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FISSION TRACK DATING OF A VOLCANIC ASH LAYER NEAR PISTICCI (BASILICATA, ITALY)

G. Bigazzi (1) **- F. P. Bonadonna** (2)
(1) Istituto di Geocronologia e Geochimica Isotopica, C.N.R., Pisa - (2) Dipartimento di Scienze della Terra, Università di Pisa

ABSTRACT - The results of fission track dating on a volcanic ash level interlayered in a sedimentary clay section are reported. The section is located near Pisticci (Basilicata, South Italy) and is formed by a marine clay, about 100 m thick. The volcanic ash level, 7-8 cm thick, shows wavy upper and lower boundaries.

Fission track measurements were made with the reactors of Pavia University and IPEN-CNEN (São Paulo, Brazil). The obtained results (an age between 3 and 2.5 MA) are coherent and in good agreement with biostratigraphical results.

RIASSUNTO - Vengono esposti i risultati di una misura di età eseguita con il metodo delle tracce di fissione su frammenti di vetro vulcanico costituenti un livello cineritico primario intercalato in una serie marina attribuita biostratigraficamente alla zona a *Globorotalia aemiliana* (sottozona a *Globorotalia crassaformis crassaformis)* di Iaccarino e Salvatorini (1982).

La serie in questione si trova in Basilicata a pochi chilometri a sud di Pisticci (Matera) (Fig. 1); è costituita da argille marine grigiastre di oltre 100 metri di potenza. Il livello cineritico si presenta come un livello indurito di sabbia grigio-bianca ad andamento ondulato; lo spessore medio non supera i 7-8 centimetri.

Le misure sono state eseguite con due irraggiamenti diversi, uno nel reattore IPEN-CNEN (San Paolo, Brasile) ed uno nel reattore dell'Università di Pavia (Italia). I risultati ottenuti (vedi tab.1) si sono dimostrati coerenti tra loro dando, per il livello cineritico, un'età compresa tra 3 e 2.5 MA, in buon accordo, allo stato attuale delle conoscenze, con i risultati biostratigrafici.

Key-words: Fission tracks, volcanic ash, Basilicata
Parole-chiave: Tracce di fissione, ceneri, Basilicata

During a field work in Basilicate region, a group of paleontologists (A. Bossio, R. Mazzei, and G. Salvatorini) of Dipartimento di Scienze della Terra of Pisa University, sampled a volcanic ash level interstratified with a marine Neogene-Quaternary series. The ash level outcrops 6 kilometres south of Pisticci (Matera), (Sheet 201, III S.W. of the Geological Map of Italy) on the SW of Masseria Concarone (Fig. 1).

The Masseria Concarone ash level appears as a light grey sandy layer, 7-8 cm thick, stratified within a very thick (over 100 metres) marine clay series of a probable deep-sea close-to-bathial environment. The ash level upper and lower boundary lines are not straight but undulate, a peculiarity that may be related to the depositional environment, and pockets up to 20 cm deep are found. The ash level is here and there fractured, with calcite cementing fractures (Fig.2).

This volcanic ash level is surely older than the level studied by Capaldi et al. (1979) in the same area (Bossio, Mazzei, Salvatorini, personal communication).

The marine clay just above and below the ash level was attributed biostratigraphically to the *Globorotalia aemiliana* zone (*Globorotalia crassaformis crassaformis* subzone) of Iaccarino and Salvatorini (1982) (Bossio, Mazzei, Salvatorini, personal communication) on the basis of foraminifera and calcareous nannoplankton determinations.

The Masseria Concarone volcanic ash was sampled to attempt age measurements with the fission track method. An enrichment in heavy and mafic minerals is present towards the bottom of the level. The samples were washed with hydrogen peroxide in an ultrasonic bath and sieved under a water flow. The residual consisted mainly of volcanic ash shards showing hyaline transparence.

After the washing standard magnetic methods were used in order to eliminate the mafic minerals, and heavy liquids (a mixture of bromoform and acetone) to separate the glass shards from the scarce salic minerals such as

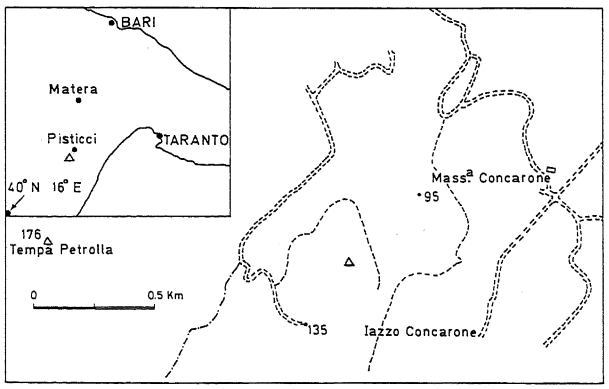

Fig. 1 - Geographical position of the volcanic ash layer outcrop, near Pisticci (marked by a triangle).
Posizione geografica dell'affioramento delle cineriti, vicino a Pisticci individuate con un triangolo.

TABLE 1

IRR	ρ_s (n_s)	ρ_i (n_i)	φ ($\cdot 10^{15}$)	T_{app}	D_s/D_i	T_{app}/T_{corr}	T (MA)
IP_2-1	2590 (206)	180,000 (1389)	2.12	1.85	.77	.63	2.93±27
P_9-27	2490 (104)	290,000 (1369)	3.60	1.88	.80	.68	2.77±33
P_9-27 (250°C)	1870 (105)	160,000 (1164)	3.60	2.60	1.03	-	2.60±26

Measurements on sample PIS-15. IRR = name of irradiation; ρ_s (ρ_i) spontaneous (induced) track density; $n_s(n_i)$ counted spontaneous (induced) tracks; φ = thermal neutron dose (neut/cm^2) referred to NBS standard SRM 963a; T_{app} = apparent age; D_s/D_i = average size rate of spontaneous tracks vs. induced tracks; T_{app}/T_{corr} = correction factor; T = corrected age by size method and by plateau method (last line). Used parameters: spontaneous fission decay constant for ^{238}U, $\lambda_F = 6.85 \cdot 10^{-17}$ y^{-1}; induced fission cross section for ^{235}U, s = $5.802 \cdot 10^{-22}$ cm^2; isotopic rate = $^{238}U/^{235}U$ = 137,8.

Datazione del campione PIS-15. IRR = sigla dell'irraggiamento; ρ_s (ρ_i) = densità di tracce spontanee (indotte) (tracce/cm^2); $n_s(n_i)$ = numero delle tracce spontanee (indotte) contate; φ = dose di neutroni termici (neut/cm^2) riferita allo standard SRM 963a del N.B.S.; T_{app} = età apparente; D_s/D_i = rapporto tra le dimensioni medie delle tracce spontanee ed indotte; T_{app}/T_{cor} = corrispondente fattore di correzione; T = età corretta con il metodo delle dimensioni o età di plateau (ultima riga); 250° C - trattamento termico per la misura dell'età di plateau. Parametri utilizzati: costante di decadimento per ^{238}U, $\lambda F = 6{,}85 \cdot 10^{-17}$ a^{-1} ; sezione d'urto per la fissione indotta dell'^{235}U, s = $5{,}802 \cdot 10^{-22}$ cm^2; rapporto isotopico $^{238}U/^{235}$ = 137,8.

quartz and feldspar. Glass shards in the 0.160 mm fraction were prepared, mounted and irradiated. The results of the age measurements are shown in Table 1.

Irradiations IP_2 and P_9 were performed with the IPEN-CNEN reactor (São Paulo, Brazil) and the reactor of Pavia University (Italy), respectively. The samples were divided into two portions: one was used for measurements of spontaneous track density and the other for measurements of induced track density after irradiation. The two glass shard portions were mounted in epox after irradiation, polished with diamond paste and etched in HF at 40° C for 60".

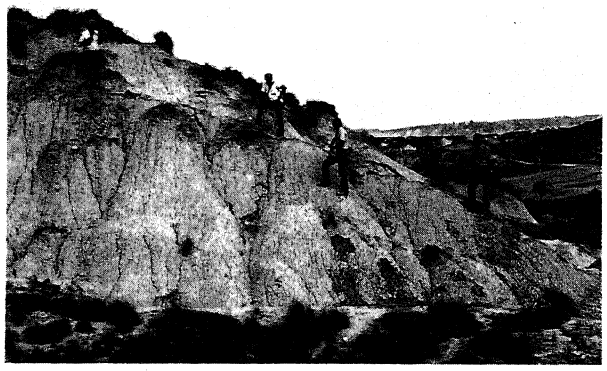

Fig. 2 - Outcrop of the ash layer near Masseria Concarone: the volcanic ash level is the indurated level near which there are the two persons on the left of the photo.
Affioramento del livello vulcanico presso Masseria Concarone: la cinerite è individuata dal livello indurito dove si trovano le due persone, sulla sinistra della foto.

As in most volcanic ash samples, a partial fading of spontaneous tracks was noted, and the size method for the correction of the apparent ages (Storzer and Wagner, 1969) was used. The ratio D_s/D_i (D_s = spontaneuos track size; D_i = induced track size) was obtained by measuring of 200 spontaneous tracks plus 200 induced tracks (IP_2-1), and 100 spontaneous tracks plus 100 induced ones (P_9-27), respectively. The correction factor was obtained with a correction diagram calibrated for Italian glass shards (Bigazzi, unpublished data).

For the age of P_9 irradiation, the plateau age correction (Storzer et Poupeau, 1973) by heating the samples for 1 hour at 250° C in a stove was also used. Attainment of a plateau was confirmed by the value approaching 1 of the D_s/D_i ratio which was obtained by counting 100 spontaneous and 100 induced tracks.

The obtained age values are in good agreement with one another within an experimental error of about 10% including Poisson counting errors and errors due to the correction technique.

However we believe that Poisson statistics is correct because for sample P_9-27, which was checked as an example, the standard error (3.02%) is very close to the Poisson error, $(1/1164)^{1/2}$ = 2.93%

Unfortunately, the low value of ρ_s as well as the small size of the glass shards (after mounting and

polishing treatments the final size was around 5 x 10^{-4} cm^2) did not allowed more significative counting for spontaneous tracks.

As, for instance, Arias et al. (1981) and Miller and Wagner (1981) observed, ages by the size and plateau methods fit together.

Analytical data also confirm the reliability of the models which the correction methods are based on. $D_s/D_i < 1$ reveals the presence of a fading. For our samples we obtained D_s/D_i ratios of 0.77 and 0.80, respectively. These values are in good agreement with one another because the error is of the order of 3% .

According to the size method, the decrease in track number (and hence of age) due to fading, is obtained by means of a curve, calibrated in the laboratory, that is very near to the parabola (Somogyi and Nagy, 1972):

$$T_{app}/T_{corr} = (D_s/D_i)^2$$

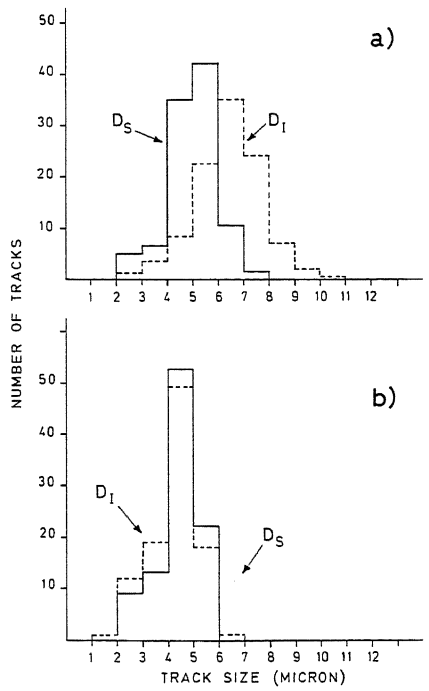

Fig. 3 - Spontaneous (D_s) and induced (D_i) track distribution as a function of size. Peaks are normalized to 100 tracks each; Fig. 3a was obtained with 300 spontaneous and 300 induced tracks, Fig. 3b with 100 tracks for each type.
Distribuzione delle tracce fossili o spontanee (D_s) delle tracce indotte (D_i) in funzione delle loro dimensioni. I picchi sono stati normalizzati a 100 tracce ciascuno; quelli della Fig.3a sono stati ottenuti con 300 tracce fossili e 300 tracce indotte, mentre quelli della Fig. 3b con 100 tracce per ciascuno dei due tipi.

According to the plateau method, when spontaneous tracks are affected by fading, they become more resistant against laboratory thermal treatments. That is, the induced tracks are more sensitive to heating in a stove. If the heating is suitably intense, both spontaneous and induced tracks will undergo a partial fading of the same intensity (preexisting natural fading plus artificial fading for spontaneous tracks and only artificial fading for induced tracks). The ratio ρ_s/ρ_i will thus be equal to that we would have measured without fading. This condition is reached when $D_s/D_i = 1$.

The experimental data of Table 1 are conformable to what discussed above. Whereas the decrease of spontaneous track density (ρ_s) is 25% after the artificial thermic treatment, the decrease of induced track density (ρ_i) is equal to 45%, so that the age increases by 40%. This result is identical to that obtained by the size correction method.

Figure 3 shows the distribution of spontaneous and induced track sizes. Before heating (Fig. 3a), induced and spontaneous tracks show two distinct peaks; after heating, the sizes of spontaneous and induced tracks are coincident and give only one peak (Fig. 3b); furthermore a small decrease in the average size of spontaneous tracks (from 5 to 4.4 μ) and a more marked decrease in that of induced tracks (from 6.4 to 4.3 μ) may be noticed.

In conclusion, the age of the volcanic ash level of Masseria Concarone is between 3 and 2.5 MA. This range is in good agreement with the present biostratigraphical age determinations.

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