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Palaeoclimatic Clue of Central India during Maastrichtian Period

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Abstract: *In the central India late Cretaceous or Tertiary system of volcanic rock formation is known as Deccan Traps. In peninsular region of India, these traps spread about a very large area of 5, 20,000 km covering almost all of Maharashtra, Madhya Pradesh, part of Gujarat and Andhra Pradesh marginally. In these beds, besides to all groups of plants, Ostracodes, Molluscus, fishes & other vertebrates flourished. The important fossiliferous localities of Maharashtra includes Malabar and Worli hills of Mumbai and Vidarbha region which includes Buldana, Amravati, Chandrapur, Kondhali, Mahurzari, Phutala tank, Takli and Sitabuldi near Nagpur; Nawargaon, Maragsur near Wardha; Jhargad, Sibla near Yeotmal. Fossil localities of Madhya Pradesh includes Singhpur, Mohgaonkalan, of Chhindwara Districts, Parapani, Shahpura, Ghugua, of Mandala district.*
The important flora of Central India divided into two assemblages as follows:
I) The Vidharbha-Chhindwara Assemblage
II) Fossil assemblage from Mandla-Dindori district
From the analysis of fossil flora of boh assemblage the following habitats and climatic conditions can be suggested (i) Coastal or estuarine – Sonnertioxylon, Palmocarpon, Arecoidocarpon, Cocos. (ii) Mangrove and Saline habitat - indicated by Acrostichum, Pandanaceoxylon, Palmoxylon, Viracarpon and Nipa. (iii) Fresh water - indicated by fresh water algae. (iv) Marshy – Fungal forms which grew luxuriantly. Acrostichum and Aeschynome a plant of marshy habitat. (v) Terrestrial and upland- indicated by conifers and other arborescent angiosperms. (a) The wet Evergreen to Semi-evergreen forest: - Conifers, Cocos, Aeschynomene, Elaeocarpus, and Ailanthus. (b) Dry deciduous forest – Phoenix (Palmoxylon sps.), Grewia, Anacardioxylon, and Ebenoxylon.

Keywords: *Megaflora, Diversity, Fossils, Deccan Intertrappean beds, Maastrichtian*

I. INTRODUCTION

In the central India late Cretaceous or Tertiary system of volcanic rock formation is known as Deccan Traps. In peninsular region of India, these traps spread about a very large area of 5, 20,000 km covering almost all of Maharashtra, Madhya Pradesh, part of Gujarat and Andhra Pradesh marginally. In these beds, besides to all groups of plants, Ostracodes, Molluscus, fishes & other vertebrates flourished. The important Megafloral fossiliferous localities explored in of Maharashtra and Madhya Pradesh. The fossil flora of this region has been treated in two assemblages because many of the forms are common to these localities. The possibility of reconstructing past vegetation and environment depends on the accurate identification of diverse fossil assemblage. In order climate of Deccan Traps a critical analysis of the Traps has been made (Bande and Prakash, 1982[3]; Bande et al., 1988[6]; Bande and Chandra 1990[5]; Kapgate, 2005[8], 2012[9,10,11], 2013[12], 2015[13]).

The botanical components of the fossil flora have been classified into:

1) Extant genera,
2) Exotic genera and
3) Those which are not assigned to any living genus and can be regarded as extinct or botanically unidentified.

Out of the three categories of generic groups, the exotic genera are more significant than the other two with respect to floral changes and the plant migration during the geological time. The exotic types give us a better estimate of past environment because they reflect a different climate than that of native group near the locality.

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Considering the flora of Deccan Intertrappean series, it has been noticed that some of the fossils have reliably been assigned to modern genera, while other are described without any proper generic affinities. The modern distribution of the living comparable form of the Deccan Intertrappean flora, wherever possible, would indicate a different picture of environment than what we see today in central India region of the Traps from where most of the well-preserved plants are known.

One of the basic aims of paleobotanical studies especially on megafossils, is to reconstruct the past vegetation. The vegetation of an area is a good indicator of its climate. The climate is governed by the position of land mass in relation to the equator in that pedicular period and the distribution of neighbouring mountain chains also affects the climate. These factors are responsible for the rainfall, temparature and wind currents of that region. Paleoenvironment deals with the environmental, climatic and ecological conditions of the geological past, whereas paleogeography deals with the position of land and seas on the earth in the past, similarly paleophytogeography are concerned with the distribution of plants in the past. On the basis of detailed investigations of fossil plants from the Deccan Intertrappean beds in Madhya Pradesh and Maharashtra, it is postulated that paleovegetation was similar to the present day evergreen to semievergreen forest of the western Ghats and north-eastern India (Lakhanpal, 1970 [14]; Mahabale 1979[15]; Bande and Prakash, 1982[3]; Bande et al., 1988[4]). This fossil flora indicates a warm tropical climate with heavy rainfall more than 200 cm per year. Paleogeographically peninsular India was nearer to the equator with proximity to the sea and absence of the Western Ghats.

From the above discussion it is clear that most of the mega fossils occurring in the Deccan Intertrappean flora had a warm humid tropical or sub-tropical climate for the Deccan Traps. In addition to megafossils, survey of microfossil referable to or affiliated with modern taxa also helps in determining the Deccan Traps (Ramanujam, 1974[19]). Microfossils are not reliable because in most cases pollen and spores described from the Deccan Intertrappean beds of India have been classified temporarily their relationship with the modern plants is not yet certain (Prakash, 1973[18]). Some of the microfossils still deserve special mention in this regard. The occurrence of pollen grains referable to Palmae, Caesalpinaceae, Myrsinaceae, Sapotaceae, Araliaceae, Santalaceae, Hippocrataceae, Meliaceae, Symplocaceae and Thymeliaceae in the South Arcot lignite indicates a moist-humid-tropical to subtropical climate during the Tertiary of South India along the east coast. Occurrence of pollen grains related to Palmae, *Barringtonia, Rhizophora*, *Sonneratia* and *Pelliceraia* in Eocene of Kutch, clearly indicates a warm-humid-coastal swampy
environment. Thus it can be inferred that the Deccan Traps are enjoying a warm, humid, tropical or sub-tropical climate.

II. MATERIAL AND METHOD

The materials were examined from the museum collections and study of previous results was drawn from published work. Records from the literature were considered for the general summarization of palaeoclimate.

2.1 Discussion

To study the paleovegetation and palaeoclimate of central India during the Deccan Intertrappean times, the flora has been broadly considered under following two Assemblages (Bande and Prakash, 1982[3] ; Bande et al., 1988[6] ; Bande and Chandra 1990[5] ; Kapgate, 2005[8] , 2012[9,10,11] , 2013[12] , 2015[13]).

(i) Fossil Assemblage from Vidharbha- Chhindwara Region

The important fossiliferous localities includes in this region are Mohgaonkalan, Bhutera, Jamsaoli, Saunser and Singhpur of Chhindwara district; Amabagoli and Rambakhedi of Baitul district (M. P.); Nagpur, Takli, Mahurzari and Kondhali of Nagpur district; Nawargaon, Margsur and Sindi-vihira of Wardha district; Patan near Chandrapur; Sibla, Zargad and Vadner of Yeotmal district (Vidharbha-Maharashtra). As many of the forms are common to these localities, the fossil flora of this region has been treated as single assemblage.

From the study of fossil Algae reported from Mohgaonkalan it seems that the semitropical rain forest type of climate was prevailing at that time in the Deccan Trap areas. Some of the Algae were found in reproductive stage, viz., *Mougeotiates deccanii, Spirogyrites deccanii* described by Barlinge and Paradkar (1979[2]). The fact that these fossils occuring in the reproductive stage confirms the finding of Prof. Sahni, that process of fossilization took place in autumn

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as evidenced by the reproductive structures of Azolla intertrappea. Deccan Intertrappean exposures have revealed a number of Fungi (Jain, 1974[18]) that grew luxurently. These various fungal forms indicate a warm and humid palaeoclimate for the Deccan Intertrappean period in which these cherts were formed.

The presence of more humid and warm conditions during the period of Deccan Trap formation is further strengthened by the fact that the Intertrappean beds, which had *Palmoxylon,* are now relative poor in palms. Presence of marshy habitat with some lakes and ponds can also be visualized by the occuurrence of fossils like *Enigmocorpon* and *Tricoccites* (Which show presence of air spaces). *Rodeites,* a hydropteridian sporocarp has been compared with Regnellidium, a water fern of Brazil, and *Cyclanthodendron* found in the Deccan Intertrappean beds, has been compared with the tropical American genus *Cyclanthus*. *Simarouboxylon* identified with the genus Simarouba of Brazil, Venunzuela and Cuba. These forms provide a link between the flora of the Deccan and modern flora of tropical America. In the past, these groups had a wide distribution but become scanty in recent times.

The important temperate genus *Sparganium* shows only two species viz. *S. ramosum* and *S. simplex* from Indian region. Their disappearance from the Trap country might be due to some tectonic movements which changed the topography of plateau and the environment due to which these plants could not survive there, and moved north-wards to suitable places. The occurrence of this temperate genus as well as the south American tropical elements in the Deccan flora during upper cretaceous to early Tertiary of India is quite enigmatic and needs further check up with modern plants before a true picture of their systematic position is known (Prakash, 1972[17]).

The presence of sea shore in Vidharbha-Chhindwara region has already been indicated by the discovery of coastal forms like *Nypa, Sonneratia* and *Cocos* and a marine alga *Peyssonnelia,* (Bande, Prakash and Bonde,1981[4]) from Mohgaonkalan and Sausar Beds indicating the presence of estuarine conditions there during the lower tertiary, either due to presence of Tethys sea or an arm of sea from the Gulf of Cambay and probably this might explain the presence of moist loving forms in some evergreen to semi evergreen or monsoon forests close to the sea.

(ii) Fossil Assemblage from Seoni, Mandla and Dindori District

In Seoni district fossil woods are exposed in Ghansor-Binori researve forest area. In Mandla district Deccan Intertrappean flora exposed at Mandala, Kathotia, Khajari, Kirdapur, Parapani, while Shahapura Samnapur and Ghugua fossil National park found in Dindori district. All localities are rich in woods and big trunks seen in scattered and also in situ, whereas Vidharbha-Chhindwara assemblage rich in all type of plant groups at their vegetative and reproductive stage. This suggests the possibility of big forest in vegetative stage at Mandla district and in fruiting stage at Vidharbha-Chhindwara region.

A study of various woods clearly indicates that most of the species represented in this fossil assemblage do not occure now -a -days in Mandla region. Rather, they are presently distributed in the more moist forest of Western Ghats and Nortn-east lndia.

The following typical ecological facies are distinguished in the Deccan Intertrappean flora of the Nagpur-Chhindwara-Mandla area (Agashe, 1995[1]).

(i) Marine: Indicated by Marine algae *Peyssonnelia, Distichoplax* and *Solenospora* .

(ii) Mangrove, coastal or estuarine, and saline habitat:- Indicated by *Acrostichum* like mangrove fern, *Barringtonioxylon, Nipadites, Nypa, Palmoxylon (Cocos) sundaram, Palmocorpon*, *Palmostroboxylon, Arecoidocarpon, Sonneratia* like angiosperms. According to Mahabale and Deshpande (1957[16]) *Sahnianthus* flower and Enigmocarpon fruit are comparable to those of Mangrove living species of *Sonneratia acida* and *S. apetala*, *Sonneratiorhizos, Dicotylirhizos*, *Sonneratioxylon, Viracarpon* (member of Pandnaceae), *Shuklanthus superbum* (*Viracarpon*).

(iii) Fresh Water: Indicated by Fresh water algae-*Spirogyrites, Oedogonites, Ulothrix, Chara;* Water ferns-*Marsilea, Azolla, Salvina*; Aquatic angiosperms- *Eichhornia, Nymphaeocaulon*, *Aerorhizos.*

(iv) Marshy Habitat: It is indicated by a number of fungal forms (Jain, 1974[18]) which grew luxuriantly. These fungle spores suggests warm and humid climate in this region; Bryophytes- *Notothyllus, Andreaites* and a thallus of *Riccia.* Pteridophytes- *Marsilea, Rodeites, Azolla, Salvinia, Odontosorites, Selaginella, Equisetum.* Angiosperms -

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Tricoccites, Enigmocarpon fruits shows arenchymatous pericarp, *Barringtonia, Syzygium, Cyperaceoxylon, Bridelioxylon* (affinities is pointed out with *Bridelia hamiltoniana*, a marshy species), Typhaceae.

(v) Terrestrial and upland: Indicated by

The wet Evergreen to Semi-evergreen forests:- *Araucaria, Podocarpus, Musa, Cocos*, *Elaeocarpus, Ailanthus malabarica, Leena sp., Tetrameles nudiflora*.

Dry deciduous forest:- *Phoenix (Palmoxylon sps.), Grewia, Boswellia serrata, Mallotus phillipensis,*

III. CONCLUSION

From the above discussion it is therefore clear that with well preserved material, we can learn much more about the climate of the past, as well as rate of evolution and factors regulating the appearance of major group (Stewart and Rothwell, 1993[19]). In addition to megafossils discussed above, a survey of microfossils referable to or affiliated with modern taxa also helps in determining the possible paleoclimatic or palaeoenvironmental pattern during the time of the Deccan Traps deposition (Ramanujam, 1974 [20]).

This paleovegational study from the various Deccan Intertrappean exposurs of Central India reconstruct the past climate of these areas and compare with their present day climate of these area. The climatological details of these localities can be considered to indicate the past climate of the fossiliferous area. The past and present climatological data from these areas indicates that this flora was well represented in India in the past but has become restricted to Burma and Andaman -Nicobar Islands due to change in the climatic conditions. The comparison of the temperature data from these fossiliferous localities and the comparable modern areas (Bande and Prakash, 1982[03]) clearly indicates that the climate in Central India during the Intertrappean times was much more uniform throughout the year with winters almost totally absent or very mild. The uniform temperature along with a much higher rainfall must have been responsible for the growth of a tropical evergreen forest very similar to the modern forests of the Konkan and Western Ghats during the uppermost Cretaceous- lower Tertiary times in Central India. However, while Yeotmal-Chandrapur -Nagpur-Chhindwara area is presently covered by a tropical, dry deciduous forest, Whereas at Mandla district, today a tropical moist deciduous forest occurs(Champion and Seth, 1968[7]).

Figure: Reconstruction of vegetation around Vidharbha region of Maharashtra and -Chhindwara region of Madhya Pradesh.

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