CHAPTER VI

AGE AND CORRELATION

In the following pages an attempt has been made to discuss the age of the Laki, Kirthar, Nari and Gaj Formations. Besides attempting the zonal correlation of the two sections under study, an effort has also been made to correlate the Aali-Aorawadi river section with those of Aanoj-Sehe and Lakhpat areas in Kutch.

It has been already stated that Foraminifera of the Eocene and Oligocene rocks of Sind and Baluchistan areas have been studied in detail by Vredenburg (1905, 1908), Nuttall (1925, 1926), Pinfold and Davies (1937), Davies (1940), and Gill (1953). In Kutch, Tewari (1956a & b, 1960) studied the larger Foraminifera of the Kirthar, Nari and Gaj Formations. He (1957, 1960) assigned Aquitanian to burdigalian age to the Gaj Formation. It is apparent from the above contributions that the ranges of larger Foraminifera in the western India, are well established. In view of this fact, larger Foraminifera have been utilized here for assigning ages to the various zones and for their delineation.

Smaller Foraminifera including the planktonic forms, which have been widely used for local inter-regional correlations, have not received much attention in Kutch, though lately some work has been done by Tewari and Singh (1967), Mohan and Soodan (1970) and Samanta (1970). Ostracodes in general
have not been employed for wide inter-regional correlation, however, there are certain sequences (Bold, 1966c) where the study of Ostracoda has been utilized for the purpose of zonal subdivisions. An attempt has been made to delineate five ostracodal zones in the Tertiary sequence of this area (Text-fig. 8). In the following paragraphs, the ages of the various formations and zones of the two sections studied have been discussed.

The Deccan Traps covering a great part of Indian Peninsula have been assigned to various ages from Upper Cretaceous to Oligocene. Sahni (1934) has assigned the Deccan Traps of Madhya Pradesh to Lower Eocene on the basis of various paleobotanical evidences especially the preponderance of fossil palms from the Inter-trappean beds. Rao (1941) noted the occurrence of Deccan Traps immediately below Pallatispira beds referred to Upper Eocene in Surat area. On this contention, he considered the Deccan Traps to be as young as Upper Eocene. Tewari (1960) refers the Deccan Traps in Autch to upper Cretaceous and/or Palaeocene age, since these underlie the Laki (Lower Eocene) beds with an intervening layer of laterite. Subsequent workers on the Tertiary beds of Autch have supported the view.

The Laki Formation in the present area has not yielded any Ostracoda and Foraminifera except the solitary species of Ostrea flemingii. Hence its age can only be inferred
from the fragmentary evidence furnished by O. Flemingi and other indirect evidences, by correlating the Nali-Koraadi river section with Narada section (Tandon, 1962), which has yielded an assemblage of Assilina daviesi de Cizancourt, A. granulosa (d'Archiac) mummilites ataticus Leymerie etc., it can be referred to Lower Eocene (Ypresian) age. A. granulosa has also been recorded from the Subdistrict of the Himalayas, Lower Eocene beds of Europe and Afghanistan and Mammal shales of Salt Range. A. daviesi also occurs in the beds of Ypresian age from Afghanistan and in the Chadar beds (Lower Eocene) of Salt Range. A. ataticus is a long ranging species. In Sind it has been found from the beds ranging in age from Ypresian to Middle Lutetian. It is also commonly found in Sakesar limestone and Chadar beds of Salt Range and Shekhan limestone of Aohat.

The overlying Kirthar Formation encompassing Zones-I to IV in this area rests conformably over the Laki beds. The Zones-I, II, III and IV have their zonal fossils as Operculina sp. aff. O. subgranulosa d'Orbigny, mummilites obtusus (Sowerby), A. cancellata and A. maculatus Muttall respectively. However, this formation, as a whole, has yielded rich assemblage of larger Foraminifera like Discocyclina (A.) dispersa (Sowerby), D. (A.) sowerbyi Muttall, A. beaumonti d'Archiac and Haime, A. stamincaut Muttall, Assilina subcancellata Muttall, Dictyonoconoides cooki (Carter) and Alveolina elliptica (Sowerby). The above assemblage is
characteristic of Kirthar Formation (Lutetian) of Sind, Baluchistan and Kutch. Some of these forms have also been recorded from the Bandah Formation (Middle Eocene) of Rajasthan.

The Upper Eocene beds are conspicuously absent in the present area. Absence of Upper Eocene beds from Kutch has also been shown by Tewari (1957) and Raju et al. (1970). Later Tewari and Singh (1967) assigned Auversian age to the uppermost parts of the Kirthar beds from Kanoj-Sehe section, Kutch on the basis of two planktonic Foraminifera. However, from the Cambay and Surat regions of western India, Upper Eocene beds containing *Pellatispira* have been noticed by Rao (1941), Raju et al. (1970). In Assam Upper Eocene is represented by Kopili beds containing *Hantkenina* and *Pellatispira* (Miswas, 1954).

Kirthar Formation is overlain by the Wari Formation comprising Zones-V to VII. The Zone-V of the Wari Formation is characterized by the association of *Lumulitas fichteli* Michelotti, *H. intermedius* d'Archiac and *Heterostegina* (H.) sp. ex gr. H. (H.) *complanata* Meneghini. According to Clarke and Slow (1969) the range of *H. fichteli-intermedius* extends from the base of planktonic foraminiferal Zone P.18 to little later than the middle part of Zone P.19 (Text-fig.7).
However, *H. fichteli-intermedius* without the association of *Bululpidina* is a characteristic fossil assemblage of planktonic foraminiferal Zone P.18 which is equivalent to Lattorfian stage of Europe. This assemblage has also been recorded from the beds of Lattorfian age of Southern Europe, Middle East, East Africa, Pakistan, Netherlands and East Indies (Bames *et al.*, 1962). It has also been recorded from Tertiary Tc stage of Indonesia.

*Bululpidina fichteli* continues in the overlying Zones-VI and VII of the Nari Formation. In the Zone-VI, *H. fichteli* is associated with *Lepidocyclina* (*Bululpidina*) *dilatata* (Michelotti). The range of *Bululpidina* spp. extends from the base of planktonic foraminiferal Zone P.18 to basal zone of Zone VI (Clarke and Blow, *op. cit.*). Hence its association with *H. fichteli-intermedius* enables us to compare this zone with planktonic foraminiferal Zone P.19 (excluding uppermost part) which is considered equivalent to Rupelian stage of Europe. The younger part of the Rupelian equivalent to Zone-VII of the present area in Kutch is devoid of *Bululpidina* obviously on account of ecological factors, but still can be recognized by the presence of *H. fichteli*. The association of *H. fichteli-intermedius* and *Bululpidina* is characteristic of the beds of Rupelian age of Southern Europe, North Africa, Mediterranean, Middle East, East Africa, Pakistan, Netherlands and East Indies.
(Dams et al., 1962). This association is also characteristic of Tertiary Td stage of Indonesia.

Gaj Formation comprising Zones-VIII and IX overlies unconformably the Sari Formation. Zone-VIII contains an assemblage of Spiroclypeus sp. cf. S. ranijanae Tewari, Spiroclypeus tewarii n. sp., Heterostegina (Vlerkina) sp. ex gr. h. (V.) assilinoides Blanckenhorn emend Henson, h. (V.) sp. aff. h. (V.) involutiformis Papp and Kupper and rare specimens of Miogypsina s.l. The two species Heterostegina (V.) sp. aff. h. (V.) involutiformis Papp and Kupper and Spiroclypeus tewarii n. sp. continue to the upper Zone-IX of this area. According to Clarke and Slow (1969) the range of Heterostegina (Vlerkina) spp. is confined to Chattian-Bormidian. Also the beginning of Miogypsina s.l. from later part of planktonic foraminiferal Zone P.19 and absence of Globigerinoides points to Chattian-Bormidian (Uppermost Oligocene) age (Clarke and Slow, 1969). Hence both the Zones-VIII and IX of the Gaj Formation can be referred to Chattian-Bormidian (Uppermost Oligocene) age. This point has already been discussed in Chapter-IV.

CORRELATION OF THE SECTIONS UNDER STUDY

A complete sequence of Zones-I to IX are encountered in the beds of the Kali river-Kora-adi river section whereas in the Babia Hill section the corresponding Zones-I to VII,
with the absence of Zone-VI, are only met with. Hence in the Labia Hill section Zone-V is directly overlain by Zone-VII. It has also been found that only a part of sequence of the Laki beds is present here. Zones-VIII and IX of the Aali-Korawadi river section are absent in the Labia Hill section (Text-fig. 9).

CORRELATION WITH KANOJ-SEHE SECTION

The Kanoj-Sehe section which was studied by Singh, N.P. (1967), represents all the formations which have been encountered in the present area. Laki Formation, though present in the Kanoj-Sehe area, has not been studied. Singh (op. cit.) referred upper parts of the Airthar to Auversian on the evidence of the presence of certain characteristic planktonic Foraminifera. Since no biostratigraphic zones have been demarcated in the Kanoj-Sehe area, it is not possible to carry out zonal correlation. However, it has been found that the Zones-I to IV comprising bed Nos. 7 and 8 of the Kali-Kora-wadi river section are equivalent to bed Nos. 1 to 5 of the Kanoj-Sehe section referred to Lutetian age. Beds of Auversian age reported from Kanoj-Sehe section are not represented in the present area. The Zone-V comprising bed no. 9 of the Aali-Korawadi section is equivalent to bed Nos. 12-14 of the Kanoj-Sehe section referred to Lattorflian age. The Zones-VI and VII encompassing bed Nos. 10 and 11 of the present section are equivalent to bed Nos. 15 to 18 of the
Xanoj-Sehe section referred to Rupelian age. Similarly, the Zones-VIII and IX comprising the bed Nos. 12 to 15 of the Aali-Aorawadi river section are equivalent to bed Nos. 19 to 21 of the Xanoj-Sehe section (Text-fig. 10).

CORRELATION WITH THE LAKHPAT AREA

In Lakhpat area, Sen Gupta (1964) recorded no evidence of Palaeocene-Lower Eocene (Ranikot-Laki) sedimentation. The Deccan Traps and associated laterites are directly overlain by the Kirthar Formation. In the present area, Deccan Traps and associated laterites are overlain by Laki Formation (Lower Eocene) though no definite fossil evidence has been found. Sen Gupta (op. cit.) delineated zones I-3 in the Kirthar Formation (Middle Eocene) which roughly correspond to Zones-II to IV of the present area. Zone 4 of the Lakhpat area is equivalent to Zone-V of the Kali-Aorawadi river section referred to Lattorfanian age. Zones 5 and 6 of Sen Gupta (op. cit.) do not contain any larger Foraminifera. A part of zone 7 of Lakhpat area may be equivalent to Zones-VIII and IX of the present area (Text-fig. 10).