World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(Research Article)

Check for updates

Sedimentological depositional features of Imam Hatip, Çiftlik Basin Central Anatolia, Turkey

Ghislain Berlin Viban * and Ali Gürel,Honorine Nug

Department of Geological Engineering, Ömer Halisdemir University, 51240 Niğde, Turkey.

World Journal of Advanced Research and Reviews, 2024, 22(03), 110–126

Publication history: Received on 23 April 2024 revised on 02 June 2024; accepted on 04 June 2024

Article DOI: https://doi.org/10.30574/wjarr.2024.22.3.1677

Abstract

This research seeks to unveil the sedimentological features of Imam Hatip for the first time in this region.Found in the Çiftlik Basin particularly at latitude 38°10'48.15" N and longitude 34°28'9.42" E and about 1535 m above sea level.In this article,Imam Hatip in Çiftlik (IMA-1 to IMA-16) (A-P), consisting of paleosols and terrestrial sediments in which a profile from a collection of 54 specimens was initially examined.This article assesses the depositional patterns of fluvial and lacustrine sediments at Imam Hatip during the Quaternary period. The Quaternary deposits comprise terrestrial sediments and paleosols, encompassing a range of particle sizes from fine to coarse grains, including peat, silt, clay, sands, and pebbles. While some coarse and angular grains originated from nearby sources, finer grains likely underwent extensive transportation by wind and water, experiencing repeated cycles of erosion and deposition with a core depth of 860cm.

The sedimentological depositional features of the Imam Hatip Formation in the Çiftlik Basin, Central Anatolia, Turkey, are investigated in this study. The Imam Hatip Formation represents a significant geological unit in the region, offering insights into the depositional processes and environmental conditions during its formation. Through detailed field observations, sedimentological analyses, and stratigraphic interpretations, this study aims to characterize the depositional facies, sedimentary structures, and lithological variations within the Imam Hatip Formation. Additionally, paleoenvironmental reconstructions and interpretations will be conducted to elucidate the depositional environments and paleoclimatic conditions prevalent during the deposition of the formation. The integration of sedimentological data with regional geological context and stratigraphic frameworks will provide valuable insights into the depositional history and paleogeography of the Çiftlik Basin during the time of Imam Hatip Formation deposition. This research contributes to the broader understanding of sedimentary processes and paleoenvironmental dynamics in Central Anatolia, while also providing a foundation for further geological investigations and resource assessments in the region.

The sediments exhibit significant variability in sorting within unconsolidated or partially lithified sediments and paleosols. While some levels display poor sorting, others exhibit moderate sorting characteristics. Additionally, paleosol, silty, and sandy levels commonly contain quartz, feldspar, amphibole, as well as fragments of metamorphic, volcanic, and igneous rocks.

Keywords: Depositional Facies; Imam Hatip; Reconstruction; Paleoclimate; Çiftlik Basin; Paleosols

1. Introduction

Some researchers have delved into studies in the Central Anatolia and the Çiftlik Basin proper.The following researchers had written on the Central Anatolian region,viz;Gürel and Kadir (2008), revealed the geology, mineralogy and geochemistry of Late Miocene clayey sediments in the southeast part of the Central Anatolian Volcanic Provence (OAVP).

* Corresponding author: Ghislain Berlin Viban

Before this study, there is no information about the Mustafapaşa Formation and weathered Cemilköy clay sedimentology and mineralogy from Late Miocene units. According to the authors, Late Miocene clayey sediments were deposited in lakeshore and shallow lacustrine environments southeast of OAVP (the clear name for this abbreviation).In the studies conducted by Yavuz- Işık and Toprak (2010), the Neogene-Quaternary aged sedimentary rocks intercalated with the Cappadocia Volcanic Region were examined palynologically. As the authors stated, important findings have been obtained about the vegetation and climatic conditions of the study area, and new palynological studies to be made from different parts of the region covering a large area in the future will contribute to revealing the paleoecology of the sedimentary rocks in the Cappadocia Volcanic Province in more detail.Viereck-Goette et al. (2010), field studies determined that the Sofular Ignimbrite should be included in the Sarımaden Tepe member in the light of mineralogical and geochemical evidence. In this study, they also defined the Plinian fall deposits in two levels and suggested the Ürgüp Formation as a member of Güzel Dere.Aydar et al. (2012), contributed to the stratigraphy of the region with 206Pb/238U isotopic age data obtained from 40Ar/39Ar and zircon minerals obtained from plagioclase minerals in ignimbrites in the Central Anatolian Volcanic Region.Paquette and Le Pennec (2012), discovered with their isotope geochemistry studies that the Upper Miocene aged ignimbritic units contain very old zircon crystals that crystallized during the formation of the earth's crust.Kadir et al. (2013), investigated the distribution and geochemical properties of clay minerals in different paleosol levels and clayey sediments in the Ürgüp Formation in the region between Araplı and Erdemli and contributed to the paleo-environmental interpretation of the region.Piper et al. (2013),analyzed the paleomagnetic and magnetic properties of the Cappadocia ignimbrites and interpreted the tectonic events that took place in the region during the Neogene.Kulah et al. (2014, 2015), investigated the geological, mineralogical and geochemical features of the Upper Miocene aged Mustafapaşa member sediments of the Ürgüp Formation and investigated the formation of clay minerals formed in these units.Lepetit et al. (2014), interpreted the evolution of the Nevşehir Plateau and the tectonic events that continued with the deposition of the Ürgüp Formation, using the isotopic age determinations made so far.Gürel (2017),commented on the paleoenvironmental and paleo-climatic records of the region by using mineralogical, geochemical and stable isotope geochemistry data of Upper Miocene aged paleosol and caliche levels in the western part of the Central Anatolian Volcanic Region. As a result, they determined the qualitative and quantitative properties of the above-mentioned local clays and diatomites that will enable them to be used effectively in industry and industry.

The following researchers have worked specifically on Ciftlik and surroundings.They are,Mouralis et al. (2002),investigated the Quaternary aged Göllüdağ and Acıgöl valcanic rocks in Çiftlik plain and revealed their genesis, instability and eruption phases.Mouralis, D., (2003), in his doctoral thesis, examined the Quaternary aged Göllüdağ and Acıgöl volcanic rocks located in Çiftlik plain and revealed their genesis, instability and eruption stages. He also determined the eruption or dome formation ages of rhyolite and pyroclastic for the first time by dating the rhyolite and pyroclastics in the region.Türkecan and Kuzucuoğlu.,(2004) investigated the Quaternary aged sedimentary and volcanic rocks in the Çiftlik plain within the scope of the MTA-CNRS-TÜBITAK joint project. The petrographic features of the rocks in the region and the geomorphological structure of the region were revealed.Kuzucuoğlu et al., (2013), the authors examined the Quaternary aged sedimentary and volcanic rocks in the Çiftlik plain and specifically deduced the geomorphological structure of the plain and the evolution of the plain.Gürel (2016), the author studied the Quaternary aged sedimentary and volcanic rocks in the Çiftlik plain and determined especially the sedimentological, petrographic and geochemical properties of the Pliocene aged sediments of the plain. In addition, the chins andspecies of diatom fossils found in the sediments of the plain were also revealed for the first time.Gürel (2017), examined the Quaternary aged sedimentary and volcanic rocks in the author Çiftlik plain and determined the diatom species and mineralogical content of the Pliocene aged sediments of the plain.

1.1. Location of the Study Area

The research area lies within the Niğde province, specifically in the Çiftlik district, Ovalıbağ-Çiftlik Region, depicted on the 1/25,000 scale Aksaray L32-c3 and K33-c2 maps (see Figure 1). Access to the study area is facilitated by a 20 km asphalt road branching off the Niğde-Çiftlik highway to the northwest. The Çiftlik plain is situated amidst settlements such as Niğde-Çiftlik, Ovalıbağ, Bozköy, and Divarlı (refer to Figure 2). Positioned at a low environmental altitude, the plain is bordered by the southern Cappadocia volcanic heights (including Hasandağ, Keçiboyduran, and Melendizdağ) to the northwest and the Sileğin corridor at the base of Göllüdağ to the north. The Derinkuyu Plain, forming the eastern gravity basin, feeds into the Çiftlik plain from the northeast. The plain's western and eastern boundaries are delineated by Cappadocia's Keçiboyduran and Melendizdağ formations (dating back to the late Miocene and Pliocene) and deformed volcanic rocks forming the Göllüdağ-Melendiz barrier, respectively. Characterized by flat terrain, the Çiftlik plain is covered with dry, low-level steppe vegetation. The altitude of the plain ranges from 1400 m near Çiftlik to 1220 m on the Derinkuyu plain in the southwest, which separates the two plains. The current flow network of the plain runs from northwest Çiftlik to southwest Ihlara- Aksaray, with shallow hydraulic channels forming braided stream patterns. Although non-uniform, the main channel's water flow is concentrated in the southwest of the study area. The research encompasses drilling activities conducted in the Melendiz and Çiftlik districts situated in the south of Ovalıbağ. Within the framework of the Master's Thesis, over 300 paleosol, siliceous clastic, and volcanoclastic sediment sites were selected within the Çiftlik plain study area (Ço), two of which are exemplified in Figures 2 and 6, respectively.

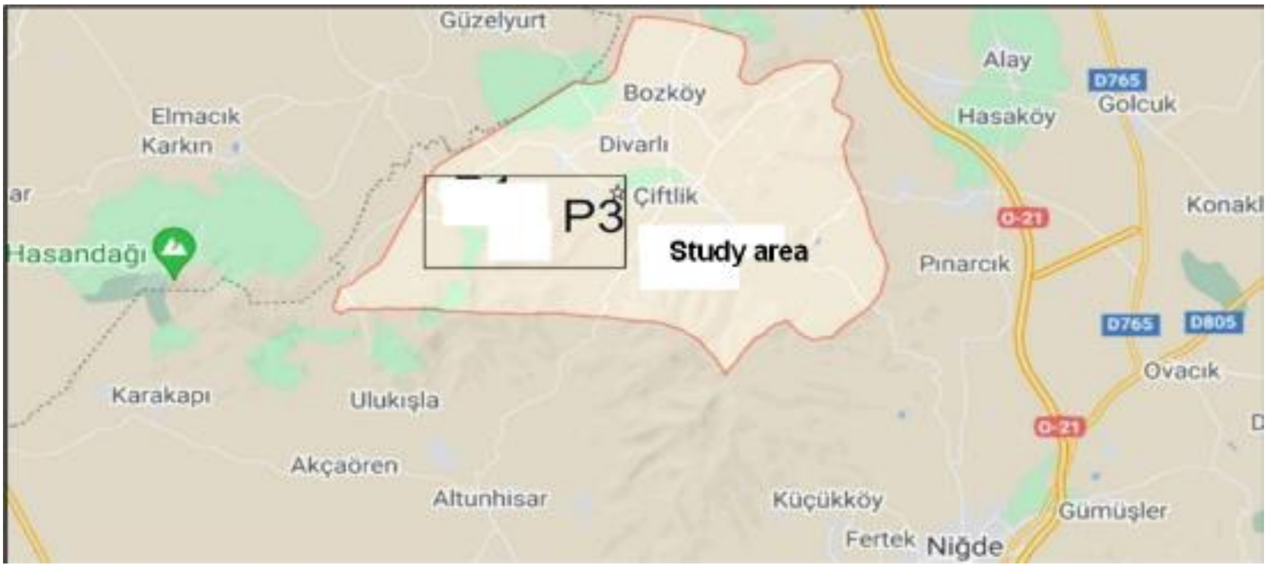

Figure 1 Location map of paleosol and unconsolidated sediment samples collected in the study area (P3: Imamhatip)

1.2. Geology of the study area

The geology of the research area is summarized in the figure below.

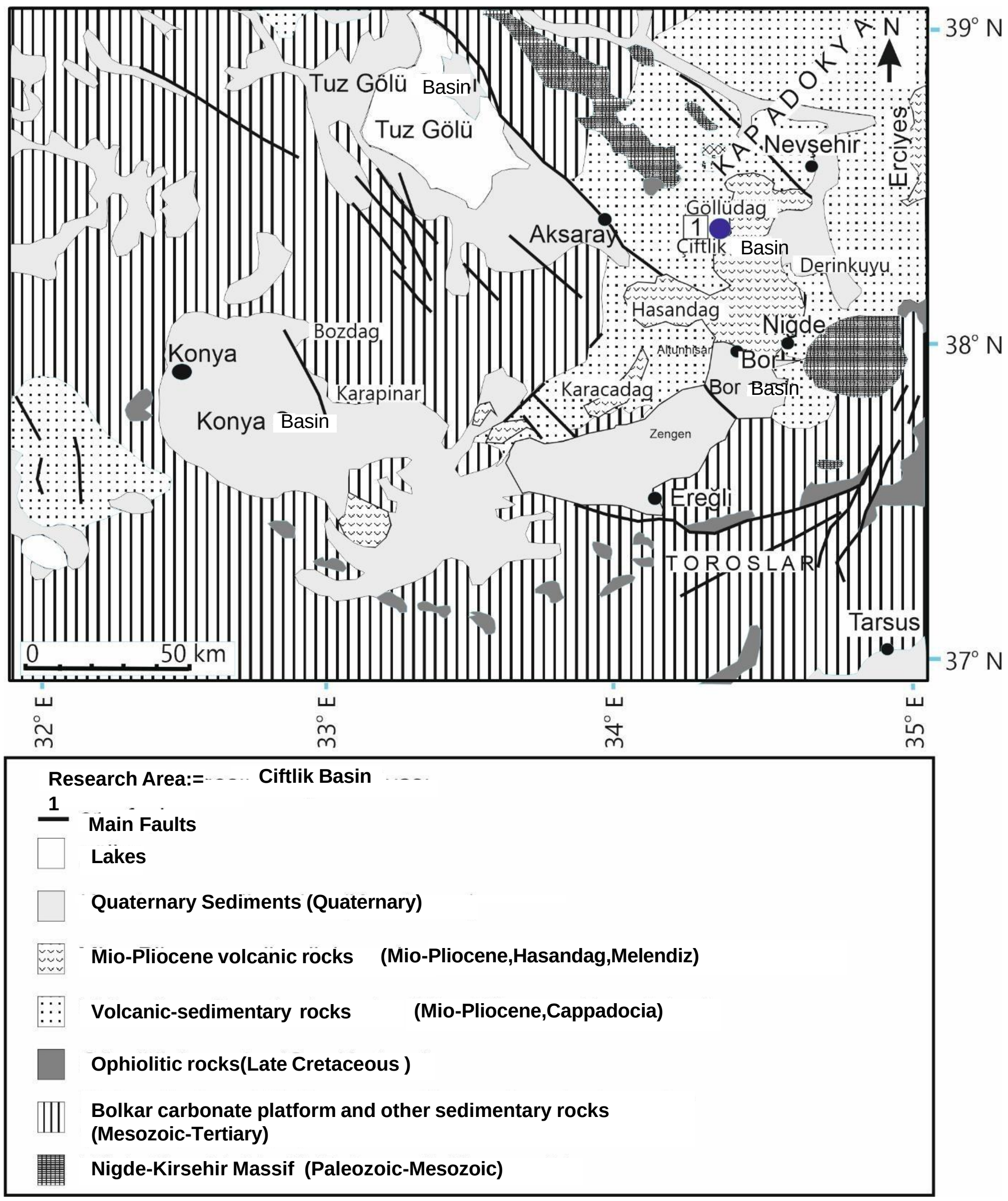

Figure 2 Geological map of the study area and its immediate surroundings and the location of Çiftlik plain (modified from MTA, 1/2 000 000 scaled map).

2. Materials and method

In this research; By examining the Quaternary fillings of the old sand pits with the help of drilling, hand probes and/or splitting from the Çiftlik plain, paleosol, unconsolidated or low-consolidated sediment samples were collected from various lines and depths suitable for the purpose of the project. In addition, various rock samples were taken from the immediate surroundings of the plain and at the base of the Quaternary fillings. The research undertaken to complete this article were carried out in two stages being field and laboratory.

Table 1 Imamhatip, (Çiftlik Plain) - Core Depth: 860 cm. 38°10'48.15" N and 34°28'9.42" E (1535 m. a.s.l)

Sample No/cm	CaCO3	Colour	Plant	Pebbles%	Sand %	Silt %	Clay%
IMA 17d1(0-3)	none	Dark grey	Present	--	20	40	40
IMA 17d1(8-11)	none	Dark grey	Present	--	35	42	23
IMA 17d1(20-25)	none	Dark grey	Present	5	45	20	20
IMA 17d1(33-35)	none	Dark grey	Present	2	50	21	27
IMA 17d1(38-40)	none	Dark grey	present	5	55	25	15
IMA 17d1(43-47)	none	Dark grey	none	10	65	15	5
IMA 17d2(5-8)	none	grey	none	5	30	35	30
IMA 17 d2(11-14)	none	grey	none	5	35	40	20
IMA 17 d2(20-23)	none	grey	none	2	40	38	20
IMA 17 d2(30-33)	none	grey	none	10	45	30	15
IMA 17 d2(38-41)	none	grey	none	20	40	20	20
IMA 17 d3(6-10)	none	grey	none	10	43	27	20
IMA 17 d3(17-20)	none	grey	none	15	45	30	10
IMA 17 d3(24-27)	none	grey	none	20	50	15	15
IMA 17 d3(33-38)	none	grey	none	20	38	20	22
IMA 17 d4(0-7)	none	grey	none	10	40	30	20
IMA 17 d4(12-16)	none	grey	none	12	44	34	10
IMA 17 d4(19-22)	none	grey	none	12	55	18	15
IMA 17d4(26-29)	none	grey	none	25	60	10	5
IMA 17d4(34-37)	none	grey/orange	none	--	75	15	10
IMA 17d4(44-49)	none	grey/orange	none	5	70	15	10
IMA2 17d1(10-13)	none	orange	none	--	30	30	40
IMA2 17d2(9-13)	none	yellow	none	--	25	30	45
IMA2 17d2()23-28)	none	orange	none	--	10	42	48
IMA2 17d2(36-44)	none	orange	none	--	10	50	40
IMA2 17d2(50-52)	none	orange	none	--	10	50	40
IMA2 17d2(60-64)	none	orange	none	--	70	20	10
IMA2 17d2(67-72)	none	grey	none	--	50	30	20
IMA2 17d3a(3-6)	none	white	none	--	--	40	60
IMA2 17d3a(6-9)	none	white	none	--	1	45	54
IMA2 17d3a(11-13)	none	white	none	--	5	40	55
IMA2 17d3a(20-88)	none	white	none	--	--	30	70
IMA2 17d3a(30-38)	none	white	none	--	--	30	70
IMA2 17d3a(40-48)	none	brown-grey	none	--	--	20	80
IMA2 17d3a(50-58)	none	brown grey	none	--	--	25	75

IMA2 17d3b(8-14)	none	yellow	none	--	3	32	65
IMA2 17d3b(18-24)	none	yellow	none	--	--	40	60
IMA2 17d3b(28-34)	none	yellow	none	--	--	35	65
IMA2 17d3b(38-44)	none	yellow	none	--	--	40	60
IMA2 17d3b(48-54)	none	yellow	none	--	--	42	58
IMA2 17d3b(58-62)	none	yellow	none	--	--	41	59
IMA2 17d3b(62-64)	none	dark yellow	none	--	10	40	50
IMA2 17d3b(66-67)	none	dark yellow	none	--	15	35	50
IMA2 17d4a(5-13)	none	dark yellow	none	--	--	45	55
IMA2 17d4a(25-33)	none	grey	none	--	--	40	60
IMA2 17d4a(36-43)	none	dark grey	none	--	--	35	65
IMA2 17d4a(57-63)	none	grey	none	--	--	44	56
IMA2 17d4a(62-64)	none	white	none	--	5	45	50
IMA2 17d4a(67-69)	none	white	none	--	5	50	45
IMA217d4a(75-84)	none	dark grey	none	--	2	43	55
IMA217d4(87-94)	none	dark grey	none	--	4	44	52
IMA2 17d4b(5-11)	none	grey	none	--	--	30	70
IMA2 17d4b(15-21)	none	grey	none	--	--	35	65
IMA2 17d4b(25-33)	none	grey	none	--	--	38	62

A total of 54 terrestrial sedimentary samples were collected from the region for research purposes.

3. Results

3.1. Hand Drills and Profile Descriptions

Type lithostratigraphic strut section descriptions of Imamhatip (IMA, P3 profile) region

More than 6 lithostratigraphic strut sections were excavated on the Çiftlik plain. The most important of these, and the third lithostratigraphic vertical section that can represent the whole region, was searched and it was determined that this type of section was between Imamhatip (İma, P3 profile) (38°10' 48.15" N and 34°28'9.42 E), (Profile 3); beginning at 1520 m); the findings and results of this research are as follows (Table 4, Figure 11).

Unit 1 (47 cm), brown peat (chocolate color) containing root stock. In the first 20 cm, small and sparse pebbles and dense small plant rootlets are observed, and in the next 16 cm, coarse or fine pebbly levels are observed in chocolate-colored paleotropics. In the lower levels of this unit, fine-grained gravel levels are striking. A little oxidation zone is observed at 43 cm where this level ends, and a transition to yellow clay is observed after 40 cm. Brown peat consisting of pebbles was found at the end of the unit.

Unit 2 (8 cm), black clay (peat) is present and they are found in alternation with beige-ocra clay layers. In addition, some beige clay in the matrix within the clayey levels, and after 86 cm, it passes into the oxidation zone and beige-ocher clay and sparse pebbly peat levels. Gravel and fine pebbles were detected in the matrix containing organic matter. Just below this level are yellow clay, pink and clay with hardened matrix content. After this level, the presence of tightly packed clay proves that there is aeration, and they are alternated with white and pink clay levels. The level with glossy mica content is between 125-158 cm, just below the level described above. Gravel with brown sandy clay matrix, gravels surrounded by brown sandy clays, sparsely pebbly black clay levels continue in profile. Tephra (reworked?) = yellow clay, this level is followed by yellow tephra and then below yellow tephra: black fine sand grains are commonly observed. Very tight black paleo-soil was observed at the 2 cm continuation. In the continuation of the profile, after 28 cm, it consists of compacted light yellow clay, fine sand, very fine pumice tephra, and finally, gravelly sand with coarse sand and fine gravel-sized tephra level.

(The second part varies between 158 cm – 860 cm and is the continuation of the above profile)

Unit 3 (140 cm) is a gravel-containing level (coarse alluvium) and gravels (alluvial fan) reaching approximately 4-5 cm in diameter.

At Unit 4 (23 cm), this level begins with beige clay containing oxidised sparse pumice sands, the next 3 cm may contain a lot of pumice, yellow sands and little gray sands in oxidized beige clay. Below this, there is oxidized beige-clay level containing oxidized beige clay and medium sand.

Unit 5 (82 cm) and unit 6 (46 cm) begin with an inter-bedded level of oxidized brown clay, sand. In Unit 6, the silty clay is massive light beige in color and is a level with less oxidized plant traces towards the bottom. It is a light beige colored, sandy, pebbly clay level and fine grained pumice pebbles were also detected. Just below this level, oxidation zones are more common starting from 32 cm. The unit is very similar to the above level with larger pebbles at the end.

Table 2 The paleosol and terrestrial sediments detected in the pillar section of Imamhatip

0 - 58 cm; brown peat (chocolate-coloured), plant rootlets are widespread and in sparse gravel, brown peat levels are found where sparse gravel level decreases (Unit I)
58 - 284 cm, black clay (peat) level, black clay / beige-dark clay alternating, there is oxidation and beige-dark clay up to 38 cm at the bottom of these levels. Gravel and pebbles with various lithologies are observed in a matrix containing organic matter at the above-mentioned levels. Very tightly packed clay takes on a blown-down appearance (tephra?), these levels end with brown sandy clay and sparse gravel towards the end of the unit (Unit II)
284 - 424 cm; gravel-containing level (coarse alluvial fan deposits), (Unit III)
424 – 478 cm; There are sparse grains of sand in oxidized beige clay, this level passes to the level of increasing yellow colored sand in oxidized beige clay and ends with a slightly gray clay level. Alluvial fan sands in oxidized beige clay [Unit IV]
478 - 560 cm; oxidized brown clay (60 – 76 cm), sand inter-layer (= 48 - 56 cm true sand level), [Unit V]
560 - 653 cm; slightly silty clay, light beige, massive and dense (not plastic), around 6 cm, traces of oxidized plant roots, lower levels with alternating sand and gravel, light beige clay level, (Unit VI)
653 – 658 cm; oxidized yellow sand and black clay intercalations are present, (Unit VII) 653
- 660 cm; level containing grey basalt or tephra products (Unit VIII)
704 - 780 cm; level containing dark grey, blue clay, [Unit IX]
780 - 820 cm; tephra level (formed in very hot chimney environment), later blast (surge), steam explosion products, [Unit X]

Unit 7 (5 cm) and unit 8 (2 cm) are one level with an alternation of oxidized yellow sand and a beautiful black organic layer and offer 3 different thicknesses, they can be 1 mm, 1.5 mm and 2 mm respectively. Unit 8 is completely composed of basaltic gray tephra (scoria products).

Unit 9 (76 cm) and unit 10 (15 cm), unit 9 has a dark gray-blue clay level and looks like a massive unit. The continuation of Unit 9 consists of alternating fine sand and brown clay layers between 61 and 61- within a gray-yellow matrix. These levels pass to the coal-containing level at 63 cm and continue between 63 and 73 cm. At the end of this unit, pumice is observed between 69 and 71 cm.

Unit 10 (40 cm) has levels of compressed blue-grey clay terminating the profile, and a summary of this profile (Imamhatip) is presented in Table 4 and Figure 11 below.

As a result, the lithostratigraphic strut sections of Çiftlik plain were excavated. The most important of these, being Imamhatip lithostratigraphic vertical sections that can represent the whole region. Imamhatip (İMA) of this type section was examined. It has been determined that climatic changes have changed facies in the sedimentary environment and storage conditions have also changed.

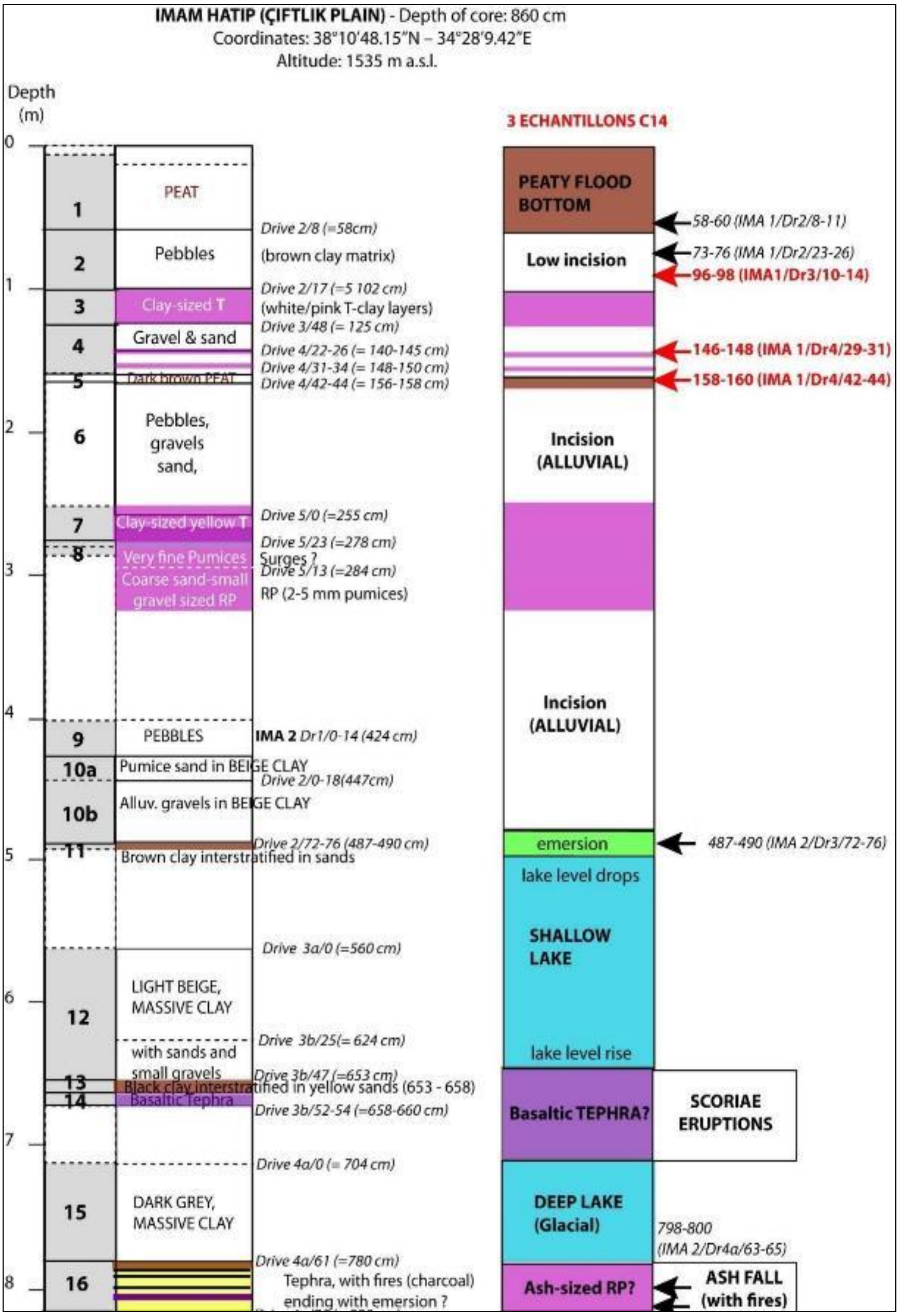

Figure 3 Stratigraphic section and lithological features of the pillars from the Imamhatip (Çiftlik) region (Source: Kuzucuoğlu and Gürel, 2022, unpublished

Table 3 Identification of lithologic and pedologic profiles (cores) and paleoenvironmental interpretation of Quaternary deposits of the Central Anatolian Imam Hatip (Ciftlik Plain), Turkey

Facies	Code	Description	Interpretation	Field Photo
Lithofacies-A Dark Peat	Pt	Dark gray color, very rich in plant remains and organic matter, some pebbles present, fine- to coarse-grained, muddy matrix, medium to well-sized, sub-rounded to rounded	Fluvial	
Lithofacies-B Brown Gravel	Pb	Brown gravel Pb Grayish brown, pebbles embedded in clay matrix, coarse grained, angular-rounded, poor-medium sized. 58cm-102cm thick	Fluvial	
Lithofacies-C White Clay	Cy	White/pink in color, clayey matrix, dark pebble clasts, rare plant rootlets, fine to coarse grains, subangular to well rounded, poor to good sized, thickness 102cm to 125cm.	Fluvial	
Lithofacies-D Gravel and Sand	Gs	Grayish brown, small and coarse pebbles embedded in clayey matrix, angular to medium sized, poorly to moderately rounded, 125 cm to 150 cm thick.	Fluvial	
Lithofacies-E Brown Peat	Bp	Dark brown in color, pebbles embedded in sandy matrix, fine to coarse grained, medium sized, angular to sub-rounded, thickness 150cm-158cm	Fluvial	
Lithofacies-F Dark gravel / pebbles / sand	Pg	Dark to grayish brown, coarse to granular in size with numerous pebbles larger than 10 mm, angular to sub-rounded, poorly to moderately sized, thickness 158 cm to 255 cm..	Alluvial	
Lithofacies-G Yellow Clay	Yc	Yellow, very fine to coarse grained, massive in a sandy matrix, very well sized and very well rounded. 255 cm to 278 cm thick	Alluvial	
Lithofacies-H Yellow Pumice	Pu	Yellow, very fine to coarse grained sands, sandy matrix, very well sized, well rounded with a thickness between 278cm and 284cm	Alluvial	
Lithofacies-I Yellow Pebble	Pl	Brownish yellow, fine to coarse grains, pebbles larger than 5 mm in sandy matrix, angular to rounded, 284 cm to 424 cm thick, poor to medium size	Alluvial	

Lithofacies-J Yellow pumice sand/gravel	Ps	Yellow, very fine to very coarse grains, pebbles mixed with clay matrix, poorly to well sized, angular to well rounded, thickness 447cm to 487cm.	Alluvial	
Lithofacies-K Brown Clay	Ka	Brown clay, very fine to coarse grains, clayey or muddy matrix, presence of pebbles, angular to well-rounded, moderately well- sized, thickness 487 cm to 490 cm.	Lacustrine	
Lithofacies-L White sand/clay/pebbles	Lc	White/brown in color, the upper boundary is made of massive clay, white in color, very fine grains, well-sized, well-rounded, the lower part is made of brown, fine, grained and fine-grained sand and small pebbles, pebbles, sub- angular-rounded, poor-medium sized. It is between 490 cm and 653 cm thick.	Lacustrine	
Lithofacies-M Yellow clay	By	Dark yellow, fine to coarse grains, presence of a few pebbles embedded in silty/sandy matrix, subangular to rounded, moderate to well sorted, 653 cm to 658 cm thick	Lacustrine	
Lithofacies-N Brown basaltic tephra	Bt	Brown colored, very fine to coarse grained, very well sized, well rounded, sandy matrix ranging in thickness from 658cm to 660cm.	Lacustrine	
Lithofacies-O Dark clay	Dg	Dark grey, massive, very fine grained, well rounded, very well sized, thickness between 660cm and 780cm	Lacustrine	
Lithofacies-P Grey Tephra	Tp	Grey, massive, muddy/clayey matrix, very fine-grained and very hard and kiln-fired, very well- sized and rounded with thicknesses between 780cm and 820cm.	Lacustrine	

4. Discussion

The findings of this research shed light on the sedimentological characteristics of the Imam Hatip Formation in the Çiftlik Basin, Central Anatolia, Turkey. Through the examination of fluvial and lacustrine sediments, the study identified a diverse range of particle sizes and lithological components within the formation. The presence of peat, silt, clay, sands, and pebbles suggests varying depositional environments, potentially indicative of fluctuations in water flow and energy levels during the Quaternary period.

Furthermore, the analysis revealed notable variability in sediment sorting within different layers of the formation, indicating dynamic depositional processes and environmental conditions. The identification of quartz, feldspar, amphibole, and rock fragments in the sedimentary layers provides insights into the provenance and composition of the sediments, highlighting the influence of both local and distant geological sources.

The integration of sedimentological data with regional geological context allowed for the reconstruction of paleoenvironmental conditions prevailing during the deposition of the Imam Hatip Formation. These interpretations contribute to our understanding of past climate fluctuations, hydrological regimes, and landscape evolution in Central Anatolia during the Quaternary period.

5. Conclusion

In conclusion, this study offers valuable insights into the sedimentological characteristics and depositional history of the Imam Hatip Formation in the Çiftlik Basin. By examining sedimentary facies, structures, and lithological variations, the research enhances our understanding of past environmental dynamics and geological processes in the region.

The findings presented in this article contribute to the broader geological knowledge of Central Anatolia and provide a foundation for further research and resource assessments in the area. The comprehensive analysis of sedimentological features not only advances our understanding of past environments but also facilitates the interpretation of geological records and landscape evolution in the Çiftlik Basin and beyond

Limitations

Some potential limitations of this study could include:

- The study focuses specifically on the sedimentological features of Imam Hatip within the Çiftlik Basin. This narrow geographical scope may limit the generalizability of the findings to other regions within Central Anatolia or other sedimentary basins.
- The examination of a profile from a collection of 54 specimens may not fully capture the sedimentological variability within the Imam Hatip Formation. A larger sample size or additional sampling locations could provide a more comprehensive understanding of the depositional patterns and lithological variations.
- While the core depth of 860cm provides valuable insights into the sedimentary sequence, it may not capture the entire depositional history of the formation. Deeper cores or additional drilling may be necessary to fully elucidate the stratigraphic record and paleoenvironmental conditions.
- Paleoenvironmental reconstructions and interpretations are subject to uncertainties and assumptions inherent in the interpretation of sedimentary features and paleoclimatic conditions. Factors such as diagenesis, post-depositional processes, and preservation biases could introduce uncertainties in the interpretation of the data.
- The accuracy and reliability of sedimentological data, such as grain size analysis and mineralogical composition, could influence the robustness of the interpretations. Ensuring consistent and high-quality data collection methods is essential for minimizing potential biases and uncertainties in the results.

Addressing these limitations could enhance the reliability and applicability of the findings and provide a more comprehensive understanding of the sedimentological features and paleoenvironmental dynamics within the study area and beyond.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Kuzucuoğlu C,Geomorphology Of The Melendiz River in Cappadocia (Turkey): Setting Of Pre-Pottery Neolithic Sites Of Arikli And Musular, And Climate Reconstruction During The Onset Of The Holocene,*Geogr. Fis. Dinam. Quat. 36 ,2013,9/-10/, 6 figg.*

[2] Çiner et al,Late Pleistocene Glaciations And Paleoclimate Of Turkey,*Bull. Min. Res. Exp. (2015) 151: 107-127.*

[3] Doğan et al, Geomorphological Evolutionary History of the Melendiz River Valley,Cappadocia,Turkey,*Springer volume 1,2019,pages 203-222*.

[4] Keller,Volcanism related to plate tectonics in the western and eastern Mediterranean,*1974.*

[5] Pasquaré, G., Poli, S., Vezzoli, L., ve Zanchi, A., Continental arc volcanism and tectonic setting in Central Anatolia, Turkey. Tectonophysics, 146,1988, 217-230.

[6] Koçyiğit and Doğan, Morphotectonic evolution of Maviboğaz canyon and Suğla polje, SW central Anatolia, Turkey,Geomorphology Volume 306, 1 April 2018, Pages 13-27*.*

[7] Doğan,Climate-controlled river terrace formation in the Kızılırmak Valley, Cappadocia section, Turkey: Inferred from Ar–Ar dating of Quaternary basalts and terraces stratigraphy,Geomorphology *Volume 126, Issues 1–2, 1 March 2011, Pages 66-81 .*

[8] Çiner et al,Quaternary uplift rates of the Central Anatolian Plateau, Turkey: insights from cosmogenic isochron-burial nuclide dating of the Kızılırmak River terraces,*Quaternary Science Reviews Volume 107, 1 January 2015, Pages 81-97.*

[9] Kuzucuoğlu C, Mouralis D, Türkecan A, Geomorphological mapping as an illustration of geomorphological evolution reconstruction: the example of the Çiftlik Plain in Cappadocia (Niğde).In: Öner E (eds) Profesör Doktor İlhan Kayan'a Armağan, Ege Üniversitesi Yay. Edebiyat Fakültesi Yayını,2015, pp 133–144.

[10] Kuzucuoğlu, C. Demoulin, J.-P. ve Saulnier Copard, S., Geomorphological and Palaeoenvironmental Setting of Aşıklı Höyük, The Early Settlement at Aşıklı Höyük - Essays in Honor of Ufuk Esin (eds. M. Özbaşaran, G. Duru, M. Stiner): 2017,. Ege Yayınları, Istanbul,15-42 .

[11] Beekman, P.H., Pliocene and Quaternary Volcanism Activities in the Hasan Dagi-Melendiz Dagi Region M.T.A Journal 66, p.1966, 90 - 105, Ankara.

[12] Dogan U , Geoarchaeology: The Case of Aşıklı Höyük. Geomorphology Association Bul,2018 1:8-18

[13] Kuzucuoğlu, C., Demir, M., Gürel, A., Dumoulin, JP. and Maner, Ç., Palaeoenvironmental Evolution of the Last Glacial Maximum (Lgm)-Late Holocene Eregli Basin: Preliminary Results with the Aid of Geological Indicators. Nigde Omer Halisdemir University, Journal of Engineering Sciences, Volume: 7, 2018, Nigde, Issue: 3, 475-482 .

[14] Aydar, E., Schmitt, A.K., Çubukçu, H.E., Akin, L., Ersoy, O., Sen, E., Duncan, R.A., ve Atıcı, G., Correlation of ignimbrites in the central Anatolian volcanic province using zircon and plagioclase ages and zircon compositions. Journal of Volcanology and Geothermal Research,2012 213-214, 83-97.

[15] Kuzucuoğlu, C., Mouralis, D. ve Türkecan, A., Geomorphological Mapping as an Illustration of Geomorphological Evolution Reconstruction: The Example of the Çiftlik Plain in Cappadocia (Niğde). Ege Üniversitesi Basımevi,2013, p. 133-144.

[16] Mouralis D, Aydar E, Türkecan A, Kuzucuoğlu C , Quaternary volcanic landscapes and prehistoric sites in Southern Cappadocia: Göllüdağ, Acıgöl and Hasandağ. In: Kuzucuoğlu C, Çiner A, Kazancı N (eds) Landscapes and landforms of Turkey. Springer,Berlin,2019, pp 551–563.

[17] Gencalioglu ve al,Review of post-collisional volcanism in the Central Anatolian Volcanic Province (Turkey)with special reference to the Tepeköy Volcanic Complex,2008,pages 593-621.

[18] İlkışık OM, Gürer A, Tokgöz T, Kaya C ,Geoelectromagnetic and geothermic investigations in the Ihlara Valley geothermal feld. J Volcanol Geotherm Res 78:1997,297–308.

[19] Türkecan, A. ve Kuzucuoğlu, C., Upper Pleistocene volcanism and palaeogeography in Cappadocia, Turkey. MTA-CNRS-TÜBITAK 2001-2003 Research Programme. Tübitak Project 101Y109 and MTA Report 10652. Ankara, 152 pp. (unpublished), 2004

[20] Sarı M, Çömlekçiler F ,Investigation of discontinuities in Kızılkaya ignimbirites and identification of rock mass.S.Ü. Müh-Mim Fak Derg 23:,2007,207-216.

[21] Karabacak V , General properties of travertines of Ihlara valley (Central Anatolia) and their importance in terms of crustal deformation.Eskissehir Osmangazi University Engineering Architecture Faculty Journal XX(2):2007,65-82.

[22] Kuzucuoglu C, Dumoulin J-P, Saulnier-Copard S,Geomorphological and palaeoenvironmental setting of Aşıklı Höyük.In: Özbaşaran M, Duru G, Stiner M (eds) The early settlement at Aşıklı Höyük-Essays in honour of Ufuk Esin. Ege Publications, Istanbul,2018, pp 15-43.

[23] Karabacak V, Uysal IT, Ünal-İmer E, Mutlu H, Zhao J (2017) U–Th age evidence from carbonate veins for episodic crustal deformation of Central Anatolian Volcanic Province. Quat Sci Rev,2017,177:158–172.

[24] Özsayın E, Gürbüz A, Kuzucuoğlu C, Erdoğu B ,Salted landscapes in the Tuz Gölü (Central Anatolia): the end stage of a Tertiary Basin. In: Kuzucuoğlu C, Çiner A, Kazancı N (eds) Landscapes and landforms of Turkey. World geomorphological landscapes. Springer,2019, pp 339–351.

[25] Dirik K, Erol O, Tuzgölü ve civarının tektonomorfolojik evrimi Orta Anadolu, Türkiye. TPJD Bül Özel,2000, Sayı 5:27–46.

[26] Fernández-Blanco D, Bertotti G, Çiner TA, Cenozoic tectonics of the Tuz Gölü Basin (Central Anatolian Plateau, Turkey). Turk J Earth Sci,2013, 22:715–738.

[27] Özsayın E, Çiner A, Rojay B, Dirik K, Melnick D, Fernandez-Blanco D, Bertotti G, Schildgen TF, Garcin Y, Strecker MR, Sudo M , Plio-Quaternary extensional tectonics of the Central Anatolian Plateau: a case study from the Tuz Gölü Basin, Turkey. Turk J Earth Sci 22:2013,691–714.

[28] Kürçer A, Gökten E, Paleoseismological three dimensional virtual photography method; a case study: Bağlarkayası-2010 trench, Tuz Gölü fault zone, Central Anatolia, Turkey. In: Sharkov E (ed) Tectonics—recent advances. InTech, Rejika,2012, pp 201–228 .

[29] Kürçer A, Gökten E (2014) Neotectonic Period Characteristics, Seismicity, Geometry and Segment Structure of Tuz Gölü Fault Zone. MTA Journal 149:2014,19-69.

[30] Gürbüz A, Kazancı N (2014) Facies characteristics and control mechanisms of Quaternary sediments of Tuz Gölü basin. MTA Journal,2014,149:1-18

[31] Le Pennec, JL., Bourdier, J.-L., Froger, J.-L., Temel, A., Camus, G. ve Gourgaud, A., Neogene ignimbirites of the Nevşehir Plateau (Central Anatolia): stratigraphy, distribution and source constraints. J. Volcanol. Geoterm. Res., 1994, 63, 59-87.

[32] Aydar E, Gourgaud A, The geology of Mount Hasan stratovolcano, central Anatolia, Turkey. J Volcanol Geotherm Res 85:,1998,129–152.

[33] Temel, A., Gündoğdu, M.N., Gourgaud, A. ve Le Pennec, J.–L., Ignimbrites of Cappadocia (central Anatolia, Turkey): petrology and geochemistry. Journal of Volcanology and Geothermal Research 85,1998, 447-471.

[34] Dönmez, M., Türkecan, A. ve Akçay, A., E., Kayseri-Niğde-Nevşehir bölgesi Tersiyer volkanikleri. Maden Tetkik ve Arama Genel Müdürlüğü Jeoloji Etütleri Dairesi Başkanlığı, Ankara., 2003.

[35] Dönmez, M., Akçay, A. E., Genç, Ş. C. ve Acar, Ş., Biga Yarımadasında Orta-Üst Eosen volkanizması ve denizel ignimbiritler. Maden Tetkik ve Arama Dergisi, 131,2005, 49-61.

[36] Toprak, V. ve Göncüoğlu, C., Tectonic control on the development of the Neogene-Quaternary Central Anatolian Volcanic Province, Turkey. Geol. J. 28,1993, 357-369, 1993.

[37] Mouralis D, Aydar E, Türkecan A, Kuzucuoğlu C , Quaternary volcanic landscapes and prehistoric sites in Southern Cappadocia: Göllüdağ, Acıgöl and Hasandağ. In: Kuzucuoğlu C, Çiner A, Kazancı N (eds) Landscapes and landforms of Turkey. Springer, Berlin,2019, pp 551–563.

[38] Pasquaré G, Poli S, Vezzoli L, Zanchi A ,Continental arc volcanism and tectonic setting in Central Anatolia, Turkey. Tectonophysics 146:,1988,127–230.

[39] Gürel, A., Geology, mineralogy and geochemistry of Pleistocene-Holocene deposits in the Çiftlik Basin (Niğde)(Central Turkey) , 2016a, 153-176

[40] Gürel, A., Sedimentary Fills of The Bor Basin (Central Anatolıa): Climate ond Environment during Early Holocene and the Mid-Holocene. SGEM 2016, Vol I Book Series: SGEM Pages:2016b, 533-539.

[41] Toprak, V., Vent distribution and its relation to regional tectonics, Cappadocian Volcanics, Turkey. Journal of Volcanology and Geothermal Research, 85.1998 55-67.

[42] Batum İ, Geology and Petrology of Acıgol and Golludağ Volcanics at Southwest of Nevşehir (Central Anatolia/Turkey). Yerbilimleri Dergisi 4:1978,70–88.

[43] Kuzucuoğlu C (2013) Geomorphology of the Melendiz River in Cappadocia (Turkey): setting of Pre-Pottery Neolithic sites of Aşıklı and Musular, and climate reconstruction during the onset of the Holocene. Geogr Fis Din Quat ,2013,36:95–105.

[44] Mouralis, D., The Quaternary volcanic complexes of Cappadocia (Göllüdağ and Acıgöl)-Turkey: morphodynamic evolutions and environmental implications. PhD Thesis, Univ. Paris 12-Val de Marne, LGP, 282 pp, (unpublished), 2003.

[45] Kuzucuoğlu, C. ve Gürel, A., Hydrogeomorphological Records of Climate Changes during the Bronze and Iron Ages in the Bor Plain (Central Anatolia), (Submitted as book chapter to springer publishing house for printing), 2022.

[46] Soil Survey Staff, Keys to Soil Taxonomy, 8th edn. U.S. Dept. Agri. Nat. Res. Conserv. Serv., 1998,327 p.

[47] Soil Survey Staff. Keys to Soil Taxonomy. Eighth Edition. Natural Resources Conservation Service, United States Department of Agriculture, Washington DC, 2001.

[48] Aydın F., Schmitt AK., Siebel W., Sönmez M., Ersoy Y., Lermi A., Dirik K. ve Duncan R., Quaternary bimodal volcanism in the Niğde Volcanic Complex (Cappadocia, central Anatolia, Turkey): age, petrogenesis and geodynamic implications. Contrib. Mineral. Petr.,2014, 168:1078-1102.

[49] Sarıkaya MA, Çiner A, Zreda M ,Fairy chimney erosion rates on Cappadocia ignimbrites, Turkey: insights from cosmogenic nuclides. Geomorphology 234:2015,182–191.

[50] Bottema, S., Woldring, H., Late Quaternary vegetation and climate of southwestern Turkey. Paleohistoria 26, 123 1 49, 1984.

[51] Fontugne, M., Kuzucuoğlu, C., Karabıyıkoğlu, M., Hatté, C. ve Pastre, J-F., From Pleniglacial to Holocene. A ^{14}C chronostratigraphy of environmental changes in the Konya Plain, Turkey. Quat. Sc. Reviews 18,,1999, 4-5: 573-592.

[52] Kuzucuoğlu, C., Bertaux, J., Black, S., Denèfle, M., Fontugne, M., Karabıyıkoğlu, M., Kashima, K., Limondin-Lozouet, N., Mouralis, D. ve Orth, P., Reconstruction of climatic changes during the Late Pleistocene, based on sediment records from the Konya Basin (Central Anatolia, Turkey). Geological Journal 34,1999, 175-198.

[53] Ghislain Berlin ve Gürel,Sediment grain-size distribution in the Çiftlik plain-(Ovalıbağ, Melendiz and Imamhatip) Niğde Province, Turkey,2023.

[54] Yıldız, A. ve Gürel, A., Diatom community and palaeoenvironmental interpretation of Pleistocene-Holocene lacustrine diatomite deposits in the Çiftlik Basin (Niğde, Central Anatolia, Turkey). 12 th RCMNS Congress, Wienna, Abstracts,2005, p.82.

[55] Le Pennec, JL., Identifying ash flow sources with directional data: An application to the Kızılkaya ignimbrite, central Anatolia, Journal of Geophysical Research, 105, B12, , 2000,427-441.

[56] Le Pennec, JL., Temel, A., Froger, J.L., Sen, S., Gourgaud, A., ve Bourdier, J.L., Stratigraphy and age of the Cappadocia ignimbrites, Turkey: reconciling field constraints with paleontologic, radiochronologic, geochemical and paleomagnetic data. Journal of Volcanology and Geothermal Research,2005, 141, 45–64.

[57] Lepetit, P. ve Viereck-Goette, L., Paleosols in Cappadocia – Archives of ecosystem changes in the Late Neogene Goldschmidt Conference Abstracts,2007, A561.

[58] Lepetit, P., Kohlenstoff-Isotopie miozäner Calcretes in Kappadok-ien (Türkei). (Doktora Tezi) Friedrich-Schiller-Üniversitesi, Jena,2010, 123 pp.

[59] Lepetit, P., Viereck, L., Piper, JD.A., Sudo, M., Gürel A., Çopuroğlu, I., Gruber, M., Mayer, B., Koch, M., Tatar, O. ve Gürsoy, H., 40Ar/39Ar dating of ignimbrites and plinian air-fall layers fromCappadocia, Central Turkey: Implications to chronostratigraphic andEastern Mediterranean palaeoenvironmental record. Chemie der Erde.2014, 74, 471–488,.

[60] Akıman, O., Erler, A., Göncüoğlu, M.C., Güleç, N., Geven, A., Türeli, TK. ve Kadıoğlu, YK., Geochemical characteristics of granitoids along the western margin of the Central Anatolian Crystalline Complex and their tectonic implications. Geological Journal, 28,1993, 371-382.

[61] Gürel, A. ve Kadir, S., Palaeoenvironmental approach to the geology, mineralogy and geochemistry of an Early Miocene alluvial-fan to cyclic shallow-lacustrine depositional system in the Aktoprak Basin (central Anatolia), Turkey. Clay Miner,2010, 45: 51-75.

[62] Gürel, A., Palaeontological, chemical and mineralogical properties of diatomites of Çiftlik (Niğde) region. Nigde Omer Halisdemir University Journal of Engineering Sciences 6 (1), 140-150, 2017a

[63] Gürel, A., Geology, mineralogy, and geochemistry of late Miocene paleosol and calcrete in the western part of the Central Anatolian Volcanic Province (CAVP), Turkey. Geoderma,2017b, 302, 22-38.

[64] Gürel, A., Quaternary Period sediment deposits and palaeoclimate records of Bor-Altunhisar vicinity: Bor plain climate records and their comparison with Central Anatolian climate records, FEB 2014/07-BAGEP project report, 2021, (unpublished),181 p.

[65] Innocenti, F., Mazzuoli, R., Pasquare, G., Radicati Di Brozolo, F. ve Villari, L., The Neogene Calc-Alcaline Volcanism of Central Anatolia: Geochronological data on Kayseri-Niğde area: Geol. Mag.,1975, 112, 349-360.

[66] Kadir, S., Gürel, A., Senem, H., ve Külah, T., Geology of Late Miocene clayey sediments and distribution of palaeosolclay minerals in the northeastern part of the Cappadocian Volcanic Province (Araplı-Erdemli), central Anatolia, Turkey.Turkish Journal of Earth Sciences,2013, 22, 427-443.

[67] Kuzucuoglu, C., Karabiyikoglu, M., Fontugne, M., Pastre, J.-F. ve Ercan, T., Environmental changes in Holocene lacustrine sequences from Karapinar in the Konya plain (Turkey), In: Dalfes, N., Kukla, G., Weiss, H. (Eds.), Third Millenium BC Social Collapse and Climate Change. NATO ASI Series Vol. 49,1997, pp. 451-463.

[68] Kuzucuoglu C., Parish R. ve Karabiyikoglu M., The dune systems of the Konya Plain (Turkey): their relation to environmental changes in Central Anatolia during the late Pleistocene and Holocene. Geomorphology,1998, 23:257–271.

[69] d'Alfonso, L., Balza, M.E. ve Mora, C., eds., Geo-Archaeological Activities in Southern Cappadocia – Turkey, Studia Mediterranean 22, Italian Univ. Press, 2010.

[70] Dhont, D., Cgorowicz, C., Yürür, T., Froger, J.L., Köse, O. ve Gündoğdu, N., Emplacement of volcanic vents and geodynamics of Central Anatolia, Turkey, Journal of Volcanology and Geothermal Research, 85,, 1998, 33-54.

[71] Folk, R. L. ve Ward, W. Brazos River bar: A Study İn The significance of grain size parameters. J. Sed. Petrol. 41,1957, 1045-1058.

[72] Froger, J., Lenat, J.F., Chorowicz, J., Le Pennec, J.L., Bourdier, J.L., Köse, O., Zimitoğlu, O., Gündoğdu, N. ve Gourgaud, A., Hidden calderas evidenced by multisource geophysical data; Example of Cappadocian calderas, central Anatolia, Journal of Volcanology and Geothermal Research, 85,1998, 99–128.

[73] Gürel, A. Ciftci, E., ve Kerey, I.E., Sedimentological characteristics of the Cukurbag˘ formation deposited along the Ecemis Fault Zone (Central Anatolia, Turkey). Journal of the Geological Society of India, 70,2007, 59-72.

[74] Gürel, A., Sedimentological and mineralogical investigation of the Late Miocene successions of Aktoprak Basin (Central Turkey): Implication for sediment source and palaeoclimates, Clay and Clay Minerals, 54,2008, 555-570.

[75] Gürel, A. ve Kadir, S., Geology and Mineralogy of Late Miocene Clayey Sediments in the Southeastern part of the Central Anatolian Volcanic Province, Turkey. Clays and Clay Minerals, 56,2008, 307-320.

[76] Gürel, A. ve Lermi, A., Pleistocene-Holocene fills of the Bor-Eregli Plains (Central Anatolia): Recent geoarcheological contributions. Published in Italy, Pavia University, 2010.

[77] Mouralis, D., The Quaternary volcanic complexes of Cappadocia (Göllüdağ and Acıgöl)-Turkey: morphodynamic evolutions and environmental implications. PhD Thesis, Univ. Paris 12-Val de Marne, LGP, 282 pp., (unpublished), 2003MTA (Maden Tetkik ve Arama Genel Müdürlüğü), 1/100, 000 Ölçekli Türkiye Jeoloji Haritası, Kayseri-J 19 Paftası, (1989), (Adana M 33, 2005 yeni pafta), 2005.

[78] Taylor, JC., Computer programs for standardless quantitative analysis of minerals using the full powder diffraction profile, Powder Diffraction 6,1991, 2-9.

[79] Temel, A., Petrological and Geochemical Properties of Cappadocia Explosive Volcanism, Hacettepe University Doctoral Thesis (Unpublished), 1992.

[80] Temel, A., Gündoğdu, M.N., Gourgaud, A. ve Le Pennec, J.–L., Ignimbrites of Cappadocia (central Anatolia, Turkey): petrology and geochemistry. Journal of Volcanology and Geothermal Research 85,1998, 447-471.

[81] Toprak, V., Central Kızılırmak Fault Zone: Northern margin of Central Anatolian Volcanics, Doğa-Turkish Journal of Earth Sciences, 3,1994, 29-38.

[82] Toprak, V., Keller, J. ve Schumacher, R. Volcano-tectonic features of the Cappadocian Volcanic Province. International Volcanological Congress, Excursion Guide, Ankara,1994, 58 pp.

[83] Tributh, H., Qualitative and Quantitative Determination of Clay Minerals in Soil Clays, In: İdentification and Charekterisation of Clay Minerals, Conference of the German, Clay and Clay Mineralle. Giessen1991, 37-87

[84] Viereck-Götte, L. ve Gürel A., Climate and vegetation changes documented in Upper Miocene paleosols of Cappadocia, Central Anatolia', reports of the German Mineralogical Society, supplements to the European Journal of Mineralogy, 15, pp 211, Stuttgart, 2003

[85] Viereck-Goette, L., Lepetit, P., Gürel, A., Ganskow, G., Çopuroğlu, İ. Ve Abratis, M., Revised volcanostratigraphy of the Upper Miocene to Lower Pliocene Ürgüp Formation, Central Anatolian volcanic province, Turkey, Geological Society of America Special Paper, Cilt: 464, 2010,85-112.

[86] Walker, R. G., Non deltaic deposition al environments in the Catskill clastic wedge. Bull. Geol. Soc. Amer. 82.1971, 1305-1326.

[87] Yalınız, KM., Floyd, P. ve Göncüoğlu, MC., Geochemistry of volcanic rocks from Çiçekdağ ophiolite, centra Anatolia, Turkey, and their inferred tectonic setting within the northern branch of Neotehyan ocean. In: BOZKURT, E., WINCHESTER, J.A. & PIPER, J.D.A (eds), Tectonics and Magmatism in Turkey and the Surrounding Area. Geological Society, London, Special Publications 173,2000, 203-218.

[88] Yavuz-Işık, N. ve Toprak, V., Palynostratigraphy and vegetation characteristics of Neogene continental deposits interbedded with the Cappadoica ignimbrites (Central Anatolia, Turkey). Int. J. Earth Sci. 99,2010, 1887-1897.

[89] Yıldız, A. ve Gürel, A., Diatom community and palaeoenvironmental interpretation of Pleistocene-Holocene lacustrine diatomite deposits in the Çiftlik Basin (Niğde, Central Anatolia, Turkey). 12 th RCMNS Congress, Wienna, Abstracts,2005, p.82.

[90] Külah, T., Kadir, S., Gürel, A., Eren, M. ve Önalgil, N., Mineralogy, geochemistry, and genesis of mudstones in the upper Miocene Mustafapaşa member of the Ürgüp formation in the Cappadocia region, central Anatolia, Turkey. Clays and Clay Minerals , 2014,62, 267-285.

[91] Matessi, A., Gürel, A., Kuzucuoğlu, C. ve d'Alfonso, L., East of Konya: Settlements, routes and environment in Southern Cappadocia, and the political landscape of South Central Anatolia during the Second Millennium BCE. In The Konya Plain at the cross-roads in central Anatolia, from the Bronze Age to the Byzantine period, edited by C. Maner, Varia Anatolica, Istanbul, IFEA &Ege Yay:2019, 17-41.

[92] Mouralis, D., Pastre, JF., Kuzucuoğlu, C., Türkecan, A., Atıcı, Y., Slimak, İ., Guillou, H. ve Kunesch, S., The Quaternary rhyolitic volcanic complexes of Central Anatolia (Göllüdağ and Acıgöl, Turkey) : genesis, instability, environmental constraints. Quaternary, 2002, 13, 219-228.

[93] MTA (General Directorate of Mineral Research and Exploration), Geological Map of Turkey at a scale of 1/100,000, sheet Aksaray-M 32, 2009.

[94] Olanca, K., Geochemistry of Quaternary Lavas of Cappadocia (Turkey) Monogenic Devices, doctoral thesis, Universite Blaise Pascal (Fransa), 1994, 156 p.

[95] Pasquare, G., Geology of the Cenozoic volcanic area of Central Anatolia. Atti Della Accad. Naz. Dei Lincei Mem., serie VIII., vol. IX s.1968, 55-204, Roma.

[96] Pauquette, J.-L. ve Le Pennec, J.-L., 3.8 Ga zircons sampled by Neogene ignimbriteeruptions in Central Anatolia. Geology 40 (3),2012, 239-242.

[97] Piper, JDA., Koçbulut, F., Gürsoy, H., Tatar, O., Viereck, L., Lepetit, P., Roberts, AP. ve Akpınar, Z., Paleomagnetism of the Cappadocian Volcanic Succession, Central Turkey: Major ignimbrite emplacement during two short (Miocene) episodes and Neogene tectonics of the Anatolian collage. J. Volcanol. Geotherm. Res. 262,2013, 47-67.

[98] Retallack, GJ., Soils of the Past.1990, 520pp. Unwin-Hyman, London.

[99] Ruan, C. ve Ward, C.R. Quantitative X-ray powder diffraction analysis of clay minerals in Australian coals using Rietveld methods, Applied Clay Science 21,2002, 277-240.

[100] Schumacher, R. ve Mues-Schumacher, U., The Kızılkaya ignimbrite-an unusual low-aspect-ratio ignimbrite from Cappadocia, central Turkey. Journal of Volcanology and Geothermal Research, 70,1996, 107–121.

[101] Seymen, L., Geology of Kırşehir Massif Around Kaman, Associate Professor Thesis, İTÜ. Faculty of Mining, Istanbul, 164 p. (Unpublished), 1982.

[102] Sheldon, DN., ve Tabor, NJ., Quantitative paleoenvironmental and paleoclimatic reconstruction using paleosols. Earth-Science Reviews, 95, 1-52, 2009.

[103] Şener, MF., Şener, M. ve Uysal IT., The evolution of the Cappadocia Geothermal Province, Anatolia (Turkey): geochemical and geochronological evidence. Hydrogeol J 25(8): 2017,2323-2345.

[104] Şen, E., Aydar, E., Gourgaud, A. ve Küçükoğlu, B., The explosive phase preceding the extrusion of volcanic domes: Example of the rhiyodasitic dome of Dikkartın Dağ, Erciyes, Central Anatolia, Turkey, C.R. Geoscience,2002, 334, 27-33.

[105] Şen, E., Kürkçüoğlu, B., Aydar, E., Gorgaud, A. ve Vincent, PM., Volcanological evolution of Mounth Erciyes stratovolcano and origin of the Valibaba Tepe ignimbrite (central Anatolia, Turkey). Journal of Volcanology and Geothermal Research, 125,2003, 225-246.

[106] Şen, PA., Temel, A. ve Gourgaud, A., Petrogenetic modelling of Quaternary post-collisional volcanism: A case study of centralvand eastern Anatolia, Geological Magazine, 141, 2004,81-98,.

[107] Göncüoğlu C, ve Toprak V., Neogene and Quaternary volcanism of Central Anatolia: a volcano structural evolution. Bulletin de la Section de Volcanologie Societe Geologique de France 26:1992, 1-6.

[108] Gromet, L.P., Dymek, R.F., Haskin, L.A. ve Korotev, R.L., The 'North American Shale Composite': its compilation, major and trace element characteristics. Geochim. Cosmochim. Acta 48,1984, 2469–2482.

[109] Gürel, A., ve Kadir, S., Geology and mineralogy and origin of clay minerals of the Pliocene fluvial-lacustrine deposits in the Cappadocian Volcanic Province, Central Anatolia, Turkey, Clay and Clay Minerals, 54,2006, 555-570.

[110] Gürel, A. ve Yıldız, A., Diatom communities, lithofacies characteristics and paleoenviromental interpretation of Pliocene diatomite deposits in the Ihlara-Selime plain (Aksaray, Central Anatolia, Turkey), Journal of Asian Earth Sciences, 30,2007, 170-180.

[111] Ghislain Berlin ve Gürel,The Interpretation of Quaternary-sediments of the Çiftlik Plain(Ovalibağ) Niğde, Turkey,2024,pp1-18.