

DISCUSSION

Stratigraphy and Paleoenvironmental Analysis of Offshore Gulf of Cambay, Western India by Abhiraman Govindan and L. Chidambaram. Jour. Geol. Soc. India, v.97, 2021, pp.1403-1407

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P. K. Kathal, Department of Applied Geology, Dr. Harisingh Gour Vishwavidyalaya, Sagar (E-mail: kathalpk@rediffmail.com) comments:

The study aimed to bring out 'biozonal scheme' and analyse the 'depositional setting based on the faunal and floral record', besides developing biostratigraphic zonation and correlating the 'biostratigraphic and depositional setting' of the sequences of Gulf of Cambay with Broach Jambusar to Narmada Tapti block, a sequel to an integrated stratigraphic and paleoenvironmental studies from Narmada-Tapti block, south Cambay basin, western India (Govindan and Mallikarjuna, 2019). The foraminifera fauna of the present study, obtained from 'well cuttings', includes Rotaliids, Lepidocyclinids, Operculinids and Miogypsiniids besides a few Globigerinids, all encountered only at two sites (at 725m and 770m depths), but otherwise absent at the corresponding level in other sites. Such studies are always important for striking commercial exploration for oil and gas!

The authors employed "normal conventional methods for recovery of microfauna" including smaller foraminifera but not in the study of 'larger foraminifera' as their identification requires 'proper separation' and cutting 'equatorial sections' revealing true 'embryonic apparatus' (protoconch and deutoconch and the nature of subsequent chambers). Such sectioning is not possible if their tests are obtained from 'well cuttings'. As such, the 'identification of larger benthic species', the 'age of some smaller and larger foraminifera' and 'their role in developing biozonation' raise some issues, as mentioned below:

1. Plate 1 (Fig. 10 to 16) shows partially broken tests of *Nummulites beaumonti*, *N. chavansi*, *N. burdigalensis*, *N. fitcheli*, *Discocyclina angusta*, *D. dispensa*, *Orbitocyclina variange*, *Porocyclina flintensis* (*Porocyclina* synonymized with *Pseudophragmina*, nom. transl., Loeblich and Tappan, 1988, p. 485), *Asterocyclina stella* and *Assilina spinosa* without 'embryonic apparatuses'. Although *Pseudophragmina* (for *Porocyclina*) can only be identified on the basis of "globular proloculus and much larger embryonic deutoconch followed by a single ring of nepionic chambers"; *Orbitocyclina* by "megalospheric embryonic apparatus enclosed by thick wall, followed by spiral chambers of about three-fourths of the whorl"; *Nummulites* by "an imperforate common wall with a single central rounded pore and with a row of pores at the base of septum separating proloculus and deutoconch"; *Discocyclina* in megalospheric embryo form is identified mainly based on "small globular protoconch embraced by larger reniform deutoconch"; and *Asterocyclina* by "globular megalospheric protoconch partly embraced by larger reniform deutoconch followed by two

principal auxiliary chambers and microspheric protoconch followed by a short nepionic spiral of arcuate chamber" (p. 485, 656, 685, 688, 690, Loeblich and Tappan, 1988, respectively). Furthermore, *Nummulites obtusus*, identified only on the basis of 'axial section' is not desirable for the reasons specified above;

2. The authors included SEM images (Plate 1) of abraded/broken planktonic foraminifera which contributed little in developing biozonation (Fig. 2), but excluded important smaller benthics (*Ammina beccarii*, *Cavarotalia annectens*, *Asterorotalia gaimardii inermis*) and larger benthics (*Nummulites beaumonti*, *Operculina alpina*, *Chilostomella cylindroidesi*, *Lepidocyclina sumtraensis*, *Miogypsina globulina*, *M. antillea*) on the basis of which biozonation has been attempted. The SEM images of these species would have strengthened the impact of the study;
3. The authors accepted that 'well cuttings' restricted them to assign the 'lower age limits' of taxon due to contamination by cave ins (p. 1404; Foraminiferal Assemblage, lines 1-5;). Based on the presence of *Ammonia umbonata*, *Asterorotalia gaimardii*, *Cavarotalia annectens* and *Ammonia beccarii* in the upper sequence, they assigned 'probable basal middle to Pliocene and younger age' (p. 1405, para 1) which is incorrect as *Ammonia* ranges from L. Miocene and *Asterorotalia* from Pliocene to Holocene (p. 664 and p. 666, Loeblich and Tappan, 1988). Furthermore, the opinion that "the presence of larger benthic such as *Lepidocyclina sumtraensis*, *Miogypsina globulina* and *M. antillea* giving credence to basal middle Miocene" (p.1405, para 1) is questionable as their upper age limit is only up to L. Miocene (p. 614 and 679, Loeblich and Tappan, 1988) and not 'basal middle Miocene';
4. *Asterorotalia gaimardii* of the 'Partial Range Zone' (360-520m), was assigned upper Miocene age (Govindan and Mallikarjuna, 2019, p. 173) following Billman et al. (1980), but the same has been bracketed within "basal middle Miocene to Pliocene and younger age" in the present study, although it has a well-accepted age starting from Pliocene (Loeblich and Tappan, 1988).
5. The 'Partial Range Zone' was assigned 'upper Miocene age' based on *Asterorotalia gaimardii* (Govindan and Mallikarjuna, 2019, Fig. 3), but 'basal middle Miocene to Pliocene and younger age' has been assigned to *Asterorotalia gaimardii* in the present study (Fig. 2). But, surprisingly, the biostratigraphy in both the studies is identical. As *Asterorotalia* appeared in Pliocene (Loeblich and Tappan, op cit.), the zone could rather be assigned a little older age; and
6. Genus *Pseudohasterigerina* has been synonymized with *Globonamalina* (p. 485, Loeblich and Tappan, 1964, p. C 665).

In the light of the above comments, correct 'biostratigraphic age'

and 'biostratigraphic correlation' of the sequences are needed to 'pin-point' the 'commercial strikes' for petroleum exploration in this part of offshore Gulf of Cambay.

Abiraman Govindan and **L. Chidambaram**, Chennai; (E-mail: abiramangovindan@gmail.com*; chid1955@yahoo.com), reply:

We thank Prof P.K. Kathal for taking keen interest in our contribution dealing on Biostratigraphy and Paleoenvironmental analysis of Offshore Gulf of Cambay published in Jour. Geol. Soc. India, v.97, 2021, pp.1403-1407.

The adjoining onland Cambay basin has been in focus for oil exploration for more than 6 decades and exhaustive studies have been made in different aspects by earlier Geoscientists. Our aim is to bring out a brief biostratigraphy and paleoenvironmental analysis of adjoining offshore Gulf of Cambay basin for which the published data is very limited.

We have been a part of the extensive studies on exploration well samples from Cambay basin at ONGC Geology laboratory, Baroda. Our contribution is not on taxonomic part of foraminiferal studies. Only a few selected forms seen in the studied area have been illustrated for the benefit of readers.

This basin is very limited in microfaunal occurrence, confined to a few intervals that coincide with transgression events yielding forms for establishing biostratigraphic control. The major exploration pursuit in confining to pay horizon is mostly in Middle Eocene age. The palynofossil studies of this section give added information to paleoenvironmental setting for further lead in exploration. One of the studied wells in this report (Well No GC-3), has helped in documenting palynofloral remains for environmental setting. This finding was not highlighted earlier.

Instead of entirely relying on a single tool (microfauna), the other

taxa in the studied well samples represented by Ostracoda, Bryozoa and palynofossils have also been mentioned.

The following clarifications have been given for the issues raised by Prof. P.K. Kathal:

1. As we must rely on the fauna recovered from the cuttings, which were limited in number (occasionally, only a few were well preserved), we have illustrated only a few forms.
2. Most of the benthic forms have been shown in earlier publications (Govindan, Mallikarjuna U.B 2019) of this adjoining onland Cambay basin well.
3. The associated occurrence of *Miogypsina antillea* is suggestive of the lower limit down to basal Middle Miocene, as this taxon has not been extended down to Lower Miocene.
4. The range of *Asterorotalia gaimardii* has been covered within the range of basal Middle Miocene to Pliocene age.

As and when new additional data is published, the known stratigraphic ranges of individual taxon would need minor revision.

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