



PALEOENVIRONMENTAL CONSIDERATION 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. The sedimentary layers sandwiched in between two lava flows or traps, known as Intertrappean Beds. In these beds, besides to all groups of plants, Ostracodes, Molluscus, fishes & other vertebrates flourished. The important fossiliferous localities of Maharashtra (vidharbha region) and Madhya Pradesh (Chhindwara region) are considered for this work. The fossil flora reported from algae to angiosperms from vidharbha and Chhindwara region but only angiosperm woods reported from Mandla-Dindori region of M.P. So the flora has been broadly considered under following two assemblages:-

(i) Fossil Assemblage from Nagpur- Chhindwara region, (ii) Fossil Assemblage from Mandla district. An analysis of the floral assemblage with respect to the forest type reveals that the flora was dominated by evergreen forest followed by moist deciduous forest. A few taxa among them still occur in Central India presently. Most of the equivalents modern species of Deccan Intertrappean flora of Vidarbha and other adjoining area are distributed in the tropical evergreen to moist deciduous forest of western Ghats, Andaman Islands and north-east region.

Key words: - Deccan intertrapps, Paleoenvironment, central India, Maastrichtian period

INTRODUCTION:

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 neighboring mountain chains also affects the climate. These factors are responsible for the rainfall, temperature and wind currents of that region. Paleoenvironment deals with the environmental, climatic and ecological conditions of the geological past

The Deccan Trap covers almost all of Maharashtra, a part of Gujrat, Karnataka, Madhya Pradesh and Andhra Pradesh marginally. The sedimentary layers sandwiched in between two lava flows or traps, known as Intertrappean Beds. An attempt has been made to reconstruct the floristic composition

(Paleovegetation) and paleo-environments of central India from the study of plant fossils known from the Deccan Intertrappean beds of Maharashtra and Madhya Pradesh.

There are several factors to be considered to reconstruct the paleoenvironment of particular region. The possibility of reconstructing past environment depends on the accurate identification of diverse fossil assemblage. 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. Bande & Shaila Chandra (1990) have attempted reconstruction of the paleovegetation of the Nagpur- Chhindwara area based on the occurrence of fossil plants in the Intertrappean beds and an understanding of the habit and habitat of their closely resembling modern plants.

METHODOLOGY & DISCUSSION

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.

The fossil flora of this region has been treated as a single assemblage because many of the forms are common to these localities. Among algae: *Chara* and *Spirogyrites*, represent the fresh water genera. Few fungal forms like *Epicoccum* grew luxuriantly on woods of *Barringtonia* indicates a warm and humid climate of this region. Beside to these *Andreaites* like bryophyte; *Acrostichum* like Pteridophyte and *Takliostrobus*, *Harrisostrobus*, & *Deccanostrobus* like gymnosperm cones are reported. The angiosperm remains are preserved as permineralization, impressions, compressions and casts of vegetative organs. Among them, however, fossils of reproductive organs such as inflorescence, flower, fruit and seed are meager as compared to the vegetative organs such as roots, stems, leaves etc. Fruits like *Enigmocarpon*, *Daberocarpon*, *Harrisocarpon*, *Chitaleocarpon*, *Baccatocarpon*, *Oleaceocarpon*, *Areoidocarpon*, *Nypadites*, *Palmocarpon*, *Cocos*, *Tricocites*, *Viracarpon hexaspermum*, and *Sahnianthus*, *Sahnipushpum*, *Chitaleypushpum*, *Raoanthus*, *Tetraplasandra*, *Chenopodianthus*, *Kapgateanthus* like flowers are described from this assemblage.

Fossil dicot woods showing affinities with modern genera are *Ailanthoxylon indicum*, (Anacardiaceae); *Aeschynomene tertiara* (Leguminosae); *Perrottetioxylon mahurzarii* (Fabaceae); *Amooroxylon deccanensis* (Meliaceae); *Aristolochioxylon prakashii* (Aristolochiaceae); *Barringtonioxylon mahurzarii*, (Lecythidaceae); *Calophylloxylon dharmendrae* (Guttiferae); *Canarioxylon deccanii* (Burseraceae); *Dryoxylon intertrappea*, (Bombaceae); *Ebenoxylon mahurzarii* (Ebenaceae); *Elaeocarpoxyton antiquum* (Elaeocarpaceae); *Eunymusoxylon mahurzarii* (Celastraceae); *Heliocarpoxyton mahurzarii* (Tiliaceae); *Gmelinoxylon* (Verbenaceae); *Guaiacum takliensis* (Zygophyllaceae); *Havetiopsioxylon nagpurensis* (Clusiaceae); *Heterophragmoxyton indicum* (Bignoniaceae); *Hibiscoxylon intertrappeum* (Malvaceae); *Leoxylon multiseriatum* (Ampelidaceae); *Oetomelioxylon mahurzarii* (Distiaceae); *Rutaceoxylon mahurzarii* (Rutaceae); *Pandanaceoxylon kulkarnii* (Pandanaceae); *Shoreoxylon mahurzarii*, (Dipterocarpaceae); *Sapindoxylon pandharakwadense*, (Sapindaceae); *Sonnertioxylon nawargaoensis* (Sonnertiaceae); *Sterculioxylon baradense* (Sterculiaceae) and Many species of wood, leaf and petioles of Palm are also reported from these beds.

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 semievergreenforest of the western Ghats and north-eastern India (Lakhanpal, 1970; Prakash 1974, Mahabale 1979; Bande and Prakash, 1982; Bande et al., 1988, Bande 1990; Srivastava 1991; Kapgate 2005; Srivastav & Guleria 2006). 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.

In order Palaeoenvironment of Deccan Traps a critical analysis of the Traps has been made (Uttam-Prakash, 1973; Bande and Prakash, 1982; Bande et al., 1988; Bande and Chandra 1990; Kapgate, 2005, 2013). 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.

PALEOVEGETATION & PALEOCLIMATE

To study the paleovegetation and paleoclimate of central India during the Deccan Intertrappean times, the flora has been broadly considered under following two assemblages:-

- (i) Fossil Assemblage from Nagpur- Chhindwara region,
- (ii) Fossil Assemblage from Mandla district.

(i) Fossil Assemblage from Nagpur- Chhindwara region:-

The important fossiliferous localities includes in this region are Mohgaonkalan, Saunser, Singhpur of Chhindwara district(M.P.) and Nagpur, Takali, Mahurzari, Nawargaon, Chandrapur & Yeotmal (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). Deccan Intertrappean exposures have revealed a number of Fungi (Jain, 1974) that grew luxuriently. 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 occurrence of fossils like *Enigmocorpon* & *Tricocites* (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 & 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 presence of sea shore in Nagpur-Chhindwara region has already been indicated by the discovery of coastal forms like *Nypa*, *Sonneratia* and *Cocos* and a marine algae (Bande, Prakash & Bonde, 1981) from Mohgaonkalan and Saunser 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 semievergreen or monsoon forests close to the sea. The presence of *Elaeocarboxylon antiquum*, *Ailanthoxylon*

ghiarense, *Barringtonioxylon deccanense*, *Tetrameleoxylon prenudiflora*, *Aeschynomene tertiara*, *Grewioxylon mahurzariense*, *Palmoxyylon of Phoenix*, *Musa cardiosperma*, *Heliconiaites mohgaensis* and *Cannites intertrappea*, *Ailanthus grandis*, *Barringtonia acutangua*, *Tetrameles nudiflora*, *Aeschynomene* sp., *Grewia laevigata*, *Phoenix robusta*, *Musa* sp., *Heliconia* sp. and *Canna indica* respectively indicate a somewhat more humid climate in the Deccan Trap region during the Eocene times than that of the present day as most of these plants are presently growing in moist places like Western Ghats. The dry deciduous comparable forms of the fossils like *Mallotus*, *Boswellia*, *Grewia*, *Terminalia* and *Leea* would appear to occupy low dry hills of the Deccan Trap further away from the watershed. With the rise of the Himalayas and the disappearance of the Tethys sea, desiccation followed in the Deccan Trap region due to which moist loving members of the evergreen to semi evergreen forests pushed into more favorable climatic regions like nearby Western Ghats where similar moist conditions still exist, while the dry deciduous types like *Mallotus philippinensis*, *Boswellia serrata*, *Terminalia tomentosa* and *Grewia tiliifolia* remained on the plateau.

(ii) Fossil Assemblage from Mandla District

In Mandla district Deccan Intertrappean flora exposed at Mandla Parapani, Shahpur & Shamnapur (Bande & Prakash 1982). All localities are rich in woods and big trunks seen in scattered and also in situ, whereas Nagpur-Chhindwara assemblage rich in all type of plant groups at their vegetative and reproductive stage. These suggest the possibility of big forest in vegetative stage at Mandla district and in fruiting stage at Nagpur-Chhindwara region. The fossil wood of *Polyalthioxylon parapaniense*, *Homalioxylon mandlaense*, *Hydnocarpoxyylon indicum*, *Garcinioxylon tertiarum*, *Sterculioxylon deccanensis*, *Sterculioxylon shahpurensis*, *Grewioxylon* sp.,

Elaeocarpoxyylon mandlaensis, *Atalantioxylon indicum*, *Burseroxyylon preserratum*, *Gomphandroxyylon samnapurensis*, *Heyneoxylon tertiarum*, *Dracontomelumoxylon mangiferumoides*, *Syzigioxylon mandlaense*, *Barringtonioxylon mandlaensis*, *Bischofinium deccanii* resembles with modern *Polyalthia simiarum*, *Garcinia cowa* (Guttiferae), *Sterculia foetida* & *S. angustifolia*, *S. campanulata* (Sterculiaceae), *Grewia laevigata* (Tiliaceae), *Echinocarpus sigun* (Flaeocarpaceae), *Bursera serrata* (Burseraceae), *Gomphandra tetradra* (Icacinaceae), *Dracontomelum mangiferum* (Anacardiaceae), *Syzygium cumini* (Myrtaceae), *Barringtonia acutangua* (Iecythidaceae), *Bischofia javanica* (Euphorbiaceae) respectively. A study of these woods clearly indicates that most of the species represented in this fossil assemblage do not occur now - a - days in Mandla region. Rather, they are presently distributed in the more moist forest of Western Ghats and North-east India (Cook, 1958).

CONCLUSION:

The following typical ecological facies are distinguished in the Deccan Intertrappean flora of the Nagpur-Chhindwara-Mandla area (Agashe, 1995). (i) Marine - indicated by Marine algae *Peyssonnelia*, *Distichoplax* and *Solenospora* (ii) Coastal - Cocos (iii) Mangrove - indicated by *Sonneratia* and *Nipa* (iv) Fresh water - indicated by fresh water algae, *Azolla*, *Salvinia* & *Marsilea* like water ferns; aquatic lakes, Ponds angiosperms like *Barringtonia*, *Syzygium* & *Aeschynomene* (v) Terrestrial - indicated by *Araucariaceae*, *Podocarpaceae* and upland - arborescent angiosperms.

PALAEOENVIRONMENTAL CONSIDERATIONS

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 & Rothwell 1993). 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). This paleovegetational study from the various Deccan Intertrappean exposures 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 & 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 & Prakash, 1982) clearly indicates that the climate in Central India during the Intertrappean times was much more uniform throughout the year with winter 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 Nagpur-Chhindwara area is presently covered by a tropical, dry deciduous forest, whereas at Mandla district, today a tropical moist deciduous forest occurs (Champion & Seth, 1968).

The main reasons for this environmental changes happen due to (i) the position of the Indian Plate during the late cretaceous to early Tertiary times as indicated in the palaeogeographical maps given by Schuster in 1972, it becomes quite evident that the Peninsular India was occupying a much southern latitudinal position at that time as compared today. This region is presently located between about 21' to 23.5' north of

equator was almost equatorial in position during the this geological times. This equatorial position of present day Central India must be responsible for the presence of typical tropical climate at that time. (ii) Presence of fossils of coastal plants like *Cocos*, *Nypa*, *Sonneratia* and marine alga *Peyssonnelia* (Lakhanpal 1970, 1974) indicates the presence of a sea in the near vicinity along with the equatorial position of the Indian peninsula resulted in a much uniform warm humid tropical climate in central India during the late cretaceous to early tertiary period. Thus, for the establishment of present day Tropical, dry deciduous to moist deciduous vegetation in Central India as against a Sub-tropical, wet evergreen forest of the past, the responsible main factors are (i) withdrawal of the an arm of Tethys sea from Central India, (ii) the movement of the northward drift of the Indian plate, and (iii) the formation of Western Ghats in the post trappean time.

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Reconstruction of vegetation around Nagpur- Chhindwara (Mohgaonkalan) area during Late Cretaceous (Maastrichtian) period.