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## S&amp;T REVIEW

# COMMENTS ON “BIOSTRATIGRAPHIC INVESTIGATION AND DEPOSITIONAL MODEL OF THE LATE THANETIAN RANIKOT AND THE YPRESIAN LAKI FORMATIONS IN THE SUBSURFACE OF THE SOUTHERN INDUS BASIN, PAKISTAN”

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## ABSTRACT

This note aims to criticize the identification of key larger benthic foraminifera (LBF) at species or genus rank and the biostratigraphic interpretations. The species figured in the under-discussion paper are largely misidentified. The authors did not follow the fundamental principles for the identification of the LBF. Using the misidentified species led to the incorrect establishment of the shallow benthic zones (SBZ). Consequently, provided the wrong biostratigraphic age to the Lower Eocene succession of the Southern Indus Basin. The micropaleontological analysis coupled with microfacies description that suffers from the misidentification of most key-index taxa is useful for the definition of a precise depositional environment. The stratigraphic nomenclature is also wrong throughout the article where the authors confused the Group and Formation. The italic and non-italic protocols for the species and genus rank are also wrong throughout the article. Therefore, this note highlights the errors which have been made regarding the age, depositional model, and nomenclature of the Lower Eocene succession of the Southern Indus Basin.

## KEYWORDS

Laki Formation, Lakhra Formation, Biostratigraphy, Lower Indus Basin

## 1. INTRODUCTION

In the recently published article on the LBF biostratigraphy and depositional setting, Asghar et al., (2021), reported LBF that were used for biostratigraphy and paleoenvironmental modeling. They collected and investigated 20 subsurface samples from two well sites i.e., Ranpethani and Khadeji wells, providing microfacies and micropaleontological data. Based on microfacies and micropaleontological observations Asghar et al. (2021) discussed in detail the shallow benthic zones (SBZ) and depositional setting of the so-called Ranikot Formation and Laki Formation.

This note aims to criticize the identification of key LBF at species or genus rank and the biostratigraphic interpretations. Indeed, the species figured in the paper are largely misidentified as explained in detail below and the type of taxonomic approach is not discussed in the text. Using the misidentified species led to the incorrect establishment of the SBZ. Consequently, provided the wrong biostratigraphic age to the Lower Eocene succession of the Southern Indus Basin. The micropaleontological analysis coupled with microfacies description that suffers from the misidentification of most key-index taxa is useful for the definition of a precise depositional environment (e.g., Flugel, 2004). Similarly, comparisons with the distribution of LBF in the recent carbonate system are required to define environmental and ecological control on the vertical and lateral distribution of taxa (e.g., Höttinger, 1997).

Asghar et al., 2021 used the term Ranikot Formation at least 69 times throughout the article but the Ranikot is not a Formation, it is a group of formations (i.e., Khadro, Bara, and Lakhra formations) (Cheema, 1977; Shah, 1977). Asghar et al. (2021) provided a stratigraphic chart of the study area in which the Ranikot is mentioned as a group and the formations are further classified but they used the term Ranikot Formation in the manuscript title and text, and even in many places the authors used the term “Ranikot Limestone”. Similarly, in many places used the term “Laki Limestone” for Laki Formation. The language is extremely poor and even in many places, it is misleading. The italic and non-italic

protocols for species and genus rank are also wrong throughout the article.

Another big mistake in the article is the position of the SBZ5. Asghar et al. (2021) placed SBZ5 in Thanetian stage but in the updated shallow benthic zones the SBZ5 is assigned to Ypresian stage (e.g., Hanif et al., 2021; Papazzoni et al., 2017; Scheibner et al., 2005; Scheibner and Speijer, 2009). Asghar et al. (2021) confidently claimed in the discussion section that the controversy regarding the age of the so-called Ranikot Formation has been overcome after their present study. However, the study led to another controversy regarding the name and age of the studied sequence.

The article provides 2 figures of 11 photographs for 10 taxa, 3 of which are in genus rank and 7 are in species rank. Many species based on which Asghar et al. (2021) claimed that they defined the SBZ5 i.e., *A. vredenburgi*, *A. aramaea*, *Lockhartia diversa*, and *Assilina dandotica* are not figured and not present in the distribution chart. However, they mentioned in the text that the SBZ 5 is defined by these species. Similarly, 8 photographs in 2 figures are provided for 4 microfacies but photographs for Orthophragminids packstone facies (Microfacies A) are missing.

Asghar et al. (2021) illustrated LBF species that are used for biostratigraphy and microfacies analysis such as *Ranikothalia* sp, *Alveolina elliptica nuttalli*, *Alveolina globosa*, *Alveolina oblonga*, *Alveolina elliptica*, *Alveolina pasticillata*, and *Nummulites globulus* but likely misidentified, since they also require the investigation of centered equatorial and axial sections to take biometrical measurements of the embryonal apparatus.

## 2. TAXONOMY

The main problem, as above stated is the identification of LBF to a correct specific species. The correct species identification in LBF needs the analysis of oriented thin sections (i.e., axial and equatorial) passing through detailed taxonomic characters typical for each group (Benedetti, 2021). Species-rank identification typically needs loose materials to obtained matrix-free specimens or an obvious number of thin sections of hard rock to get as many sections as possible of specimens belonging to

the same taxon to show all the diagnostic elements needed e.g., embryonic chamber, type of chamber arrangement, lateral chambers to take biometric data (Benedetti, 2021). However, poorly preserved specimens may lead to misidentification that usually results in misinterpretations. Asghar et al. (2021), figured taxa based on which they divided the studied succession into SBZ. None of the figured taxa is in the oriented view (e.g., axial, or equatorial). In all the figured taxa, the embryonic portion is missing, which indeed leads to misidentification of the species. Asghar et al. (2021) claimed the demarcation of five SBZ in which four are demarcated based on the *Alveolina* species. The *Alveolina* at species rank is vastly studied by (Drobne, 1977; Hadi et al., 2019a, 2019b; Hottinger, 1974, 1960; Rahman et al., 2021; Sirel and Acar, 2008) Based on the diagnostic features such as the shape of the test, the arrangement of whorls and biometric measurements (diameter of the proloculus, axial and equatorial diameters, elongation index, chamberlets size, and shape) are needed for the taxonomic identification (Drobne, 1977; Hadi et al., 2019a, 2019b; Hottinger, 1974, 1960; Rahman et al., 2021a; Sirel and Acar, 2008). However, the *Alveolina* species claimed by Asghar et al. (2021) are missing all the mentioned biometric parameters. Similarly, the other LBF species are also not identified as per the original description and typical parameters i.e., *Nummulites* (Schaub, 1981), *Discocyclus* (Less, 1987) etc.

In figure 3A, Asghar et al. (2021) claimed *Ranikothalia* species but there are no visible LBF species. In figure 3B, the authors mentioned *Somalina* species but the embryo in the specimen and the size and pattern of chamberlets are not according to the original description of (Silvestri, 1939). As per the scale provided for the so-called *Somalina* species, the size specimen is far smaller than the *Somalina* species. In figure 3C, the authors mentioned the *Discocyclus* species, but the specimen is obliquely cut, and the diagnostic features are missing. However, based on the specimen shape and chamber arrangement it seems like *Orbitoclypeus* species (e.g., Özcan et al., 2018). In figure 3D, the authors claimed the *Miscellanea miscella*, but the shape of the species is flattened, unlike lenticular. The species is more similar to *Miscellanea dukhani* which has a compressed test in comparison to *Miscellanea miscella* (Höttinger, 2009).

Asghar et al. (2021) in figure 4 mentioned 6 species (5 *Alveolina* species and 1 *Nummulites* species) that were misidentified. As above mentioned, various biometric parameters are required for the identification of the *Alveolina*, but these all parameters are completely or partially missing in the provided photographs. The authors provided oblique sections of the genus *Alveolina* in which proloculus, various ontogenetic stages, complete axial and equatorial diameters, and the shape of the test is missing that are compulsory for identification. Moreover, the authors also did not mention or discussed in the text that based on which parameters they identified species. I will not further discuss these *Alveolina* species because the provided photographs do not fulfil the fundamental criteria of taxonomic identification of *Alveolina*. Similarly, in figure 4G the authors described the species as *Nummulites globulus* which indeed misidentified. According to the provided scale, the species diameter is 0.277 mm which is very smaller than the normal size of *Nummulites*. The internal features are not very clear, but the visible chambers pattern is different from the original species. The chamber's width is larger than the heights which is inverse in the original species (e.g., Schaub, 1981; Pl 40, figures 1-60).

Asghar et al. (2021) have the same issue of the species and genus identification in the microfacies section. In figure 5A, the authors figured out a clear matrix-free specimen of *Alveolina* but described it as *millioids*. Similar problem with the rest of the figures of the microfacies section where the species are mentioned in the text but missing in the figures.

### 3. SHALLOW BENTHIC ZONATION

The formal shallow benthic zones were first established by Serra-Kiel et al. (1998) and updated by Papazzoni et al. (2017). The SBZ were recalibrated by Scheibner and Speijer (2009), particularly along the Paleocene Eocene boundary. The SBZ is mostly Opeel zones based on the concomitant occurrence of different LBF taxa belonging to different lineages (Pignatti and Papazzoni, 2017). However, the first appearance datum (FAD) and last appearance datum (LAD), allow the specialists to established biozonal horizons, also with a certain degree of subjectivity (Benedetti, 2021). The Alveolinids and Nummulitids biozone were previously established by Hottinger (1960) and Schaub (1981), respectively that were mostly based on FAD and LAD. The range of the species of the Hottinger (1960) and Schaub (1981) biozones was almost the same in Serra-Kiel et al. (1998) with the addition of other LBF. In some cases, the researcher established their local biozone and correlated it with the SBZ of Serra-Kiel et al. (1998). These local biozones may be reliable for the regional correlation but cannot be followed as a standard for the establishment of the biozone in another region because the paleoecology

and regional basin tectonics are not the same, as the LBF are sensitive to palaeoecological variations. Asghar et al. (2021) followed the local biozones of BouDagher-Fadel et al. (2015) from the Tibetan Himalayas. BouDagher-Fadel et al. (2015) established local biozones and they are not consistent even within the studied sections. In some sections (e.g., Zongpubei Section) BouDagher-Fadel et al. (2015) established a single biozone (e.g., TP6) but in other sections (e.g., Shenkeza Section) the same biozone (TP6) has been divided into three sub-biozone (e.g., TP6 a, b, c). Therefore, the biozones of BouDagher-Fadel et al. (2015) are even not consistent in the studied area, so how it can be followed in the other regions. Asghar et al. (2021) also not mentioned how they marked the boundary between the two biozones because the so-called identified LBF are mostly long range and they covered more than one biozone. Asghar et al. (2021) assigned SBZ5 to the so-called Ranikot Formation (correct; Lakhra Formation). However, they not correctly identified a single species from the SBZ5. Asghar et al. (2021) placed SBZ5 in the Thanetian stage which is wrong as discussed above. Rahman et al. (2021a, 2021b) studied the systematics and biostratigraphy of Orthophragminids and Alveolinids from Lakhra Formation (so-called Ranikot Formation by Asghar et al. (2021) and Laki Formation in Laki Range southern Indus Basin. Rahman et al. (2021a, 2021b) marked the SBZ5-6 and 7 at the top of the Lakhra Formation by using Orthophragminids and Alveolinids with the addition of *Ranikothalia* species, *Miscellanea* species, and *Orbitoclypeus* species. The SBZ5 and SBZ6 are undivided in the study area even Rahman et al. (2021b) reported 11 LBF species from SBZ5-6. Asghar et al. (2021) reported the so-called *A. oblonga* from SZB6 which is never been previously reported from SBZ6 (Rahman et al., 2021a) and the diagnostic species of the SBZ10 (FAD). The rest of the misidentified species of Asghar et al. (2021) are long-range species and based on these species the demarcation of a biozone is not reliable. Asghar et al. (2021) also mentioned a biozonal gap in the distribution chart but they not clarified that this is what kind of gap either unconformity or sacristy of LBF?. The LBF based biostratigraphy of the Laki Formation is well documented by Rahman et al. (2021a, 2021b). The Laki Formation has two members Sohni Member (clastic) and Chat Member (limestone). The SBZ7 started at the top of the Lakhra Formation and end at the base of Chat Member of the Laki Formation. The SBZ7 is followed by SBZ8-9, SBZ10, 11, 12, and 13 (Rahman et al., 2021a), and there is no biozonal gap which is mentioned by Asghar et al. (2021).

### 4. MICROFACIES AND PALEOENVIRONMENT

As above stated that the key LBF species and genera are misidentified by Asghar et al. (2021), therefore, it will not discuss again in detail here but will only highlight the key issues in microfacies analysis and paleoenvironmental interpretations. The description and evidence provided for the microfacies are inadequate. The microfacies need to be described in detail with proper evidence for environmental interpretations but it is completely missing. Out of five in four microfacies, the authors refer to Babazadeh and Alavi (2013) for paleoenvironmental interpretations but Babazadeh and Alavi (2013) provided a complete description and evidence for their interpretations and then referred to related previous literature but Asghar et al. (2021) lack such descriptions, evidence, and references. Babazadeh and Alavi (2013) worked on the shelf system but Asghar et al. (2021) referred to the ramp system.

### 5. CONCLUDING REMARKS

- 1) It is recommended that the "Ranikot Formation" should be changed into the correct Lakhra Formation in title and text. Similarly, at some places, the Laki Limestone is used which needs to be corrected to Laki Formation.
- 2) The figured species are misidentified, and the figures did not qualify the requirements of LBF species identifications.
- 3) The demarcation of the SBZ and the biostratigraphic age is suffered from misidentified species which is indeed wrong.
- 4) The microfacies description and interpretation are inadequate and suffered from misidentified species and genera.

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