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FORAMINIFERAL EVIDENCE FOR THE EOCENE FAULTING IN THE SUB SURFACE SECTION NEAR SAM, JAISALMER BASIN, RAJASTHAN

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ABSTRACT

The cores from the subsurface section located in the Kanoi fault zone near Sam village (27°30':70°30'), Jaisalmer district, record a sequence of carbonaceous shale and lignite at the base overlain by the pale carbonate and bentonitic clay units. These core samples contain well - preserved planktic and benthic foraminifers in the carbonaceous shale and bentonitic clay units. The carbonaceous shale consists of an assemblage of planktic foraminifera indicative of Zones P7–P8 (early Eocene), while the overlying bentonitic clay unit contains the assemblage characteristic of Zone P2 (Early Palaeocene). These age assessments are further supported by the occurrence of *Assilina granulosa* (d'Archiac, 1857) and *A. subdaviesi* Gill, 1953 in the carbonaceous shale and *Laffitteina bibensis* Marie, 1946 (index species of SBZ1) in the overlying bentonitic claystone. The ages indicated by the planktic and the larger foraminiferal species confirm the stratigraphic inversion due to fault in the subcrops.

Keywords: Foraminifera, Subsurface Section, Sam-6 (Jaisalmer), Kanoi Fault zone

INTRODUCTION

The samples for the study of foraminiferal content came from the cores drilled by the Rajasthan state Department of Mining and Geology at the Site Sam-6 (Fig.1). In the present work, the early Eocene foraminifers are recorded from the strata underlying the rocks having foraminiferal assemblage of Palaeocene age. The studied assemblages are recorded from the basal 12 m of the 45 m thick subsurface Sam-6 section (Fig,2).The present assemblages provide evidence for faulting in the subcrops (Kalia *et al.*, 2005).

LITHOSTRTIGRAPHY

The Palaeogene shelf sedimentary succession in the Jaisalmer Basin, northwest India merges with the Sulaiman-Kirthar foredeep belts (Fig.3) in Pakistan. Largely concealed by the sand-cover in the Thar Desert, the Palaeocene-Eocene exposures in the Jaisalmer Basin are limited to the Sanu-Ramgarh-Khuiala region (Fig.1). The major tectonic elements of the basin (Fig.3) consist the Mari-Jaisalmer Arch flanked by the Ramgarh and Kanoi regional strike-slip fault zones, aligned parallel to it (Das Gupta and Chandra, 1978). The drilling near Sam village of the Jaisalmer Basin showed a 45 m. thick sedimentary succession. The lower 12 m portion of this succession is characterized by carbonaceous shale, lignite and carbonate rocks at the base which are overlain by bentonitic clay-carbonate intercalations topped by a thick foraminiferal (larger) limestone unit (Fig.2). The sediments are richly fossiliferous, and the samples from the carbonaceous shale (sample nos. 50 & 53) and bentonitic claystone (sample no. 46) have yielded well-preserved planktic and benthic foraminiferal assemblages that include biostratigraphic indices.

FORAMINIFERAL RECORD AND BIOZONES

The samples from the studied sequence show that the lower Palaeocene part contains more diversified assemblage of planktic foraminifers than the early Eocene part. Planktic foraminifers are moderately preserved in the argillaceous rocks studied, but their wall texture clearly shows the effect of diagenesis as illustrated by the SEM pictures (Pls. I and II). Amongst benthic index taxa, *Assilina* spp. are well preserved in the carbonaceous shale unit, while *Laffitteina bibensis* Marie, 1946 in the lower Palaeocene bentonitic claystone is not that well preserved.

As shown in the Fig.4, the carbonaceous shale unit is characterized by the occurrence of the two widely recorded lower Eocene species of the genus *Assilina* d'Orbignym 1826, namely, *A. granulosa* (d'Archaic) and *A. subdaviesi* Gill,1953 (Pl. III, figs. 3 and 2 respectively). Planktic foraminiferal assemblage from the carbonaceous shale unit is represented by the common occurrence of the Eocene species of *Acarinina* represented by *A. interposita, A. pentacamerata* and *A. pseudotopilensis* along with *Parasubbotina inaequispira* (Pl. II). Association of these species suggests equivalence with a standard planktic foraminiferal zones P7-P8 (in accordance with biostratigraphic scheme by Berggren *et al.*,1995), corresponding to the Zones E5-E6 (Berggren and Pearson, 2005). The overlying bentonitic claystone contains a well-preserved, diversified assemblage of planktic foraminifers consisting of *Praemurica inconstans, P. uncinata, Eoglobigerina spiralis, Parasubbotina pseudobulloides* and *Morozovella praeangulata* (Pl. 1) which correlate with Zone P2, i.e. Danian. A few specimens of *Laffitteina* Marie, 1946 identified as *L. bibensis* occur in the bentonitic claystone (sample no. 46, Pl. II, figs. 14-15; Pl. III, fig.4) in association with early Palaeocene planktic foraminiferal assemblage. The planktic foraminiferal species not documented earlier from Rajasthan are systematically described and illustrated, whereas the larger foraminiferal species compared with forms reported from the Indus Basin (Gill, 1953a; 1953 b) are only illustrated (Pl. III).

SYSTEMATIC DESCRIPTION

From the basal 12m a total of nine planktic foraminiferal species of lower Palaeogene were identified from the studied section. The type reference of each species is given with its systematic description. The detailed synonyms of each species have been omitted as they are described in Olsson *et.al.* (1999) and Pearson *et al.* (2006). For the taxonomy "Atlas of

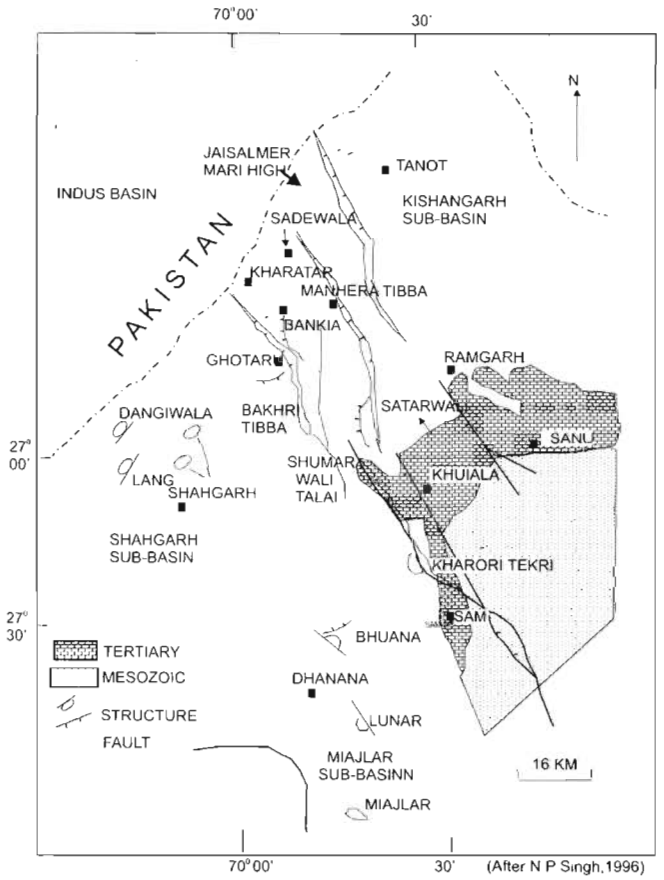


Fig.1. Geological map of the Jaisalmer Basin showing the location of Sam-6.

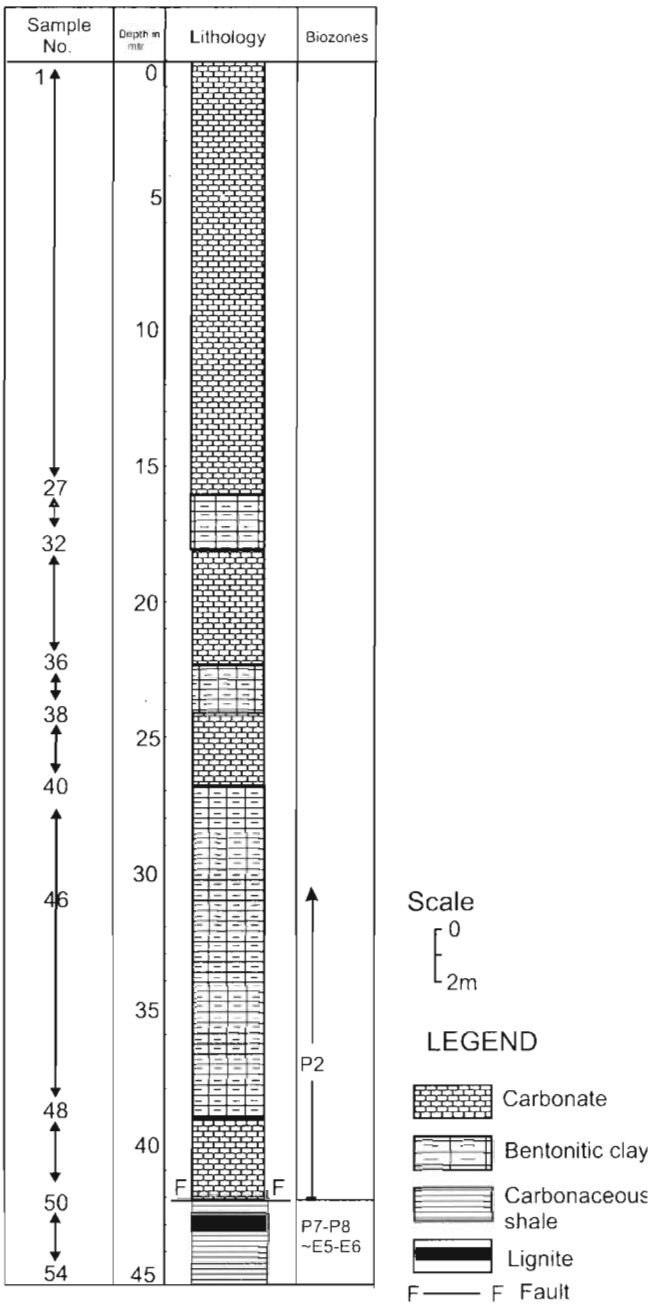


Fig.2. Subsurface lithocolumn at Sam-6 with planktic biozones.

Paleocene Planktonic Foraminifera" (Olsson *et.al.* , 1999) and "Atlas of Eocene Planktonic Foraminifera" (Pearson *et.al.*, 2006) has been followed.

Order **Foraminiferida** Eichwald, 1830
Family **Globigerinidae** Carpenter, Parker, and Jones, 1862
Genus ***Eoglobigerina*** Morozova, 1959
Eoglobigerina spiralis (Bolli, 1957)
(Pl. I, figs. 8-11)

Type reference: *Globigerina spiralis* Bolli, 1957a: 70, pl. 16: figs. 16-18

Remarks: Small trochospiral test of *E. spiralis* with 5 chambers in the last whorl occurring with *Praemurica uncinata* in sample no.46 indicates the presence of Zone P2 in the Sam-6 section. The wall texture shows the effect of diagenesis (Pl. 1, fig. 11).

Stratigraphic range: Zone P2; ? Uppermost Zone P1c.

Genus ***Parasubbotina*** Olsson, Hemleben, Berggren, and Liu, 1992

Parasubbotina inaequispira (Subbotina, 1953)
(Pl. II, figs. 10-12)

Type reference: *Globigerina inaequispira* Subbotina, 1953: 84, Pl. 6: figs. 1a-c

Remarks: Trochospiral test with 4-5 chambers in the last whorl along with cancellate spinose wall texture are

EXPLANATION OF PLATE I

(magnification x370 except for figs. 7, 11 & 15)

1-3. ***Praemurica inconstans*** (Subbotina), umbilical, spiral & axial views.
4-7. ***Praemurica uncinata*** (Bolli), 4-6, umbilical, spiral and axial views.
7- Wall texture showing diagenetic overprint x 4500.
8-11. ***Eoglobigerina spiralis*** (Bolli), 8-10, umbilical, spiral and axial views.
11-Weakly cancellate spinose wall texture, x 2250.
12. ***Morozovella praeangulata*** (Bolli), umbilical view.
13-15. ***Parasubbotina pseudobulloides*** (Plummer), 13-14, umbilical and spiral views.
15-cancellate spinose wall texture, x 2250.

Plate I

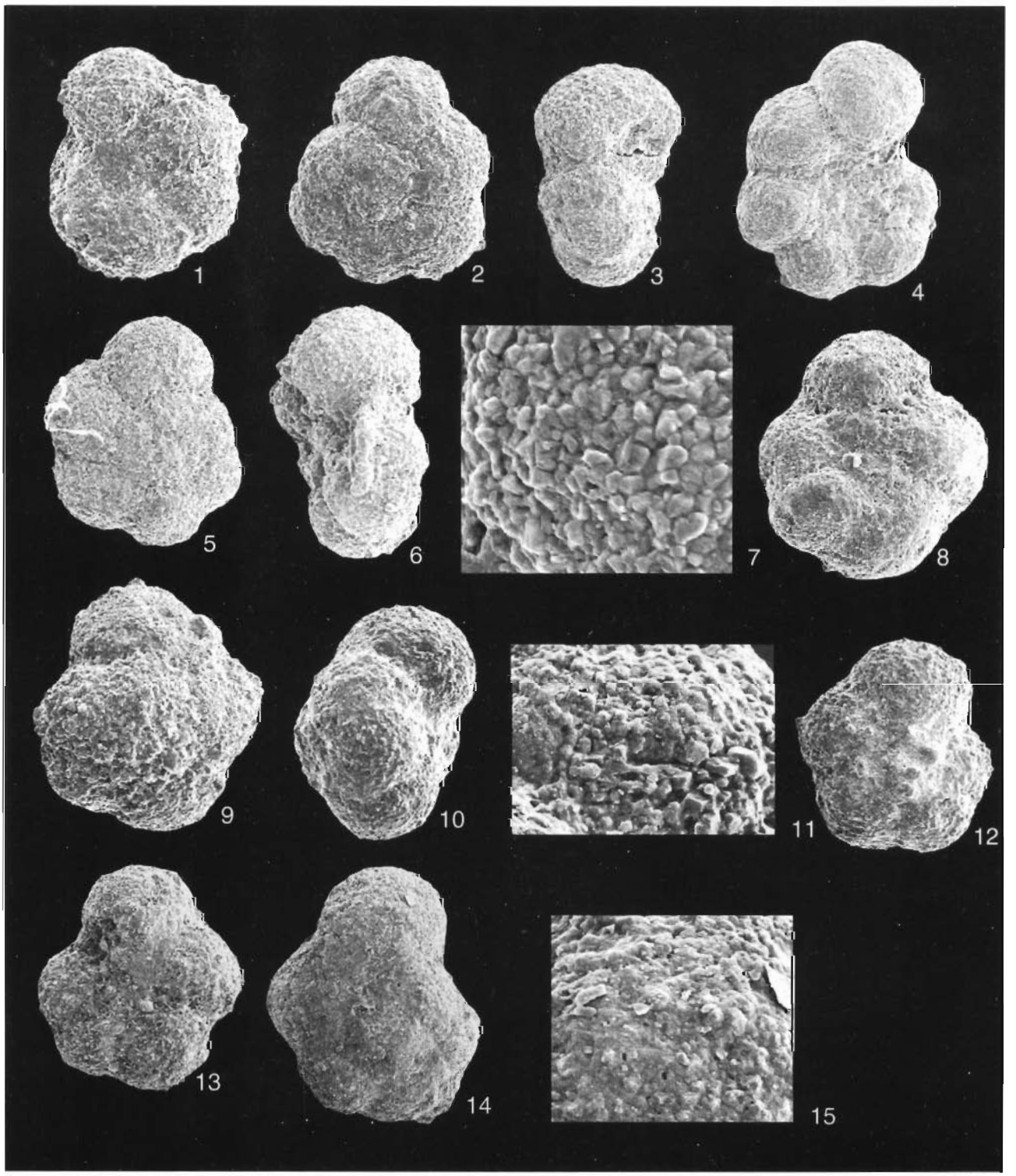
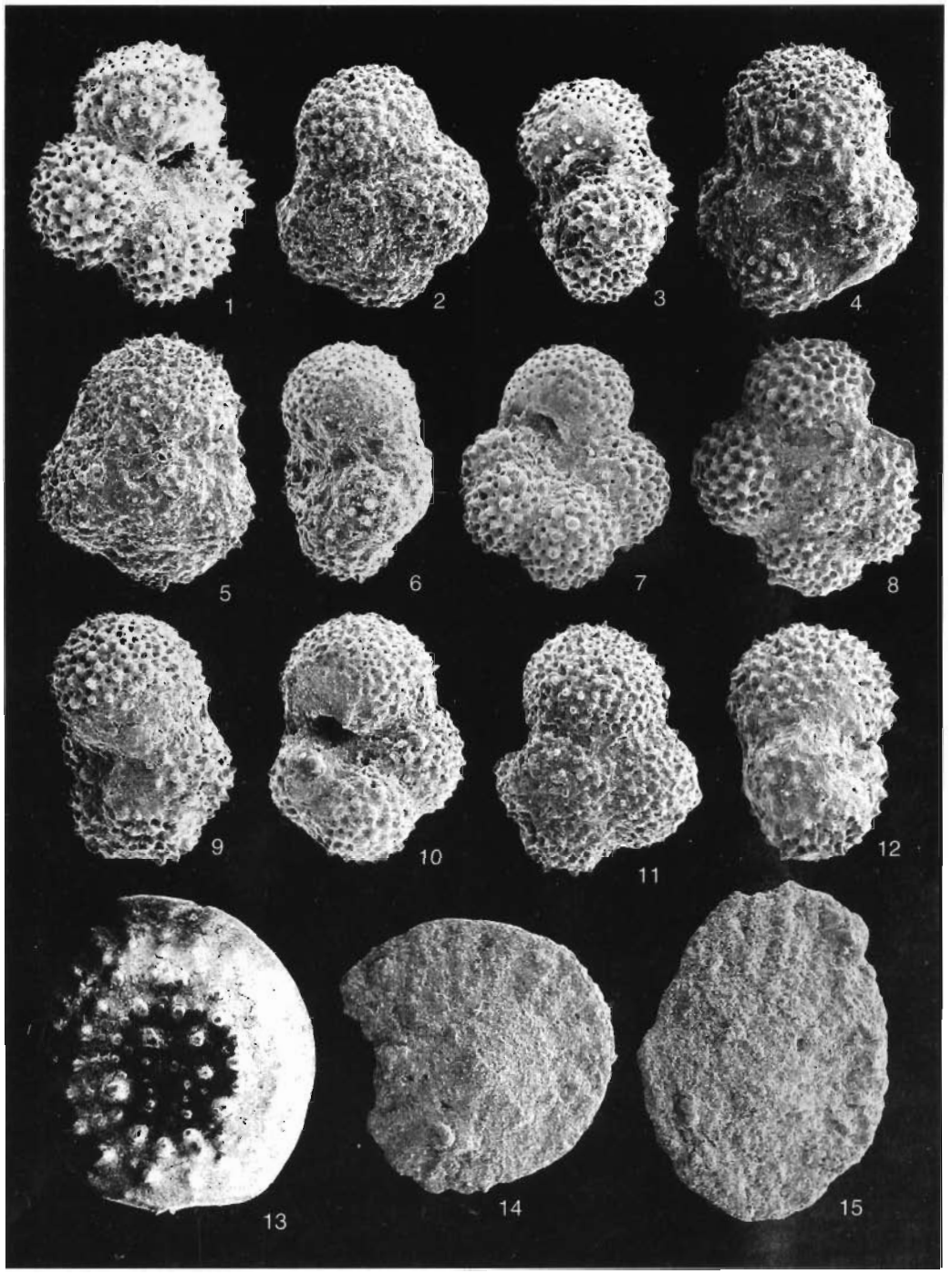


Plate II



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EXPLANATION OF PLATE II

(magnification x370 except for figs. 13-15)

1-3. ***Acarinina interposita*** (Subbotina), umbilical, spiral and axial views.

4-6. ***Acarinina pseudotopilensis*** (Subbotina), umbilical, spiral and axial views.

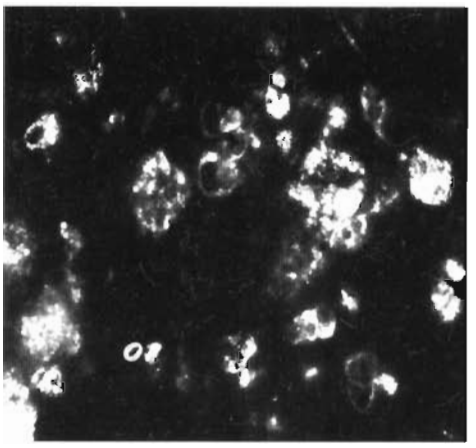
7-9. ***Acarinina pentacamerata*** (Subbotina), umbilical,spiral and axial views.

10-12. ***Parasubbotina***, umbilical, spiral and axial views.

13. ***Assilina granulosa*** (d'Archaic), 1847, side view x 50

14-15. ***Laffitteina bibensis*** Marie 1946, two views of asymmetrical test x 150

Plate III



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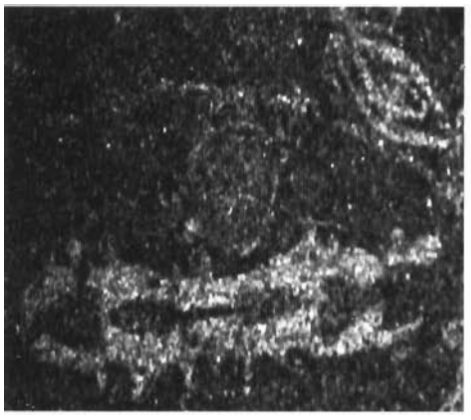

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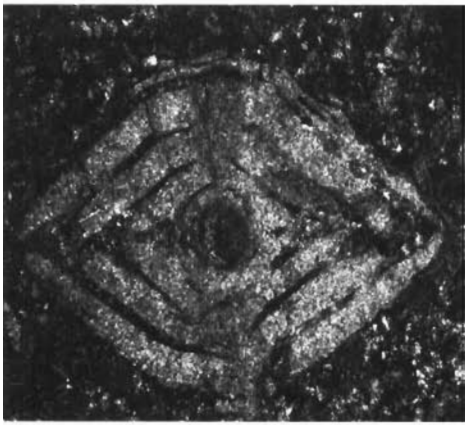

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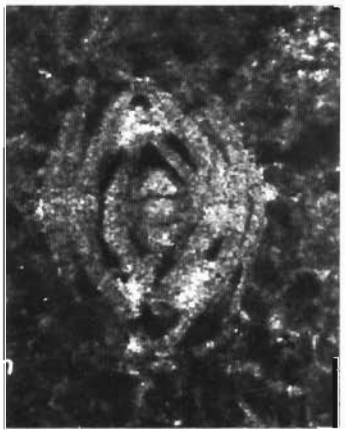

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EXPLANATION OF PLATE III

1. Thin section of carbonaceous shale (sample no.50) showing common occurrence of planktic foraminifers, x 100.
2. Typical wasp shaped axial section of ***Assilina subdaviesi*** Gill, 1953 showing 4 whorls in the megalosheric form (sample no.50) x 50.
3. Axial section (part) of ***Assilina granulosa*** (d' Archiac) with large number of whorls, granules at the septa (sample no.50) x 50.
4. ***Laffitteina bibensis*** Maren in thin section (sample no.46) x 200.
5. Slightly oblique axial section of ***Ranikothalia thalicus*** Davies, 1929 (sample no. 24) x 50.
6. Slightly oblique axial section of ***Miscellanea miscella*** (d'Archaic and Haime, 1935) in sample no.19 x 50.

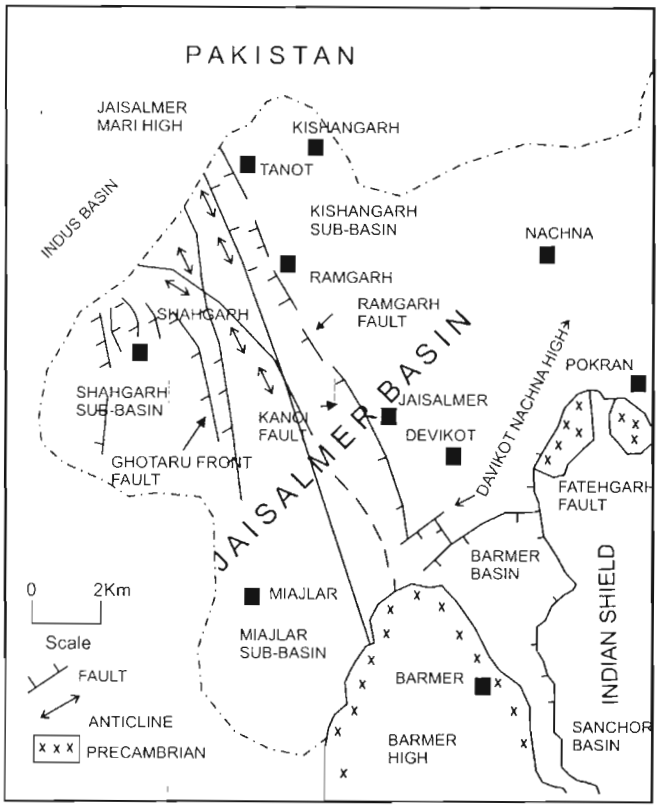

Fig. 3. Tectonic map of the Jaisalmer Basin (after Das Gupta, 1978 and N.P. Singh, 1996).

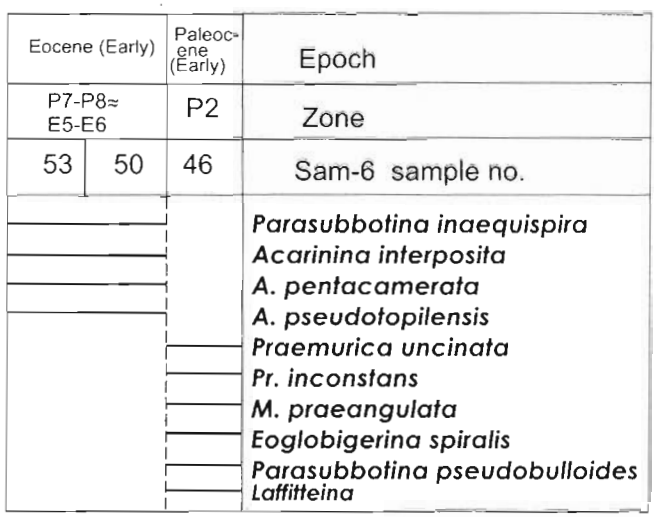

Fig.4. Ranges of planktic foraminiferal species and biozones described at Sam-6.

moderately well preserved in sample no.50 and 53 in Sam-6 section.

Stratigraphic range: Zone E1 to Zone E8.

Parasubbotina pseudobulloides (Plummer, 1926)
(Pl. I, figs. 13-15)

Type reference: *Globigerina pseudobulloides* Plummer, 1926: 133, pl. 8: fig. 9a-c.

Remarks: Trochospiral test with typically five chambers in the last whorl increases rapidly in size and is fairly well preserved in sample no. 46. The wall texture shows the effect of diagenesis (Pl. I, fig. 15).

Stratigraphic range: Uppermost Zone P to Zone P3a; ? P3b

Family **Truncorotaloididae** Loeblich and Tappan, 196
Genus ***Acarinina*** Subbotina, 1953
Acarinina interposita (Subbotina, 1953)
(Pl. II; figs. 1-3)

Type reference: *Acarinina interposita* Subbotina, 1953:231, pl. 23: fig. 6a-c

Remarks: Trochospiral test with 4 chambers in the last whorl, muricate wall texture, accompanied by loose arrangement of chambers is well preserved and occurs in the sample no.50 and 53.

Stratigraphic range: Zone E4 to Zone E6.

Acarinina pentacamerata (Subbotina, 1947)
(Pl. II, figs. 7-9)

Type reference: *Globorotalia pentacamerata* Subbotina, 1947:129-129, pl. 7: figs. 15-17.

Remarks: Trochospiral test with 5 loosely packed chambers in the last whorl, muricate nonspinose wall texture is fairly well preserved in sample no. 50 and 53.

Stratigraphic range: Zone E5 to Zone E7.

Acarinina pseudotopilensis Subbotina, 1953
(Pl. II ; figs. 4-6)

Type reference: *Acarinina pseudotopilensis* Subbotina, 1953: 227, pl. 21: fig. 8a-c and 9a-c.

Remarks: Quadrate test of *A. pseudotopilensis* with 4 chambers in the last whorl and umbilical-extraumbilical aperture shows cancellate non-spinose normal perforate wall texture. Preservation is good in sample no. 50 and 53.

Stratigraphic range: Zone E1 to Zone E7

Genus ***Morozovella*** (McGowran in Luterbacher, 1964)
Morozovella praeangulata (Blow, 1979)
(Pl. I, fig. 12)

Type reference: *Globorotalia (Acarinina) praeangulata* Blow, 1979:942-944, pl. 82: fig. 5, 6 s.

Remarks: Planoconvex test with 5 chambers in the last whorl, muricate but not muricocarinate, moderately well preserved , rarely occurs in sample no. 46.

Stratigraphic range: Zone P2 to Zone P3a.

Genus ***Praemurica*** (Olsson, Hemleben, Berggren, and Liu, 1992)
Praemurica inconstans (Subbotina, 1953)
(Pl. I, figs.1-3)

Type reference: *Globigerina inconstans* Subbotina, 1953:58, pl. 3: figs. 1, 2.

Remarks: Subcircular test characterized with 5-6 chambers in the final whorl shows umbilical-extraumbilical aperture, nonspinose wall texture and radial suture. Preservation is good and forms are abundant in sample no. 46.

Stratigraphic range: Zone P1c to lower Zone P3.

Praemurica uncinata (Bolli, 1957)
(Pl. I, figs. 4-7)

Type reference: *Globorotalia uncinata* Bolli, 1957a: 74, pl. 17: fig. 13-15.

Remarks: Planoconvex noncarinate test with 6-7

chambers in the last whorl with radial and depressed suture on the umbilical side and strongly recurved on the spiral side. Wall texture shows the effect of diagenesis and the tests are fairly well preserved and abundant in sample no.46.

Stratigraphic range: Zone P2 to Lower Zone P3

BIOSTRATIGRAPHY

Biozones P1c to P5 were described (Kalia and Chakravorty, 1985) in the subsurface cores at SDC-49, located 50 kms northeast of Sam-6. The sandstone-dominated basal transgressive unit is truncated and therefore the foraminifers indicative of Subzone P1c, e.g. *Globoconusa daubjergensis* (Bronniman, 1953) are not recorded at Sam-6. The concurrence of species suggests biozones P7-P8 (Berggren *et al.*, 1995) equated to the Eocene zones E5-E6 (Berggren and Pearson, 2005) for the carbonaceous shale unit. The species of *Morozovella* McGowran, 1964 are absent, and the occurrence of *A. interposita, A. pseudotopilensis, A. pentacamerata and Parasubbotina inaequispira* assigns the carbonaceous shale to the zones E5-E6 (Fig.4). The lower Palaeocene zone P2 (*Praemurica uncinata* Zone) is identified by the presence of nominate taxa and assemblage of *Praemurica inconstans, P. uncinata, Eoglobigerina spiralis, Parasubbotina pseudobulloides* and *Morozovella praeangulata* (Fig.4) in the bentonitic claystone.

The occurrence of carbonaceous and lignitic strata containing early Eocene index foraminiferal species of zones E5-E6 below the strata with early Palaeocene index species of the Zone P2 marks the disruption of stratigraphic order by faulting.

DISCUSSION

The drill Site Sam-6 falls within the Kanoi fault Zone (Fig.1) and the stratigraphic reversal is marked by the occurrence of strata containing foraminifers of lower Eocene age at the base of the section overlain by the rocks with lower Palaeocene index foraminifers. The foraminiferal record thus provides an evidence for faulting in the subsurface which is the effect of the Kanoi Fault near Sam village.

The Kanoi fault is attributed to the upthrusting and wrench faulting (Mitra *et al.*, 1993). The present biostratigraphic (foraminiferal) evidence supports this. The regional strike-slip domain in the Jaisalmer Basin is regarded to mark the tectonic event of collision (Molner and Tapponier,1975) between the Indian subcontinent and a microcontinent in the southern Tethys during the early Eocene. The same tectonic event was documented in the upper Palaeocene to middle Eocene mudstone-dominated Ghazij Formation in the Sulaiman and Kirthar ranges in central Pakistan (Beck *et al.*,1995;Warwick *et al.*,1998).

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