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Marine influence in Hutar Coalfield, Bihar

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Circumstantial evidences based on the proximity of upper part of Talchir and lower part of Karharbari formations in Hutar Coalfield with those of Daltonganj Coalfield having reported evidence of marine bed as well as evidences of wave activity and salinity raise the possibility of some marine influence in Hutar too. A few evaporites in this coalfield indicate dessication though temperature does not seem to have attained a high level. The presence of foraminiferal genera *Tolypammina, Saccammina, Bigenerina* and *Ammobaculites* in addition to *Frondicularia* cf. *cavernula* (Paalzow) in this background strongly argues for a marine influence in the basal part of Karharbari and adjacent Talchir areas. Significance of this has been discussed.

Key-words—Foraminifera, Marine conditions, Talchir Formation, Karharbari Formation, Hutar Coalfield.

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साराँश

बिहार में हुतार कोयला-क्षेत्र में समुद्री प्रभाव

एँस० चौधरी

डॉल्टनगंज कोयला-क्षेत्र की भाँति हुतार कोयला-क्षेत्र में तालचिर के ऊपरी भाग एवं करहरबारी शैल-समूह के निचले भाग की पारस्परिक निकटता पर आधारित प्रमाणों से हुतार में भी कुछ समुद्री प्रभाव की सम्भाव्यता बढ़ गई है। इस कोयला-क्षेत्र में कुछ वाष्पनजों से निर्जलीकरण व्यक्त होता है हालाँकि तापमान अधिक नहीं पहुँच पाया था। **फ्रोन्डिकुलेरिया** सजातीय **केवरनुला** (पालज़ॉ) के साथ-साथ इस क्षेत्र में **टोलीपेम्मीना, सेक्कामीना, बाइजेनेरीना** एवं **ऍम्मोबेकुलाइटिस** की उपस्थिति से करहरबारी एवं निकटस्थ तालचिर क्षेत्रों के निचले भाग में समुद्री प्रभाव की संभावना और प्रबल हो जाती है। इसी प्रभाव का महत्व सभी दृष्टिकोणों से विवेचित किया गया है।

HUTAR Coalfield in Bihar shows development of Lower and Upper Gondwana sediments (Rizvi, 1972). Lower Gondwana, according to Rizvi (1972), consists of Talchir and Barakar sediments. Ghosh and Basu (1967) and Sastry *et al.* (1977) designate a part of the Barakar sediments of Rizvi, as exposed in Deori Nala, as Karharbari; this nomenclature has been adopted in the present discussion. The environments of the sediments of Talchir and Karharbari formations are normally considered as nonmarine. This contention seems to owe its basis on the presence of coal, some botanical evidences and absence of marine fauna. It is widely known that coal may develop in a variety of environments including marine. The botanical data can provide important clues regarding environment of their site of origin but *in situ* records are insufficient. The availability of any fauna depends in addition to its environment, on preservation and intensity and resolution of search. The presence of marine bed (?s) (in Sastry *et al.*, 1977) in Talchir Formation at Rajhara, Daltonganj Coalfield, about thirty kilometres due north of Hutar (Text-fig. 1a), raises a possibility of marine influence in Hutar Coalfield though fossil evidences are lacking. This issue is examined in the sections exposed in the Deori Nala and some of its

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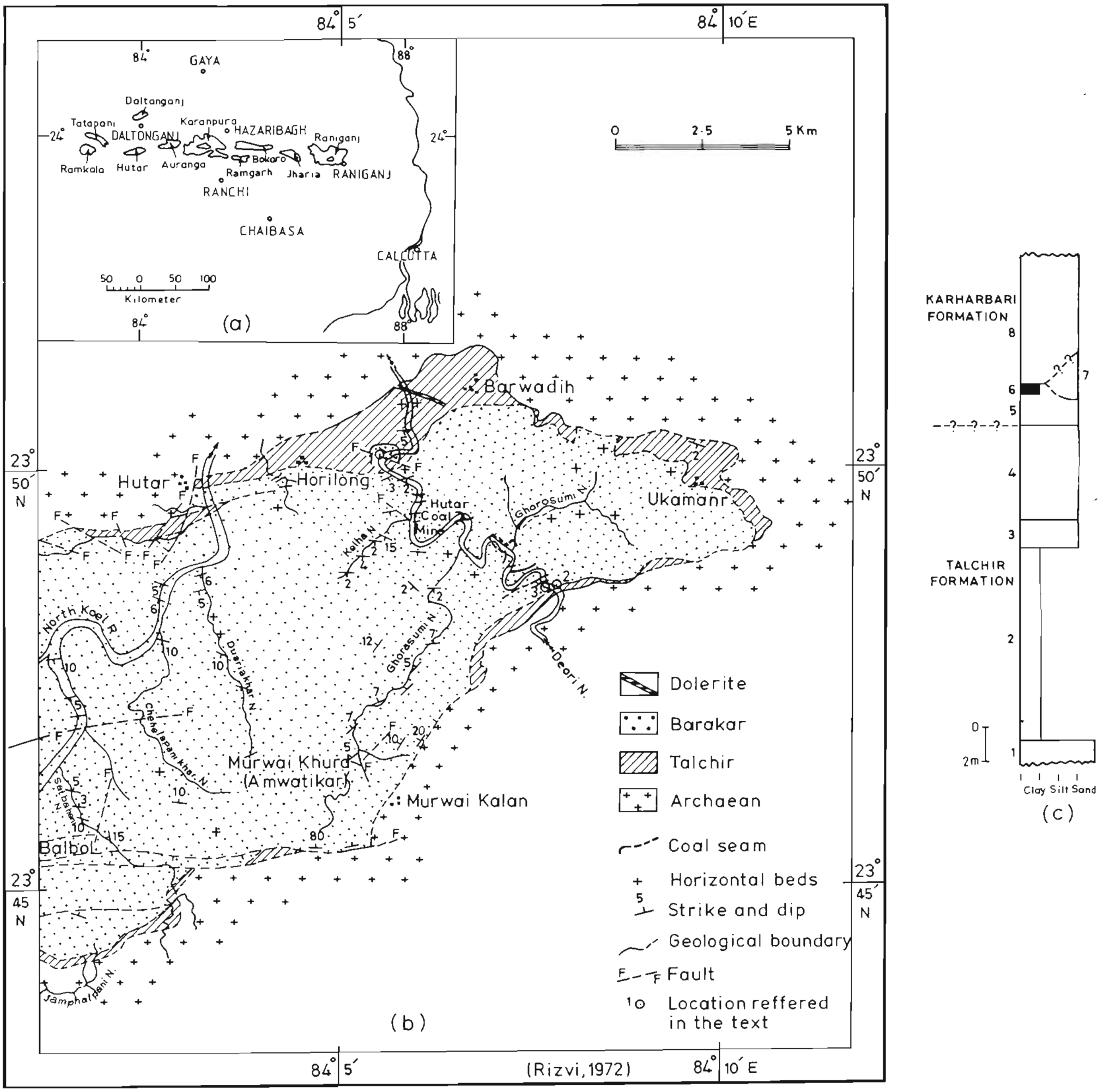

Fig.1.

Text-figure 1—a, Map showing location of Hutar and Daltonganj coalfields; **b,** the geological map of the eastern part of Hutar Coalfield, (from Rizvi, 1972). The Barakar rocks in and around Deori Nala are mentioned as of Karharbari Formation in the text except at location 1 which is considered as of Talchir Formation because of the presence of green shale; and **c,** a vertical column of rocks drawn on the basis of exposures at locations 2 and 3 of Text-fig. 1b and a little upstream. The boundary between Talchir and Karharbari formations is tentatively drawn following Rizvi (1972). The numbers by the side of the column refer to the various litho-units. The unit? which is a wave-rippled sandstone with the authigenic nodule in it occurs at location 3 of Text-fig. 1b. Samples for SEM studies were collected from this unit. Units 1 and 5 contain clastic grains of up to boulder size. Unit 6 is carbonaceous shale with alternations of sand. Unit 3 contains pebbles and unit 2 is greenish with varves.

tributaries in the eastern part of the coalfield (Text-fig. 1b).

In Hutar Coalfield, the Talchir Formation consists of boulder bed, sandstone, siltstone and shale while the Karharbari sediments comprise sandstone, locally with pebbles and coarser grains, siltstone, shale and coal. So far, five coal seams, with a few of local nature, have been recognised and all of them are more or less thin, none being more than two metres or so in thickness.

SEDIMENTARY FEATURES

Wave ripple including wave ripple bedding/lamination is one of the significant sedimentary structures in this area (Pl. 1, figs 1, 2). Recognition of this structure is based on cross sectional profile and internal structures following De Raaf *et al.* (1977). Significantly, Karharbari sediments (Barakar of Rizvi, 1972) of Daltonganj Coalfield also reveal similar structure (Pl. 1, fig. 3). So far, presence of wave ripple has not been reported from the Lower Gondwana sediments of India. Besides, planar and trough cross strata are observed in Hutar.

In the north-western end of Deori Nala (location 1, Text-fig. 1b) the top part of Talchir Formation contains, besides green shale, a very soft white medium to fine sandstone with small wave ripples. In places, the rock is cemented by sparry calcite and it contains some translucent brown microcrystalline textured ellipsoidal phosphate-bearing (confirmed by qualitative chemical analysis) peloid-like masses possibly of faecal origin together with water soluble salts bearing Na^+, K^+, Ca^{++} and Cl^- SO_4^{--} ions. A carbonate, sulphate and halite (halide) association is apparent in this case. Similar salts have also been noted in a red medium sandstone from the lower part of Karharbari Formation exposed in a tributary of Deori Nala near Hutar Colliery. Here occur a few pseudomorphs after gypsum crystals which had poikilitic as well as displacive growth affecting the primary sedimentary structures and hence reflecting an early diagenetic development of the gypsum crystals. Syndepositional origin is also evident from dissolution of some of the upper parts of the crystals of the pseudomorphs at places followed by deposition of the clastic grains.

THE FAUNAL RECORD

So far, no megascopic fossil diagnostic of sedimentary environment has been observed either in Talchir or in Karharbari sediments of the Hutar Coalfield. In view of this, an intense search for microfossils was carried out under SEM even though light microscopic studies did not reveal anything significant. As a first step, a white wave rippled Karharbari sandstone exposed a little above Talchir-Karharbari contact in the south-eastern end of Deori Nala (Text-fig. 1c, unit 7) was chosen. The sample collected from this exposed rock was disintegrated in 10 per cent acetic acid and then examined under SEM. In this sandstone occur some authigenic nodules consisting of a core of pyrite and an outer shell of magnetite (altered) and hematite. Such a nodule reflects a more or less reducing and alkaline or nearly so condition (Garrels & Christ, 1965; Krauskopf, 1979) on a local scale which must have been the result of biogeochemical activity in the sediments where organic debris were abundantly present. In fact, pyrite is known to develop by biogeochemical decay of such debris very early in the history of diagenesis. Magnetite has a similar history being contemporaneous with, to later than pyrite in origin. This is a mineral not commonly formed in (post-Precambrian) sedimentary environment (Ramdohr, 1980; Blatt *et al.*, 1980) though of organic origin (Trudinger *et al.*, 1979; Nealson, 1983).

One of these nodules as well as the grains separated from its host rock when examined under SEM yield some fossils, of which some foraminifera are important. These are identified following Loeblich and Tappan (1964) and/or Brasier (1980) and include the genera *Tolypammina, Bigenerina, Saccammina* and *Ammobaculites* (Pl. 1, figs 4,5,6; Pl. 2, fig. 1). Chaudhuri (1987) reported *Frondicularia* cf. *cavernula* (Paalzow) from the same nodule. The size of the tests is small and diameters are near the lower range, i.e., 10 μm as suggested by Shrock and Twenhofel (1953) and Baksi (1976) for foraminifers. The study of the microfossils has been qualitative. In fact, such SEM studies are extremely time consuming and often difficult because of tiny size, unsatisfactory preservation and problem of

PLATE 1 →

1. Symmetrical cross sectional profile of wave ripple. Location 2 of Text-fig. 1b, Karharbari Formation, Hutar Coalfield.
2. Wave ripple bedding in coarse to medium sand with some flasers. Note form discordance, bidirectional forests (both above the arrow at the lower central part) differently structured lenses some of which are swollen, lateral transition of cross lamination into low angle parallel laminations, irregular, curved lower set-boundaries, weakly developed bundled upbuilding (marked by arrow on the right). Some asymmetry of ripples and dominantly unidirectional forests are also observed. The 25 paise coin serves as scale. Location 3 of Text-fig. 1b and unit 7 of Text-fig. 1c, Karharbari Formation, Hutar Coalfield.
3. Wave ripple with bifurcating crest, Karharbari Formation, Daltonganj Coalfield.
4. *Tolypammina*, in-situ in the nodule. Note the large proloculus (marked by arrow) and irregularly wound second chamber.
5. *Bigenerina*, in-situ in the nodule. The test is biserial in the early part followed by uniserial growth, aperture terminal. It is of agglutinated type and the lower part is broken.
6. *Saccammina* in wave rippled sand. Agglutinated spherical test with an aperture.

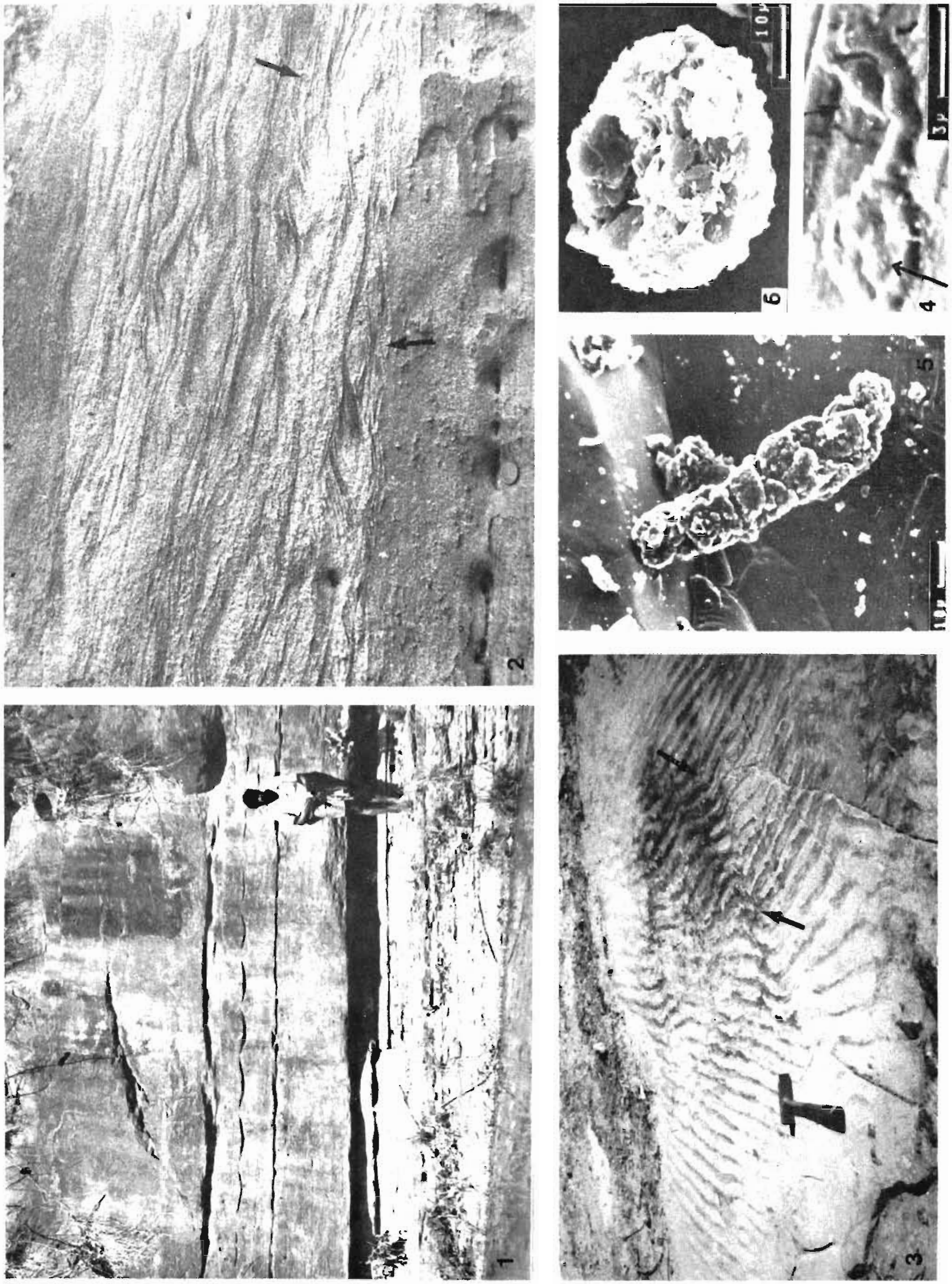

PLATE 1

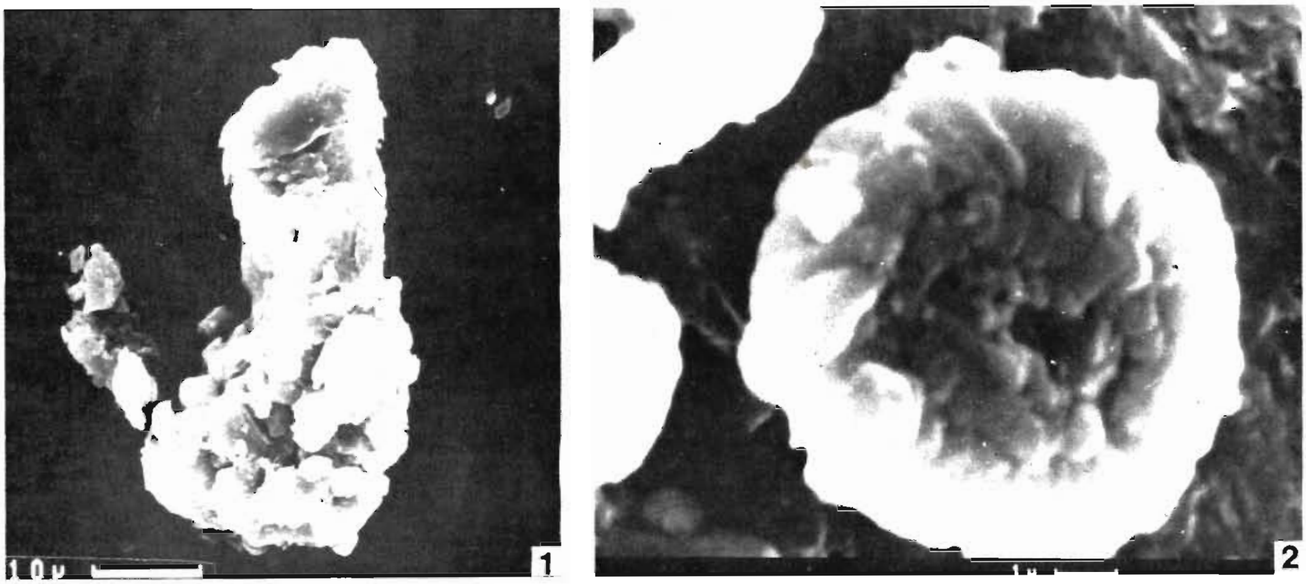

PLATE 2

1. *Ammobaculites*, in wave rippled sand. Agglutinated test with early planispiral coiling followed by uniserial growth, aperture terminal.
2. Coccolith in Talchir Formation of Ramgarh Coalfield.

recognition in *in situ* position where chance of encountering the fauna in a better state is more than if the rock is disintegrated.

THE SEDIMENTARY ENVIRONMENT

The water soluble salts, particularly the gypsum of pseudomorphs, in the beds are probably a result of evaporation during and a little after (diagenetic) sedimentation of clastic grains, e.g., during Talchir Karharbari times. Evaporites form where evaporation exceeds inflow and temperature is not of prime importance (Hardie *et al.*, 1977). Cold polar deserts too can witness development of such minerals. In Hutar, high temperature aridity is not expected during Talchir-Karharbari times due to the well-known glaciation but some dryness is indicated by the abundance of large clasts of mechanically weak and hence locally derived, pyrofusinite (fusain) in some sandstones and shales. Occasional dry zones in peninsular India during Lower Gondwana times were suggested by Datta *et al.* (1977), too. Thus, existence of dry, but not hot (could even be cold), condition facilitating process of desiccation necessary for the development of evaporites, is possible.

Wave action takes place in shallow marine (Johnson, 1981), lacustrine (Collinson, 1981) and even in fluvial environment where its effects and records are in general poor. In fact, wave action may take place in other areas under marine influence also, e.g., in a delta or an estuary. Considering the strong wave action as suggested by the coarse grain size and appreciable amplitude of the wave ripples, one would tend to favour a marine influence rather than that of a lake (Collinson, 1981). Moreover, phosphate and evaporite minerals besides carbonate in Hutar seem to lend support to the idea of marine influence (Johnson, 1981). The sedimentological evidences generally do not indicate the environment with confidence but in present case provided impetus for search of fauna in a terrain which is apparently uninviting. The faunal characteristics are encouraging. The foraminiferal genera, as found in Hutar, point to brackish to marine environment (Loeblich & Tappan 1964). The genus *Tolypammina* is known from the Manendragarh marine bed (Bhatia & Singh, 1959). Fossil records of fresh water foraminifera are rare (Brasier, 1980).

The usefulness of fossils, particularly of microfossils, as indicator of sedimentary environment depends to a great extent on whether they are autochthonous. Autochthony is often difficult to establish by direct evidence. In the present case the microfossils have known ranges (Brasier, 1980) that encompass the Talchir-Karharbari sediments. *F. cavernula* (Paalzow) has distribution in the Early Permian Zechstein (Z_1) rocks of parts of Europe (Pattison, 1981). Moreover, occurrence of the microfossils in the ferruginous sediments of nodules point to their emplacement very early in the history of the rock and in all possibility during deposition of the clastic grains. This is strengthened by the record of wave action and somewhat high palaeosalinity in the host and associated rocks. The possibility of the microfossils getting incorporated into the sediments by post-burial leaking and reworking is very remote. The transportation, which fossils might have undergone, was in all probability not considerable not beyond the domains of marine processes-marine to brackish water areas.

It is now clear that weight of evidences, as offered by the regional setting, palaeohydrodynamics as reflected by the sedimentary structures, palaeosalinity and the faunal content, strongly favours a marine influence in the coalfield.

CONCLUDING REMARKS

Extensive sedimentological studies coupled with improved knowledge on the faunas, mega-, micro- and nanno-, will help decipher various palaeogeomorphic units and associated environmental features in space and time on local as well as on regional scale. There are some indications of ?tidal effect in the form of water level fluctuation, and bidirectionality of flow. The possibility of some of the rocks being as of storm origin is not remote. A coccolith (Pl. 2, fig. 2), though of not precisely known significance, has been found in a wave rippled siltstone below Talchir-Barakar contact in the northern part of Bhera Nala in Ramgarh Coalfield, Bihar (Chaudhuri *et al.*, 1987).

On the basis of the present study the following points emerge:

1. The absence of fauna, marine or not, in many beds is likely to be more apparent than real.
2. The marine influence is not necessarily confined to the already recognised marine beds only.
3. Careful sedimentological studies may help to delineate areas of interest, though not necessarily diagnostically.
4. Cross stratifications of wave and current origin are very often difficult to distinguish between unless extreme care is taken.

The presence of wave ripple beds is not confined to Hutar and Daltonganj only. Preliminary investigations by the author and his associates reveal the presence of this structure in Ramgarh and Manendragarh-Chirimiri areas of Bihar and Madhya Pradesh, respectively. So, hydrodynamic interpretations together with directional aspects of the cross strata should be taken care of appropriately in order to avoid serious consequential implications.

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REFERENCES

Baksi, S. K., 1976. *Purajivavidya* (in Bengali). West Bengal State Book Board, Calcutta.

Bhatia, S. B. & Singh, S. K. 1959. Carboniferous (Uralian) foraminifera from Manendragarh, central India. *Micropaleontology* **5**(1) : 127-134.

Blatt, H., Middleton, G. & Murray, R. 1980. *Origin of sedimentary rocks.* Prentice Hall Inc., New Jersey, Englewood Cliffs.

Brasier, M. D. 1980. *Microfossils.* George Allen and Unwin, London.

Chaudhuri, S. 1987. Significance of some microfossils, as revealed by SEM, in some Lower Gondwana sediments. in : *Special publication on '10 years of SEM-LAB in G.S.I.'*, (in press).

Chaudhuri, S., Mondal, K. & Gupta, A. 1987. Marine microfossils in Lower Gondwana sediments of Ramgarh Coalfield, Bihar—new finds. *Indian Jl Earth Sci.* (communicated).

Collinson, J. D. 1981. Lakes. *in* : Reading, H.G. (Ed.)—*Sedimentary environment and facies.* Blackwell Scientific Publications, Oxford.

Datta, N. R., De, A. K. & Chakraborty, S. K. 1977. Environmental interpretation of Gondwana coal measures in peninsular India. *in* : Laskar, B. & Raja Rao, C. S. (eds)—*Proc. IV int. Gondwana Symp., Calcutta* **1** : 255-264.

De Raaf J. F. M., Boersma, J. R. & van Gelder, A. 1977 Wave generated structures and sequences from a shallow marine succession, Lower Carboniferous, County Cork, Ireland. *Sedimentology* **24** : 451-483.

Ghosh, P. K. & Basu, A. 1967. Stratigraphic position of Karharbaris in the Lower Gondwana of India. *in* : *Gondwana Stratigraphy, IUGS Symp. Buenos Aires* **2** : 407-419, Unesco, Paris.

Hardie, L. A., Joseph, P. S. & Eugster, P. H. 1979. Saline lakes and their deposits: A sedimentological approach. *in* : Matter, A. & Tucker, M. E. (eds)—*Modern and ancient lakes sediments.* Spl. Pub. Int. Assoc. Sedimentologists, pp. 7-41.

Johnson, H. D. 1981. Shallow silicaclastic seas. *in* : Reading, H. G. (Ed.)—*Sedimentary environment and facies,* Blackwell *Scientific Publications,* Oxford.

Krauskopf, K. B. 1979. *Introduction to geochemistry.* McGraw Hill, Kogakusha Ltd., Tokyo.

Loeblich Jr., A. R. & Tappan, H. 1964. Protista 2 : Sarcodina chiefly 'Thecamobians' and Foraminiferida, *in* : Moore, R. C. (Ed.)—*Treatise on invertebrate paleontology,* part C, Geol. Soc. Am. and University of Kansas Press.

Nealson, K. H. 1983. The microbial iron cycle. *in* : Krumbein, W. C. (Ed.)—*The Microbial geochemistry,* Blackwell Scientific Publishing Co., Oxford.

Pattison, J. 1981. Permian. *in* : Jenkins, D. G. & Murray, J. D. (eds)—*Stratigraphic atlas of fossil formaninifera*. Ellis Horwood Ltd.,The British Micropalaeontological Society, pp. 70-77

Ramdohr, P. 1980. *The ore minerals and their intergrowth* **2** : Pergamon Press, Oxford.

Rizvi, S. R. A. 1972. Geology and sedimentation trends in Palamau coalfields, Bihar, India. *Mem. geol. Surv. India* **104**.

Sastry, M. V. A., Acharyya, S. K., Shah, S. C., Satsangi, P. P., Ghosh, S. C., Raha, P. K., Singh, G. & Ghosh, R. N. (eds)—1977. Stratigraphic Lexicon of Gondwana formations of India. *Geol. Surv. India, Misc. Publ.* **36**.

Shrock, R. R. & Twenhafei, W. H. 1953. *Principles of Invertebrate Paleonotology*. McGraw Hill Co. Inc., New York

Trudinger, P. A., Swaine, D. J. & Skyring, G. W. 1979. Biogeochemical cycling of elements—general considerations. *in* : Trudinger, P. A. & Swaine, D. J. (eds)—*Biogeochemical cycling of mineral-forming elements*, Elsevier Scientific Publishing Co., Amsterdam.