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Nota Breve
Short communication

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U/TH DATING OF A TUFA DEPOSIT FROM THE CARSOLI INTRAMONTANE BASIN (ABRUZZO, ITALY)

ABSTRACT: DRAMIS F., SOLIGO M., GRACIOTTI E., D'OREFICE M. & GRACIOTTI R., *U/Th dating of a tufa deposit from the Carsoli intramontane basin (Abruzzo, Italy)*. (IT ISSN 0391-9838, 2008).

A few km far from the confluence of the Fioio Valley into the Carsoli basin, some hundreds m^2 wide and ca. 1.5 m thick carbonatic deposit is present, embedded within late Middle Pleistocene alluvial gravels. The deposit formation might be related to sub-aerial deposition of $CaCO_3$ (*tufa*) from emerging groundwater. A U/Th dating to 46 ± 6 ka BP constrains the deposit within the MIS 3, corresponding to a phase of warming between the MIS 4 and 2. (KEY WORDS: Tufa, U/Th dating, Quaternary, Intramontane basin, Apennine, Italy).

Riassunto: DRAMIS F., SOLIGO M., GRACIOTTI E., D'OREFICE M. & GRACIOTTI R., «*Datazione U/Th di un deposito travertinoso nel bacino intermontano di Carsoli (Abruzzo, Italia)*». (IT ISSN 0391-9838, 2008).

A pochi chilometri dallo sbocco del Fosso Fioio nella Conca di Carsoli, incassato entro sedimenti alluvionali del Pleistocene Medio finale, si rinviene un deposito carbonatico esteso poche centinaia di m^2 e spesso non più di 1,5 m, la cui genesi può essere riferita, con ogni probabilità, alla deposizione di travertino da parte di acque sorgive. Una datazione U/Th del deposito ha fornito una età di 46 ± 6 ka BP che lo colloca all'interno dello stadio isotopico 3, corrispondente a una fase di riscaldamento tra gli stadi isotopici 4 e 2. (TERMINI CHIAVE: Travertino, Datazione U/Th, Quaternario, Bacini intermontani, Appennino, Italia).

INTRODUCTION

The scarcity of chronological data represents a heavy limit to the understanding of the geomorphologic-stratigraphic evolution of continental environments. In this context, isotopic dating methods may play a relevant role.

The U/Th dating of a carbonatic deposit, outcropping in the central-southern sector of the Carsoli intramontane basin, sided by geochemical and mineralogical-petrographic analyses, allowed to chronologically constrain its deposition as well as to formulate a possible interpretation of its genetic process.

The obtained chronological/palaeoenvironmental data may result particularly important in defining the Quaternary stratigraphic succession of the Carsoli basin in the morphoevolutive context of Central Apennine, where few chronological data are still available.

THE GEOLOGICAL CONTEXT

The Carsoli intramontane basin where the carbonatic deposit outcrops is placed in the western sector of Central Apennine, close to the Abruzzo/Latium border (fig. 1). It consists of a wide tectonic depression, located at the contact between the «laziale-abruzzese» platform domain, to the east, and the transitional «sabino» domain to the west, both separated by the «Olèvano-Antrodoco» lineament (Parotto & Praturlon, 1975).

In the Carsoli basin a thick succession of continental sediments of Quaternary age outcrops. The basal ones were deposited on the bottom of an ancient lake, which has probably occupied the basin since the Lower Pleis-

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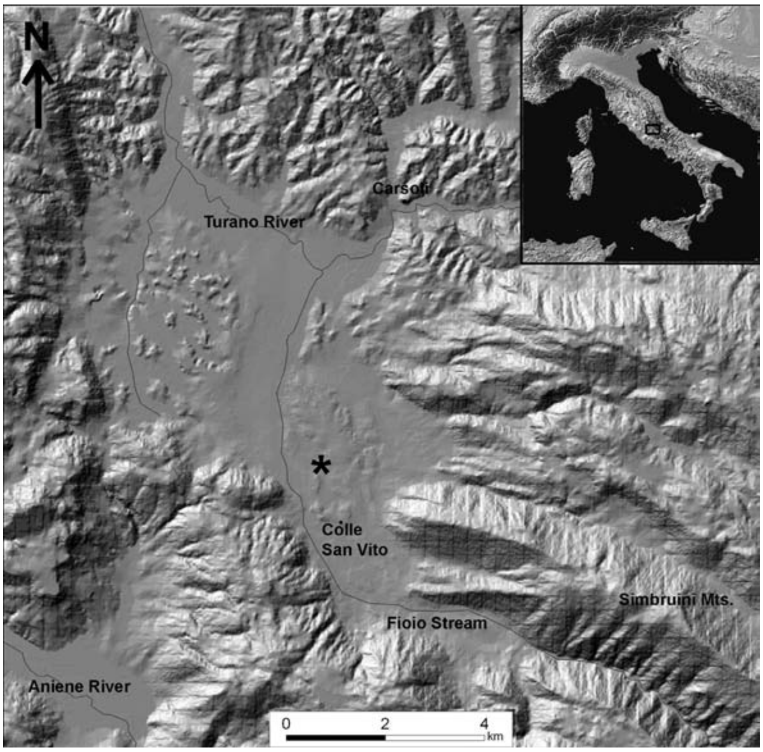

FIG. 1 - Location map of the study area. The star indicates the position of the carbonatic deposit.

tocene to the early Middle Pleistocene (D'Orefice & Graciotti, 2005).

At Bosco di Oricola, the lacustrine sediments are unconformably overlain by volcanic deposits of local origin, dated 530,000-540,000 yrs. BP (Bosi & *alii*, 1991). These latter consist of three main pyroclastic units: heterolithic breccias, grey tuffs, and red tuffs (D'Orefice & Graciotti, 2005).

More recent sediments, mostly related to fluvial processes outcrop in the southern and eastern sectors of the examined area. From their morphostratigraphic features, the fluvial sediments may be distinguished into different nested units whose age ranges between the Middle Pleistocene and the Present.

THE CARBONATIC DEPOSIT

One km north of Colle S. Vito, at ca. 630 m a.s.l., a sedimentary deposit consisting of massive cemented calcareous layers, outcrops. It has a triangular shape, ca. 250 m long and up to 100 m large, with thickness ranging between 0.5 and 1.5 m. It is covered by a brown soil containing reworked volcanic materials (fig. 2). The carbonatic deposit overlays an erosional surface cut across both the lacustrine sediments and coarse fluvial deposits referred to the late Middle Pleistocene (APAT, in press). Heterometric clasts with the same carbonatic composition deposit are widespread in the surrounding fields,

FIG. 2 - A small hill whose core is formed by the carbonatic deposit.

where they have been upraised to the surface by ploughing. This seems to indicate a larger extension of the deposit in the past.

From field observation, the deposit showed to be made of endurated, locally laminated, brown-yellowish (10YR 6/4) sedimentary material, mostly composed of fine calcareous particles, as clearly confirmed by the strong effervescence with HCl. Manganese dendritic mineralizations, randomly oriented dark brown coatings and calcite crystals and veins are also visible. Shells of gastropoda were locally found within the carbonatic mass.

Calcimetric analysis provided a CaCO3 composition of 65%. Mineralogic-petrographic study, carried out through a Shintag x 1 diffractometer and a polarizing microscope, allowed defining the mineral composition of the deposit as well as its fabric and sedimentary structures. The results showed: dominant minerals – *calcite*; accessory minerals in traces – terrigenous *quartz*, *phyllosilicates* and *mica* (paragonite). From the petrographic point of view the sample has been defined as a micritic limestone with a relatively abundant detritic fraction (fig. 3).

ISOTOPIC CHRONOLOGY

Five coeval sub-samples from the carbonate level were collected and analysed by U-series method, according to the total-sample dissolution (TSD) technique developed by Bischoff & Fitzpatrick (1991) for dating impure carbonates. The choice of such a method has been preferred to using leachates alone (Schwarcz & Latham, 1989) because the leaching method gives reliable results only in case of selective dissolution of the carbonate fraction, without any removal of U and Th isotopes from the detritic component, or when U and Th are leached without any fractionation. Generally this condition is not verified because U and Th are often fractionated and Th can be readsorbed onto the residual component. With the use of TSD method the sample is totally dissolved and consequently no preferential leaching or readsorption occur. U and Th were alpha-counted using high resolution ion implanted Ortec silicon surface barrier detectors.

The age of the carbonate deposit was calculated measuring the $(^{230}Th/^{232}Th)$, $(^{234}U/^{232}Th)$ and $(^{238}U/^{232}Th)$ activity ratios of the five coeval sub-samples in order to obtain the value of $(^{230}Th/^{234}U)$ and $(^{234}U/^{238}U)$ activity ratios in the pure carbonate fraction. Such values are respectively calculated from the slopes of the regression lines in the $(^{230}Th/^{232}Th)$ vs. $(^{234}U/^{232}Th)$ and $(^{234}U/^{232}Th)$ vs. $(^{238}U/^{232}Th)$ isochron plots reported in figures 4 and 5. Calculations have been carried out using ISOPLOT, a plotting and regression program for radiogenic-isotope data.

Uranium and thorium activity ratios and ages are summarised in table 1. Quoted uncertainties are 1 standard deviation (± 1 sigma).

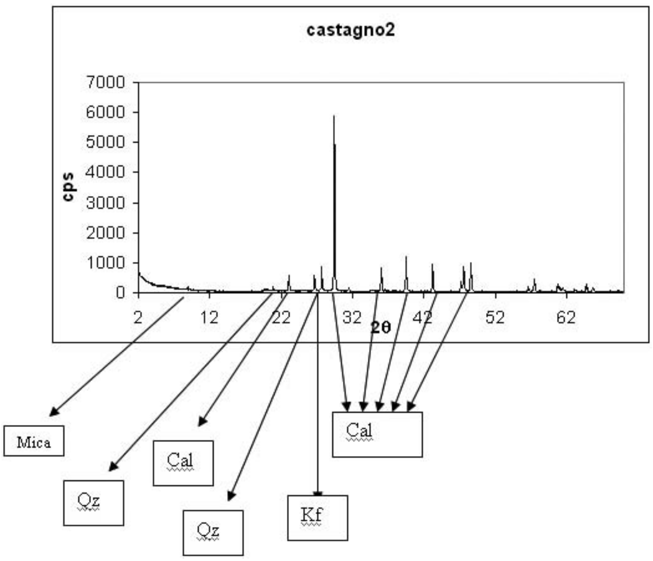

FIG. 3 - Diffractogram of a deposit sample, produced using a Shintag dust diffractometer (mod. x 1, configuration - q. Radiation Cuk a).

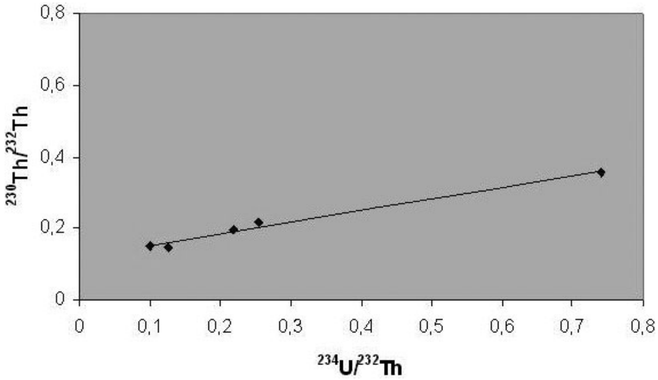

FIG. 4 - Isochron line built on five sub-samples to calculate the $(^{230}Th/^{234}U)$ activity ratio in pure carbonate. The error on single sub-sample is about 5%.

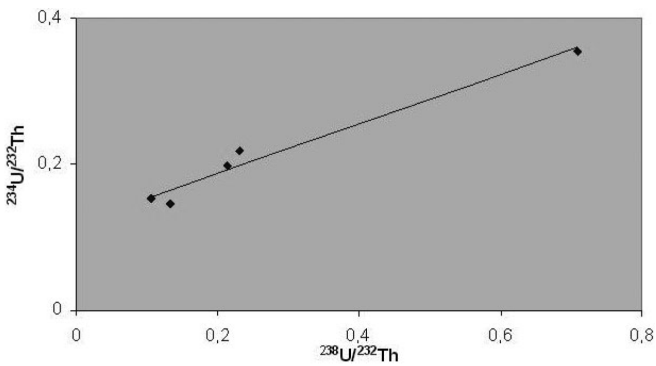

FIG. 5 - Isochron line built on five sub-samples to calculate the $(^{234}U/^{238}U)$ activity ratio in pure carbonate. The error on single sub-sample is about 5%.

TABLE 1 - U and Th activity ratios obtained by alpha spectrometry

Weight of sample	Spike (ml)	($^{238}U/^{232}Th$)	Error ±	($^{234}U/^{232}Th$)	Error ±	$^{230}Th/^{232}Th$	Error ±	$^{230}Th/^{234}U$ carb.	$^{234}U/^{238}U$ carb.	Age of sample
20	0,8	0,134	0,007	0,126	0,006	0,146	0,007			
23	0,8	0,106	0,005	0,101	0,005	0,153	0,008			
20	0,8	0,231	0,012	0,255	0,013	0,218	0,011	0,341± 0,034	0,901± 0,070	**46 ± 6ka**
20	0,8	0,710	0,036	0,740	0,037	0,356	0,018			
20	0,8	0,214	0,011	0,220	0,011	0,198	0,010			

Data points are finely distributed on the ($^{230}Th/^{232}Th$) vs. ($^{234}U/^{232}Th$) and ($^{234}U/^{232}Th$) vs. ($^{238}U/^{232}Th$) isochron plots and arranged in two straight lines whose correlation coefficients R^2 are higher than 0.98. The obtained age is equal to 46 ± 6 ka.

It is worth nothing that ($^{234}U/^{238}U$) activity ratios in the pure carbonate fraction is lower than 1 (table 1), while in the natural carbonate this value is generally greater than 1. In our case this anomalous value can be due to leaching process operated by circulating water after the deposition of carbonate.

THE CARBONATIC DEPOSIT GENETIC CONTEXT

From the observed sedimentary features and the occurrence of freshwater *gasteropoda* shells, the carbonatic deposit could be classified as *freshwater travertine* or *tufa* (Pedley, 1990). It might have been emplaced by spring water (fed by the underlying alluvial gravels, hydraulically connected with the Simbruini Mts. limestone aquifer), oversaturated with calcium carbonate in connection with a climate shift to warmer conditions (Dramis & *alii*, 1999).

This interpretation seems to be consistent with the radiometric age of 46 ± 6 ka which constrains the deposit within the MIS 3, a milder interval between the cold MIS 4 and MIS 2, characterized by the occurrence of nine Dansgaard-Oeschger millennial events (Bond & *alii*, 1999), inducing significant increases of air temperature (Martrat & *alii*, 2004; Van Meerbeeck & *alii*, 2008) and related advances of arboreal vegetation cover (Huntley & *alii*, 2003). Calcium carbonate (tufa and speleothems) deposition in the same interval is also reported from other localities of Italy and Europe (D'Anna & *alii*, 1988; Soligo & *alii*, 2002; Spötl & Mangini, 2002).

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