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THE PLEISTOCENE CALCAREOUS TUFA OF SANTA SABINA (PERUGIA, CENTRAL ITALY): STRATIGRAPHY, PALYNOLOGY AND VERTEBRATE PALEONTOLOGY

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ABSTRACT: Pazzaglia F. *et al.*, *The Pleistocene calcareous tufa of Santa Sabina (Perugia, central Italy): stratigraphy, palynology and vertebrate paleontology.* (IT ISSN 0394-3356, 2011)
An integrated sedimentological, geochronological, paleontological (mammal fauna) and palynological study was carried out on the calcareous tufa of Santa Sabina, outcropping in the Ellera basin (Perugia, central Italy). Previous U/Th datings on the investigated sections provided an absolute age of 115±8 ka as confirmed by the vertebrate fauna which could be biochronologically referred to the early-middle Aurelian Mammal Age. It corresponds to the MIS 5e, and to the last interglacial period (Eemian) characterised by wet and warm climate conditions suitable for calcareous tufa depositon.

RIASSUNTO: Pazzaglia F. *et al.*, *I "calcareous tufa" pleistocenici di Santa Sabina (Perugia, Italia centrale): stratigrafia, palinologia e paleontologia a vertebrati.* (IT ISSN 0394-3356, 2011)
Lo studio integrato sedimentologico, geocronologico, paleontologico (fauna a vertebrati) e palinologico dei calcareous tufa di Santa Sabina, affioranti nella zona ad ovest di Perugia (Italia centrale, ha messo in evidenza la presenza di una mammalofauna riferibile all'Aureliano inferiore-medio. Questo è in accordo con quanto precedentemente indicato dalle datazioni U/Th, che hanno restituito un'età assoluta di 115±8 ka per le sezioni studiate. Questo intervallo di tempo corrisponde all'intervallo isotopico MIS 5e e all'ultimo interglaciale (Eemiano), caratterizzato da condizioni climatiche caldo-umide, ideali per la deposizione dei calcareous tufa.

Key words: Pleistocene, calcareous tufa, Santa Sabina, mammal fauna, palynology

Parole chiave: Pleistocene, calcareous tufa, Santa Sabina,mammalofauna, palinologia

Among terrestrial carbonates (calcareous tufa, speleothem and travertines), calcareous tufa represent good proxy-indicator of environmental changes. They can be successfully approached by integrated analyses because of their multiple reliable geochemical records.
A multidisciplinary investigation was carried out on the calcaerous tufa outcropping in the Ellera basin area, located immediately west of Perugia (central Italy). The stratigraphical study and sedimentary facies analysis throughout two key sections (SSAB2 and Chiusa section) was combined with preliminary paleontological (fossil mammals) and palynological data. These data were compared with radiometric analyses carried out on SSAB2 section (PAZZAGLIA, 2008), in order to obtain a detailed paleoecological and chronological framework.
The Ellera basin is a little basin bordered to the north and north-east by Mesozoic carbonate mountains, to the west by Miocene flysch hills and to the south by Pleistocene continental hills. It consists of a semigraben with a eastern master-fault dipping towards west and probably antithetic western minor faults. The thickness of sediments (calcareous tufas, silts, clays, sands and rare gravels) that have filled the basin is greater than 140 m. Two units separated by erosional surfaces can be observed: the Santa Sabina Unit and the San Biagio Unit. The first 22-30 m thick unit covers an area of 10 km^2 and its surface appears flat, with an elevation higher in the center. The Santa Sabina Unit shows two lithofacies: PGU_{4a} (calcareous tufa) and PGU_{4b} (clays, silts, peats and calcareous tufa) (PAZZAGLIA, 2008).
This study is focused on the characterisation of the calcareous tufa lithofacies which outcrop in the more proximal part of the Santa Sabina Unit, with respect to the Mesozoic ridge, where possible $CaCO_3$-enriched water springs could be presumably located.
From bottom to top the SSAB2 section is characterised by the presence of a basal calcareous-siliciclastic sand level with rare lithoclasts and organic laminations (40 cm thick). At the top of the sandy level there is a centimetric calcareous crust, followed by a 110 cm thick level mainly consisting of coherent micritic tufa with phytohermal clusters/ tufts and lenticular accumulations of phytoclasts. The section is closed by centimetric strata of microhermal and phytoclastic tufa (40 cm thick) (Fig. 1). U/Th datings on the SSAB2 sections provided an absolute age of 115±8 ka (PAZZAGLIA, 2008). The Chiusa section is characterised by the absence of microhermal facies and by the predominance of decimetric to metric strata of micritic and phytoclastic tufa. The total thickness of the section is about 10 m.

Fig. 1, SSAB2 section, with indication of the 8 samples taken for palynological analysis.
Sezione SSAB2, con indicazione degli 8 campioni raccolti per le analisi palinologiche.

In the PGU_{4a} phytohermal tufas, previous paleontological data (PRINCIPII, 1930) have revealed the presence of leaves and stems of Poaceae (*Arundo* sp., *Phragmites* sp.) and Cyperaceae (*Carex*?). In the micritic tufa abundant lacustrine molluscs (PRINCIPI, 1930), ostracods and oogons of Characeae have been found (PAZZAGLIA, 2008).
Some of the sedimentological data recorded from SSAB2 section reveal a partial fluvial origin of the deposits (i.e. siliciclastics inputs, presence of microhermal facies, current structures). These evidences are absent in the Chiusa section. So, the facies association of the examined sections suggests a gradual passage from fluvio-palustrine to fully palustrine conditions from north (SSAB2 section) to south (Chiusa section), as the distance from the Mesozoic carbonate ridge increases.
Fossil vertebrate finds from Pleistocene travertine s.l. deposits are rare in Europe. The most important site is Weimar-Ehringsdorf (Germany), that has provided a diverse vertebrate collection, including fish, amphibians, reptiles, birds and mammals (SCHÄFER *et al.*, 2007). The first report about the presence of mammalian fossils from the "travertines" near the village of Ellera was written by BONARELLI (1900), who generically cited "hippopotamus remains". Later, PRINCIPI (1930) published a more complete description of the "travertine" outcrops near Ellera, where he listed and synthetically described the mammals. Principi's collection from Ellera was long reported missing, but it was recently found again in the warehouse of the "Soprintendenza per i Beni Archeologici per l'Umbria".
The mammal fauna from Ellera was collected at the beginning of the 20th century. Unknown is the stratigraphic origin of the fossils: PRINCIPI (1930) wrote that they became from "travertine" near "Rosci's house", a farm still there, near Chiusa section. The type of carbonatic encrustations on the fossil bones are comparable with the facies outcropping at Chiusa section. Because of the high rate of sedimentation of the calcareous tufa (i.e. PENTECOST & WHITTON, 2000), it could be reasonably supposed that the mammal remains form a chronologically homogeneous assemblage.
The collection is poor in terms of quantity of fossil material, but it is characterised by a quite abundant paleodiversity. The most represented taxon is *Bos primigenius*. Four isolated molar teeth (two lower and two upper), a left astragalus, the distal end of a metacarpal, the proximal end of a radius, the proximal end of a femur, and lots of other fragments were identified. *Elephas antiquus* is represented by fragments of molar teeth and tusks. The tip of a little tusk is still partially embedded in a block of very compact tufa. The distal end of a tibia belongs to a medium size cervid and is mor-

phometrically compatible with *Cervus* sp.. Four lateral teeth (p_4, m_1, m_2, m_3) can be rather related to a smaller, *Dama*-like form. Cervidae are also represented by a dorsal vertebral centrum, lacking of the anterior and posterior epiphysis, thus referred to a young animal. Other Artiodactyla remains are a right m^2 of *Sus scrofa* and some teeth fragments of *Hippopotamus* sp.. Perissodactyla are represented by a tooth fragment and an astragalus of *Stephanorhinus* sp.; further analysis of the latter bone will probably allow to determine the rhinoceros species. The only remain belonging to a Carnivore is a left p_4 of *Ursus spelaeus*. The mammal fauna is typical of a forested landscape on the whole, with the presence of quite large palustrine and/or lacustrine habitats (because of the occurrence of *Hippopotamus* sp.) as revealed by sedimentological inferences, and other paleontological data (plants, molluscs, and ostracods).

Although palynological processing of carbonates is still generally discouraged because considered as unfavourable lithotypes, some literature reveals that calcareous tufa could be palynologically productive and often suitable for pollen analysis (i.e. BURJACHS & JULIÀ, 1994; VERMOERE *et al*., 1999).

A palynological investigation was carried out on 8 samples taken from the SSAB2 section (Fig. 1). The section was sampled with a variable interval (max. 60 cm) from both micritic and phytohermal facies. Standard chemical and physical treatments were employed to remove most of the mineral sediment and to concentrate pollen grains in the residue. Pollen analyses are in progress to define vegetational and climatic conditions during carbonate deposition. Although most of the fossil material from Ellera is fragmentary and some of the specimens have not been thoroughly examined yet, the finds allowed to infer some biochronological and paleoecological conclusions. The mammal collection could be biochronologically referred to the early-middle Aurelian Mammal Age, as previously suggested by a radiometric dating (115±8 ka, PAZZAGLIA, 2008). This age corresponds to the MIS 5e, and to the last interglacial period (Eemian) characterised by wet and warm climate conditions suitable for calcareous tufa depositon (BAKER *et al*., 1993; SOLIGO *et al.,* 2002; MARTIN-ALGARRA *et al.,* 2003).

The integrated stratigraphical, sedimentological, paleontological (mammalian fauna), and palynological analyses, carried out in this study, could allow to better define the depositional and climatic conditions controlling the deposition of the Santa Sabina calcareous tufa.

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