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RESEARCH PAPER

Planktic Foraminiferal Study of Jhimpir Area, Sohnari Member (Laki Formation), Southern Indus Basin, Pakistan

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ABSTRACT

Biostratigraphic study is important to learn about the stratigraphic record which mainly focuses on determining the relative ages of rock strata by studying variety of fossil assemblages within them in order to understand paleo-environment conditions. The Planktonic foraminifera of Sohnari Member (Laki Formation) in Jhimpir Area, Southern Indus Basin, Sindh Pakistan, is described and illustrated on the basis of Planktonic zonation. The main objective of this research work is to collect data and rock samples systematically from the study area, to identify the Stratigraphy of Jhimpir area, to collect fossil content for the biostratigraphic age determination of Laki Formation and systematic paleontogical study of Laki Formation. Shale in Jhimpir having a Spinose species fauna of Globogerina is considered to be of upper Eocene(Ypresian) age and presence of Morozovella and Acarinina species (Latelian) confirm the age of Sohnari Member as Ypresian to Lutetion.

Introduction

The study of foraminifera was started in early 1849. Nuttall was the first to describe the formaminifera of laki formation. The studied area belongs to lower part of Laki series, Southern Indus Basin, the studied area overlies Ranikot group (Lakhra Formation). The studied area is located in Jhimpir, Thatta District. The contact between Lakhra Formation and Sohnari Member is unconformable and contact between Sohnari Member and Meting Limestone (Chat Member) is conformable.

Biostratigraphy

Mass extinction events occurred periodically throughout the evolution of life on Earth and caused dramatic shifts in evolution and ecology. Largest extinction events that occurred in phanerozoic eon are studied extensively and the accurate mechanisms responsible are still in debate. Most of the large extinction events occur during periods of pronounced climatic change or are associated with events such as meteorite impacts or large volcanic eruptions (Alvarez et al., 1980; Courtillot et al., 1986; Courtillot, 1990; Hallam and Wignall, 1997). Raup and Sepkoski (1982) identified what are referred to as the “big five” mass extinction events; the end Ordovician, the late Devonian, the Permo-Triassic, the Triassic-Jurassic and the Cretaceous-Paleogene extinction events.

While mass extinction events are unfavorable to life at the present time, they can be tremendously useful for biostratigraphy, that they provide useful horizons for correlation globally and can determine the age.

Foraminifera

Foraminifera are marine, free-living, amoeboid protozoa. They are eukaryotic in nature i.e. organisms which contain complex structured cytoplasm along with internal membranes, a nucleus, mitochondria, chloroplasts, and Golgi bodies and they show animal and plant like activities. Foraminifera was first appeared in Cambrian with a benthic form of life and, over the span of the Phanerozoic, they invaded most marginal to fully marine environments. Both living and fossil foraminifera come in a extensive diversity of shapes. Foraminiferal tests are geologically useful because of their complexity and specific characteristics (and their evolution over deep-time).

Planktic Foraminiferal Zone

Mostly, foraminifera are of marine in nature, there are two major types of foraminifers out of which the majority live on or within the seafloor sediment (i.e.benthic), while a smaller number float in the water column at a range of depths (i.e. planktonic), which belong to the suborder Globigerinina.

Planktonic foraminifera are comprised of tests which are made of globular chambers that provide buoyancy composed of secreted calcite or aragonite. They float freely in the upper water column of the world's oceans, with species not exceeding 600 µm in diameter.

Benthic Foraminifera

Benthic foraminifera are single celled, aquatic (marine and brackish) eukaryotic organisms. They are bottom dwellers characterized by high range and abundance. The cytoplasmic body in benthic foraminifera is covered in organic or mineralized test i.e. shell, which provides a fossil record which is Cambrian to recent. Due to the presence of the test, benthic foraminifera are of geological usefulness of Paleo-environmental changes. Foraminiferal shells consist of single or multiple chambers connected with each other by a channel, called foramen.

Microfossil

Microfossils are found in rocks and sediments as the microscopic remains of plants, animals, fungus, protists, bacteria and archea. Terrestrial microfossils include pollen and spores. The sizes of microfossils are between 0.001 mm to 1 mm which can only be seen by an electron microscope. Any fossils which can be seen by naked eye is called a macrofossil. These fossils are the main features of geologic study. These fossils are found in deposits of marine environments, stagnant water, fresh water and terrestrial sedimentary deposits. These different kinds of microfossils also provide inFormation of paleoclimate and these fossils also provides us the various kinds of energy resources including liquid and gas forms.

Tectonics and Geology of the studied area

Pakistan has two major basins (Indus and Balouchistan).The Indus Basin is located between the boundary of the Indian, Asian, and Arabian plates. Tectonically, it has been divided into Northwest Himalayan fold–thrust belt, Kohistan–Ladakh magmatic arc, Karakoram block, Kakar Khorasan flysch basin and Makran accretionary zone, Chagai magmatic arc, Pakistan offshore, and the Indus Basin (Kazmi & Jan, 1997)., which have been linked with each other in Cretaceous/Paleocene time and connected by the Ornach-Nal–Chaman strike–slip faults (Kadri, 1995).

The Indus Basin area contains the rocks of Precambrian to Recent age and divided into two main parts (Upper and Lower), and the lower part is further divided in to central and southern parts (Kadri, 1995; Shah, 2009).

The studied area is mainly composed of a mixed lithology of clastic and non-clastic sediments which belongs to Early Eocene (Ypresian) age. The major constituents are Shale, Sandstone, Loose Sand, Mudstone, Silty shale and Limestone.

Lakhra Formation

Ahmed and Ghani proposed the name Lakhra Formation, after Lakhra, Laki range for the "upper Ranikot (limestone)" of Vredenburg (1906).

In the study area the formation consists of limestone.

Laki Formation

The term Laki Formation was introduced by Cheema et al. (1977) for the Laki group of the Jones (1960) and the Laki series of the Noetling

(1903). Blanford (1879) included series of massive limestone containing Alveolina spp. An Early Eocene age was assigned to Laki Formation by Vredenburg (1906), Nuttall (1925), Davies (1926), Haque (1962) and Jones (1960).

In the studied area the Laki Formation contains Sohnari member and Chat member (Metting Limestone) members. Which is composed of mainly shale, sandstone, limestone and gypsum. It dips 2^0SE and strikes E1^0N.

Literature Review

There is not much Literature on the Laki Formation, but related to Laki Formation and its surroundings some different aspects were researched by Geoscientists in which the age factor of Laki Formation which is also the subject of study is revealed as Ypresian to Lutetion.

Vredenberg (1909) included in the Laki series of Sindh; the Laki limestone and Meting shale, which is underlain by the upper Ranikot group. Nuttall's (1925) subdivision for Laki series has been widely accepted; he classified these beds in descending order as under:

Laki limestone.
Meting Shale.
Meting limestone.
Basal Laki laterite.

An early Eocene age was assigned to it by Vredenberg (1906, 1921), Nuttall (1925), Davis (1926), Cox (1931), Noetling (1905), Haque (1962), Hunting Survey Corporation (1960) and Iqbal (1973).

According to P. A. Usmani, et al., At the Chohar Pass area of Surjan anticline the Laki limestone member of Laki Formation is exposed consisting mostly of limestone with minor amount of shale, sandstone and marl. The nodular limestone is mostly hard, compact and massive. The basal part of the Laki limestone is chalky. In the studied area Laki limestone dips steeply on the eastern flank and dips gently on the western flank of Surjan anticline. The amount of dip on the western flank is 3.5° to 8° NW. The base of the Laki Formation is not exposed in the studied area but its upper contact is conformable with overlying Tiyon formation.

A.A. KURESHY carried the study of Laki Formation of Kirthar Province of the lower Indus basin of Pakistan which is vastly folded area of the basin. According to Kureshy. The formation is predominantly marine origin, characterized by Nummulites atacicus, N. mamilla, Assilina granulosa, A. ley-merie, Alveolina oblonga, Flosculina globosa, Lockhartia tipperi, and Orbitolites complanatus etc., The planktic Foraminifera are characterized by Globo-rotalia rex, G. imitata, G. wilcoxensis, G. brodermanni, G. arago-nensis, G. formosa, G. palmerae and Globigerina turgida, designated to Globorotalia rex, G. aragonensis and G. palmerae zones. The Laki Formation is correlated to Ta 2 Letter Stage Classification of East Indies by Van der Vlerk and Umbgrove (1927).

The laki deposits were designated by Blanford (1876) as the lower part of the Kirthar Series in the Rakhi Range of the Kirthar Province of the Lower Indus Basin. Noelting (1903) noticed that the lower part of the Kirthar series of Blanford (1876) is quite district in its Paleontological record, thus he introduced the term Laki for the deposits which were previously referred as lower Kirthar. Further studies by Vredunburg (1906), Nuttall (1925) and Davies (1926) supported the separation of Laki deposits from Kirthar on the basis of the larger foraminiferal assemblages, as both deposits are of different ages.

Material and Methods

Samples for this study have been collected at varying interval of 10 ft. 20 samples have been examined for Foraminiferal study. The samples were collected mainly from shale and loose sand which varied from generally soft material. The samples were processed by the standard techniques described by KUMMEL and RAUP (1965).

The separation of microfossils required washing and sieving. The sieving set was used with the sieve sizes of 14, 72, 84 and 100 micron with lid and pan.

For isolation and separation of micro fauna the compact material was soaked in water for an overnight. Soaked samples were boiled with soda ash NaCO3 (two or three table spoon) for 35-45 minutes. The boiling saple was stirred continuously for better results. The boiling samples were then washed through the sieves under the jet of faucet so that the finer material is removed and the sample gets clear. Washed samples were than dried in an oven at 100^{o}. The dried material was sieved through 32, 52, 85, 100 and 120 mm mesh sieves. The material was thoroughly shaken for about 10 minute The dried sieve fractions were studied under binocular microscope using generally 4X and 20Xmagnification. The photography has been carried out on Liesa DM 2500 P microscope in the Advanced Laboratory at Centre for Pure and Applied Geology in the University of Sindh, Jamshoro, Pakistan.

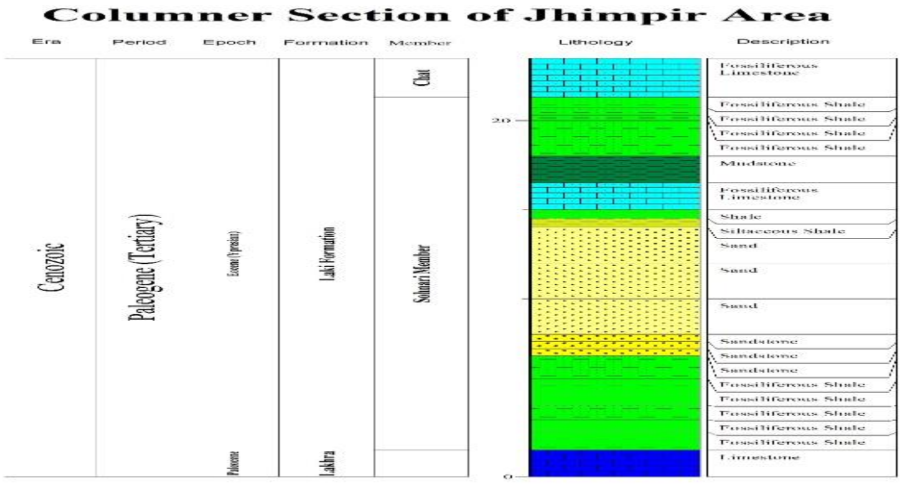

Fig.1. Lithological columnar section of the studied area

Systematic Paleontology

Morozovellaaragonensis (Nutall)*Globorotaliaaragonensis*Nutall, 1930, P-288, Pl. 24, Figs. 6-11**Remarks:** Morozovellaaragonensis differs from Morozovellalensiformis mainly by the large number of chambers in the last whorl, the almost circular periphery and the heavier. Its test is rather tightly coiled and has 5 to 7 chambers in the last whorl. The suture on the spiral sides are flushed or slightly raised. **Stratigraphic Range:** Early Eocene.

Morozovellasubbotinae (Morozova) *Globorotaliasubbotinae*Morozova, 1929, PP. 80-1, Pl. 2 Fig. 16 **Remarks:** Morozovellasubbotinae differ from Morozovellaaequa by the more fragile, generally tightly coiled aspect and by the distinct spinose. Morozovellasubbotinae has generally 4-5 chambers but in some cases, it has 6 chambers is last whorl this is rare. **Stratigraphic Range:** Early Eocene.

Morozovellaformosagracilis (Bolli) *morozovellaformosagracilis* (Bolli), 1957a, P.75, Pl.18, Fig. 4-6.**Remarks:** Differ from M. subbotinae and M. lensiforms on the basis of its chambers. It is identifying by its chambers; it has 5-6 chambers which increase rapidly but regularly in size. The suture on the spiral side are strongly curved and frequently beaded. The umbilicus is open and deep, the umbilical shoulders of the chambers are rounded and without bundles of spines. **Stratigraphic Range:** Early Eocene.

Morozovellaedgari (Permoli Silva and Bolli)*Globorotaliaedgari* (Permoli Silva and Bolli), 1973, P. 526, Pl. 7, Figs. 10-12, Pl. 8, Figs 1-12.**Remarks:** Differ from M. subbotinae by the large number of chambers in the last whorl and the less lobate peripheral outline. M. formosagracilis is more robust and has a better developed 'keel'. M. edgari has small in size, fragile aspect with only a weakly developed 'Keel'.**Stratigraphic Range:** Early Eocene.

Acarininanitida (Martin)*Acarininanitida*(Martin), Fig: 18.1-2; 5,7,10 **Remarks:** The nominate species generally dominates the assemblage of this zone. The compact test is almost sub globular in lateral view and has an equatorial periphery which is only very slightly lobate .**Stratigraphic Range:** Early Eocene.

Hantkeninanutalli *Hantkeninanutalli,* Toumarkine. Figure 23.1-5; 5,8,10 **Remarks:** The base of this oldest zone of the middle Eocene is marked by the first occurrence of representatives of the genus Hantkenina. It is different from the other species of the genus by its large size (0.5 to 1.0 mm) and the stellate shape of the test. **Stratigraphic Range:** Middle Eocene.

Globorotalia sp. (Cushman) *Globorotaliasp.*Cushman and Renz 1948, Cush. Lab.Foram. Res, Specl.publ.,24,40, pl. 8, Fig.7-8 **Remarks:** Test small trochospiral side slightly convex equatorial periphery rounded. Surface finely pitted. Chambers with a fain keel, about 10-12 arranged 2-3 in the final whorl. **Stratigraphic Range:** Early Eocene.

Pararotalia sp. (Le Calvez**)** *Pararotaliasp.*Terquem, Le Calvez, 1949, p. 39, PL 6, figs. 97-98; Le Calvez, 1952, p. 48.**Remarks:** Test trochospiral, planoconvex, spiral side is convex but umbilical side is flat, periphery is strongly angled, all whorls visible on the deeply umbilical side around the prominent umbilical plug. The last formed whorl bearing a short peripheral spine. Wall is calcareous and perforate. This species resemble to Pararotaliacurryi but the latter is biconvex and has only feebly developed peripheral spines .**Stratigraphic Range:** Early Eocene

PLATE NO: 01 DESCRIPTIONS

Fig. 01: Pararotaliaspingeria. (1a,1b,1c,1d)

Fig. 02: Hantkeninanutalli (2)

Fig. 03: Morozovellaedgari. (3a, 3b)

Fig. 04: Morozovellaformosagracilis. (4)

Fig. 05: Pararotaliawilcoxensis. (5a, 5b)

Fig. 06: Globorotalia Sp. (6)

Fig. 07: Acarininanitida. (7a, 7b)

Fig. 08: Pararotalia sp. (8a, 8b)

Fig. 09: Morozovellasubbotinae (9)

PLATE NO: 02 DESCRIPTIONS

Fig. 01: Morozovellaaragonensis. (1)

Fig. 02: Morozovellaformosagracilis. (2)

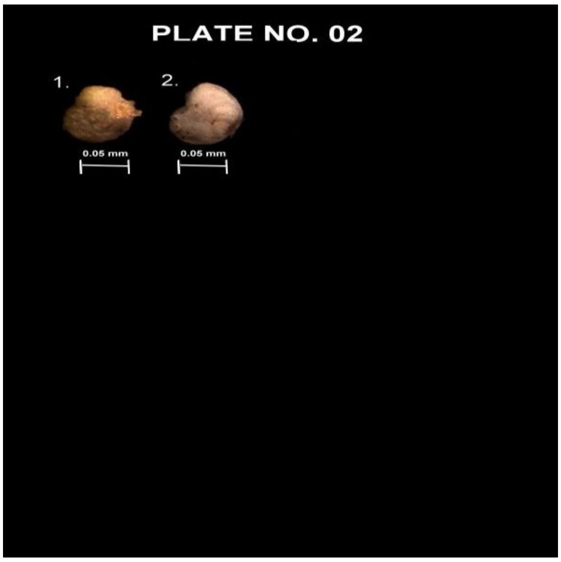

Fig.2 plankticforaminifa

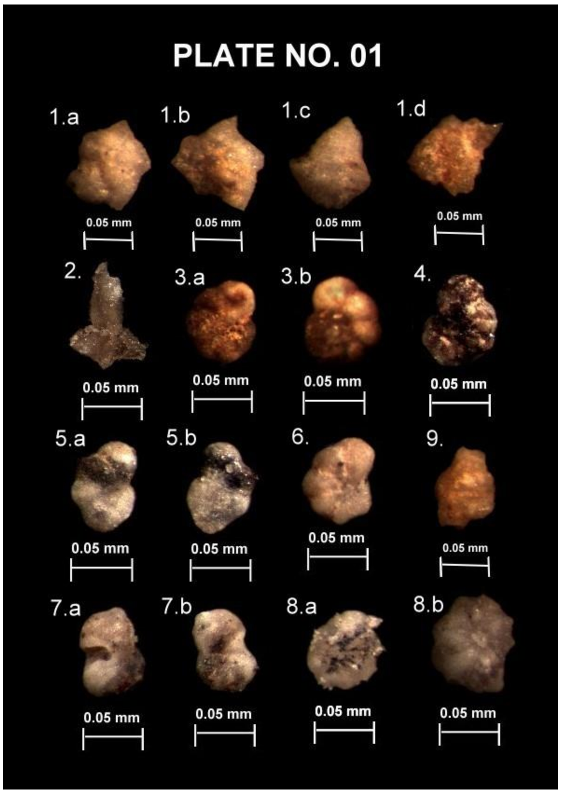

Fig. 3. Planktic Foraminifera

Table 1.
Zonation of Planktonic Foraminifera of Laki Formation (Early to Middle Eocene)

Early Eocene	Middle Eocene	Planktonic Foraminifera	Author
		Acarininanitida	Martin,1943
		GloborotaliaSp	Cushman and Renz, 1948
		Hantkeninanutalli	Toumarkine
		Morozovellaaragonensis	Nutall, 1930
		Morozovellaedgari	
		Morozovellaformosagracilis	Permoli Silva and Bolli, 1973 Bolli, 1957
		Morozovellasubbotinae	
		Pararotaliasp	Morozova, 1929
			Terquem, Le Calvez, 1949

Conclusion

The specific composition of the fanules are coherent and reflects, fluctuating bathymetry with alpha diversity α = 5-6. Suggesting hypersaline to normal marine warm later condition.

On the basis of Planktonic foraminifera (Permoli Silva &Bolli 1973), species of two zone are observed.

Morozovella Edgari Zone

(Morozovellasubbotinae, Morozovellaformosagracilis, Acarininasoldadoensisgracilis, Morozovellaedgari, Morozovellavelascoensis, Psendohastigeninawilcoxensis).

FAD of Morozovella Velascoensis and LAD of Morozovella Edgari (Permoli Silva &Bolli 1973).

Acarinina Pentacamerata Zone

(Turbotraincerroazulensis, Planorotalalitesplamerae, Hantkeninaaragonensis, Acarininabulbrooki, Morozovellaspinulosa).

The top of the AcarininaPentacamerata Zone corresponds to the boundary between the Early to Middle Eocene adopted by the majority of authors (Bolli 1975b), Krashevimikov (1965a), Toumarkine (1981).

(TurbotrainCerroazulensis, PlanorotalalitesPlamerae, Hantkenina Aragonensis, AcarininaBulbrooki, MorozovellaSpinulosa).

On the base of zone with its particular Index Planktonic foraminifera age can be assigned Early Eocene (Ypresian) to Middle Eocene (Lutetian). Both boundaries are conformable on the basis of particular species (Bolli 1975). The benthic assemblage shows distinct affinities with the Ypresian and Lutetian fauna of Hampshire basin and Paris basin (John and Murray 1974) and Kutch of India.

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