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EARLY HOLOCENE WATERFALL TUFA FROM SEMI-ARID MAHARASHTRA PLATEAU (INDIA)

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Abstract

Waterfall tufa occurring in the semi-arid parts of the Upland Maharashtra has been dated by employing uranium series disequilibrium dating method. The dates correlate well with other evidences and suggest a wet climate during the genesis of the tufa.

Introduction

In some parts of the semi-arid region of Upland Maharashtra a few large and many small masses of depositional carbonate protrude from escarpments forming the sides of valleys or the edges of tablelands. These waterfall tufa or travertines are the only conspicuous late-Quaternary valley-side features in the study area. The dimensions of the waterfall tufa are variable, some consist only of a thin veneer of carbonate covering a pre-existing scarp face, whereas others are formed of large masses of deposited calcium carbonate up to 10 m thick. The tufa deposits are finely laminated and porous calcium carbonate, containing casts and impressions of leaves and twigs, and sometimes detrital material. Examination of some specimens indicate that the tufa contains impressions of *Odina woodier* Roxb., *Diospyros melanoxylon* Roxb., *Tectona grandis* Linn., *Leea* species Linn., *Ziziphus jujuba* Jurs., *Bambusa arundinacea* Scherb, *Bridelia hamiltoniania* Wall. cat. etc. (Mahajan 1976).

Geomorphic setting

There appears to be a tendency for the tufa deposits to occur at preferred geomorphic locations, which can possibly be correlated with the edges of major denudational surfaces or with the head of incised river channels (Fig. 1b). At most sites, a fractured basalt aquifer occurs beneath the tableland, whereas at the edge of the major denudational surfaces there is an outcrop of an underlying fine-grained basalt aquiclude which forces groundwater to the surface as a small spring. Tufa does not often occur at the edge of the surfaces or tablelands, unless these geological conditions are present. This implies that the break in slope has provided favourable location for the initation and deposition of tufa from suitable groundwater springs.

Age of the Tufa

On the basis of their position in the geomorphological sequence of landforms as well as a few radiometric dates, it appears that the deposits belong to early Holocene period. In the absence of any organic matter for radiocarbon dating, the radioactive disequilibrium relationship between ^{230}Th and ^{234}U has been used to date three samples. The samples collected from three different sections (Fig. 1a), spaced over a distance of more than 100 km, have given dates ranging from 8,000–10,000 yrs BP (Table I).

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TABLE I.

Sample No.	Lab. No.	Weight (gms)	U (ppm)	$^{234}U/^{238}U$	$^{230}Th/^{234}U$	$^{230}Th/^{232}Th$	Yield (%) U	Yield (%) Th	$^{230}Th/^{234}U$ date yrs BP
S-1-10	UEA-229	60.275	2.1615	1.316	0.086	45.368	67.9	42.2	9,800+200
WD-3-16	UEA-225	38.500	0.1878	1.637	0.082	6.095	42.3	75.5	9,200+900
M-1-16	UEA-228	50.388	0.3580	1.584	0.073	30.464	37.6	42.9	8,100+400

The analysis was carried out at the University of East Anglia, Norwich (U.K.).

Genetic considerations

The tufa indicates that the formation occurred when there was sufficient groundwater recharge to form a spring, enhance solution of carbonate and to carry it downstream. This implies that the tufa can be equated with wetter climatic periods (Goudie 1983). Continental and oceanic sediments from western India have provided ample evidence of the intensification of the southwest monsoon and increased stream runoff, during the early Holocene period (Kale and Rajaguru 1987). An amplified seasonal cycle of solar radiation at the solstices and increased precipitation of 20–100% has been estimated by Kutzbach and Otta-Bleaner (1982) for

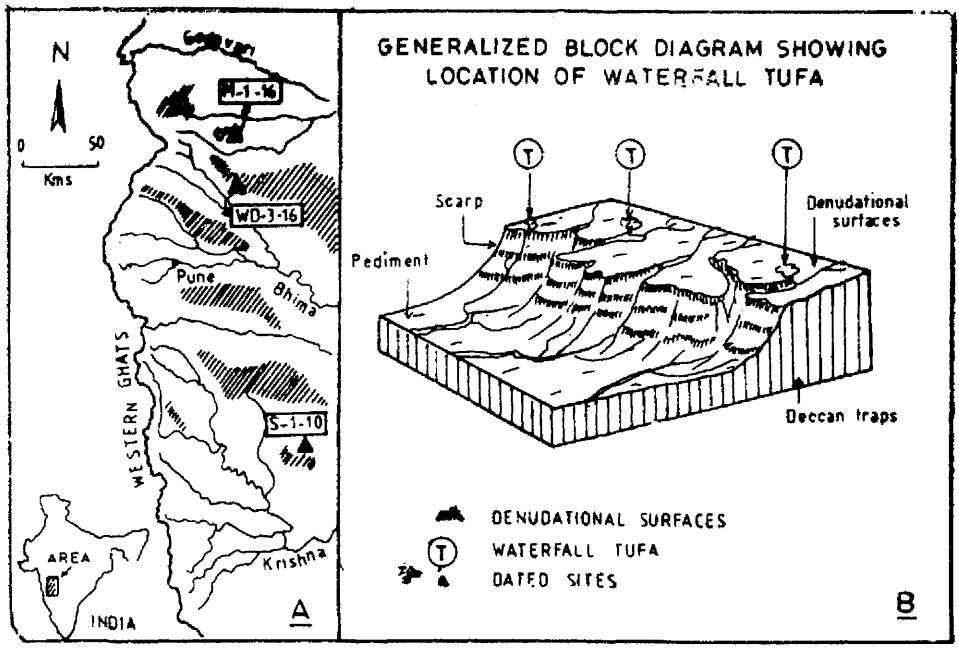

Figure 1A. Figure 1B.

Fig. 1A – Location of the sample sites.

Fig. 1B – A generalized block diagram showing the location of waterfall tufa at the edge of Denudational surfaces.

India, for 9000 yrs BP. Such an increase in precipitation would be sufficient to increase groundwater recharge, groundwater levels and the discharge of springs, as well as surface runoff. An increase in spring discharge would, therefore, be accompanied by an increase in the amount of calcium in solution. Since, degassing and precipitation is also related to waterfall turbulance and agitation (Ordonez and Garcia del Cura 1983), it is logical to suppose that major breaks in slopes along the scarps, would have provided suitable locations for the precipitation of carbonate. The presence of mosses (as seen today) and vegetation (as evidenced from leaf impressions) might have aided the degassification by photosynthetic activity (Ordonez and Garcia del Cura 1983).

Although, most waterfall tufa are inactive today, calcium deposition in limited extent is observed at restricted sections of the total tufa zone, at some sites. At other sites, tufa appear to be suffering net erosion by present-day flood waters in the monsoon season. The present degradation and diminition of the waterfall tufa clearly suggest that the maximum deposition and growth took place during early Holocene humid phase, when the water properties and the genetic conditions were most suitable.

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should read:

'While these are the adverse effects of ignoring the Conrad, talking about regional geological structures in the absence of magnetic data, may lead to faulty inferences'