Palaeoclimate changes in the Afyon province, Sw-Turkey, during the Middle-Late Pleistocene: Signals from calcareous tufa pollen and stable isotope records

Article · January 2018

CITATIONS
0

READS
77

2 authors:

Ezher Tagliasacchi
Pamukkale University
14 PUBLICATIONS **23** CITATIONS
SEE PROFILE

Mine Sezgül Kayseri Özer
Dokuz Eylul University
36 PUBLICATIONS **301** CITATIONS
SEE PROFILE

Available online http://amq.aiqua.it
ISSN (print): 2279-7327, ISSN (online): 2279-7335

Alpine and Mediterranean Quaternary, Vol. 31 (Quaternary: Past, Present, Future - AIQUA Conference, Florence, 13-14/06/2018), 161 - 164

PALAEOCLIMATE CHANGES IN THE AFYON PROVINCE, SW-TURKEY, DURING THE MIDDLE-LATE PLEISTOCENE: SIGNALS FROM CALCAREOUS TUFA POLLEN AND STABLE ISOTOPE RECORDS

Ezher Tagliasacchi [1], Mine Sezgül Kayseri-Özer [2]

1 Pamukkale University, Geology Engineering Department, Kınıklı, Denizli, Turkey
2 Dokuz Eylul University, Institute of Marine Science and Technology, Haydar Aliyev Bul, İnciraltı-Izmir, Turkey
Corresponding author: E. Tagliasacchi <egulbas@pau.edu.tr>

ABSTRACT: The calcareous tufas of Sarıkavak located in the northern part of NE-SW trending Acıgöl Graben in SW-Turkey are investigated in detail. For this aim, various analyses (stable isotopes, U/Th dating, palynology) have been carried out on samples obtained from both outcrops and drilling logs in and surrounding Sarıkavak Village. U/Th dating shows that these carbonates precipitated from 400 ka up to 80 ka. Preliminary pollen data, document climatic variability between MIS 11 and MIS 8 in the studied area.

KEYWORDS: Calcareous tufa, palynology, palaeoenvironment, palaeoclimate, Afyon, SW-Turkey

1. INTRODUCTION

Terrestrial carbonates such as travertine and calcareous tufa are exposed in several depositional, climatic, and tectonic contexts throughout the world (Chafetz & Folk, 1984; Pedley, 1990; Ford & Pedley, 1996; Pentecost, 2005). Their depositional, geochemical, isotopic and palynological signatures are very complex to interpret in terms of paleoenvironmental and palaeoclimatic changes (Altunel & Hancock, 1993; Guo & Riding, 1998; Bertini et al., 2008; Bertini et al., 2014; Ricci et al., 2015; Toker et al., 2015 and Toker, 2017).

The purpose of this study is to reveal the sedimentological and depositional processes as well as to approach the palaeoclimatic changes during the Middle-Late Pleistocene in Sarıkavak calcareous tufa located in Afyon province, SW-Turkey.

2. STUDY AREA

The Acıgöl Graben Basin is located approximately 50 km northeast of Denizli and southern Afyon province in SW-Turkey (Fig. 1). It is an asymmetric graben, approximately 30 km long and 10 km wide, floored by the Mesozoic-Paleogene carbonate and ultramafic bedrocks (Göktaş et al., 1989; Şenel, 1997; Konak & Şenel, 2002). The Upper Miocene-Pliocene deposits unconformably overlay molasse type deposits known as "Çardak-Dazkırı Basin" and mainly consist of mudstone-sandstone alternations and clay-rich limestone (Göktaş et al., 1989; Şenel, 1997; Toker, 2009). The basin is bordered by NE-SW trending faults (i.e. the Acıgöl fault in the south and the Maymundağı fault in the north) which created a narrow corridor in which Lake Acıgöl developed during the Pliocene (Fig.1). The Acıgöl Graben basin started to form during the Neotectonic period and deposits have been uplifted by activated older faults or newly generated younger faults (Helvacı et al., 2013). Travertine and calcareous tufa deposits overlay on the Pliocene sediments and they are very well exposed in the Örtülü and Sarıkavak villages (Fig. 1).

3. MATERIAL AND METHODS

Investigations on the Sarıkavak calcareous tufa were divided into two steps: field work and laboratory analyses. During the field survey, we carried out facies description and samples collection from the non-marine carbonates and associated sediments.

Stable carbon and oxygen isotope measurements of the carbonates (sixty-three old tufa samples) for the palaeoenvironmental interpretation of these tufas were performed at the carbonate laboratory of stable isotopes, department of Geoscience, University of Arizona (USA). Carbon and oxygen isotope analyses of bulk carbonate samples were carried out using the continuous flow technique (Spötl and Vennemann, 2003). $^{13}C/^{12}C$ and $^{18}O/^{16}O$ ratios were determined in CO_2 gases liberated by phosphoric acid using a Finnigan delta plus XP mass spectrometer (Thermo Fisher Scientific, Bath, UK).

U-Th disequilibrium analyses were accomplished in low primary porosity twenty-three tufa samples. These samples were analyzed at the GEOTOP research center of the University of Quebec (Montreal, Canada).

Palynological analyses were conducted in two different laboratories. Eight samples from the Sarıkavak non-marine carbonates were analyzed at the Laboratory of Palynology of the University of Florence, Italy, and the rest of them was analyzed at the Laboratory of Palynology of the Department of the Institute of Marine Science and Technology, İzmir, Turkey.

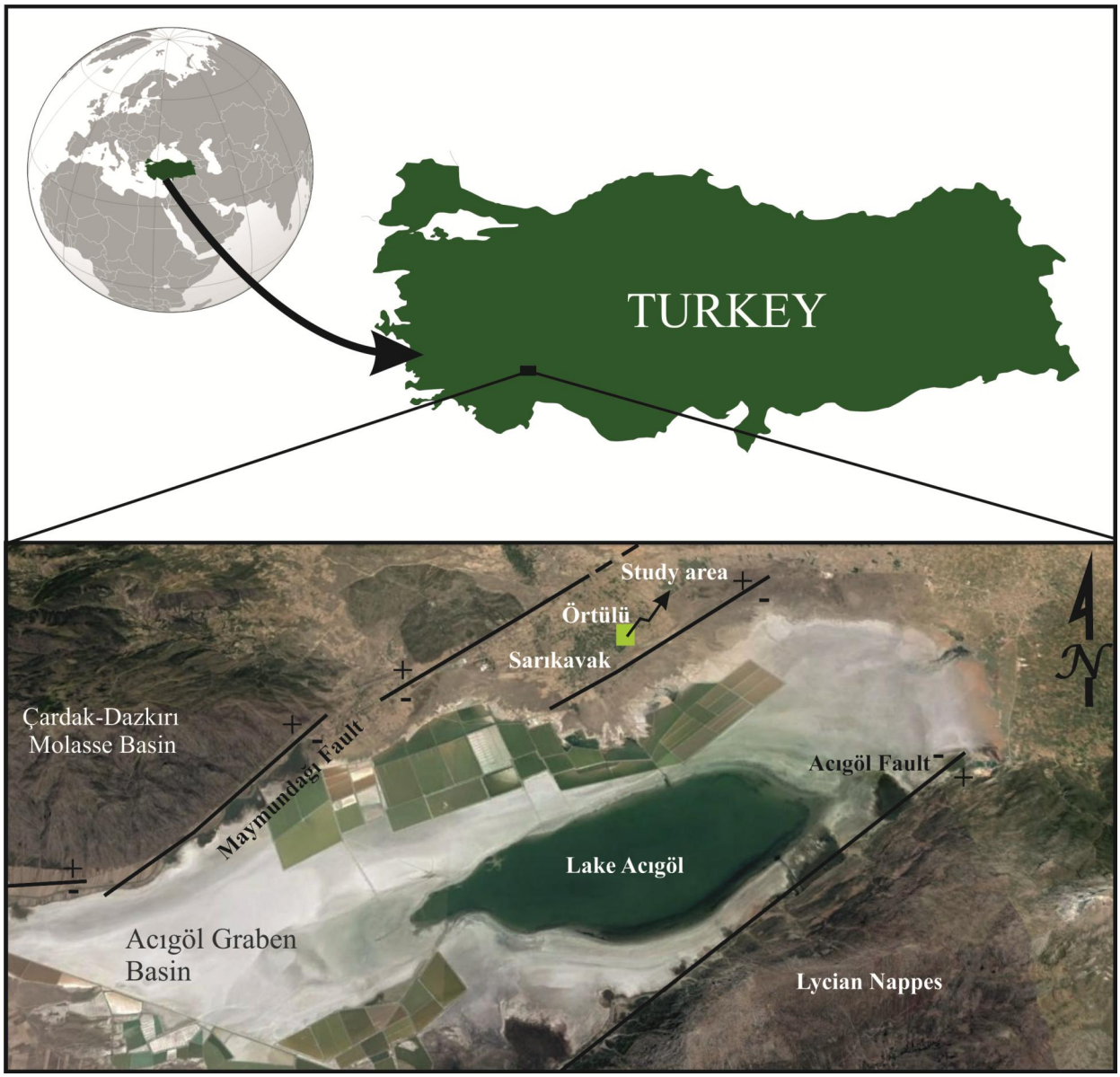

Fig. 1 - Location of the study area. The satellite photo shows the Sarıkavak and surrounding areas in SW-Turkey.

4. RESULTS

In the Sarıkavak tufas, seven lithofacies were distinguished. They are characterized by the good occurrence of mosses -included bryophytes, and macrophytes. However also other tufa lithofacies are well expressed by the occurrence of phytoclastic, oncolitic, stromatolitic, intra and extra clasts and sapropelitic tufas. All facies represent fluvial and fluvio-palustrine depositional systems (Toker, 2017). Ostracods and gastropods are the most abundant faunal remains. Palynological analyses showed that palaeosol levels are more enriched in palynomorphs than bulk carbonate deposits. Pollen of gymnosperms and angiosperms plus non-pollen palynomorphs are scarcely observed in travertine samples, whereas they are abundant in palaeosol samples. Palynoflora defined in the palaeosol level is especially characterized by herbaceous taxa (i.e. Poaceae, Asteraceae Asteroideae, *Artemisia*, Asteraceae Cichorioideae, *Polygonum persicaria*, Geraniaceae and Chenopodiaceae) but also includes trees taxa (i.e. *Quercus*, *Castanea*, *Cedrus* and other Pinaceae). Non-pollen palynomorphs and other organic material were also abundantly recorded (Fig. 2). Pollen and other palynomorphs were detected in the bulk carbonate deposits in the Sarıkavak tufas between the MIS 8 (291±28ka) and MIS 11 (359±21ka). The MIS 11 interval is characterized by gymnosperm and angiosperm pollen (Pinaceae-*Pinus* spp., *Cedrus, Castanea,* Oleaceae and Chenopodiaceae). The pollen assemblage of MIS 10 especially includes *Abies,* Pinaceae-*Pinus* spp., Oleaceae, Fagaceae-*Quercus* evergreen type, As-

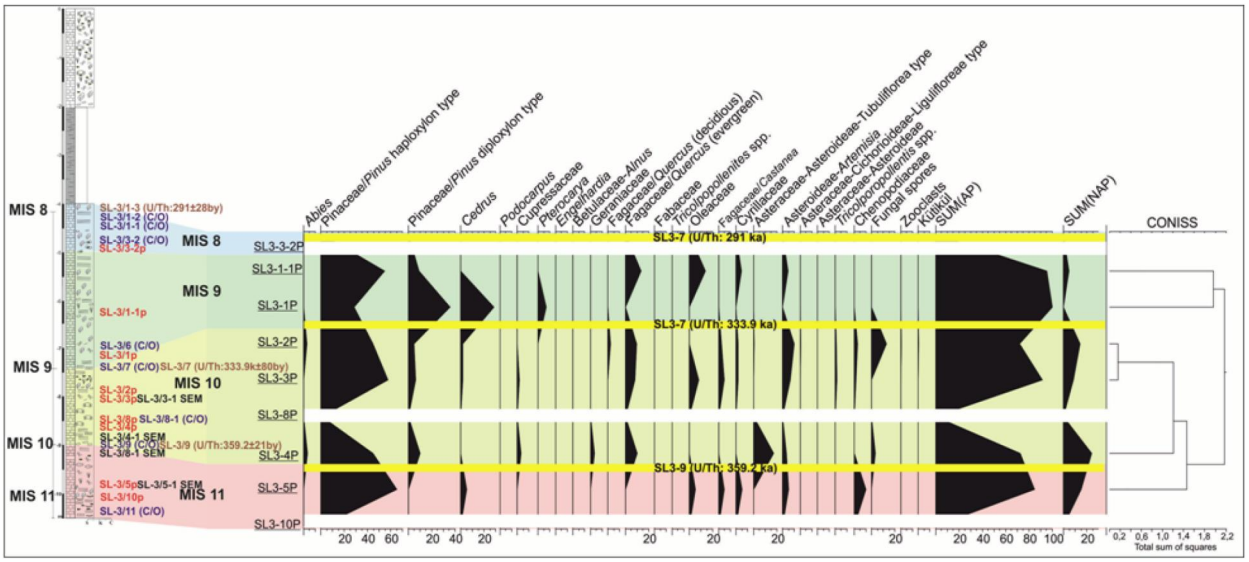

Fig. 2 - Palynomorph assemblage in the interval between MIS 11 and MIS 8.

teraceae Asteroideae, *Artemisia* and Chenopodiaceae. Palynomorph association of MIS 9 was dominated by Pinaceae-*Pinus* sp. (haploxylon and diploxylon types), *Cedrus, Pterocarya*, Oleaceae, Fagaceae-*Quercus* evergreen type and *Artemisia*. These changes in the palynomorph association could be related to the climatic changes in the MIS periods. $\delta^{18}O$ values are in the range −10.83‰ to −7.49‰ VPDB while $\delta^{13}C$ values vary from −1.63‰ to +1.5‰ VPDB. U/Th dating of the Sarıkavak calcareous tufas yielded 474 ka, 333 ka, 291 ka, 188 ka and 80 ka. Stable isotope pattern is apparently coherent with the palynological-derived palaeoenvironental reconstruction.

5. DISCUSSION AND CONCLUSION

This study permitted identification of seven tufa lithofacies which represent fluvial to fluvio-palustrine depositional systems. According to radiometric dating, carbonate precipitation occurred continuously across consecutive interglacial (e.g. MIS 11 and MIS 9) and glacial periods (e.g. MIS 10 and MIS 8) (Fig. 2). The presence of palaeosols land debris flow supports main changes in atmospheric and edaphic humidity. Precipitation of terrestrial carbonates started again to the edge of the graben fault (which confined the Acıgöl Graben, as fluvial tufa deposits), along MIS 5, till ca. 80 ka.

According to the stable isotopic measurements, $\delta^{13}C$ values are between ‰ -1.6 and +1.5 ‰ while those of $\delta^{18}O$ are between ‰ -7.4 and ‰ -10.8. The changes of $\delta^{18}O$ values could be related to the evaporation in the depositional environment, while the less negative $\delta^{13}C$ values could be interpreted as surface water mixing with the CO_2 transported from deep hydro thermal waters and decreasing the C isotope values.

The spores and pollen records give some preliminary clues about the palaeovegetational and palaeoclimate of the region which is especially useful for a better interpretation of the $\delta^{13}C$ stable isotopic fluctuations (i.e. arid vs less arid/humid conditions).

ACKNOWLEDGEMENT

This study is financially supported by TUBİTAK (The Scientific and Technological Research Council of Turkey) (Project no. 115Y493) and Pamukkale University Scientific Research Project Unit (Project no. 2014HZL010). The authors warmly thank to reviewers for the helpful comments and suggestions.

REFERENCES

Arenas-Abad C., Vazquez-Urbez M., Pardo-Tirapu G., Sancho-Marcen C. (2010) - Fluvial and associated carbonate deposits. In: Carbonates in Continental Settings: Facies, Environments, and Processes (Eds A.M. Alonso Zarza and L.H. Taner), Dev. Sedimentology, 61, 133-175.

Bertini A., Minissale A., Ricci M. (2008) - Use of Quaternary travertines of central-southern Italy as archives of paleoclimate, paleohydrology and neotectonics, Il Quaternario, 21 (1B), 99-112.

Bertini A., Minissale A., Ricci M. (2014) - Palynological approach in upper Quaternary terrestrial carbonates of Central Italy: anything but a “mission impossible, Sedimentology, 61, 200-220.

Chafetz H.S., Folk R.L. (1984) - Travertines: Depositional morphology and the bacterially constructed constituents. Journal Sedimentary Petrology, 54, 1, 289 - 316.

Göktas F., Çakmakoğlu A., Tan E., Sütçü Y.F., Sarıkaya H. (1989) - Çivril- Çardak arasının Jeolojisi. (The Geology between Çivril-Çardak Region). Mineral Research and Exploration Institute of Turkey (MTA), Report no. 8701, pp. 109 (in Turkish with English abstract).

Guo L., Riding R. (1998) - Hot-spring travertine facies and sequences, Late Pleistocene Rapolano Terme, Italy. Sedimentology, 45, 163-180.

Helvacı C., Alçiçek M.C., Gündogan I., Gemici Ü. (2013)

- Tectono sedimentary development and palaeoenvironmental changes in the Acıgöl shallow perennial playa-lake basin, SW Anatolia, Turkey. Turkish Journal of Earth Sciences, 22, 173-190.

Konak N., Şenel M. (2002) - Geological Map of Turkey in 1/500.000 scale: Denizli Sheet. Mineral Research and Exploration Institute of Turkey (MTA) Publications.

Ricci M., Bertini A., Capezzuoli E., Horvatinčić N., Andrews J.E., Fauquette S., Fedi M. (2015) - Palynological investigation of a Late Quaternary calcareous tufa and travertine deposits: the case study of Bagnoli in the Valdelsa Basin (Tuscany, central Italy). Review of Palaeobotany and Palynology, 218, 184-197.

Spötl C., Vennemann T.W. (2003) - Continuous-flow IRMS analysis of carbonate minerals. Rapid Communications in Mass Spectrometry, 17, 1004-1006.

Şenel M. (1997) - Geological maps of Turkey in 1:100.000 scale: Denizli K9 sheet. Mineral Research and Exploration Directorate of Turkey, Ankara, p. 17.

Toker E. (2009) - The investigation of Tectono-sedimentary evolution of the Tertiary deposits in the north of Acıgöl Çardak (Denizli) Graben Basin). PhD Thesis, p. 242 (in Turkish with English abstract, unpublished).

Toker E. (2017) - Quaternary fluvials tufas of Sarıkavak area, southwestern Turkey: Facies and depositional systems. Quaternary International, Non-marine Carbonates, Special Issue, 437, 37-50.

Toker E., Kayseri-Özer M.S., Özkul M., Kele S. (2015) - Depositional system and palaeoclimatic interpretations of Middle to Late Pleistocene travertines: Kocabaş, Denizli, SW Turkey. Sedimentology, 62 (5), 1360-1383.

Ms. received: May 2, 2018
Final text received: May 22, 2018