sonuçları sunulmuştur. Karot örnekleri litolojik olarak çoğunlukla ritmik laminalı çökel içermektedir, bunun yanı sıra masif tabakalı seviyeler ile E10 karotunda tanımlanan bir tefra seviyesi içermektedir. Göl tabanının faylı yapısı (sismik araştırma sonuçları ve detaylar için bakınız Toker vd., 2017; Toker ve Tur, 2018) nedeniyle her iki karot, farklı yaş aralıklarını göstermektedir. E1 sediment karotunun polen analizi sonuçlarının, Van Gölü Geç Holosen (Meghaliyen) polen diyagramları ile uyumsuzluğu, gözlenen Amaranthaceae polenlerinin %60 civarındaki bolluğu ile yaprak döken Quercus ve Poaceae polenlerinin tüm diyagramdaki minimum değeri ile Toker vd., 2017 ve Toker ve Tur, 2018 tarafından tanımlanan, göl tabanındaki normal fayların lokasyonu ve karot lokasyonu karşılaştırıldığında, E1 karotunun Grönlandiyen yaş aralığına denk geldiği düşünülmektedir. Taban bloğundan örnekleme sonucu, E1 karotunun üst seviyeleri çökel içerisinde gözlenmemiştir. Bu normal fay oluşumu ve taban bloğunun bu çalışma kapsamında örneklenmiş oluşu nedeniyle, E1 ve E10 sediment karotları farklı yaş aralıklarını temsil etmektedir. Değişebilir yaş seviyeleri için, Van Gölü çökellerinden elde edilen polen diyagramları ve tefra seviyeleri ile korelasyonlar yapılmıştır. Korelasyon yapılan seviyeler için Amaranthaceae, Artemisia, Poaceae, Quercus, Juglans, Compositae tubulifloreae-type, Plantago lanceolata, Betula gibi tüm örneklerde en bol gözlenen polen taksonlarının belirgin değişim gösterdiği seviyeler baz alınmıştır ve bu seviyelerden bazıları diyagramlar üzerinde gösterilmiştir (Şekil 4 ve 5). Bu korelasyonlar sonucunda E10 karotunun ise, Meghaliyen döneminde çökelmiş olduğu belirlenmiştir. E10 değişebilir zaman ölçeği, devamlı Juglans eğrisinin görülmesine, karot içinde tanımlanan tefra seviyesine, Amaranthaceae, Poaceae ve Quercus gibi paleovejetasyonun ana elementlerinin bolluk değerlerine ve bu bulguların Yakın çevredeki Holosen polen diyagramları ile karşılaştırılmasına göre yapılmıştır.

Erçek Gölü bölgesinde Holosen boyunca, paleoflora değişimleri ve paleovejetasyon gelişimi kısa dönemli iklimsel değişimler, lokal flora değişimleri ve insan etkisi kontrolü altında *şekillenmiştir. Polen diyagramlarındaki Juglans, Plantago lanceolota, Rumex polenlerinin varlığı, yetiştiricilik ve otlatmaya da işaret etmektedir. Halofitik Amaranthaceae bitkisinin polenlerindeki artış ve Cyperaceae gibi sucul bitki polenlerinin azalışı, Meghaliyen ve Grönlandiyen boyunca kısa dönemli kurak koşulların hakimiyetine işaret etmektedir. Greenlandian dönemini temsil eden maksimum Amaranthaceae polen değeri, yarı kurak iklim koşullarını göstermektedir ve bu Holosen başlangıcından sonra gözlenen küresel iklim salınımları ile uyumludur. E1 sediment karotunun polen verilerine göre yüksek orandaki kuraklık belirteci bu bitki polenlerinin varlığı küresel 8,2 bin yıl soğuma olayı ile karşılaştırılabilir olarak görünmektedir. Diğer yandan, Meghaliyen katı Erçek Gölü bölgesi için Holosen başlangıcına göre minimum Amaranhaceae, Artemisia ve maksimum Quercus değeri ile daha nemli iklim özelliklerine sahip olarak tanımlanmıştır.*

ACKNOWLEDGMENT

This study was funded by Scientific Research Projects Unit of Van Yüzüncü Yıl University (Project Number: MİM-B-075). I would like to thank my undergraduate students for their help during field studies.

ORCID

Güldem Kamar https://orcid.org/0000-0003-4712-5997

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