Response

Organized opposition to infrastructure projects in India does not seem to suffer from shortage of funds. Therefore, it is a valid question to ask whether environmental activism, at least some of it, is driven by non-environmental considerations. Still, if Rauf Ali thinks all this is only a 'state of mind', then it can be easily cured by disclosing who pays for obstructing infrastructure projects in India. Why is that such a closely guarded secret?

Just as Ali is anguished that, in the context of saving tigers, the opinion of 'a group of non-scientists' has prevailed, likewise we too felt aggrieved that the group which met in Bangalore and went public with some theories about ILR, did not include a single water-resources engineer.

Ali's comment that '… at least one economic analysis shows that the costs of pumping the water uphill will make the project unviable', is based on a paper N. Pelkey, a professor of environmental sciences and information technology in Pennsylvania. He is not a known authority on strategic planning for food, water and energy security for India, wrote his paper before the feasibility reports were made public, thus perhaps without reading them.

But Ali seems to think that such a paper by a foreigner from whatever discipline is sufficient to trash 25 years of work by a team of more than a hundred Indian water-resources engineers in the NWDA, CWC and other specialized institutions of the Government of India – say 2500 engineer-years of work. In that case, since food and energy security has strong strategic implications, whenever India plans major infrastructure projects, one can find papers, and rather easily, that will seek to trash the projects.

CHETAN PANDIT

Indian Water Resources Society – Delhi Center,
C/o Upper Yamuna River Board
e-mail: cm_pandit@hotmail.com

Nannofossil assemblage in Kutch

Jyotsana Rai's[1] report on the occurrence of nannofossils of Albian age from a plant bed of the Bhuj Formation is interesting and significant. It is an accidental but important discovery. She has rightly stressed its importance on the age and environment of deposition of the Bhuj Formation. However, conclusions drawn by her on these two aspects raise controversies and need to be discussed. I had reviewed this paper. Considering the limitations of the study, I suggested modifications in order to avoid contradictions with the existing field data and proven facts. However, it appears that my comments and suggestions were not taken into account while revising the manuscript. For the benefit of the researchers I feel it is necessary to explain here the anomalies created by rash conclusions drawn on limited data.

Two important conclusions drawn are: (i) The nannofossil assemblage indicates early Middle Albian age of the Bhuj Formation (referred as Bhuj 'Member' in the text by Rai); (ii) The presence of nannofossils confirms the marine environment of the Bhuj Formation supporting 'an uninterrupted marine succession from at least Late Bajocian to early Middle Albian in Kutch basin'.

The following points need to be noted for discussion:

1. Occurrence of nannofossils is limited, only one sample out of two collected from a shale bed in the Bhuj Formation yielded nannoforms.
2. Middle Albian age of the Bhuj Formation has been determined on the basis of one sample only from the Lower Member of the Bhuj Formation in Central Mainland, which is equivalent to the Neocomian Ghuneri Member in Western Mainland, which occurs below the Aptian Ukra Member of the formation.
3. The sample comes from a fossiliferous horizon, which is rich in well-preserved terrestrial plant fossils. The excellent state of preservation of the leaves speaks of provenance proximity and thereby the environment.
4. Association of terrestrial plant fossils and marine nannofossils together in a bed is baffling and needs to be explained.
5. The horizon from where the nannofossil-bearing sample was collected is overlain by an intensely bioturbated zone which is devoid of nannofossils as also the barren shales below it.
6. The sandstone-dominated Bhuj Formation, which is interpreted as marine deposit, is barren of fossil fauna but rich in fossil flora occurring in shale beds.

Age of Bhuj Formation: In the type area around Bhuj the formation is 400 m (+) thick and divided informally into two members, lower and upper[2,3]. The formation thickens enormously towards the west and in Gadhuli–Ghuneri area attains a thickness of over 900 m. In this area the formation comprises three members – Ghuneri, Ukra and Upper in ascending order. The palyno-assemblage indicates Neocomian and Albian to (?)Santonian ages for the Ghuneri and Upper members respectively, whereas the ammonite index and absolute dating determined the Aptian age of the Ukra Member. The Neocomian age of the Ghuneri Member is also supported by the ammonite index[4]. The Ghuneri and Upper members have the same lithofacies association, distinguished only by the local occurrence of Ukra Member between them. As the green, glauconitic shales and marl beds of Ukra Member pinch out, it is difficult to distinguish the two members. Both merge into one formation that continues eastward in the rest of the Mainland as the Bhuj Formation[2]. This formation comprises more than half of the total thickness of the Mesozoic succession. Detailed mapping by tracing of the marker-defined litho-units (see figure 10 in Biswas[3]) established that the Lower Member of the Bhuj Formation of the type area changes laterally into the facies of the Ghuneri Member as the formation thickens westward. Several dark grey, carbonaceous shales with well-preserved fossil-leaf impressions and carbonized plant remains, occur at different levels within the formation. The megaflora and palynomorph (the formation is rich in microflora also) indicate Neocomian age for the Bhuj Formation[5] (mainly Lower Member in the type area), which agrees with the stratigraphic position explained above. The reported occurrence of the

nannofossil is from one of the plant beds of the Lower Member exposed near Jakh temple, 25 km west of Bhuj. Apparently, Rai had not taken note of the precise stratigraphic location of the sampled bed since she followed a classification[4,6], which is more concerned with the nomenclature priority than the ground reality described above. This misled Rai to believe that Albian 'Bhuj Member' (Upper Member[2]) continues eastward in the Bhuj area, and the sample was collected from the lower part of the member, whereas in reality the sample was collected from the Neocomian Lower Member (= Ghuneri Member). Thus, the reported occurrence of Mid-Albian nannofossils in rocks below the Aptian Ukra beds created a stratigraphic anomaly. I would, therefore, suggest that a definite conclusion regarding the Albian age of the Bhuj Formation in the type area should be postponed till all the plant and other shale beds are examined for the nannofossils.

Depositional Environment of Bhuj Formation: Presence of marine fossil in sediments does not necessarily mean that the deposit is holomarine. There are reports of occurrence of micro-fauna in aeolian and fluvial deposits[7,8]. It is difficult to accept that the Bhuj Formation with well-preserved Upper Gondwana floral assemblage but barren of fossil fauna is holomarine deposit as interpreted by some workers[9], whose views Rai has tried to validate by the reported single occurrence of marine nannofossils. She does not discuss the contradictory evidence presented by the well-preserved plant fossils and marine nannofossils in the same bed. Proponents of marine deposition[4,9] based their opinion mainly on the repeated occurrence of trace fossils and the bioturbated ferruginous beds in the formation. They tried to explain the absence of hard-bodied fossils by desolution processes, but do not mention the absence of micro-fauna and preservation of fragile terrestrial plant fossils in the so-called marine sediments. Mere presence of bioturbated zones or trace fossils does not evince a marine origin for the host sediments. Trace fossils represent behavioural traits of organisms and it is an established fact that like behaviour can be seen in all types of environments[10]. Detailed study of the trace fossils reveals that they are typically restricted occurrence of ichno assemblage in transitional environments (K. G. Kulkarni, pers. commun.).

The Mesozoic sequence typically represents a transgressive-regressive megacycle[11,12]. The early Middle Jurassic transgressive sequence is characterized by highly fossiliferous shale–limestone–sandstone litho-association. The upper Late Jurassic–Early Cretaceous, thick regressive sequence (Bhuj Formation) is predominantly sandy and barren of fossil fauna, but rich in fossil flora and ichnofossils. Based on detailed studies and extensive mapping, the Bhuj Formation has been interpreted as a wave-dominated estuarine palaeo-delta with well-developed aggradational/progradational sequences during normal regression of the sea[11,12]. The delta prograded westward progressively shifting the wavefront, which left the marine (tidal) signatures like bioturbated sediments and occasional mollusk shells (poorly preserved) across the basin. In the delta front zone in Western Mainland, the fossiliferous Ukra Member represents a short transgressive break in the delta progradation during a high stand. In the east, thick sequences characterized by multistoried stacks of current-bedded sandstones with frequent channel cut and fills represent the proximal fluvial facies of the formation[11]. Therefore, the conclusion by Rai that 'an uninterrupted marine succession from Late Bajocian to Middle Albian occurs in Kutch Basin', is only partially true for the western end of the basin where the transitional facies of the Lower Member grades into the coastal facies of the Ghuneri Member in the delta front.

Once it is understood that the host rocks are deposits of transitional environment, it is not difficult to explain the apparently contradictory occurrence of plant and marine fossils together in a carbonaceous shale bed. In estuarine delta environment tidal currents penetrate deep into the hinterland during high tides. Further, penetration of tidal current is deeper over the prograding delta lobes during sea-level highstands in fluctuating conditions. In the present case, tidal current during high tides carried the planktonic nannofossils towards the hinterland over the swampy lower delta plain, where these tiny fossils were trapped with the leaves and other plant remains in lakes and local pools. In fact, such occurrence is expected in tide-dominated prograding delta front and provides a supporting evidence for deltaic environment of deposition[11,12].

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S. K. BISWAS

201/C, ISM House,
Thakur Village, Kandivali (East),
Mumbai 400 101, India
e-mail: sanjibkbiswas2001@yahoo.co.in

Response:

S. K. Biswas, a name synonymous with Kutch stratigraphy has always been a source of inspiration throughout my research career in the Kutch basin and his comments on my paper are welcome. I wish to add here that the suggestions and corrections by the two referees for the revision of the manuscript were contrasting. I modified the manuscript based on these comments. However, many of the comments were not valid and hence not incorporated. It may be added here that lithostratigraphic mapping of Kutch was done by Biswas[1]. Later work on palaeobiology and depositional facies has provided a more precise interpretation on depositional environment[2]. The queries raised by Biswas are addressed pointwise below.

The present rare but important finding throws light on the precise age and environment of part of Umia Formation exposed in this part of the succession.

1. The nannofossil assemblage recorded in my study, although only from one