DISCUSSION

REWORKED CARBONIFEROUS PALYNOFOSSILS FROM PANNA FORMATION, BOMBAY OFFSHORE BASIN: CLUE TO HIDDEN TARGET FOR HYDROCARBON EXPLORATION by N.C. Mehrotra, S.N. Swamy and R.S. Rawat, Jour. Geol. Soc. India, 2001, v.57, pp.239-248.

R.K. Kar and **A.K. Srivastava**, Birbal Sahni Institute of Palaeobotany, 53 University Road, Lucknow - 226 007 comment:

In a sediment there is generally a mixture of older elements along with the existing ones. Heavy minerals, fossil spores and pollen grains, due to their hardness and imperishable nature, are often redeposited from older sediments. The occurrence of reworked fossils in younger sediments was recorded by palynologists, but the authors have not mentioned such instances in their paper (Bartlett, 1928; Dijkstra, 1949; Potnié and Sah, 1960; Venkatachala and Kar, 1969, 1990). The authors have not indicated any Early Eocene marker palynological taxa from the studied borehole cores. In Wardha valley, below the Deccan Trap, there are the Lameta, Kamthi and other Permian sediments. In Pranhita-Godavari valley, Permian sediments are common. Carboniferous sediments are missing in these areas and the authors also point this out (p.241). It is therefore not conceivable as to how the Carboniferous sediments could rest below the Deccan Trap and get recycled. The authors admit that the age of the Deccan Trap is Late Cretaceous-Palaeocene (p.245), and the age of the borehole cores is Early Eocene. Deccan Trap has generally a large thickness in the western India. So it is beyond imagination that a river could erode the whole Deccan Trap and then the Carboniferous sediments without appreciable time gap. The authors have failed to notice the presence of huge Permian sediments in western India, which could have been the source for the reworked palynomophs. In fact, in the absence of Carboniferous sediments in peninsular India, it is the Permian sediments, which were eroded and redeposited, in the Eocene time.

Identification of the reworked palynofossils is not convincing for the following reasons:

In *Calamospora* Schopf, Wilson & Bentall, 1944 the trilete rays are notably short (Schopf, Wilson and Bentall, 1944, p.49). In the type species viz., *C. hartungiana* Schopf (Schopf, Wilson and Bentall, 1944, p.51) the trilete rays are about one fourth of the spore diameter. *Calamospora* cf. *perrugosa* (loose) Schopf, Wilson & Bentall, 1944 figured by Mehrotra et al. (2001, pl.1, fig.1) shows a very well developed trilete extending about two-thirds the spore radius. This spore could be very well accommodated in *Neocalamospora plicata* Bose and Kar (1976, pp.42-43, pl.3, figs.1-3) described from the Permian sediments of Greinerville, Zaire by its sub-triangular to sub-circular shape, folded exine and extension of the trilete rays up to two-thirds of the spore radius. *Florinites* Schopf, Wilson and Bentall (1944) occurs both in Upper Carboniferous and Permian strata (Schopf, Wilson and Bentall, 1944, p.58) and has bilateral symmetry, trilete rays are generally not evident and probably always extremely obscure (Schopf, Wilson and Bentall, 1944, p.56). The specimen illustrated by Mehrotra et al. (2001, pl.1, fig.3) has more or less radial symmetry and well-developed, open trilete extending about half of the central body. So this specimen should not be placed in *Florinites*. In fact by its strong, semilunar fold on each of the haptotypic mark and complete enclosing of the central body by the saccus on the distal side, this specimen seems very similar to *Potoneisporites* Bhardwaj, 1954 – a common form both in Permian and Carboniferous.

Vallatisporites Hacquebard (1957, p.312) has thin central body with well defined margin. Its perispore thickens into narrow 'ridge' and characterized by single row of pits, from which it tapers to equator in the form of a flange, the area between body margin and perisporal ridge becoming rampart-like in appearance. The central area is covered with grana, small cones or warts. The specimens assigned to *Vallatisporites vallatus* Hacquebard, 1957 by Mehrotra et al. (2001, pl.2, figs.3,4,5) as seen from the illustration do not have these characters. They are very much different from the photograph of the type species provided by Hacquebard (1957, pl.2, fig.12). The central body, the thickened perisporal ridge with single row of pits, and the rampart-like appearance are not observed in the specimens figured by Mehrotra et al. (2001). They are, however, very close to *Indotriradites* Tiwari (1964, pl.1, figs.4, 4a) described from the Barakar Formation (Early Permian) of Madhya Pradesh by its subtriangular to sub-circular shape, distinct trilete rays, well developed flange and ornamented, with closely placed coni and spines on the distal surface.

Mehrotra et al. (2001, pl.2, fig.8) identified one specimen as *Verrucossisporites microverrucosus* Ibrahim, 1933. Potonié and Kremp (1954) emended *Verrucosisporites* and designated *V. verucosus* as the type species which was earlier described by Ibrahim (1932) as *Sporonites verrucosus*. *Verrucosisporites* is circular to sub-circular in shape and they have closely placed warts as sculptural elements on the exine. The specimen figured by Mehrotra et al. (2001, pl.2, fig.8) seems to be cingulated and the warts are not clearly visible, and hence this should not be placed in *Verrucosisporites*. The specimens assigned to *V. microverrucosus* by Smith and Butterworth (1967, pl.5, figs.12-14) are also different from the figured specimen of Mehrotra et al. (2001, pl.2, fig.8) as the verrucae are very distinct and do not show any cingulated configuration. The specimens identified as *Densosporites gracilis* Smith & Butterworth (1967, not 1969, as mentioned by the authors, pl.2, figs.1-2) and *Lycospora* cf. *granulose* by Mehrotra et al. (2001, pl.2, fig.7) are poorly preserved and the distinguishing characters of the genera could not be deciphered from the illustration.

It seems that the fossil assemblage of the area has *Neocalamospora plicata*, *Potoniésporites* and *Indotriradites* and these genera are more common in Permian than Carboniferous. So the thesis that the Carboniferous sediments were redeposited during the Early Eocene is not convincing. In all probability, these are the Permian palynofossils which were redeposited during the Early Eocene.

N.C. Mehrotra, S.N. Swamy and **R.S. Rawat**, Keshab Dev Malviya Institute of Petroleum Exploration, Oil and Natural Gas Corporation Limited, Kaulagarh Road, Dehra Dun - 248 195 reply:

Reworked Permian palynofossils from subsurface of various sedimentary basins in India are studied at the Palynological Laboratories of ONGC, Dehra Dun. These are routinely recorded from the Mesozoic and Tertiary sediments, particularly from Assam, Krishna-Godavari and Cauvery basins, because of the hiatus between Permian and the overlying Mesozoic/Cenozoic sediments. Hence, these have not been specifically mentioned. Moreover, the objective of our paper was quite different – looking for hidden hydrocarbon targets from a Carboniferous basin. Giving a history of reworked palynomorphs was therefore not considered necessary. Reworked palynofossils within Panna Formation which contains excellent Ypresian, dinoflagellate and spores-pollen taxa (Rawat et al. 1996a, b) led us to look for Permian taxa as these are commonly known to occur. However, the complete absence of striated disaccate pollen with or without saccii (eroded by reworking) directed us to think differently. We are well aware that the Permian sediments are characterized by a very high representation of these striated disaccate pollen, but not even a single pollen of this type has been encountered from the Panna Formation. Further, the pattern of reworking of Permian palynofossils as observed by us in different basins is also quite characteristic. Generally these occur vertically throughout the studied well sections and are also distributed geographically over most of the basinal part. The recycled taxa are restricted to Heera-Bassein Block and are not present vertically throughout the well sections.

The presence of recycled Carboniferous assemblage suggested several possibilities, besides the probability of distance transportation from the west. However, the available evidences do not fully convince us of distance transportation. Considerable data have been collected over the last decade from study of some 100 well samples. Searching for 'concentration zones' of reworked palynomorphs led us to the Heera-Bassein Block where they are restricted. The present geological model is a sequel to such studies which explains the erosion of a thin cover of Deccan Trap and deposition of Carboniferous sediments into the Panna Formation during Ypresian. Our findings also corroborate the results from organic matter maturation studies that suggest presence of mature sediments. This means the Deccan Trap cover was thin at the site of erosion. Seismic data also further supports this conclusion by indicating the presence of low velocity zones below the Deccan Trap.

However, as Kar and Srivastava have concentrated mainly around identification of certain taxa and made comments we would specifically respond to them, as follows:

Calamospora cf. *perrugosa* (pl.1, fig.2) Diagnosis (expanded from diagnosis in Potonié and Kremp, 1955, p.51 as in Smith and Butterworth, 1967, p.137) for *Calamospora perrugosa* (loose) Schopf, Wilson and Bentall, 1944. "Amb oval to round. Laesurae simple, straight, one third of radius or more. Exine relatively thin, markedly folded". Our specimen is quite similar to the *C. perrugosa*, illustrated by Smith and Butterworth (1967, pl.3, fig.6). The folding has rendered a subtriangular shape. We still prefer to identify the specimens as *Calamospora* cf. *perrugosa*.

Regarding *Calamospora microrugosa* (Ibrahim) Schopf, Wilson and Bentall, 1944 (pl.1, fig.2) we have no comments. We would further add that *Calamospora* are mostly folded because of its thin wall and show variation

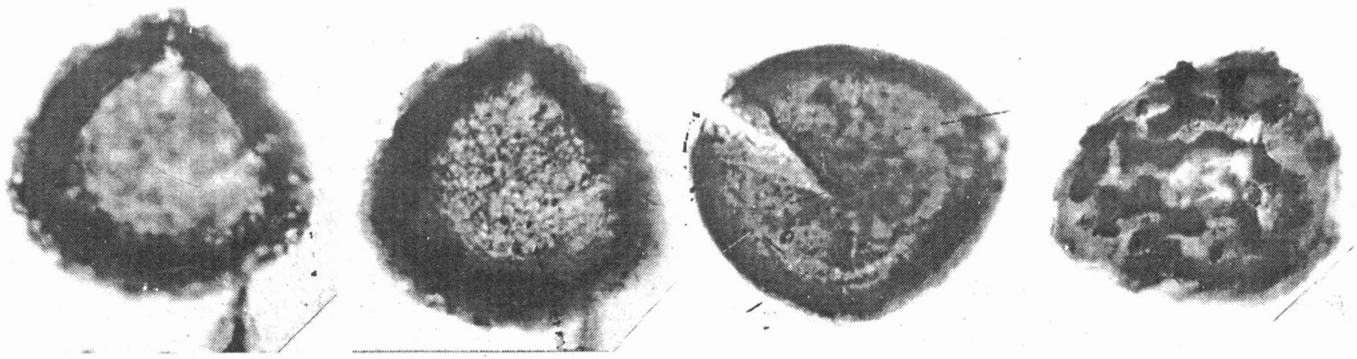

Plate 1. Figs.1-2. *Densosporites gracilis* Smith and Butterworth, 1967 (B-166A/2360-2635 M/2/103.60); **1.** Upper surface, Y-mark indistinct; **2.** Lower surface, vermcuate; **3.** *Lycospora* cf. *granulosa* (B-166-A/2630-2635 m/2/109.5:565) laesurae with elevated lips, Y-mark extending up to margin, granulose; **4.** *Verrucosisporites verrucosus* Ibrahim 1933 (B-131-1/2035-2040 m/1/45.5:111). Note verrucose ornamentation. Figs.1-3 approx. x1400; fig.4 approx. x800; all in transmitted light.

in Y-mark characters. On the other hand, the suggested name for this *Neocalamospora plicata* by Bose and Kar (1976) is the only record. We need further confirmation of its occurrence in other areas/basins.

Florinites sp. (pl.1. fig.3). The illustrated specimen shows only a small trilete mark which is well covered within the definition of the genus: "Diagnosis (abbreviated from Schopf, Wilson and Bentall, 1944, p.56 as in Smith and Butterworth, 1967, p.301)". Bilateral pollen grains, broadly elliptical in outline. Body somewhat more spherical and nearly entirely enclosed by bladder; greatest diameter of body corresponds to major diameter of bladder; body generally marked by numerous peripheral folds. Bladder smooth, finely granulose or rugose on exterior surface, reticulate on inner surface, tends to be obsolescent in central proximal area. Bladder and body walls are jointed distally and centrally from this junction there is no evidence of reticulation. Trilete imprint (where discernible) is vestigial. *Potoniésporites* Bhardwaj, 1954, though a monosaccate pollen like *Florinites*, is characterized by the presence of a straight suture, the two arms mostly form a obtuse angle which is not present in *Florinites*. Hence, we cannot agree with the suggestion of Kar and Srivastava for its presence in the assemblage.

Vallatisporites vallatus and *Vallatisporites* sp. (pl.2, figs.3-5 and 6) *Vallatisporites* Hacquebard, 1959 has been studied by many including Staplin and Jansonius (1964). The authors have redescribed its type species *V. vallatus* (Staplin and Jansonius, 1964, p.112). As we understand from the description and published photomicrographs, *Vallatisporites* are convexly triangular. The outer layer is proximally separated into a central area and a zona by a groove. The trilete rays are distinct and extend into the zona. The zona is internally vacuolated. This feature is very clearly seen in the type species *V. vallatus*. The specimens assigned to *Vallatisporites* in the present reworked assemblage clearly show all its distinguishing features including the groove between the central body and zona and the vacuoles.

Verrucosisporites microverrucosus (Ibrahim, 1933, pl.2, fig.8): The species is assigned to microspores with oval to circular amb having the laesurae extending almost up to equator; Verrucose with verrucae round to slightly elongated in shape. The illustrated specimen closely resembles in species by having the above features. An additional specimen is illustrated.

Lycospora cf. *granulose* (pl.2, fig.7): The illustrated specimen is a species of L*ycospora* which shows granulose ornamentation. A further enlarged specimen is illustrated.

Densosporites gracilis Smith and Butterworth (1967, pl.2, figs.1-2). The illustrated specimen is similar to those described and illustrated by Smith and Butterworth (1967, p.240, p.19, figs. 7 and 8) in characters by having subtriangular shape, laesurae not very distinct, seems to extend up to equator. Cingulum covering about 1/3rd of total spore diameter, with irregular outline; variously ornamented. Central area is vermiculate. An enlarged photomicrograph is illustrated.

We are confident of our identifications and interpretation of a Carboniferous age for the recorded assemblage, which is further supported by other evidences. In this connection we are thankful to Dr. B.S. Venkatachala (*pers. comm.*), one of the referees of the paper (who has worked extensively on European Carboniferous assemblages), for endorsing our identifications and dating the assemblage. We shall look forward to more constructive discussion on the presence of matured Carboniferous sediments below the Deccan Trap, as also supported by available geophysical data and our own organic matter maturation studies, in view of its great significance explaining hidden oil pools.

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LATE CRETACEOUS - TERTIARY SEDIMENTS AND ASSOCIATED FAULTS IN SOUTHERN MEGHALAYA PLATEAU OF INDIA VIS-A-VIS SOUTH TIBET: THEIR INTERRELATIONSHIPS AND REGIONAL IMPLICATIONS by S. Nag, R.K. Gaur and Tapan Paul. Jour. Geol. Soc. India, 2001, v.57, no.4, pp.327-338.

S.N. Kak and **A.V. Subrahmanyam**, Atomic Minerals Directorate for Exploration and Research, Begumpet, Hyderabad - 500 016, comment:

We appreciate the authors for the documentation of the evidences for Dauki Fault being post-Eocene age and its reactivation in the later period. However, it is known that different formations along Dauki Fault, namely, Mahadek, Langpar and Shella Formations are juxtaposed, which are seen in the Shillong-Chirapunji-Shella and Shillong-Dauki-Muktapur section. The authors have assigned Late Cretaceous age for the Jadukata and Mahadek Formations and these were compared with that of Cretaceous Gamba Formation of Tibet. It could have been appreciated had authors given the setting of Gamba Formation in the paper.

While attributing the late Cretaceous age for the Jadukata and Mahadek Formations the following observations are relevant:

(a) The Mahadek Formation has been divided into Lower Mahadek of fluvial facies and Upper Mahadek of