Journal of Engineering Technology and Applied Sciences, 2021 *e-ISSN:* 2548-0391
Received 13 June 2017, Accepted 30 October 2021 *Vol. 6, No. 3, 135-142*
Published online 28 December 2021, Research Article *doi: 10.30931/jetas.949849*

Citation: Kam, E., Yümün, Z. Ü., Açıkgöz, G., Önce, M., "Investigation of Sediment Records of Kulakçayiri Lake (Istanbul)". Journal of Engineering Technology and Applied Sciences 6 (3) 2021 : 135-142.

INVESTIGATION OF SEDIMENT RECORDS OF KULAKÇAYIRI LAKE (ISTANBUL)

Erol Kam[a], Zeki Ünal Yümün[b], Gülderen Açıkgöz[a], Melike Önce[b*]

[a]*Yıldız Teknik Üniversitesi, Fen Edebiyat Fakültesi, Fizik Bölümü, İstanbul*
erolkam@hotmail.com

[b]*Tekirdağ Namık Kemal Üniversitesi, Çorlu Mühendislik Fakültesi, Çevre Mühendisliği, Çorlu, Tekirdağ*
*zyumun@gmail.com, monce@nku.edu.tr (*corresponding author)*

Abstract

In this study, the date of the Holocene sediments of Kulakçayırı Lake was determined and the sedimentation rates were calculated. The determined sedimentation rates provide important clues about the climatic and ecological characteristics of the study area. Especially in aquatic environments, it is important to date sediment processes in order to monitor the time-dependent changes in the pollution processes of sediments. In this context, radiocarbon (14C) analysis was performed in order to date the sediments. Liquid scintillation spectrometry was used to find the radioactivity of the 14C isotope. Three drilling samples were taken from the study area (Kulakçayırı Lake / Istanbul) for 14C analysis. According to the results of 14C analysis of the samples taken; Sediment deposition in SK-1 sample took place in 5599 years, in SK-2 in 7596 years and in SK-3 in 8060 years. Sedimentation rates are; SK-1> SK-2> SK-3. From the data obtained, it was observed that the sedimentation rate has different rates at different points of the lake. There is no stream bringing material to the lake. Therefore, it can be said that a slow storage dominates the lake in general.

Keywords: Kulakçayırı, sediment, dating, radiocarbon, 14C, Istanbul

1. Introduction

Dating determination in sediments play a very important role in determining the environmental effects of natural and anthropogenic events when considered together with the distribution of chemical elements throughout the sediment. Many different methods have been developed for dating determination in sediment. The Radiocarbon (14C) method, which is based on the dissolution of the 14C atom in dead organic substances, is one of the most used methods. With this method, it is possible to age a period of 30-40 thousand years [1, 2].

The radioactive isotope of the element carbon (14C), which is common in nature, is caused by the reaction of cosmic rays from space in the upper layers of the atmosphere with nitrogen gas in the atmosphere. The 14C atoms formed react with the oxygen element in the atmosphere, becoming carbon dioxide (CO_2) gas. CO_2 mixes with other gases in the atmosphere and quickly disperses throughout the atmosphere. Most of the carbon dioxide gas in the atmosphere passes into the oceans, seas and lakes in the form of carbonate solution. It is found in the bodies of the creatures living here. With the death of living things, CO_2 also descends to the bottom of aquatic environments and precipitates along with living residues. Some of the carbon dioxide gas takes part in photosynthesis in plants and passes into the bodies of all living things on earth. Thus, every living thing has a certain 14C density and radioactivity by taking 14C from its environment continuously during its lifetime. Over time, a balance occurs and the 14C density in the atmosphere and living things stabilizes. After living creatures die, the new 14C entry into their bodies stops and the 14C concentration and radioactivity in their bodies at the time of death decrease over time [3].

There are previous studies on dating in the sediment (Yümün et al., 2016 [15]; Yümün, 2017 [15]; Yümün and First, 2017 [4]; Akçer-Ön, 2017 [5]; Bondevik et al. 1998 [6]; Güngör and Çağatay 2006 [7]). However, this study will be the first for the study area. With the study, the age of the Holocene sediments of Kulakçayırı Lake was determined and the sedimentation rate was calculated. And it provided a resource for detecting climatic and ecological changes for the study area.

In the study titled “Meiofauna, Microflora And Geochemical Properties Of The Late Quaternary (Holocene) Core Sediments In The Gulf Of Izmir (Eastern Aegean Sea, Turkey)” conducted by Yümün et al. (2016), the pollution of marine sediments in İzmir Bay was evaluated both paleontologically and geochemically. Here, radiocarbon analysis (14C) was performed to evaluate the change of pollution with time.

Yümün conducted a similar study for the West Marmara Sea sediments in 2017. Here again, the sedimentation velocities of the sediments were determined by conducting radiocarbon analysis (14C). With this determination, the effect of coastal geomorphology and rivers flowing into the sea on the sedimentation rate was evaluated. The geochronological process of heavy metal pollution occurring in the marine environment with the deposition rate has been revealed. In his work titled "Monitoring heavy metal pollution in foraminifera from the Gulf of Edremit (northeastern Aegean Sea) between Izmir", conducted by Yümün and Önce (2017) [6], foraminifera assemblages in the Quvaternary sediments in Balıkesir and Çanakkale (Turkey) Northeastern Aegean Sea and the characteristics of anomalous shell structures observed in foraminifers were investigated. Within the scope of this study, 14C analyzes were carried out in Güre (Balıkesir), Küçükkuyu (Çanakkale) and Dikili (İzmir) regions. According to the result of this analysis, the geochronological process of the contamination in the sediment column has been evaluated.

In the study by Akçer-Ön (2017) [7], named Climate Changes Due to Solar Effect in Little Ice Age: Köyceğiz Lake Sediment Records (SW Anatolia); 14 C analyzes were made on four short gravity core samples taken from Köyceğiz Lake.

In the Late Weichselian Marine 14C Reservoir Ages at the Western Coast of Norway study by Bondevik et. al.(1998) [8] 14 C analysis was performed at eight different stratigraphic levels in the marine reservoir on the west coast of Norway.

In the study by Güngör and Çağatay (2006) [9] called sudden environmental changes in the Black Sea in the last 3000 years, geochemical analyzes were applied in a total of two cores taken from the Western Black Sea basin with the multiple core system. Natural and anthropogenic environmental changes that occurred in the last 3000 years were determined and these changes were dated with ^{210}Pb method and published 14C data. In this study, analysis of three core samples taken from Kulakçayırı Lake with the 14C method was performed, and the ages and sedimentation rates of the study area were revealed.

2. Material methods

The study area is Kulakçayırı Lake and its surroundings, which is a surface water source between Istanbul province, Arnavutköy and Hadımköy districts and the Black Sea. The study area location map is given in Figure 1 and sample coordinates are given in Table 1.

Figure 1. Study Area Location Map [10].

Table 1. Kulakçayırı Drilling Coordinates [10]

	BH	X	Y
Kulakçayırı Lake	BH-1	645459.77	4572767.77
	BH-2	645529.00	4572399.00
	BH-3	645511.81	4572001.24

Radiocarbon 14C dating technique was used to age these levels after certain lithostratigraphic units were distinguished (14C) in the cores. Dating determinations were performed by Accelerator Mass Spectrometry (AMS) method. While performing the analyzes, care was taken that the samples were not moved. In order to be able to compare with the dates in other studies,

the reservoir date correction for dating and calibration to the calendar year were not performed and the margin of error was calculated as ± 1 σ (1 standard deviation). Thanks to the radiocarbon 14C dating analysis in the cores, information was obtained about the chronological sequences of the different sediment units within the 14C analysis limits, and thus precise chronostratigraphic studies of the core sediments were performed [11,17,18]. The land has a rough topography in places, almost flat in places. The region is located in the Marmara climate zone.

Depending on the Marmara climate type, the region is cold in winters and hot in rainy summers. There is an increase in surface waters in the region due to precipitation. The study area consists of hilly and undulating plains in the northern and eastern regions, and slightly undulating plains in the southern and western regions [12, 24, 25, 26].

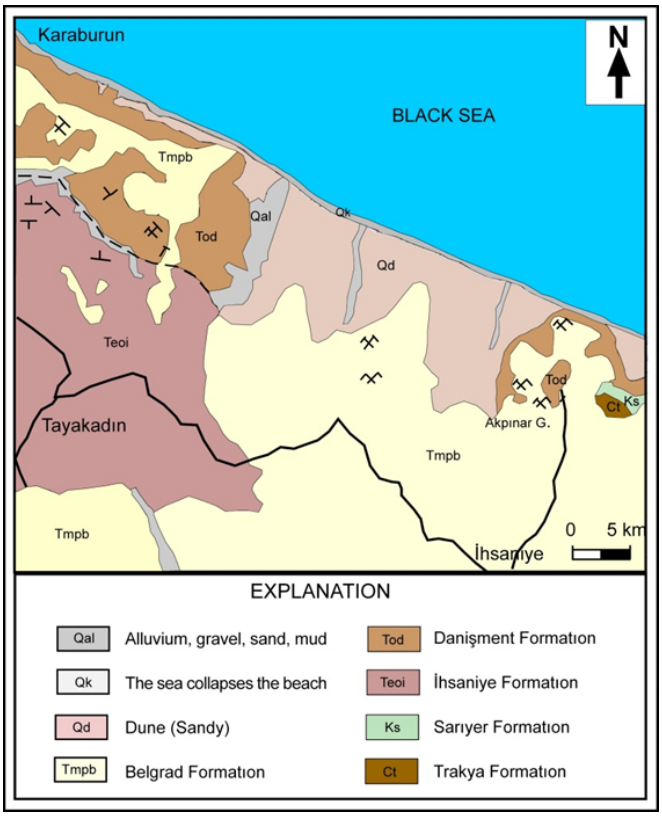

Figure 2. Geological Map of the Study Area and its Close Vicinity [13].

In the study area, the Lower Carboniferous Trakya Formation (Unsalted) is located at the basement. Upper Cretaceous (Campanian-Maastrichtian) aged Sarıyer Formation unconformably overlies this basement. The unit consists of lava, tuf and agglomerate interbedded marl, conglomerate and sandstone lithology. Upper Eocene aged İhsaniye Formation comes on the Sarıyer Formation with an angular unconformity. The unit consists of tuff intermediate level, clayey limestone, sandy limestone, marl, claystone and sandstone. Over this unit is the Upper Oligocene Danişment Formation with a discontinuity with gaps. The Danişment formation consists of an alternation of thin to medium bedded sandstone and laminated claystone. Miocene-Pliocene aged Belgrad Formation is located on the Danişment Formation. All units in the base are covered with sand dunes in places near the Black Sea coast, and are covered by alluviums in valley beds and flat areas with angular unconformity.

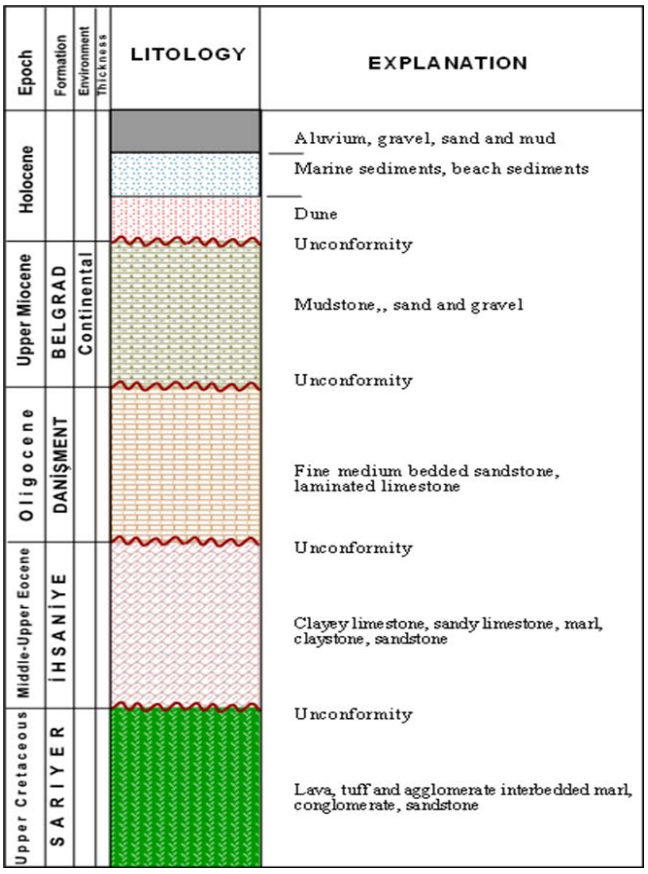

Figure 3. The Generalized Stratigraphic Colon Section of the Study Area and its Vicinity (Unscaled) [13].

Three samples were taken from the study area for analysis (SK-1, SK-2, SK-3). Sediment samples were first washed with acid and made ready for analysis. 14C analysis was carried out with the total carbon insoluble in acid in the sediment sample. In order to apply this method, samples have been converted to benzene by various chemical processes. Liquid scintillation spectrometry was used to find the radioactivity of the 14C isotope in synthesized benzene. After counting, the necessary calculations were made and the samples were dated [14, 15, 19, 20]. Each radioactive isotope has a specific half-life. The half-life of the 14C isotope is 5730 years, and the 14C radioactivity at the time the carbon-containing find died is Ao, the time elapsed from the moment the residue died to the present is called age and is called T. The relationship that gives the age of the residue is as follows.

$$T = 8267 \ln(Ao/A)$$

The number 8267 in the relation depends on the half-life of the 14C isotope, and this number is called the average life of the 14C isotope. In the relation AO indicates the current concentration or activity of 14C in the find, and A the concentration or activity of 14C that the find had at the time of its death. As can be seen, the age of a find is directly proportional to the natural logarithm of the Ao / A ratio. The greater this ratio, the greater the age of the find [2, 16, 21, 22,23].

3. The main result

The results of the 14C analysis of three samples taken from Kulakçayırı Lake are given in Table 2. While sediment deposition took place in 5599 years in SK-1 sample, it occurred in 7596 years in SK-2 and 8060 years in SK-3. Sedimentation rates are; SK-1> SK-2> SK-3.

Table 2. AMS radiocarbon ages of SK-1, SK-2 and SK-3 drillings taken from Kulakçayırı region

SAMPLE LOCATION	DEPHT (cm)	C-14 ANALYSIS AGE	SEDIMENTATION RATE (years)
BH-1	50	5599 -+ 66	5599
BH-2	100	7596 -+ 55	7596
BH-3	150	8060 -+ 60	8060

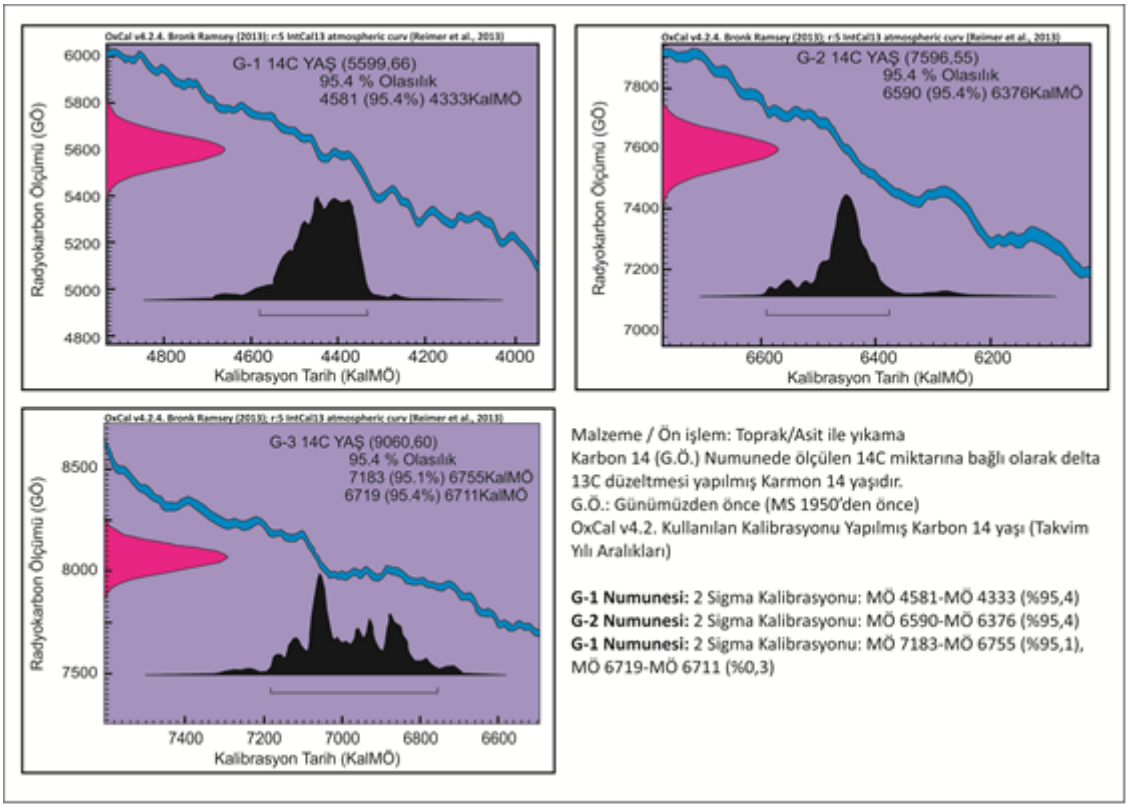

Figure 4. Graphical representation of C-14 analysis of SK-1, SK-2 and SK-3 C-14 samples

According to the analysis results, it was observed that the sedimentation rate and age have different rates at different points of the lake. There is no stream bringing material to the lake. Therefore, it can be said that a slow storage dominates the lake in general. It is concluded that the sedimentation that took place was a result of seasonal precipitation and runoff. This study will give the opportunity to interpret the scientific studies made and to be done in Kulakçayırı Lake in terms of geochronology. In addition, there will be scientific infrastructure in terms of methodology for scientific studies conducted in aquatic environments such as lakes, seas and oceans.

References

[1] Kılıç Karlıoğlu N., Yılmaz Dağdeviren R., Acar D., Küçükdemirci M., Makaroğlu Ö., Karaöz M. Ö., Şahin Altun D., Tutar A., Horuz A., Gürel A., Islam Z. and Çağatay M. N., "Paleovegetation studies based on fossil pollen analysis in Akgöl (Sakarya): Preliminary findings", Journal of Geography 40, (2020).

[2] Senkul, C., Kalıpçı, E., "A new paleoecological evaluation from Southwest Anatolia: Late Holocene paleovegetation changes and climate relations of Lake Karataş and its surroundings", Geography Magazine 38 (2019) : 35-47.

[3] Erdogan, B., Tanindi O., "The archaeological settlements of Turkey 14C database", Aegean Publications, Istanbul, (2004).

[4] Yümün, Z.U., Meriç, E., Avşar, N., Nazik, A., Barut, IF, Yokeş, B., Sagular, EK, Yıldız, A., Eryılmaz, M., Kam, E., Başsarı, A., Sonuvar, B., Dinçer, F., Baykal, K., Kaya, S., "Meiofauna, Microflora And geochemical properties of the late quaternary (Holocene) core sediments in the Gulf of Izmir (Eastern Aegean Sea, Turkey)", Journal of African Earth Sciences – Elsevier 124 (2016) : 383-408.

[5] Yümün Z., Ü., "The effect of heavy metal pollution on foraminifera in the Western Marmara Sea (Turkey)", Journal of African Earth Science 129, (2017) : 346-365.

[6] Yümün Z.Ü. and Once M., "Monitoring heavy metal pollution in foraminifera from the Gulf of Edremit (northeastern Aegean Sea) between Izmir, Balıkesir and Çanakkale (Turkey)", Journal of African Earth Science 130 (2017) :110-124.

[7] Akçer Ön S., "Climate changes due to solar effect in little ice age: Köyceğiz Lake sediment records (SW Anatolia)", Geological Bulletin of Turkey, 60 (2017) : 569-588.

[8] Bondevik S., Birks H.H., Gulliksen S., Mangerud J., "Late Weichselian Marine 14C reservoir ages at the Western Coast of Norway", Quaternary Research 52 (1998) : 104--114.

[9] Güngör E. and Çağatay M. N., "Sudden environmental changes in the Black Sea in the last 3000 years", ITU Journal of Engineering 5 (4) (2006) : 23-33.

[10] Kam E., Yümün Z.Ü., Once M., Açıkgöz G., "Gamma dose rate values in The Kulakçayiri natural lake and the vicinity (Arnavutköy, Istanbul)", Journal of Engineering technology and Applied Sciences 1 (1) (2016) : 29-33.

[11] Canpolat Ö., Eris K. K., Akkoyun E. Ö., "Determining the concentration level of some elements caused by geological period in the sediments of lake Hazar", Turkısh Journal of Agriculture - Food Science and Technology 8 (4), (2020) : 1001-1011.

[12] Yümün Mühendislik Limited Company, "Geological-geotechnical investigation of Istanbul Third Airport lakes", (Unpublished), (2013).

[13] Kam E., Yümün Z.Ü., Açıkgöz G. "Concentrations of environmental radioactivity in sediment cores from Kulakçayiri Lake", Frontiers in Enviromental Mucrobiology (2017).

[14] Appleby P.G., "Three decades of dating recent sediments by fallout radionuclides: a review", Holocene 18 (1), (2008) : 83-93.

[15] Karlioglu Kilic, N., Yilmaz Dagdeviren, R., Acar, D., Kücükdemirci, M., Makaroglu, Ö., Karaoz, M. Ö., Çagatay, M. N., "Paleovegetation studies based on fossil pollen analysis in Akgöl (Sakarya): First findings", Journal of Geography (2020), DOI :10.26650/JGEOG2019-0021.

[16] Eriş K. K, Arslan T. N., Sabuncu A., “Influences of climate and tectonic on the middle to late holocene deltaic sedimentation in Lake Hazar”, Eastern Turkey, Arabian J. for Sci. Eng 43 (2017) : 3685-3697.
[17] Kayan İ., Öner E., Doğan M., İlhan R., “Paleogeographic research and geoarchaeological evaluations in Aphrodisiad wetland”, Aegean Journal of Geography 28 (1), (2019).
[18] Canpolat Ö., Eriş K. K., Akkoyun E. Ö., “Determinin the concentration level of some elements caused by geological period in the sediments of Lake Hazar”, Turkish Journal of Agriculture – Food Science and Technology 8(4) (2020) :1001-1011.
[19] De Oliveira, S. M. B., Carlos, L., Pessenda, R., Favaro, D. I. T., Babinski, M., “A 2400-year record of trace metal loading in lake sediments of Lagoa Vermelha, southeastern Brazil”, Journal of South American Earth Sciences 5-6. (2012).
[20] Alak A. And Sümer Ö. “New findings regarding the presence of the Anthropocene in current sediments on the Marmara and Black Sea coasts”, Turkish Geology Bulletin 60(2) (2017).
[21] Ön Akçer S. “Climate changes due to the effect of the sun in the little ice age: Köyceğiz Lake Sediment Records (SW Anatolia)”. Turkish Geology Bulletin 60 (4) (2017): 569-588.
[22] Çağatay, M.N., Güngör, N., Yılmaz, Y.Z., Sarı E., “Rapid changes in the ecological conditions of the Black Sea over the last 3kyr: Evidence from sediment geochemistry“ In: Özerler, M. and Sayın, E. (eds.), The Role of Marine Studies in Ecosystems, Ecosystem 2003, Izmir, Turkey, (2005) : 85-96.
[23] Barka, A. A., Sakınç, M., Yaltırak, C. “Geology and geophysics of the Sea of Marmara, geology of the Turkish Seas and surrounding areas” (Ed. N. Görür), (1999) :131- 210.
[24] Çağatay, M. N., Algan, O., Sakınç, M., Eastoe, C. J., Egesel, L., Balkis, N., Ongan, D. and Caner, H., “A mid-late Holocene sapropelic sediment unit from the southern Marmara sea shelf and its palaeoceanographic significance”, Quaternary Science Reviews 18 (1999) : 531-540.
[25] Tolun, L. Çağatay, M. N., Carrigan, W. J., “Organic geochemistry and origin of Late Glacial-Holocene sapropelic layers and associated sediments in Marmara Sea”, Marine Geology, 190, (2002) : 47-60.
[26] Meydan A. F., Örçen S., “Physiographic variation of sedimentation rate in Lake Van, Eastern Anatolia/Turkey”, Bitlis Eren University Journal of Science 8(3), (2019): 1086-1093.