122 119

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FISSION TRACK DATING OF NATURAL GLASSES

H.S. VIRK, GURINDER SINGH and SUKHWINDER KAUR

SSNTD Laboratory, Physics Department,
Guru Nanak Dev University,
Amritsar-143 005, India.

Abstract – The chief advantage of fission track(f.t.) 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. F.T. dating of Australasian tektites provides evidence in support of different falls in this vast strewn field as reported elsewhere.

1. INTRODUCTION

Natural glasses, namely obsidians and tektites, have fascinated fission track(F.T.) geochronologists[1-10] due to the ease with which they can be dated. Fission track technique is most suitable for dating young lava samples obtained from recent volcanic eruptions[11] where most other well-established techniques fail. The purpose of this study is to test the hypothesis of historic origin of some Lipari obsidians and to find evidence in support of different falls in the vast Australasian strewn field of tektites. Ever since the application of F.T. dating, it became evident that Australites do not belong to the same age group. Fleischer et al.[12] found evidence for a second tektite fall in Australia with high sodium content. Edmund D. Gill[13] reported surprisingly young ages for a large group of in-situ Australites based on stratigraphy. Storzer and Wagner[6], using F.T. plateau dating[14], also establish that Australites are older than Indochinites and Phillipinites though they are classified together in the Australasian strewn field.

Lipari obsidians represent three principal lava flows on the island of Lipari in Italy. These are identified as Rocche Rosse, Forgia Vecchia and Gabellotto Basso. Rocche Rosse and Forgia Vecchia belong to the last volcanic eruptions of the Lipari island at the end of the Roman empire. The obsidian samples are supplied by G. Bigazzi from his personal collection.

Tektite finds are confined to certain restricted areas of the earth known as strewn fields. There are four such fields within each of which the K-Ar and F.T. ages were found to be concordant[2,3]. These ages are 0.7, 1.3, 14 and 35 m.y. for Australasian, Ivory Coast, Bohemian and North-American strewn fields, respectively. Australasian strewn field is very vast and extends from South Australia to Japan. Tektite samples were purchased from Ward's Natural Science Inc., New York, USA.

2. EXPERIMENTAL DETAILS

The technique used for preparation, etching, irradiation and counting of nuclear fission tracks in natural glasses are the standard ones described elsewhere[8-10].

Obsidian and tektite samples were irradiated in two separate Al capsules in the thermal column of CIRUS Reactor at Trombay with an integrated neutron dose of $10^{15} n/cm^2$. The samples were first polished, etched and counted for fossil tracks; then annealed in a Muffle furnace at 500°C for 1 h; and the same process was repeated after irradiation for counting of induced fission tracks. This is the best procedure to avoid errors due to non-homogeneous distribution of uranium in the samples and some ratio factors which enter the F.T. age equation. Neutron dose is measured by incorpora-

Table 1. F.T. ages of Lipari obsidians.

Flow	Track ρ_s	density $\rho_i \times 10^4$	F.T.age (yr)	F.T.age[5+] (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

Thermal neutron fluence = 1.51×10^{15} n/cm^2

+G. Bigazzi, personal communication, 1987.

Table 2. Fission Track Ages of Australasian Tektites.

Sample	Location	Track ρ_s	density ρ_i	F.T.age m.y.	Corrected age m.y.
Australite	S.Australia	508 (80)	38063 (1200)	0.79±0.08	0.79±0.08
-do-	Queensland	406 (127)	34154 (1513)	0.71±0.06	0.75±0.06
Indochinite	Thailand	349 (89)	32052 (2206)	0.65±0.07	0.65±0.07
Phillipinite	Phillipines	284 (71)	36172 (1026)	0.47±0.05	0.65±0.05

Thermal neutron fluence = 9.88×10^{14} n/cm^2.
Brackets show the number of tracks counted.
Statistical counting error, 1 σ .

ting strips of standard glass dosimeter(20 ppm U content) in Al capsules during irradiation. Induced fission tracks are counted under Carl Zeiss binocular microscope after etching glass dosimeter alongwith the irradiated samples under identical conditions (48 % HF, 30 s at room temperature).

Counting of fossil tracks in natural glasses is a tedious job. There are numerous air bubbles, glass spherules and needle-like inclusions embedded in lava flow deposits which may be confused for fossil tracks in the etched samples. Due to recent origin of Lipari obsidians, there was a paucity of fossil tracks and scanning has to be done carefully using large surface areas.

It is pertinent to carry out track size measurements on both fossil and induced fission tracks to estimate annealing correction[15] to F.T. ages. However, in case of Phillipinite samples, it became necessary to apply plateau age correction[14] due to large discrepancy in fossil and induced track diameters.

3. RESULTS AND DISCUSSION

F.T. ages are calculated using age equation[10]

$$T = 6.01 \times 10^{-8} \; \frac{\rho_s}{\rho_i} \times F \qquad (1)$$

where ρ_s and ρ_i denote fossil and induced track densities, respectively and F, thermal neutron fluence during irradiation. F.T. ages of Lipari obsidians are summarized in Table 1. Our results are in good agreement with F.T. ages determined by Italian authors in case of Gabellotto Basso and Forgia Vecchia but there seems some disagreement in case of Rocche Rosse ages. The statistical error, 1 σ, calculated on the basis of fossil tracks, is quite high due to recent historic origin of lava flows. The efficacy of F.T. technique for dating young archaeological artefacts is well established.

Fission track ages of Australasian tektites are summarized in Table 2. It is apparent that Australasian tektites fall into two distinct age groups-Australites with F.T. ages superior to 0.7 m.y. and Indochinites and Phillipinites with ages around 0.65 m.y. K-Ar ages for this strewn field are estimated to be 0.72 m.y[3]. The hypothesis of multiple falls of tektites in Australasian strewn field need to be further investigated as suggested by Fleischer et al[12].and more recently by Storzer and Wagner[6].

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