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Fission track ages of fossil woods from Deorikhurd, Keria and Mohgaonkalan, Madhya Pradesh, India

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Abstract: Sedimentary beds in between the successive Deccan lava flows contain fossil evidences of vegetational history of peninsular India. To use the evidence of plant fossils for reconstructing palaeofloras and palaeoenvironments it is necessary to ascertain the age of the fossil material as precisely as possible. This report deals with the F-T dating of the petrified woods collected from the Deccan Intertrappean beds near Deorikhurd in Mandla district and Keria and Mohgaonkalan in Chhindwara district, Madhya Pradesh (M.P.). The specimen from Deorikhurd is a dicotyledonous wood fragment and those from Keria and Mohgaonkalan are fossil palm woods usually described under the generic name Palmoxylon. F-T ages obtained are (48 ± 4) Ma for Deorikhurd, (51 ± 6) Ma for Keria and (45 ± 5) Ma for Mohgaonkalan samples. The present results agree with the Palaeocene-Eocene age suggested to these intertrappean beds on the basis of palaeobotanical studies.

Keywords: F-T dating, apatite, wood-petrification, Deccan trap, Palaeocene-Eocene flora.

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1. Introduction

The flora constituted by plant fossils preserved in the sedimentary beds deposited between successive lava flows (Deccan traps) in peninsular India is known as Deccan Intertrappean flora. Believed to be of Palaeocene-Eocene age, this flora represents the stage from which vegetation of India started acquiring its present composition and is important for understanding its vegetational history.

The Deccan Intertrappean flora has been classified under four broad assemblages viz. Rajahmundry assemblage, Nagpur-Chhindwara assemblage, Bombay-Malabar-Worli Hills assemblage and the Mandla assemblage (Bande *et al* 1988). In order to use the evidence of the intertrappean plant fossils to reconstruct the vegetational history of peninsular India it is necessary to ascertain the age of these different assemblages as precisely as possible. This can be done by (a) palaeobotanical interpretations, (b) dating of lava flow underlying or overlying the fossiliferous bed, and (c) dating the plant fossils themselves by F-T dating

method. K-Ar dating of the Deccan Traps from different localities have indicated an age varying from 30 Ma to 102 Ma for these lava flows covering a span of nearly 70 million years (Alexander 1981). Later, Courtillot *et al* (1988) have found this range as 55 to 75 Ma, after considering the distribution of 100 published K-Ar ages. Recently, the F-T dating method has been applied to the fossil material especially petrified woods, to directly date the bed in which the fossil is found embedded (Rajagopalan *et al* 1983, Srivastava 1985). One such petrified wood sample obtained in-situ from the Deccan intertrappean bed has been dated by Srivastava *et al* (1986). This paper presents the F-T dating of three pertrified wood samples collected from the intertrappean beds exposed at Deorikhurd, Mandala district and Keria and Mohgaonkalan, Chhindwara district, Madhya Pradesh.

2. Process of petrification

Barghoorn (1977) has shown that there are two competing processes taking place on a dead tree stump or wood fragment, these are wood degradation by fungi and the fossilization. The fossilization process is subject to fulfilling a number of soil-solution parameters such as pH, temperature, anerobic nature, burial conditions etc. as shown by Leo and Barghoorn (1976) through in-vitro studies. The fossilization occurs in two ways ; by petrification and by compression. In case of compression the material is burried in the sediment and flattened by overburden. Thus only a thin film of carbonaceous material is left. This is common for leaves, seeds, pollen grains etc. In case of petrification the specimen is converted into stone. The petrification is of two types ; complete mineralization and permineralization. A completely mineralized sample has no preservation of internal structure though the external appearance is that of organic matter. While in permineralization much of cellular details can be seen under microscope to deduce the genus, sometimes to species level. In the later case, minerals probably fill cell luminae and intercellular structure (Ash 1986). No distortion or compression is seen in permineralized fossil which suggests that the replacement process must have been fast. The major mineral components are silica and calcite ; phosphate, pyrite and hamaetite minerals are present as trace components. For F-T dating the permineralized woods with phosphate mineral (Apatite) deposited in the vessel part, are used.

3. Experimental procedure and results

The methodology is described in detail by Rajagopalan *et al* (1983) and Srivastava (1985). Fifteen transverse sections of each sample were prepared and the tracks were revealed after etching in 4% HNO_3 at room temperature for 50 seconds. After counting the fossil tracks, the thin sections were sent for thermal neutron irradiation at BARC, Bombay along with uranium standard

glass (Blue star microscope slide, Saini *et al* 1981 and Fisher standard glass). The fossil track density (ρ_s), induced track density (ρ_i) and thermal neutron dose (ϕ) are obtained. F-T age and 1σ error are calculated using following formulae respectively :

$$T = 14854 \log \{1 + 9.32 \times 10^{-18} \times \frac{\rho_s}{\rho_i} \times \phi\} \text{Ma}$$

$$\Delta T = T \times \sqrt{\frac{1}{n_s} + \frac{1}{n_i}} \text{ Ma}$$

The F-T age results for the presently studied petrified wood samples are given in Table 1. The sample from Deorikhurd, Mandla district has yielded a F-T age

Table F-T age of petrified wood samples from Deccan intertrappean beds, India.

Sample No.	Description	Fossil track density ρ_s (t/cm^2)	Total track density ρ_t (t/cm^2)	Induced track density ρ_i (t/cm^2)	Age (Ma)	Err (1σ)
BSFT 204	Deorikhurd, Mandala District, M.P.	1.95E+03* (145,2971,9)	2.08E+04 (260,500,9)	1.88E+04	48	4
BSFT 205	Mohgaonkalan, Nagpur Chhindwara, M.P.	1.36E+03 (115,3382,9)	1.53E+04 (172,451,9)	1.39E+04	45	
BSFT 206	Keria, Nagpur Chhindwara, M.P.	1.33E+03 (91,2730,9)	1.34E+04 (163,487,9)	1.21E+04	51	

*The bracket shows number of tracks, graticules and thin-sections respectively. Area of one graticule = 2500 μm^2 (1000 × magnification, Olympus BH-2 microscope). Thermal neutron fluence (ϕ) = 7.804E+15 n/cm^2.

of (48±4) Ma and the ages for the samples from Keria and Mohgaonkalan, Chhindwara district are (51±6) Ma and (45±5) Ma respectively.

4. Discussion

A search in literature indicates that no trap rock age measurement has been made for the localities around Mandla. Regarding the localities of Keria and Mohgaonkalan, the nearest place from where traps have been dated is Chhindwara, for which an age of (47±1.5) Ma has been obtained by Agarwal and Rama (1976).

The localities of Mohgaonkalan and Keria fall under the Nagpur-Chhindwara assemblage. From the locality of Deorikhurd no fossil has so far been described. However, in all probability, it falls under the Mandla assemblage as it is quite near to the locality of Ghughua from where a large number of plant fossils have been described. Some of the important taxa described from Nagpur-Chhindwara assemblage are the marine Algae, Peyssonnellia and Distichoplax, the mangrove palm Nipa, and genera belonging to Musaceae,

Nymphaeaceae, Elaeocarpaceae, Tiliaceae, Euphorbiaceae, Anacardiaceae, Sonneratiaceae, Lecythidaceae etc. Similarly, the Mandla assemblage mainly consists of a large number of palms and arborescent dicotyledons belonging to the families Myrtaceae, Anonaceae, Sterculiaceae, Icacinaceae, Anacardiaceae, Euphorbiaceae, Tiliaceae, Moraceae, Lecythidaceae, Flacourtiaceae, Elaeocarpaceae, Meliaceae, Celastraceae, Rutaceae, Sonneratiaceae, etc. On the basis of the antiquity of all these families a Palaeocene-Eocene age has been suggested to both these assemblages (Bande et *al* 1988). Based on detailed wood anatomical studies of the fossil dicotyledonous woods described from these localities, Bande and Prakash (1984) have suggested an older age for the Mandla assemblage as compared to the Nagpur-Chhindwara assemblage. Thus, it can be said that the F-T ages obtained for the fossil woods are in agreement with the Palaeocene-Eocene age suggested for these two assemblages, though it is difficult to support the suggestion of an older age for Mandla assemblage by Bande and Prakash (1984) on the basis of present data.

It must be borne in mind that the studies made so far to date the Intertrappean beds using F-T dating of petrified woods are too inadequate to arrive at any definite conclusion. The 1σ statistical error on the F-T ages of petrified-woods reported here are too large (10 – 15%) and as such do not help in resolution of the ages for different intertrappean beds, this problem can be overcome by dating a large number of samples from each bed and then carrying out a statistical analysis on the results obtained. Besides, more wood samples from different localities have to be dated before these data, alongwith the ages of traps from the same localities, can be successfully used to decipher the vegetational history of the Deccan plateau. These data will give additional evidences to understand the time duration of the Deccan volcanism.

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