CHAPTER IV

GEOLOGY, PHYSIOGRAPHY OF DECCAN TRAP, MANDLA DISTRICT AND FOSSIL FLORA OF THE AREA

GEOLOGY, PHYSIOGRAPHY AND FLORAL HISTORY

I. Geology

Physiographically, India is divided into three well marked regions. They are: 1. *Peninsula*, 2. *Extra-Peninsula* & 3. *Indo-Gangetic alluvial plains*. The **Peninsular India** is geologically very old and stable part of the crust lying south of the Indo-Gangetic plains. The **Extra Peninsula** is a mountainous region formed of very high Himalayan ranges. The **Indo-Gangetic alluvial plains** range from Assam and Bengal on the east, through Bihar, Jharkhand, Uttar Pradesh, Uttarakhand, Punjab and Haryana to the west. These regions have their own distinguishing characters. The Deccan Traps and intercalated intertraps belong to the Peninsular region. The Peninsula is an ancient plateau exposed for geological ages to denudation and approaching peneplanation. The mountains here are flat topped and represent the remains of the harder masses of the rocks which have escaped weathering and removal. The rivers in this area have built up shallow and broad valleys.

Stratigraphically, the Peninsula is a 'shield' area composed of geologically ancient rocks of diverse origin. These rocks have undergone much crushing and metamorphism. Over these ancient rocks lie a few areas of Precambrian and later sediments and extensive sheets of horizontally bedded lavas of the Deccan Trap formation. Some Mesozoic and Tertiary sediments are found mainly along the coastal regions. The Extra-Peninsula is predominantly a region in which the sediments, laid down in a vast geosyncline continuously from the Cambrian to early Tertiary, have been ridged up and folded. They show enormous thickness of sedimentary rocks representing the compressed entire geological column, over-thrust and elevated into dry land since the end of the Mesozoic times. The core of the mountains is composed of granitic intrusions of presumably Tertiary age.

Structurally, the Peninsula represents a stable block of the earth's crust which has remained unaffected by mountain building movements since the close of the Pre-Cambrian era. The later changes have been mainly of the nature of normal and block faulting because of which some parts have sunk down relative to the others. It has thin beds of marine transgressions belonging to the Upper Gondwana, Cretaceous or Tertiary ages.

Towards the close of the Mesozoic era there was a great volcanic activity over large parts of the Peninsular India with intermittent outburst of lava flows resulting in the formation of volcanic plateau called the "Deccan Traps". The vast peninsular region lying between the rivers Narmada and Cauvery is traditionally referred to as Deccan or Dakshinapath (Mahabale, 1966). Since the major rock type found in Deccan is 'Trap', it is also known as the "Deccan Trap Country". The characteristic low, flat topped hills of basalt represent the weathered surface of these lava beds.

The Deccan Trap Country forms one of the most ancient land masses of the globe, while the eastern and southern parts are believed to have existed as a land surface ever since the original crust was formed. The central and western parts are much younger, resting directly over the eroded surface of the old formations. They occupies an area of about 5,20,000square kilometres covering large parts of Maharashtra, Gujarat, Madhya Pradesh and parts of Karnataka and Andhra Pradesh. The thickness of the flow varies, maximum is about 20meters near Belgaon where the trap end on Southern side. Near Amarkantak and Surguja an eastern limit of the traps, the thickness is about 150meters, whereas in Kachchh they are 750 meters thick.

During the considerable time intervals elapsed between successive lava flows, there came into existence some rivers and obstruction to drainage. The fluviatile and lacustrine deposits formed in them are intercalated with thin and small lava flows, generally 0.5 to 3 meters but sometimes 0.15 meters thick. They are known as Intertrappean beds. These beds are highly fossiliferous preserving plant and animal remains that lived during the period intervening the successive lava flows. They comprise cherts, impure limestone and pyroclastic materials.

The Deccan Traps have been divided into three groups - upper, middle and lower, with the Infra-trappean beds or Lametas at their base. **Upper Traps** (450 meters thick are exposed in Maharashtra and Gujarat. They contain numerous Intertrappean beds and beds of volcanic ash.

Middle Traps (1200 meters thick are exposed mostly in Madhya Pradesh and parts of Maharashtra. They contain few or none Intertrappean beds but have ash beds in the upper parts.

Lower Traps (150 meters thick) are exposed in eastern parts of Madhya Pradesh. They have several Intertrappean beds which are without any ash beds. The upper and lower traps embody the numerous fossiliferous Intertrappean localities.

However, they are totally lacking in the Middle Traps as seen at Pune, Matheran, Mahabaleshwar and nearby areas. This may probably be due to lack of time between the successive lava flows which did not allow the plants and animals to colonize the surface.

II. Physiography

The Peninsular India is characterised with mountain ranges of Western and Eastern Ghats, Vindhyas, Satpuras, the Aravalis and mountains in Assam plateau. The Western Ghats are located on west coast of India from the Tapi valley down to Cape Comorin and from northern part down to Dharwad in Karnataka and Ratnagiri, Sindhudurg in Maharashtra is composed of the Deccan Traps. The southern part of the Peninsula consists Archian gneisses, schists and charnockites. The Western Ghats are nearly 1600 kms long with average elevation from 1000-1200 meters. In Maharashtra, they are composed of flat topped ridges forming a series of step like terraces down south of Sindhudurg district of Maharashtra. The Wertern Ghats rise again and forms Annamalai hills south of the Palghat in Kerala. The Eastern Ghats form a disconnected hill ranges of heterogenous composition ranging from northern part of Orissa to the down south of Andhra Pradesh. Their average elevation is about 750 meters. A part of Eastern Ghats in Krishna district strikes into the Bay of Bengal. The Vindhya mountains separate southern India from north India which have continuous hill ranges lying to the north of Narmada river and extended from Jobat in Gujarat to Sasaram in Bihar through Chhattisgarh and Indore, Bhopal, Sagar, Chhindwara, Seoni Jabalpur in Madhya Pradesh. The Satpura ranges are distributed from Pachmadhi hills in Madhya Pradesh to the Rajpipla hills in Gujarat through Maikal, Surguja, Ranchi and Hazaribagh ranges. They are delimited by the rivers Narmada in the North and Tapi in the South. Vindhya mountains form a watershed of Central India from which rise the rivers Narmada, Chambal, Betwa, Tons, Ken and Sone. Some of which flow northward into the Ganges and the others to southward into the Godavari and Mahanadi. The Aravalli mountains are the remnants of tectonic origin distributed from the southwest to northeast Rajasthan and divide the arid semi-desert of the Bikaner, Jodhpur and Jaisalmer area. Mount Abu is the highest point (1700 meters) in the Aravalli mountains. The Aravallis are thought to constitute one of the finest examples of a true tectonic range formed in Pre-Cambrian times and were probably lifted again in post vindhyan times (Krishnan, 1960).

III. Floral History of the Area.

Mandla district is very rich in the Deccan Intertrappean exposures. It has been quite thoroughly investigated for its floristic composition by large number of workers. They are Ambwani (1984, a), Ambwani & Mehrotra (1989), Ambwani & Prakash (1983), Awasthi *et al.* (1996), Bande (1973, 1974), Bande & Khatri (1980), Bande & Prakash (1980, 1983), Bande *et al.* (1986, 1993), Bonde (1987, 1990, 1995), Bonde & Kumaran (1993, 1994), Bonde *et al.* (2000, 2008), Guleria & Mehrotra (1998), Ingle (1972), Lakhanpal *et al.* (1979), Mehrotra (1986, 1987, 1990) and Mehrotra *et al.* (1984). The floral elements belong to the angiosperms. They are as follows:

Monocotyledons

The monocotyledons are represented by woody stems, petioles, inflorescence axis, fruits and juvenile/baby palms assigned to the family Arecaceae. In addition, a liliaceous inflorescence, a fruit of *Pandanus* and a fruit of Zingiberalean affinity have also been reported. *Palmoxylon dilacunosum* Ambwani (1984a), *P. ghughuensis* Ambwani & Prakash (1983), *P. mandlaensis* Lakhanpal et al. (1979), *P. parapaniensis* Lakhanpal et al. (1979), *P. shahpuraensis* Ambwani (1984), *P. taroides* Ambwani & Mehrotra (1989) are the palm stems. *Parapalmocaulon surangei* Bonde (1987) and *Phoenicicaulon mahabalei* Bonde et al. (2000) are the leaf axes. *Palmostroboxylon arengoidum* Ambwani (1984a), *P. umariense* Bonde(1990) and *P. sahnii* Bonde (1995) are the inflorescence axes. *Arecoidocarpon palasundarensis* Bonde (1995), *Palmocarpon arecoides* Mehrotra (1987), *P. cocoides* Mehrotra (1987) are the fruits. Whereas *Mahabalea phytelephantoides* Bonde (in press) is a juvenile palm and *Appamahabalea uhlii* Bonde (in press) is a soboliferous matured palm stem axis. In addition, a dichotomously branched palm stem comparable to *Hyphaene dichotoma* has also been reported (Bonde *et al.* 2008). *Pandanusocarpon umariense* Bonde (1990) is a fruit of *Pandanus* and *Musa cardiospermum* Jain (=*Callistemonites indicus* Bande *et al.* 1986, 1993) is a wild banana fruit with large number of seeds. Manchester & Kress (1993) objected its affinity with *Musa* but considers it as a fruit of Zingiberales. A Liliaceous inflorescence (Bonde & Kumaran, 1993, 1994) has also been reported from Umaria Intertrappeans. (List enclosed)

Dicotyledons

The permineralized dicotyledonous woods have been extensively investigated from the Mandla area. They are *Vitexoxylon indicum* Ingle (1972), *Polyalthioxylon parapaniense* Bande (1973), *Syzygioxylon mandlense* Ingle (1973), *Homalioxylon mandlense* Bande (1974), *Bischofinium deccanii* Bande (1974), *Sterculioxylon deccanensis* Lakhanpal, Prakash & Bande (1979), *Grewioxylon sp.* (Lakhanpal, Prakash & Bande, 1979), *Elaeocarpoxylon mandlensis* Lakhanpal, Prakash & Bande (1979), *Atlantioxylon indicum* Lakhanpal, Prakash & Bande (1979), *Hydnocarpoxylon indicum* Bande & Khatri (1980); Guleria & Mehrotra (1998), *Garcinioxylon tertiarum* Bande & Khatri 1980, *Gomphandroxylon samnapurensis* Bande & Khatri 1980, *Dracontomelumoxylon mangiferumoides* Ghosh & Roy (=syn. *Dracontomeloxylon paleomangiferum* Bande & Khatri, 1980; Bande & Prakash, 1983), *Barringtonioxylon mandlensis* Bande & Khatri (1980), *Sterculioxylon shahpurensis* Bande & Prakash (1980, 1983), *Calophylloxylon dharmendrae* Bande & Prakash (1980), *Burseroxylon preserratum* Bande & Prakash (1980, 1983), *Heyneoxylon tertiarum* Bande & Prakash (1980, 1983), *Laurinoxylon deccanensis* Bande & Prakash (1980), *Euphorioxylon deccanense* Mehrotra (1986), *Elaeocarpoxylon ghughuensis* Awasthi, Mehrotra & Srivastava (1996), *Lophopetalumoxylon indicum* Mehrotra, Prakash & Bande (1984), *Artocarpoxylon deccanensis* Mehrotra, Prakash & Bande (1984), *Eucalyptus dharmendrae* Bande, Mehrotra & Prakash (1986), *Tristania confertoides* Bande, Mehrotra & Prakash (1986), *Callistemonoxylon deccanensis* Bande, Mehrotra & Prakash (1986), *Polyalthioxylon parapaniense* (Bande) Mehrotra (1990).

In addition, leaf impressions, *Dicotylophyllum ghughuensis* Guleria & Mehrotra (1998), *D. mandlaensis* Guleria & Mehrotra (1998), *D. pulvinatum* Guleria & Mehrotra (1998) have also been reported from Mandla region of Madhya Pradesh.(List enclosed). Bande and Prakash (1982) suggested tropical humid climate for Mandla region based upon the above floral assemblage. They have also reconstructed the palaeoclimate and palaeogeography of Central India during the Intertrappean period and suggested evergreen to semi-evergreen vegetation during the deposition of Deccan Intertrappean sediments. They have also postulated that there was a humid tropical climate with annual rainfall of over 2000 mm per year and suggested that the Peninsular India had equatorial position enclosed by the sea. These postulations have also been supported by the later palaeobotanical investigations.

List of plant fossils from Mandla District, Madhya Pradesh, India.

I. Monocotyledons

No	Name of Plant Fossil	Family	Locality	Reference
1	*Appamahabalea uhlii*	Arecaceae	Umaria	Bonde (In press)
2	*Hyphaene deccanii*	Arecaceae	Silther	Bonde et al. 2008
3	*Mahabalea phytelephantoides*	Arecaceae	Umaria	Bonde (In press)
4	*Palmoxylon binoriensis*	Arecaceae	Seoni	Guleria & Mehrotra 1987
5	*Palmoxylon canalosum*	Arecaceae	Seoni	Guleria & Mehrotra 1987
6	*Palmoxylon dilacunosum*	Arecaceae	Silther	Ambwani 1984
7	*Palmoxylon ghughuensis*	Arecaceae	Ghughua	Ambwani & Prakash 198
8.	*Palmoxylon mandlaensis*	Arecaceae	Mohgaon	Lakhanpal et al. 1979
9	*Palmoxylon parapaniensis*	Arecaceae	Parapani	Lakhanpal et al.1979
10	*Palmoxylon shahapurensis*	Arecaceae	Ghughua	Ambwani 1983
11	*Palmoxylon siltherensis*	Arecaceae	Silther	Ambwani 1984
12	*Palmoxylon taroides*	Arecaceae	Ghughua	Ambwani & Mehroti 1989
13	*Palmoxylon vaginatum*	Arecaceae	Seoni	Guleria & Mehrotra 1987
14	*Palmostroboxylon arengoidum*	Arecaceae	Ghughua	Ambwani 1984
15	*Palmostroboxylon sahnii*	Arecaceae	Mo.Palasunder.	Bonde 1995
16	*Palmostroboxylon umariense*	Arecaceae	Umaria	Bonde 1990
17	*Parapalmocaulon surangei*	Arecaceae	Umaria	Bonde 1987
18	*Phoenicicaulon mahabalei*	Arecaceae	Umaria	Bonde 2000
19	*Sabalocaulon intertrappeum*	Arecaceae	Parapani	Trivedi &Verma 1981
20	*Amesoneuron deccanensis*	Arecaceae	Ghughua	Guleria & Mehrotra 1987
21	*Arecoidocarpon palasundarensis*	Arecaceae	Mo.Palasunder.	Bonde 1995
22	*Hyphaeneocarpon indicum*	Arecaceae	Shahpura	Bande et al.1982
23	*Palmocarpon arecoides*	Arecaceae	Samnapur	Mehrotra 1987
24	*Palmocarpon cocoides*	Arecaceae	Ghughua	Mehrotra 1987
25	*Phoenicites lakhanpalii*	Arecaceae	Seoni	Guleria & Mehrotra 1987
26	*Liliaceous Inflorescence*	Liliaceae	Umaria	Bonde & Kumaran 1993
27	*Pandanusocarpon umariense*	Pandanaceae	Umaria	Bonde 1990
28.	*Pandanusocarpon umariense*	Pandanaceae	Umaria	Bonde 1990.
29	*Musa cardiosperma*	Scitaminae	Mandla	Jain 1964

List of plant fossils from Mandla district, Madhya Pradesh, India

II Dicotyledons

No	Name of plant fossils	Family	Locality	Reference
1	*Dracontomlumoxylon mangiferumoides*	Anacardiaceae	Parapani	Bande & Prakash, 1983
2	*Dracontomeloxylon palaeomangiferum*	Anacardiaceae	Parapani	Bande & Khatri, 1980
3	*Polyalthioxylon earapaniense*	Annonaceae	Parapani	Bande 1973
4	*Burseroxylon ereserratum*	Burseraceae	Ghughua	Bande & Prakash, 1980, 1983
5	*Burseroxylon shapurensis*	Burseraceae	Ghughua	Bande & Prakash, 1980.
6	*Lophopetalumoxylon indicum*	Celastraceae	Ghughua	Mehrotra et.al. 1984
7	*Elaeocarpoxylon mandlansis*	Elaeocarpaceae	Mohgaon	Lakhanpal et.al. 1976
8	*Bischofinium deccanii*	Euphorbiaceae	Parapani	Bande, 1974
9	*Euphorbiocarpon drypeteoides*	Euphorbiaceae	Ghughua	Mehrotra et.al. 1983
10	*Homalioxylon mandlaense*	Flacourtiaceae	Parapani	Bande 1974
11	*Hydnocarpoxylon indicum*	Flacourtiaceae	Parapani	Bande & Khatri, 1980
12	*Calophyllum dharmendrae*	Guttiferae	Ghughua	Bande & Prakash, 1980.
13	*Garcinioxylon tertiarum*	Guttiferae	Parapani	Bande & Khatri, 1980
14	*Gonphandroxylon samnapurensis*	Icacinaceae	Samnapur	Bande & Khatri, 1980
15	*Laurinoxylon deccanensis*	lauraceae	Ghughua	Bande & Prakash, 1980.
16	*Barringtonioxylon mandlensis*	Lecythidiaceae	Parapani	Bande & Khatri, 1980
17	*Heyneoxylon tertiarum*	Meliaceae	Ghughua	Bande & Prakash, 1983.
18	*Artocarpoxylon deccanensis*	Moraceae	Slither	Mehrotra et.al. 1984
19	*Syzygilxlyon mandlaense*	Myrtaceae	Mandla	Ingle, 1973
20	*Atalantioxylon indicum*	Rutaceae	Mohgaon	Lakhanpal et.al. 1976
21	*Euphorioxylon deccanense*	Sapindaceae	Mehdwani	Mehrotra, 1988
22	*Sonneratioxylon preapetalum*	Sonneratiaceae	Ghughua	Mehrotra, 1988
23	*Sterculioxylon deccanensis*	Sterculiaceae	Mohgaon	Lakhanpal et al., 1976
24	*Sterculioxylon shahapurensis*	Sterculiaceae	Ghugua	Bande & Praksh, 1983
25	*Grewioxylon mahrzariense*	Tiliaceae	Mohgaon	Lakhanpal et al., 1976
26	*Vitexoxylon indicum*	Verbenaceae	Mandla	Ingle, 1972
27.	*Dicotylophyllum ghughuensis*		Ghughua	Guleria & Mehrotra, 1987
28	*Dicotylophyllum mandlaensis*		Ghughua	Guleria & Mehrotra, 1987
29	*Dicotylophyllum pulvinatum*		Ghugua	Guleria&Mehrotra,1987

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