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PALAEO-ENVIRONMENTAL RECONSTRUCTION OF THE MERCURE BASIN (BASILICATA REGION) DURING MIS 13, THROUGH A MULTI-PROXY ANALYSIS OF LACUSTRINE SEDIMENTS

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ABSTRACT: The main purpose of this work is to make a first evaluation of the potential of the carbonate lacustrine sediment of the Mercure Basin (Basilicata region), to preserve palaeoclimatic information during the Middle Pleistocene. For this purpose a multi-proxy analysis of the lacustrine sediments from a selected section of the basin was undertaken. The selected section contains several tephra layers, which constrains the timing of deposition to MIS 13. Stable isotopes (oxygen and carbon) and element content were tentatively interpreted as linked to climatic changes giving interesting results for this poorly studied interval.

KEYWORDS: Multi-proxy, stable isotopes, palaeoenvironment, palaeoclimate, Mediterranean

1. INTRODUCTION

Apennine tectonic basins are fundamental archives for the reconstruction of past climate conditions (e.g. Giaccio et al., 2015). Mercure Basin is currently a large river basin, which extends from the S-W Basilicata to the Calabria boundary (Fig. 1). During the Middle Pleistocene, the Mercure Basin was entirely occupied by a lake (Schiattarella et al., 1994; Robustelli et al., 2014). The presence of some tephra layers and their direct dating and correlation with known eruptions allowed a precise chronological definition of part of the lacustrine succession (Giaccio et al., 2014). This indicates that lacustrine succession deposited during marine isotope stage (MIS) 13, ca. 533-478 ka, an interval still poorly studied in the Mediterranean area.

2. MATERIALS AND METHODS

In this study, the composite section of S. Ciriaco (between the locations of Rotonda and Viggianello) was sampled, at a constant resolution of 10 cm, for a total of 21 m. In the sampled section, there are the volcanic tephra layers of different origins (SC5, SC4, SC3, SC2 and SC1) described by Giaccio et al. (2014).

Isotopic analyses ($\delta^{13}C$ and $\delta^{18}O$) were performed on all the samples using a Gas Bench II (Thermo Scientific) coupled with an IRMS Delta XP, whereas carbonate content was measured at resolution of 20 cm using De Astis' calcimeter. X-ray fluorescence analyses were made through spectrometer NITON XL3t Goldd + XRF. Finally, X-ray diffraction analyses were made using a Brucker D2 phaser Diffractometer.

3. RESULTS AND DISCUSSION

The analysed composite section is made of 5 subsections. Correlation among subsections was allowed during the sediment sampling thanks to the volcanic tephra layers and stratimetric criteria (Fig. 2a). Samples of conglomerate was also sampled to compare isotopic data between lacustrine and potential clastic component.

The chronology of the succession was based on $^{40}Ar/^{39}Ar$ dating on SC1 and SC5 tephras, which turn out to be between, respectively, 494 ±11 ka and 517 ±3 ka (Giaccio et al., 2014), as well as on the correlation of the SC5 tephra level with the same level found in the lacustrine basin of Ohrid, Macedonia (Francke et al., 2016). Further tuning points were obtained from comparisons with the Ohrid record (Francke et al., 2016). From the analysis, it emerges that the content of $CaCO_3$ is variable: it oscillates between a minimum of 64% and a maximum of 97% (Fig. 3), with average values of ca. 83%. The isotopic record shows that $\delta^{18}O$ and $\delta^{13}C$ records have different trends. The $\delta^{18}O$ curve shows to be roughly consistent with the percentage variation of $CaCO_3$ (Fig. 3). In the $\delta^{18}O$ record, three intervals can be distinguished on the basis of the different values with respect to the average value of -4.35‰. The first interval, from 545 ka to 520 ka, exhibits more negative values than the average; the second interval, from 520 ka to about 505 ka. is characterized by less negative values than the average; the third interval, from 505 ka to 493 ka, shows similar values to the average (Fig. 3). The $\delta^{13}C$ curve shows less congruent trend with the $CaCO_3$ record; it can be divided into two parts with respect to the average value of -0.13‰: the first part has positive values and the second has values significantly more nega-

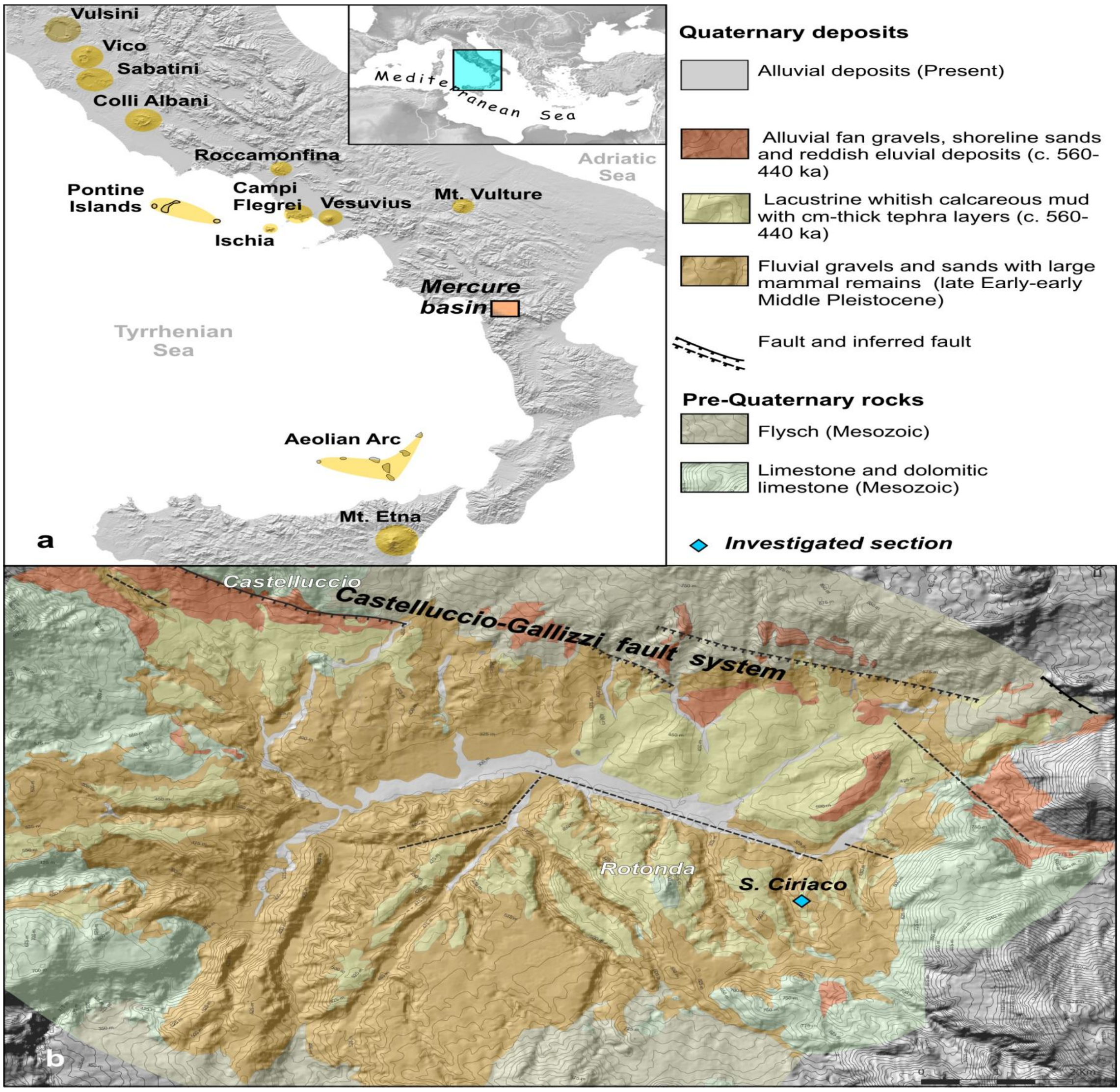

Fig. 1 - (a) Location of the Mercure Basin with respect to the main volcanic centers of central and southern Italy (b) Geological map of the Mercure Basin (modified from Giaccio et al., 2014)

tive than the average value.

Results from the X-ray fluorescence (XRF) made on fifty-nine samples were expressed as concentration curves for each element. The curves of Ca and Sr show quite congruent trends with the percentage variation of $CaCO_3$. On the contrary, the curves of K, Ti, Sr, Rb and Zr show poor congruent trends compared to the others. X-ray diffraction (XRD) points out that the main mineralogical phase is calcite, which is associated to less represented Quartz, Aragonite and Muscovite. Aragonite is possibly related to the presence of abundant freshwater shell remains.

4. DISCUSSION AND CONCLUSION

According to Leng & Marshall (2004), the content of $CaCO_3$ can be interpreted as an indicator of primary productivity within the lake. The variation of $\delta^{18}O$ is considered as an indicator of the water recharge/evaporation ratio and of the amount effect in precipitation in the basin catchment, as demonstrated for other Italian lacustrine successions (Giaccio et al., 2015; Regattieri et al., 2015, 2016). Variation of $\delta^{13}C$, despite being more complex to interpret, is considered indicator of photosynthetic activity within the lake as well as internal processes such as recycling of organic matter and the equilibration of the lake water with the atmospheric CO_2 (Leng & Marshall, 2004).

The variation of the Ca concentration was correlated to the $CaCO_3$ content and interpreted as an indicator of the quantity of bioinduced calcite. The variations of K, Ti, Si, Rb and Zr were considered as indicator of clastic input within the lake.

During the interval from 545 ka to 520 ka, the instability of $CaCO_3$ content and the progressive decrease of $\delta^{13}C$ suggest a progressive decrease of primary produc-

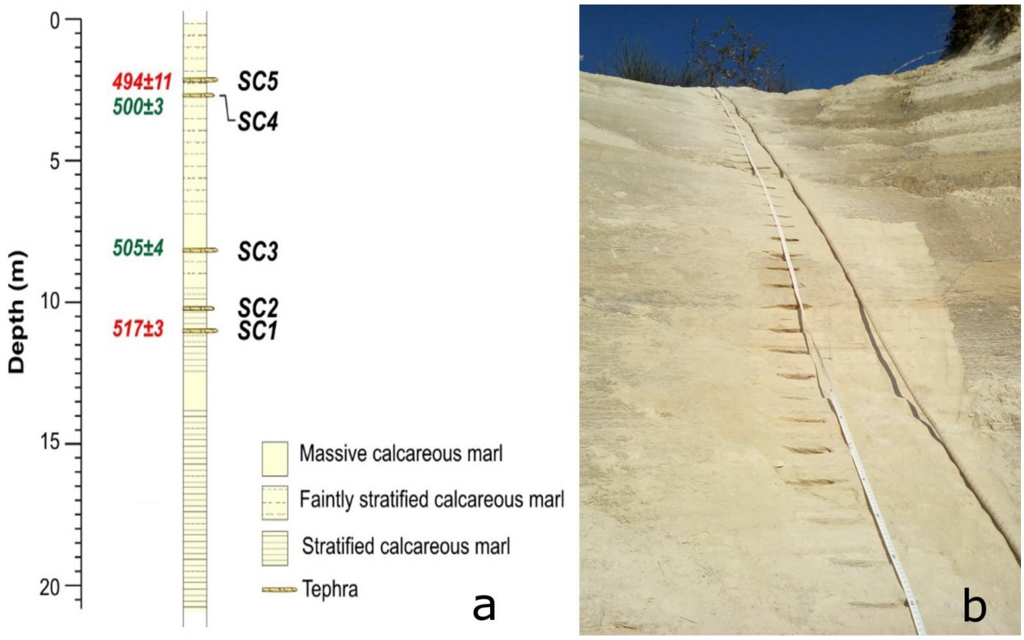

Fig. 2 - (a) Representative stratigraphic and lithological sketch of the S. Ciriaco section containing tephra layers. (b) Fieldwork of samples collection at the S. Ciriaco section, during August 2016.

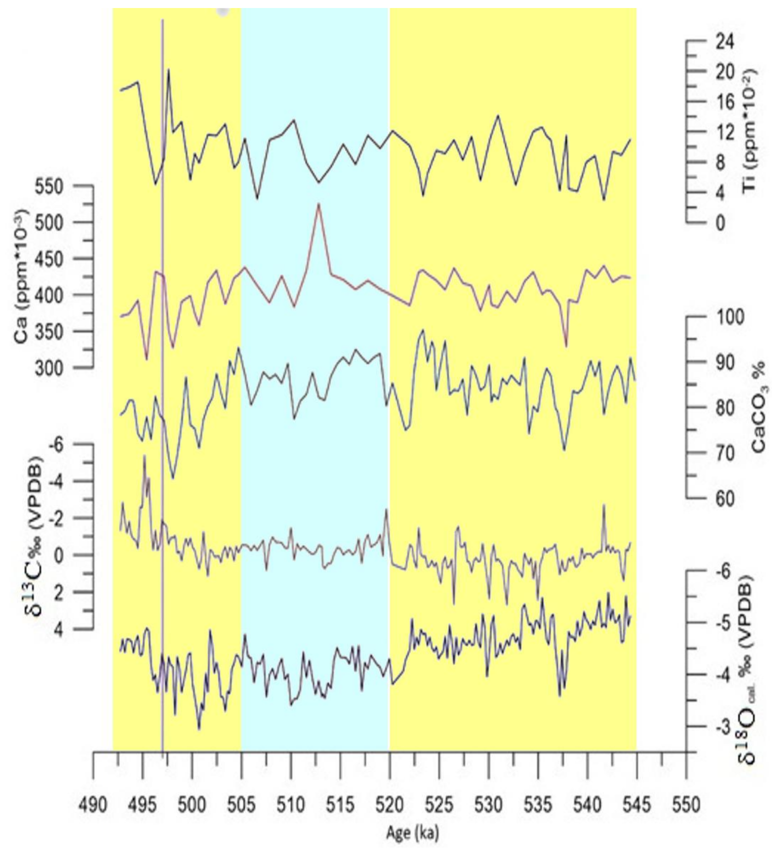

Fig. 3 - Variation trend of the $\delta^{18}O$, of the $\delta^{13}C$, of the % $CaCO_3$ and the elements Ca e Ti, with highlighted the three distinct phases expressed consistently by all the proxies.

tivity and photosynthetic activity. In this interval, a reduction of the amount of precipitation and an increase of the detrital contribution within the lake is suggested by the increasing to less negative values of $\delta^{18}O$ and increasing of the amount of K, Rb, Zr, Si and Ti. In the phase between 520 ka and 505 ka, more negative $CaCO_3$ and $\delta^{13}C$ values point to a minimum in the primary productivity and a maximum reduction of photosynthetic activity; minimum values of $\delta^{18}O$ and increase of K, Rb, Zr, Si and Ti in this interval suggest decreasing precipitation and an increase of the detrital contribution within the lake. The phase from 505 ka to 493 ka is characterised by a continuous decrease of the primary productivity as suggested by a decrease in $CaCO_3$ content; unstable values of $\delta^{13}C$ depict an unstable recovery photosynthetic activity; unstable quantities of K, Rb, Zr, Si, Ti and Ca point to instability of the detrital contribution within the lake as well as of the rates of the bioinduced calcite precipitation.

In conclusion, the Mercure Basin turned out to be a perfect archive for palaeo-environmental and palaeoclimatic studies. Moreover, it is possible to extend this kind of analysis to successions covering longer time intervals, like those cropping out to a large extent within the basin.

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