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On the occurrence of ichnogenera *Planolites* and *Psilonichnus* from the Jogira Formation (Early-Middle Eocene), Bikaner Basin, Western India: implications on depositional environment

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Abstract

The Cenozoic sediments of the Bikaner basin are lithostratigraphically classified into Palana Formation, Marh Formation, Jogira Formation and Kolayat Formation in ascending order of superpostion. The present paper records ichnofossils namely, *Planolites montanus, P. beverleyensis* and *Psilonichnus* isp from the Jogira Formation (Lower Middle Eocene) of Bikaner basin, Western India. The presence of these ichnofossils in a succession exposed in a quarry southeast of Jogira Lake plays a significant role in deciphering the depositional environment of the Jogira Formation. In the present section, two ichnofossil horizons are marked. The lower horizon is dominated by *Psilonichnus* isp whereas upper horizon is marked by *Planolites montanus, and P. beverleyensis.* From the sedimentological characteristic features and associated ichnofossils from the studied succession, we infer that the deposition of the sediments of the Jogira Formation began in a lagoonal to backshore environment with the formation of mudstone and sandy shale. Later, with the change in the bathymetry shallow marine fossiliferous limestone was deposited.

Key words: Bikaner basin, Jogira Formation, mudstone, shale, Ichnofossils, Depositional environment

Introduction

Most of the areas of Bikaner district are covered by the desert sands and sandy alluvium of Quaternary Period. The Bikaner basin lies between 26°10"-30°00’ N latitudes and 71°31’-74°26’ E longitudes. The Bikaner-Nagaur basin is a sedimentary basin trending NNE-SSW, covering an area of over 35,000 sq. km. The Cenozoic sedimentation in the Bikaner- Nagaur basin (Table 1, Fig. 1) began with Palana Formation that was deposited during the Paleocene, followed by Marh Formation, Jogira Formation and Kolayat Formation (Ghosh, 1983; Ghosh, 1983 and Pareek, 1984). During the close of Mesozoic, encroachment of sea was seen through an embayment between the two fault ridges trending ESE-WNW. The Tertiary sediments of Bikaner basin occur in distinctly separated areas which witnessed marine transgression. Exposures of the Tertiary rocks can be found as detached outcrops well exposed about 50 to 60 km WSW of Bikaner

Table No 1- Cenozoic sequence of the Kolayat area (*after* Ghosh, 1983)

Age	Formation	Lithology
Pleistocene to Recent	Kolayat	Sand and sandy alluvium; Ironstone nodules, sandy calcareous grit kankar, gypsite Ferruginous bands, semi-consolidated conglomerate; Erratic boulders of quartzite
~~Unconformity~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		
Early to Middle Eocene	Jogira	Shaly and marly limestones with foraminifers (*Alveolina, Discocyclina, Nummilites*); Unfossiliferous, white clayey marl Dirty brown impure limestone with broken shells of ostrea and foraminifers (*Assilina*); Fuller’s earth with shale partings having casts of lamellibranchs and gastropods; Yellow shales, marl with smaller foraminifers (*Nummilites, Assilina*)
~~Unconformity~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		
Late Paleocene	Marh	Upper clay horizon with one clay bed Ferruginous sandstone, gritty sandstone and sugary sandstone with white glass sand (local) Middle clay horizon with five clay beds and sandstone partings Ferruginous sandstone, gritty sandstone, grit, various siltstone with leaf impressions
~~Gradational Contact~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		
Early Paleocene	Palana	Fine grained sandstone, carbonaceous shale and lignite

Various researchers including Ghosh (1983), Khosla (1973) and Pareek (1984) made valuable contributions in the systematic study of the geology and stratigraphy of the area. In the present paper, an attempt is made to understand the depositional environment of the Jogira Formation on the basis of ichnofossils and sedimentological characteristic features.

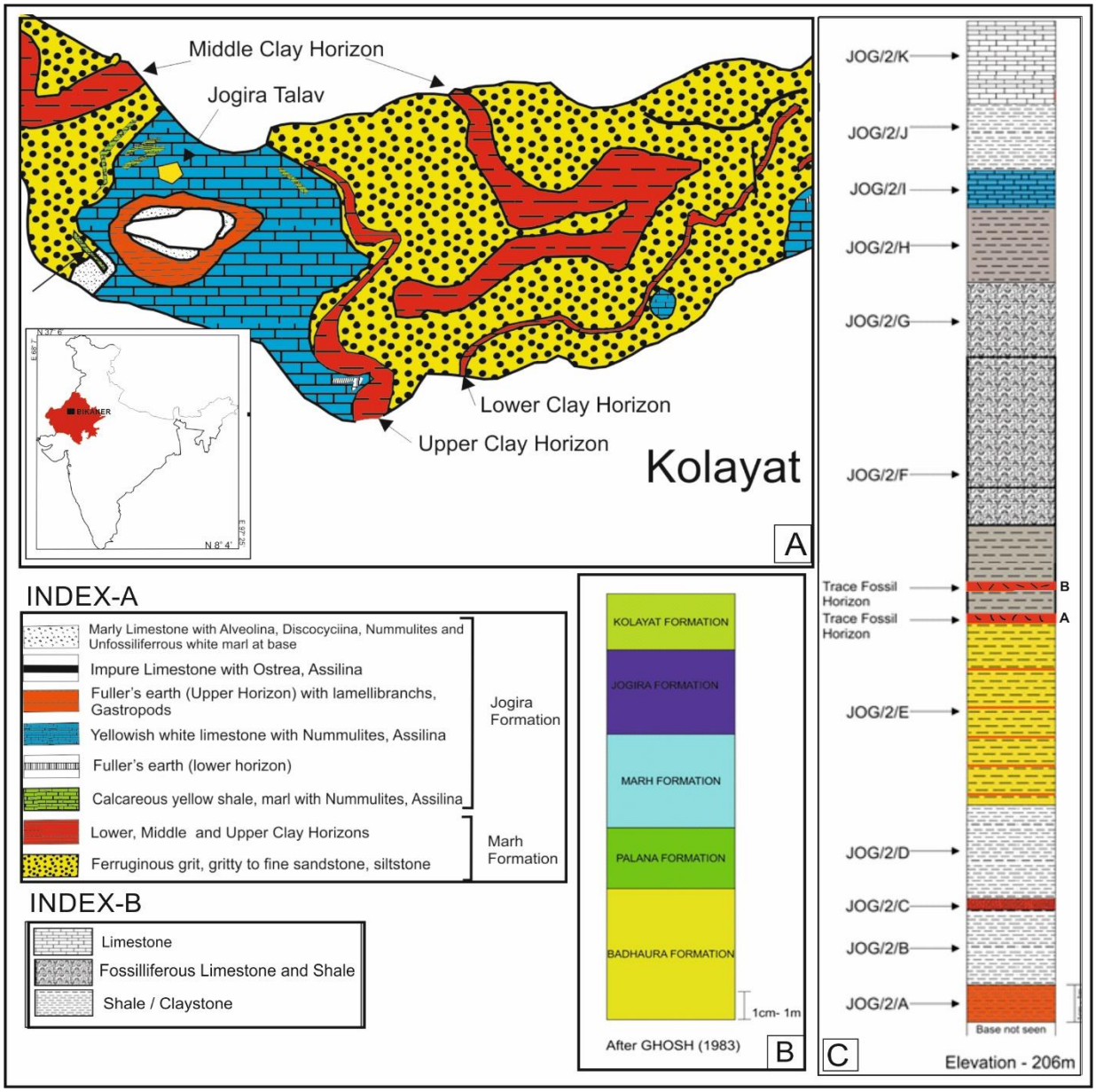

Figure 1: A. Geological map of the study area (After Ghosh, 1983), B. Litholog (After Ghosh, 1983) and C. Litholog of studied section

Methodology

The sedimentological, ichnological variations and responses of ichnofossils to sediments have been studied from the present section in the field and accordingly lithocolumn was prepared. Total 11 representative samples (JOG/2/A to JOG /2/K) were collected from the section for laboratory studies. Thin sections of limestone were prepared and analyzed microscopically whereas sandstone, claystone and shale were studied megascopically. All the measurements of the ichnofossils were done in the field. All ichnological interpretations are based on field observations and no type specimens were collected for repository. This study of palaeoichnology follows the Treatise on Invertebrate Palaeontology, (Haentschel, 1975), the morphological classification of Simpson (1975) and ethological classification of Seilacher (1964).

Jogira Talab Section of Jogira Formation

A section of Jogira Formation (27 m thick) is exposed in a quarry SE of Jogira *Talab* (N 27º52'20.5"; E 72º54'28.5"; El. 206 ± 3) (Fig. 1C; Fig.2, A and B).

The bottom portion of the succession is marked by 1 m thick brown claystone horizon overlain by 1m thick off-white coloured claystone consisting of yellow and red bands enclosing ferruginous material. The off-white claystone is overlain by 30 cm thick gritty sandstone having angular fragments of quartz along with few iron oxide nodules, and showing red ferruginous cement. Grity sandstone is overlain by 2.5 m thick claystone, showing yellow and red pockets of iron rich material. This claystone horizon is overlain by 5 m thick yellow claystone containing 5 bands of ferruginous material. Above it, 1 m bioturbated claystone / trace fossil horizon 'A' dominantly consisting of trace fossils belonging to ichnogenus *Psilonichnus*, is exposed. Above this horizon, 1.5 m thick brown coloured grity sandstone is exposed and on the top of it trace fossil horizon 'B' is exposed and shows dominant presence of ichnogenus *Planolites*. A 7 m thick horizon is overlain by the trace fossil horizon 'B', showing fine laminated shale (2.5 m thick) at the basal part which is followed by thick sequence of fossiliferous limestone (4.5 m) consisting of foraminifera viz., *Assilina* and *Discocyclina.* Fossiliferous limestone consisting of *Discocyclina* and few *Assilina* overlies the previous lithounit. Fossiliferous shale (2 m thick) consisting of *Discocyclina* and *Assilina* is exposed. This fossiliferous shale is overlain by whitish limestone (2 m thick) consisting mainly *Assilina*. Off-white to yellowish coloured claystone is exposed and overlain by limestone consisting of *Discocyclina* and *Assilina.*

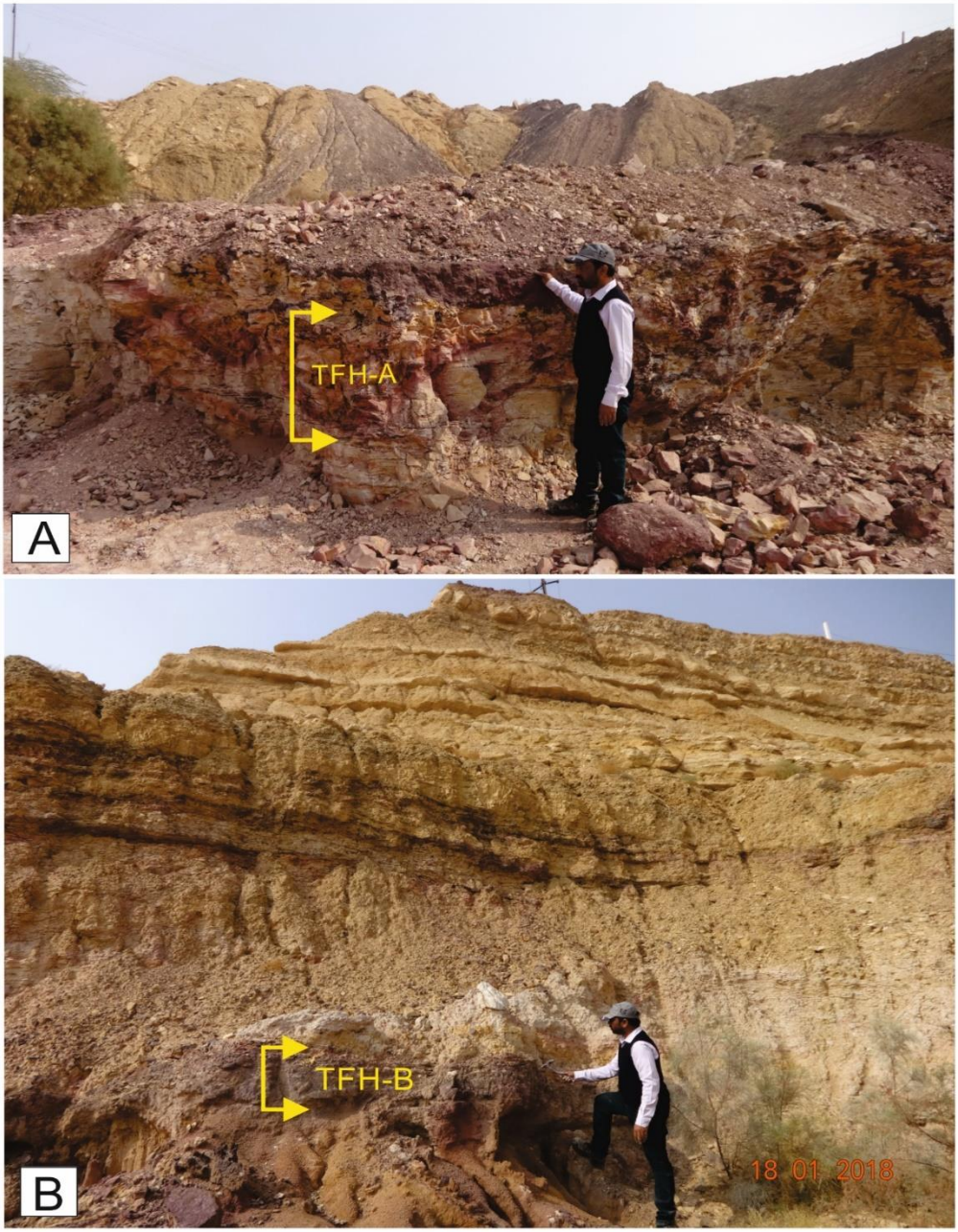

Figure 2: **A**. Trace fossil horizon- A exhibiting ichnogenera *Psilonichnus* and **B**. Trace fossil horizon- B exhibiting ichnogenus *Planolites*.

Systematics of Trace Fossils

Ichnogenus: *Psilonichnus* Fürisch, 1981
Ichnospecies: *Psilonichnus* isp (Figs.3, A, B, C and D)

Description: Cylindrical, vertical to inclined burrows without lining are observed in the claystone horizon. 'J' and 'I' shaped burrows were dominant. The diameter of burrows ranges from 10 mm to 14mm.
Remarks: Vertically oriented cylindrical unlined burrows, exhibiting variation in the diameter of burrows at places. The present specimens show many similarities with ichnogenus *Psilonichnus* and thus it is described as *Psilonichnus* isp. These species are interpreted as domichnia which are suspension feeders.
Horizon: Claystone of the Jogira Formation near Jogira Talab, Bikaner, Rajasthan

Ichnogenus: - *Planolites* Nicholson, 1873
Ichnospecies: *Planolites montanus* (Figs.3, E and F)

Description: These burrows occur without lining and are straight to curved and occur parallel to the bedding planes. The burrow fill material is different from the host. Shape is circular to semi-circular in cross section. The diameter of these species varies from 4mm to 7mm.
Remark: Burrows are straight, unbranched and disposed parallel to the bedding plane. They are semicircular to circular in cross section. They are unlined burrows infilled with material different from that of host rock i.e. colour of burrow and host rock is different. The present burrows are considerably thin. Hence, they are placed under *Planolites montanus* (Pemberton and Frey, 1982). Morphologically they are interpreted as tunnel and ethologically as fodinichnia.
Badve and Ghare (1978, 1980); Sanganwar and Kundal (1997); Kundal and Sanganwar (1998, 2000) documented this ichnospecies from Bagh Group of Madhya Pradesh whereas Chiplonkar and Ghare (1979) recorded it from Trichinopoly Group, Tamil Nadu. Kundal et al., (2005) documented this from Babaguru Formation at Bhilod village, Broach district, Gujarat. Kundal and Dharashivkar (2006) reported this ichnospecies from Shankhodhar Sand Clay Member (Dwarka Formation) at Dingeshwar Mahadev cliff.

Occurrence: Sandstone of the Jogira Formation near Jogira Talab, Bikaner, Rajasthan.
Ichnospecies: *Planolites beverleyensis* (Fig.3, F and G)

Description: These burrows occur without lining and are straight to curved. The burrow fill material is different from the host and occurs parallel to the bedding plane. Shape is circular to semi-circular in cross section. The diameter of these species varies from 15mm to 24mm.

Remark: Burrows are straight and unbranched, and disposed parallel to the bedding plane. They are semicircular to circular in cross section. They are unlined burrows infilled with material different from that of host rock i.e. colour of burrow and host rock is different. The present burrows are considerably thick. Hence, they are placed under *Planolites beverleyensis* (Billings) (Pemberton and Frey, 1982). Morphologically they are interpreted as tunnel and ethologically as fodinichnia.
Borkar and Kulkarni (1992) and Kundal and Sanganwar (1998, 2000) recorded *Planolites beverleyensis* (Billings) from Wadhawan Formation of Gujarat and Bagh Group of Madhya Pradesh, respectively. Kundal et al., (2005) documented it from Babaguru Formation at Bhilod village, Broach district, Gujarat. Kundal and Dharashivkar (2006) recorded this species from Shankhodhar Sand-Clay Member Dwarka Formation. Recently, Mude et al. (2012) documented it from the Bhuj Formation, Kachchh. Further, Mude (2012a and b) documented it from Kand Formation and Babaguru Formation, Gujarat.
Horizon: Sandstone of the Jogira formation near Jogira Talab, Bikaner, Rajasthan.

Discussion

The palaeoenvironmental study of marine sediments can be achieved by analysing lithology, associated primary structures and fossils. However, ichnofossils / ichnofossil assemblage are much significant in palaeoenvironmental investigations due to their autochthonous nature (Haentzschel,1975). Ichnofossil assemblage helps to understand the depositional environment and to reconstruct palaeoenvironments and palaeobathemetry of the sedimentary horizon (Seilacher, 1967). There are various factors that control the behavioral responses of animals and these responses are controlled by energy conditions at a depositional interface, substrate type and availability of food. Thus, ichnofossils are very sensitive to environmental conditions and can be used as environmental indicators (Crimes, 1975). The ichnogenus *Psilonichnus* generally occur within shoreface to estuarine to fluvial settings (Nesbitt and Campbell, 2006). The ichnogenus *Planolites* represent the feeding trace of a mobile infaunal deposit feeder and generally associated with shallow marine sediments with low to moderate energy conditions (Pemberton and Frey, 1982).

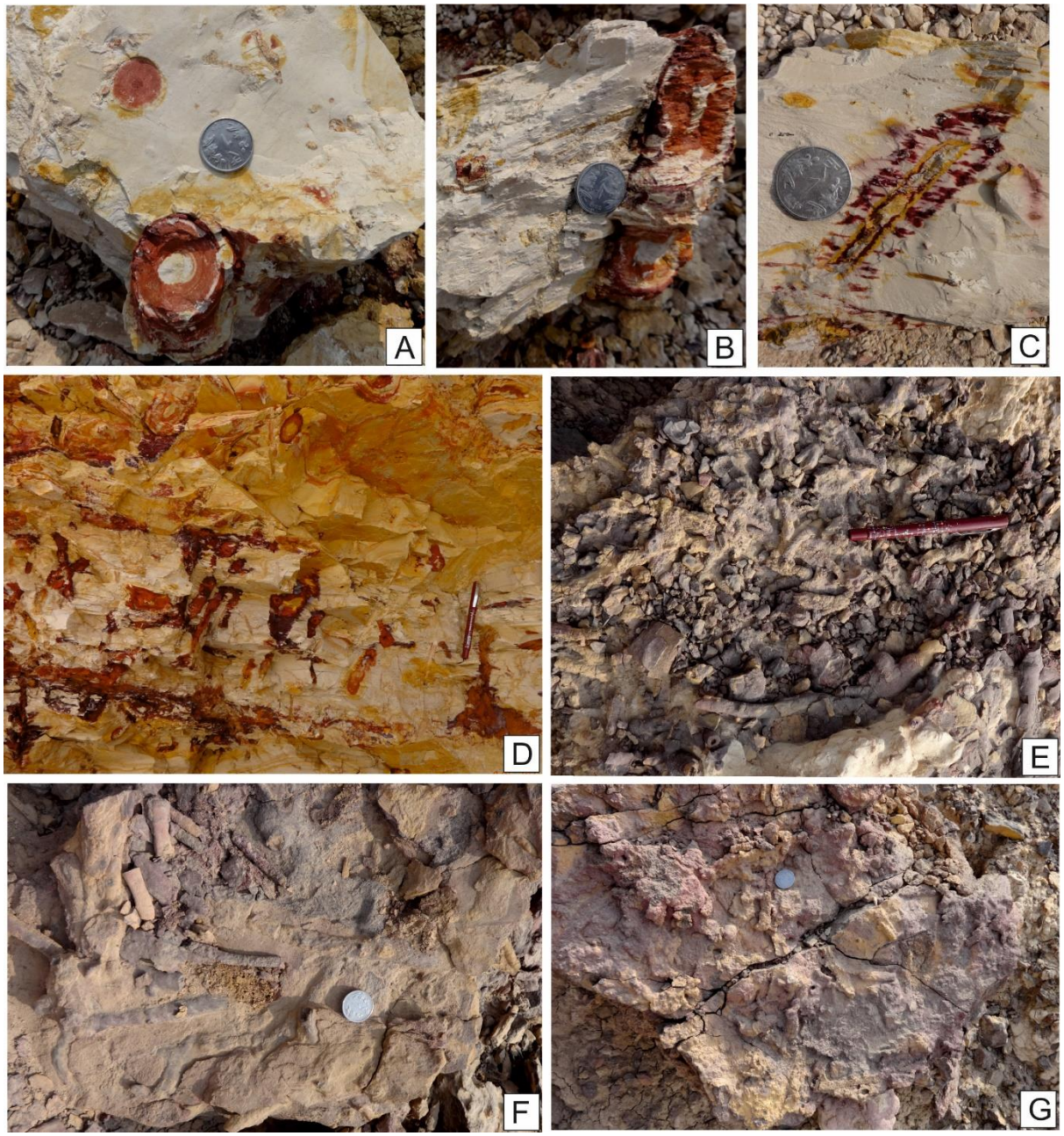

Fig. 3: A to D, field photographs of *Psilonichnus isp* and E & F, field photographs of *Planolites montanus* and F & G, field photographs of *Planolites beverleyensis*

Conclusions

1. The present paper records ichnofossils viz., *Planolites montanus, P. beverleyensis* and *Psilonichnus* isp from Jogira Formation (Lower Middle Eocene) of Bikaner basin, Western India.

2. The present ichnofossil assemblage and sedimentological studies infer that the deposition of the Jogira Formation (exposed at Jogira Talab section) was initiated with lagoonal to backshore environment and subsequent transgression leading to deposition of shallow limestones.

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References:

Badve, R. M. and Ghare, M. A., (1978), Jurassic Ichnofauna of Kutch-I, Biovigyanam, 4, 125-140.

Badve, R. M. and Ghare, M. A., (1980), Ichnofauna of Bagh Beds from Deva river valley, south of Narmada, Biovigyanam, 6,121-130.

Borkar V. D. and Kulkarni K. G., (1992), On the occurrence of *Planolites* Nicholson from the Bhaduka Limestone of the Wadhwan Formation (Cretaceous), Kathiawar, Gujarat, Jour. Geol. Soc. India, 40, 468-473.

Chiplonkar, G. M. and Ghare, M.A., (1979), Trace fossils from Upper Cretaceous rocks of Trichinopoly district, Tamil Nadu, Geol. Surv. India Misc. Publ., 45, 101-109.

Ghosh, R.N., (1983), Tertiary clay deposits of Kolayat and adjacent areas in Bikaner district, Rajasthan, Indian Minerals, 37 (4), 56-69.

Häntzschel,W.,(1975), Trace fossils and problematica. In: C. Teichert (Ed.), Treatise of Invertebrate Paleontology (2nd Edition), part W, Miscellanea, supp 1. University of Kansas and Geological Society of America, Boulder, Colorado, and Lawrence, Kansas, 269.

Khosla, S. C., (1973), Stratigraphy and Microfauna of the Eocene Beds of Rajasthan, Jour. Geol. Soc. India, 14 (2),142-152.

Kundal, P. and Sanganwar, B.N., (1998), Stratigraphy and Palichnology of Nimar Sandstone, Bagh Beds of Jobat area, Jhabua district, M. P., Jour. Geol. Soc. India, 51(5), 619-634.

Kundal, P. and Sanganwar, B. N., (2000), Ichnofossils from Nimar Sandstone Formation, Bagh Group of Manawar area, Dhar district, Madhya Pradesh, Mem. Geol. Soc. India, 46, 229-243.

Kundal, P., Mude, S. N. and Humane, S., (2005), Ichnofossils from Late Eocene to Early Miocene of Narmada block of Cambay Basin Gujarat, India, Jour. Palaent. Soc. India, 50(2), 177-182.

Kundal, P. and Dharashivkar, A.P., (2006), Ichnofossils from the Neogene and Quaternary deposits of Dwarka-Okha area, Jamnagar district, Gujarat, India, Jour. Geol. Soc. India, 68, 299-315

Mude, S. N., Jagtap, S. A., Kundal, P., Sarkar, P. K. and Kundal, M. P., (2012), Paleoenvironmental significance of ichnofossils from the Mesozoic Jaisalmer Basin, Rajasthan, north western India, Proc. Inter. Acad. Ecol. and Env. Sci., 2(3), 150-167.

Mude, S.N., (2012a), Paleoenvironmental significance of ichnofossils from the Kand Formation of the Cambay Basin, Gujarat, India. Proc. Inter. Acad. Ecol. and Env. Sci., 2(1), 12-20.

Mude, S. N., (2012b), Paleoenvironmental significance of ichnofossils from the Babaguru Formation of the Cambay Basin, Gujarat, India, Univ. Jour. Env. Res. and Tech., 2(1), 52-57.

Mude, S.N., Raut, S. D. and Wagh, R., (2012), Paleo-environmental significance of ichnofossils from the Bhuj Formation (Gondwana Sediments) of the Kachchh region, Northwestern India. World Jour. Env. Biosci., 1(1), 25-29.

Nesbitt, E. A. and Campbell, K. A., (2006), The paleoenvironmental significance of *Psilonichnus*, Palaios, 21, 187-196.

Nicholson, H. A., (1873), Contributions to the study of the errant annelids of the older Paleozoic rocks, Procee. Royal Soc. London, 21, 288–290.

Pareek, H.S., (1984), Pre-Quaternary Geology and mineral resources of Northwestern Rajasthan, Mem. Geol. Surv. India, 115,1-95.

Pemberton, R. K. and Frey, R. W., (1982), Trace fossils nomenclature and *Planolites Palaeophycus* dilemma. Jour. Paleontol., 56 (2), 416-439.

Seilacher A., (1964), Biogenic sedimentary structures. In: Approaches to Palaeoecology (Imbrie J, Newell ND, eds), John Willey and Sons, New York, USA, 246-316.

Seilacher, A., (1967), Bathymetry of trace fossils: Marine Geol., 5, 413-428.

Simpson S., (1975), Classification of trace fossils. In: The study of Trace Fossils (Frey RW, ed), Springer Verlag, Berlin, Germany, 39-54.

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