136.

NOTES

Indian Journal of Pure & Applied Physics
Vol. 27, April 1989, pp. 187-188

Fission track dating of lipari obsidians

H S Virk & Gurinder Singh
Department of Physics, Guru Nanak Dev University, Amritsar 143 005
and
G Bigazzi
Istituto di Geocronologia e Geochimica, Isotopica, CNR, Pisa (Italy)

Received 23 February 1988; revised received 9 September 1988

The chief advantage of fission track (FT) technique is that it can be used for dating of young volcanic glasses (obsidians) where most other well established techniques fail. Lipari obsidians from three different lava flows have been dated to check the hypothesis of their historic origin. An attempt is made for interlaboratory comparison of FT ages of young obsidians.

Natural glasses, viz. obsidians and tektites, have fascinated fission track (FT) geochronologists due to the ease with which they can be dated. FT technique is most suitable for dating young obsidians[1-4] obtained from recent volcanic eruptions. The purpose of this study is to test the hypothesis of historic origin of some Lipari obsidians and attempt an interlaboratory comparison of their FT ages.

Archaeological excavations provide strong evidence in support of obsidian artefacts being used by prehistoric man along the Mediterranean basin[5]. Lipari obsidians represent three principal lava flows on the island of Lipari in Italy. These are identified as Rocche Rosse, Forgia Vecchia and Gabellotto. Rocche Rosse and Forgia Vecchia belong to the last volcanic eruptions of the Lipari island that occurred sometime near the downfall of the Roman empire. The samples for the present study were collected by Dr G Bigazzi.

The techniques used for preparation, etching, irradiation and counting of glass samples are the standard ones described elsewhere[6-8].

Obsidian samples were fractured, mounted on glass slip covers using epoxy resin and polished using cerium oxide powder. Samples were etched in 40% HF for 30 s at room temperature. Fossil tracks were counted under Carl Zeiss binocular microscope using a magnification of 400 ×. Scanning of obsidian samples has to be carried out with utmost care using suitable filters as there are numerous air bubbles, glass spherules and needle-like inclusions (Fig. 1) embedded in lava flow deposits which may be confused for fossil tracks in the etched samples. Due to recent historic origin of obsidians, there was a paucity of fossil fission tracks. Hence large areas of samples need to be counted for better statistics.

The samples were annealed in a muffle furnace at 500°C for 1 hr before irradiation with a nominal thermal neutron dose of 1.5×10^{15} n cm^{-2} in CIRUS reactor of BARC, Trombay. Irradiated samples were again polished and etched as before for fossil tracks. Induced track density was quite high (Fig. 2) and there was interference from track-like features which are characteristic of all lava flows[3]. Due to this rea-

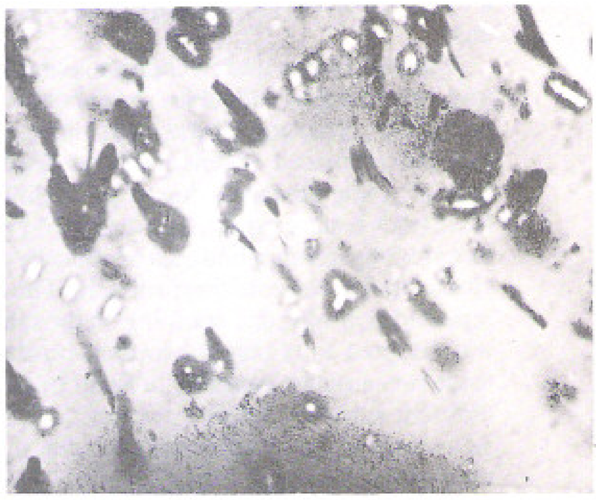

Fig. 1—Needle-like inclusions and other features in obsidian samples unsuitable for FT dating

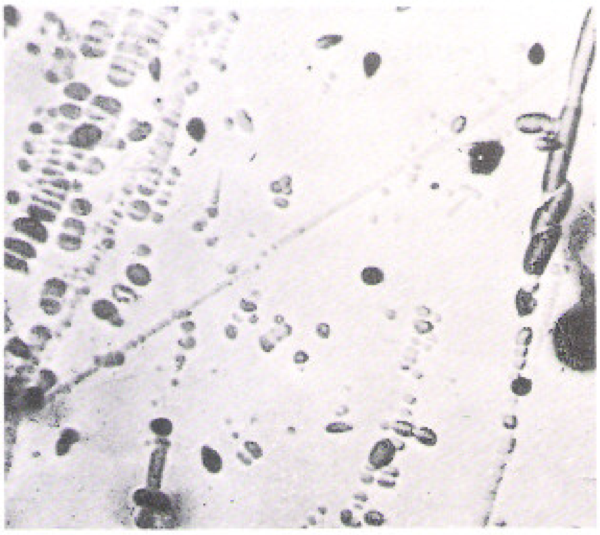

Fig. 2—Induced tracks (black dots) seen distinct from dislocations in a clean obsidian sample (etching 40% HF, 30 s at room temperature)

Table 1—FT ages of lipari obsidians

Flow	Track densities		FT age	FT age[1,10]
	ρ_s	$\rho_i \times 10^4$	yr	yr
Gabellotto Basso	19	15.66	8533 ± 1911	8600 ± 1600
Forgia Vecchia	5	22.85	1539 ± 692	1600 ± 380
Rocche Rosse	8	27.37	2662 ± 888	1400 ± 450

son, track counting done independently by different observers is generally discordant[9].

It is pertinent to carry out track size measurements to apply correction to fission track age due to annealing. Track diameters measured along the major axes of both fossil and induced fission tracks show that the annealing correction is negligible for Lipari obsidians.

Although fission track technique is simple in principle, considerable difficulties are encountered in applying it to obsidians. Bigazzi *et al.*[9] have established that inexperienced scanners obtain discordant FT ages of young obsidians due to gross differences in fossil track counts, especially in case of defect-loaded samples. Bigazzi supplied a set of optically clean samples to obviate the counting problems. The method of repeated polishing and counting on the same surface was adopted to obtain concordant results. Despite these precautions, counting of fossil tracks by three different scanners differed as much as 20%. Hence, an average value of fossil track density, ρ_s, has been used for calculating FT ages (Table 1). However, all the scanners obtained almost concordant values for the induced track density, ρ_i. Fission track ages are calculated using age equation[4]

$$T = 6.01 \times 10^{-8} \times \rho_s/\rho_i\, F$$

where ρ_s and ρ_i denote fossil and induced track densities, respectively, and F, thermal neutron fluence during irradiation. The value of F was determined by counting the number of induced fission tracks in a calibrated standard glass dosimeter (0.35 ± 0.02 U content) supplied by Robert Fleischer and used for interlaboratory standardization[8].

FT ages of Lipari obsidians are summarized in Table 1. Our results corroborate the findings of Italian authors in case of Gabellotto and Forgia Vecchia flows but in case of Rocche Rosse there seems some disagreement.

The statistical error, 1σ, calculated on the basis of fossil track counts is quite high due to paucity of tracks and young deposition ages of the lava flows. To avoid errors due to non-homogeneous distribution of uranium it is advisable to use the same sample for fossil and induced track counting. The efficacy of FT technique for dating young archaeological artefacts and its importance for interlaboratory standardization is established.

References

1 Arias-Radi G, Bigazzi G & Bonadonna F P, *Origini (Italy)*, 6 (1972) 155.
2 Bigazzi G & Bonadonna F P, *Nature (GB)*, 242 (1973) 322.
3 Yegingil Z & Goksu Y, *Nucl Tracks (GB)*, 6 (1982) 43.
4 Virk H S, *Mineral J (Japan)*, 13 (1986) 34.
5 Durrani S A, Khan H A, Taj M & Renfrew C, *Nature (GB)*, 233 (1971) 242.
6 Virk H S, *Curr Sci (India)*, 46 (1977) 583.
7 Singh S, Suri P S & Virk H S, *Curr Sci (India)*, 50 (1981) 626.
8 Modgil S K & Virk H S, *Nucl Instrum & Methods (Netherlands)*, 212 (1983) 367.
9 Bigazzi G, Hadler Neto J C, Norelli P, Osorio Araya A M, Paulino R, Poupeau G & Stella De Navia L, *Proceedings of the fourteenth international conference on Solid State Nuclear Track Detectors (SSNTD)* held in Lahore during April 2-6, 1988.
10 Bigazzi G & Radi E, *Riv Sci Preistoriche (Italy)*, 36 (1981) 223.