BIOSTRATIGRAPHY OF THE EOCENE CARBONATES EXPOSED IN KALA CHITTA RANGE, UPPER INDUS BASIN, PAKISTAN

BY

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Abstract: *A comprehensive approach was opted to carry out the biostratigraphic investigations of carbonates exposed in the Eocene sequence of the Upper Indus Basin. The studied unit is situated along the core of Kahi Synclinorium which is in the eastern part of the Kala-Chitta Range. Within these carbonate units Margalla Hill Limestone is measured ca. 52 meters thick and sampled at regular intervals. For higher resolution of the study, sampling was carried out at close and sharp intervals. Lower contact of the Formation is conformable with Paleocene Patala Formation and is predominantly composed of typical nodular limestone with subordinate shale beds. Faunal contents of the studied samples provided details of various important species such as Nummulites globule and Nummulites actacicus. Eighteen species of Larger Benthic Forams were identified namely Nummulites globulus, Nummulites actacicus, Miscellanea miscella, Miscellanea juliettae, Lockhartia conditi, Lockhartia conica, Ranikothalia sindensis, Ranikothalia sahni, Assilina subspinosa and Assilina laminosa. Based on first and last occurrence of age diagnostic Nummulites globulus and Nummulites actacicus, a biozone is established and named as Nummulites globules/Nummulites actacicus biozone. The Formation has been assigned Middle Illerdian-II age and validated as Margalla Hill Limestone.*

INTRODUCTION

Carbonate rocks exposed in the NW Pakistan bear key importance in terms of their utilization as construction material in various industries. Among many, some include usage of limestone as coarse aggregate for road construction, as raw material in cement industry and best crushed material for reinforced cement and concrete purposes. However, these rock units have attracted less academicians and researchers to deeply study their detailed geology. This study is an attempt made to decipher the age-based correlation studies of a carbonate rock unit purely based on biostratigraphy. The study area is located to the SE of Peshawar, the provincial capital Khyber Pakhtunkhwa. The Kala Chitta Range is a part of the North–Western Himalayan Fold and Thrust Belt and has been uplifted by southward oriented thrust due to India–Eurasia collision. It is in lateral continuation with Margalla hills to the east and Samana Range to the west. The carbonate unit under investigation is exposed along the core of Kahi Synclinorium. The core of the synclinorium is occupied by Patala Formation, while the older Cenozoic and Mesozoic units occur at its limbs. Furthermore, the study area is structurally well-deformed because it is bounded by Main Boundary Thrust (MBT) to the south and Hissartang Thrust to the north.

Geologically, the area lies in the jurisdiction of a mountainous range known as Kala-Chitta Range. The study section can be accessible via a 100 km metaled road from Peshawar city (Figure 1). Contributions from previous authors include work of Cotter (1933) focusing mostly on the stratigraphic framework of the study area and its structural patterns. Likewise, Geologic Survey of Pakistan and many others (Carmichael et al., 2009; F. K. Bender and H. A. Raza, 1997; Shah, 1977) studied this geologic entity in much detail and produced different maps of this area under investigation. Similarly, Pervaiz (1987) briefly discussed geology of Attock–Cherat and Kala-Chitta ranges. Approaches in term of its structural geology have been covered in Awais et al. (2013).

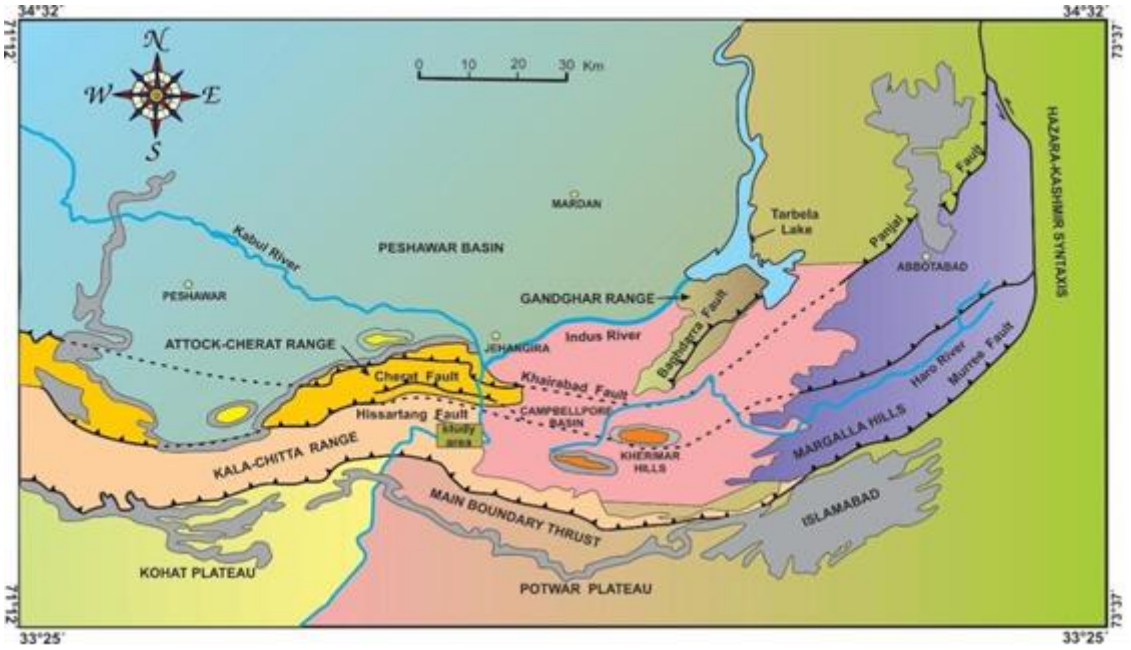

Fig.1 geological map of the study area (after Awais et al., 2016)

EOCENE STRATIGRAPHY

Carbonate rocks are ubiquitous while describing the Eocene Stratigraphy of Pakistan esp. Indus Basin. These units vary in thickness from few hundred meters to 4000 meters (Shah, 2009). In addition, these rock units serve as important reservoir rocks within the Indus Basin. Though carbonates are the dominant lithological constituents of these units, localized evaporates and marine shale also occurs at places (Kadri, 1995). A similar outcrop of carbonate rocks is exposed near the village of Kahi, Nizampur area in District Nowshera. These units represent typical sedimentation of tropical, sub-tropical Tethys.

This limestone is highly fossiliferous, thin-thick bedded having shale and marl interbeds in the lower part. Color of the limestone is mostly reddish yellow to yellowish brown on weathered surface and light grey to medium grey on fresh surface. The lower and middle parts are thin to medium and thick-bedded and the upper part consists of thick-bedded limestone with occasional interbeds of shale and marl. The shale and marl are thinly laminated greenish grey and reddish brown. Occasionally, highly fossiliferrous tempestite beds also occur in the middle and upper part of the unit. The unit has transitional contact with late Paleocene Patala shales, while the upper contact is not preserved. Detailed stratigraphy of the study area is shown in Figure 2.

Age	Formation	Lithology	Thick-ness	Description
Pliocene	Siwalik Group		>5000 m	Mostly sandstone and argillaceous matterial. clay with subordinate sandstone in the base, followed by thick sandstone, followed by cyclic alteration of clay and sandstone, followed by a sequence of conglomerate sandstone clay.
Miocene	Kamlial		60-580 m	Purple grey to dark brick-red sandstone.
	Muree		9-3000 m	Dark red and purple clay and purple grey and greenish grey calcareous sandstone and subordinate conglomarate.
Eocene	Kohat		50-170 m	Greenish grey, calcareous shale with subordinate light grey limeseone.
	Kuldana		150 m	Predominantly greenish grey to greenish yellow, brown to brownish yellow , mottled, silty and gypsiferous shales.
	Chorgali		30 m	Thin-medium bedded, grey limestone with subordinate shale.
	Margalla Hill		80 m	Grey nodular limestone with subordinate shale.
Paleocene	Patala		20 m	Light brown and grey marl with thin interbeds of limestone.
	Lockhaert		260 m	Dark grey and black limestone with intercalations of shale and marl and fetid smell
	Hangu		15 m	Ferruginous, oolitic or pisolitic sandstone, siltstone and clay
Cretaceous	Kawagarh		40-70 m	Dark marl when fresh and cleaved calcareous shale, which weathers light grey-brownish grey.
	Lumshiwal		50-60 m	Sandstone in the lower part followed by thin-medium bedded argillaceous, shelly limestone and nodular marl.
	Chichali		12-27 m	Glauconitic sandstone with glauconitic sandy shale or dark pyritic unfossiliferous shale.
Jurassic	Samanasuk		190-366 m	Thin-thick bedded limestone with some with some dolomitic and ferrugenous, sandy, oolitic beds.
	Shinawri		12 m	Limestone and calcareous shale in the lower part, while the upper part is shale and clay intercalated with limestone.
	Datta		6 m	Mottled quartzose sandstone, haematitic sandstone and fireclay
Triassic	Kingrialli		91 m	Doya membe consists of sandstone and dolomite interbeds with some limestone and minor shale. Vanjari member is mostly dolomite.
	Chak Jabbi		30 m	Thin-medium bedded grey to light grey limestone. Has not yielded any recognizable fossils.
	Mianwali		39 m	The three members are not recognizable due to faulted outcrop. Thin bedded limestone with marl interbeds in the lower part

Fig. 2 column showing major stratigraphic subdivision of the Kala Chitta Range

METHODOLOGY

Outcrop based studies were carried out in a comprehensive field work, where various lithologies were encountered in the study area. The rock unit under investigation have been measured and sampled and data was collected for plotting on a stratigraphic column (Figure 3). A total of 35 samples were collected with equal and short intervals during field studies. Thin sections were prepared from these samples for detailed petrographic studies with ca. 30 micron thick of each section.

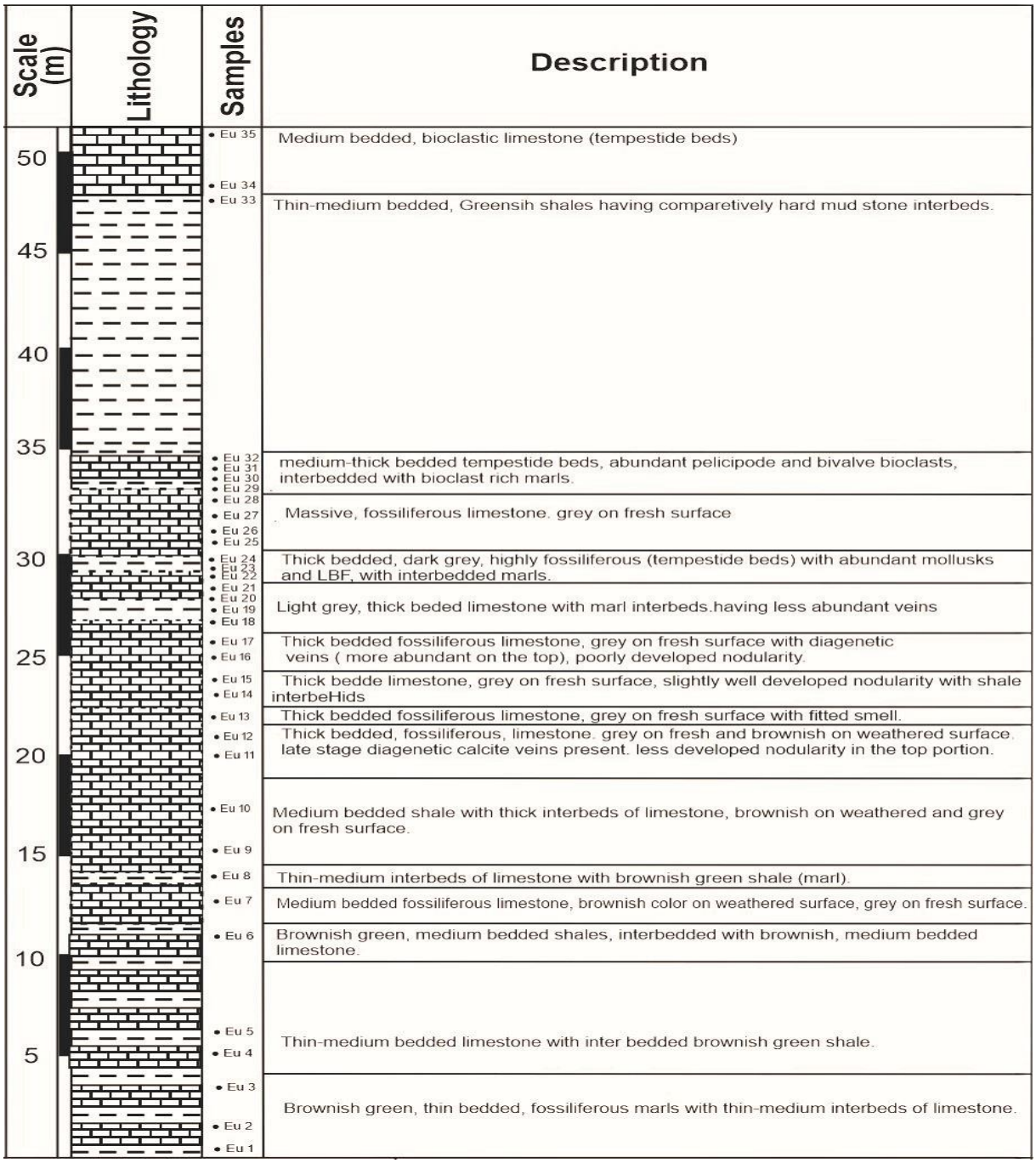

Fig. 3 Lithological Log of the Eocene unit exposed in the study area.

BIOSTRATIGRAPHY OF EOCENE UNIT

LBFs are considered as best index fossils based on their abundance and restricted geological range. The Eocene unit of the Kahi area is highly fossiliferous with abundance of foraminiferal fauna along with planktonic foraminifera and unrecognizable fragmented bioclasts. The constituent fauna of this unit is somewhat disturbed by the post-depositional alterations (diagenesis) and some reworked clasts have also been identified during petrographic studies. Through detailed petrographic study of the faunal content of the samples collected, a biozone was established in the unit based on the first and last occurrence of the diagnostic fossils of *Nummulites globulus* and *Nummulites atacicus*. This biozone is named *Nummulites globulus/Nummulites atacicus* Biozone. The foraminifer's assemblage identified, beside the diagnostic species of nummulites, also include *Miscellanea miscella, Miscellanea julietta, Assilina spinosa Assilina subspinosa, Assilina laminosa, Lockhartia conditi, Lockhartia haimei, Lockhartia*

conica, Ranikothalia sahni, Ranikothalia sindensis, Discocyclina sp, Rotalia trochidiformis and *Kathina selveri.* The biozone established is equivalent to SBZ-8 of (Serra-Kiel et al., 1998).

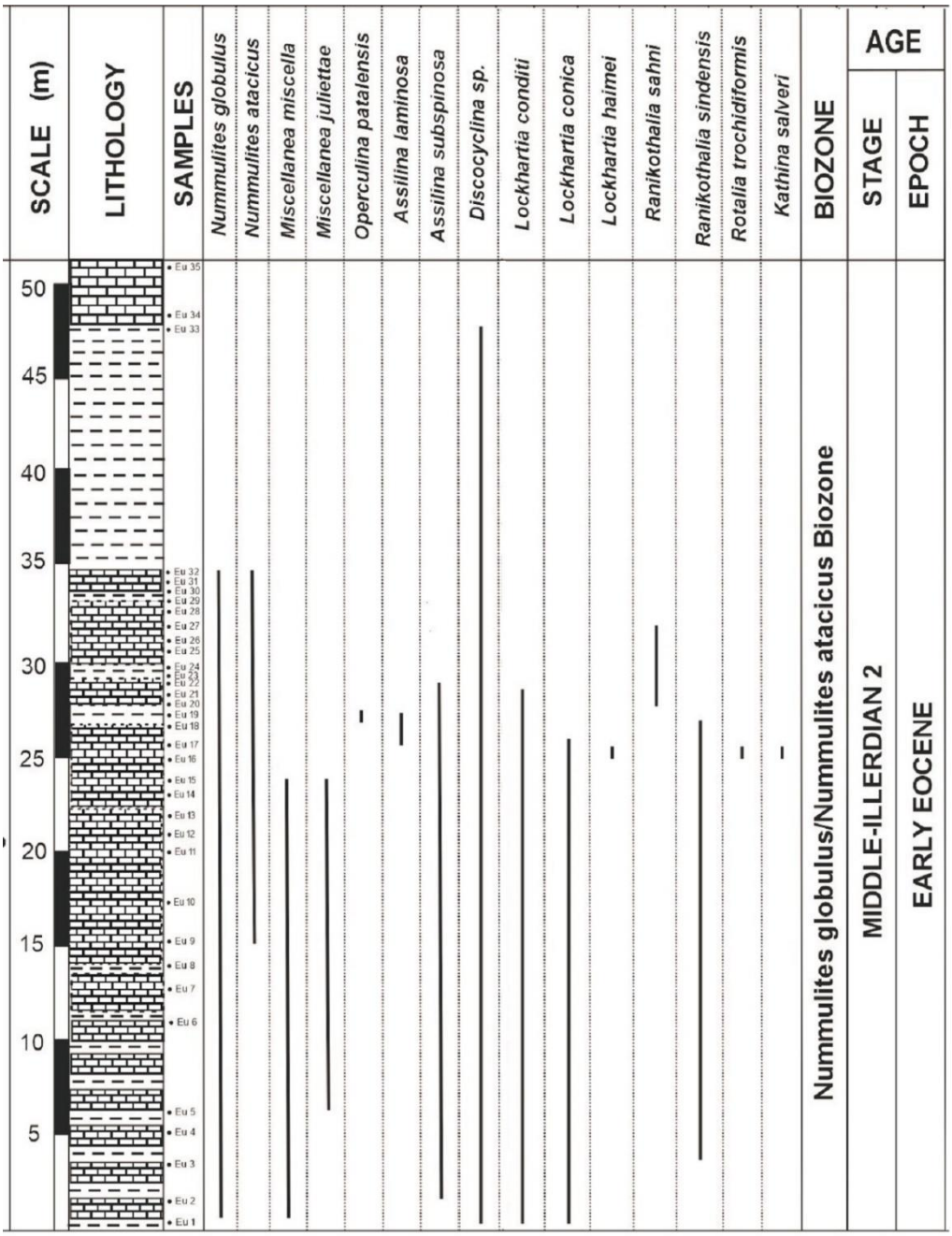

Fig. 4 The distribution of the identified LBFs in the Eocene unit.

CONCLUSIONS

Detailed petrographic and paleontological studies of the selected sample reveals that a total of 16 species of LBFs have been identified namely, *Nummulites globulus, Nummulites atacicus, Miscellanea miscella, Miscellanea julietta, Assilina spinosa Assilina subspinosa, Assilina laminosa, Lockhartia conditi, Lockhartia haimei, Lockhartia conica, Ranikothalia sahni, Ranikothalia sindensis, Discocyclina sp, Rotalia trochidiformis* and *Kathina selveri.* A biozone was established based on first and last appearance of the age diagnostic fauna *Nummulites globulus* and *Nummulites atacicus*. This biozone is equivalent to SBZ-8 of (Serra-Kiel et al., 1998). Moreover, based on previous literature, field observations, detailed petrography and correlation studies, the unit is assigned as Margalla Hill Limestone.

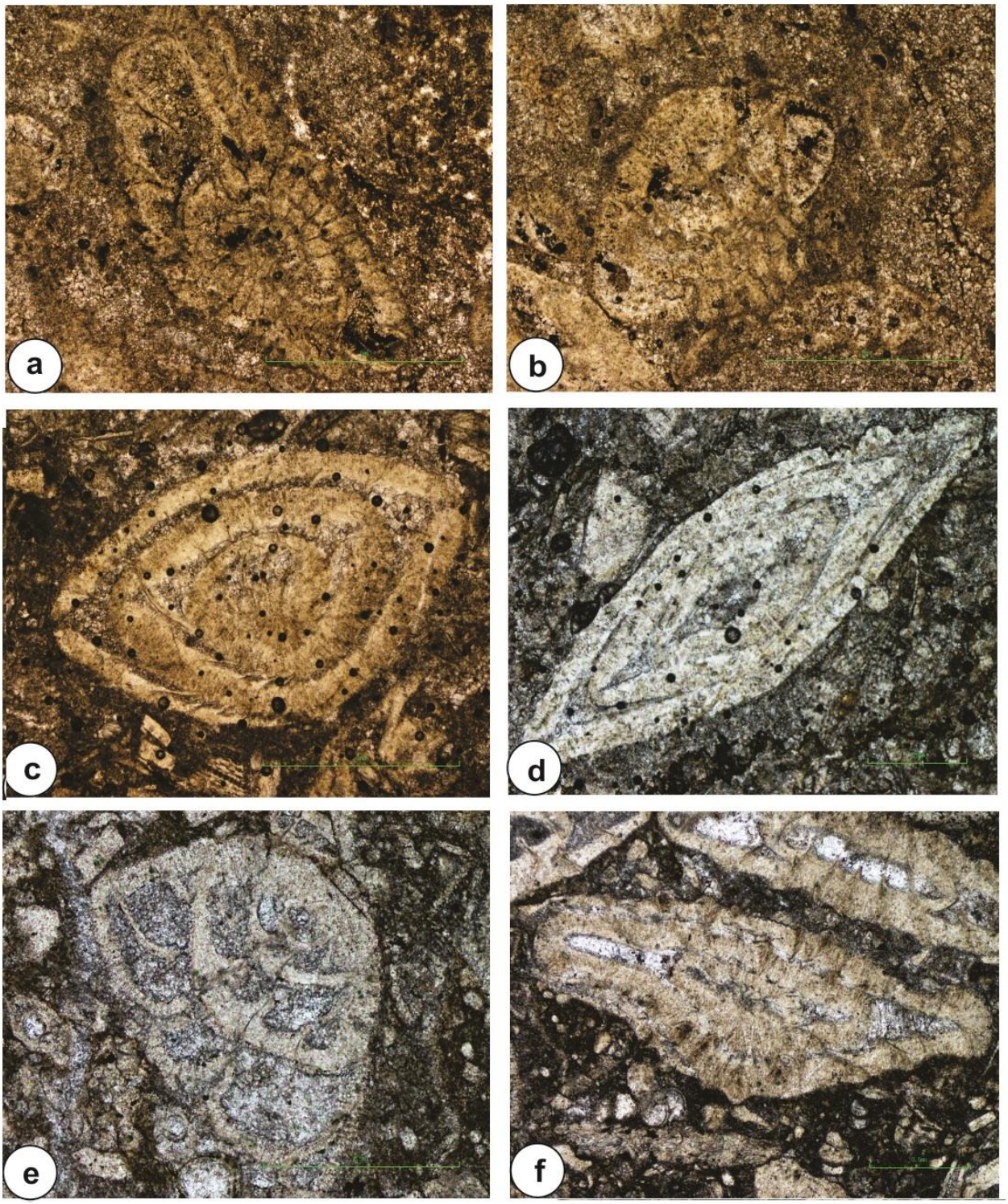

Plate 1 a) Miscellanea miscella, b) Lockhartia conditi, c) Nummulites globulus, d) Nummulites atacicus, e) Lockhartia haimei, f) Ranikothalia sahni

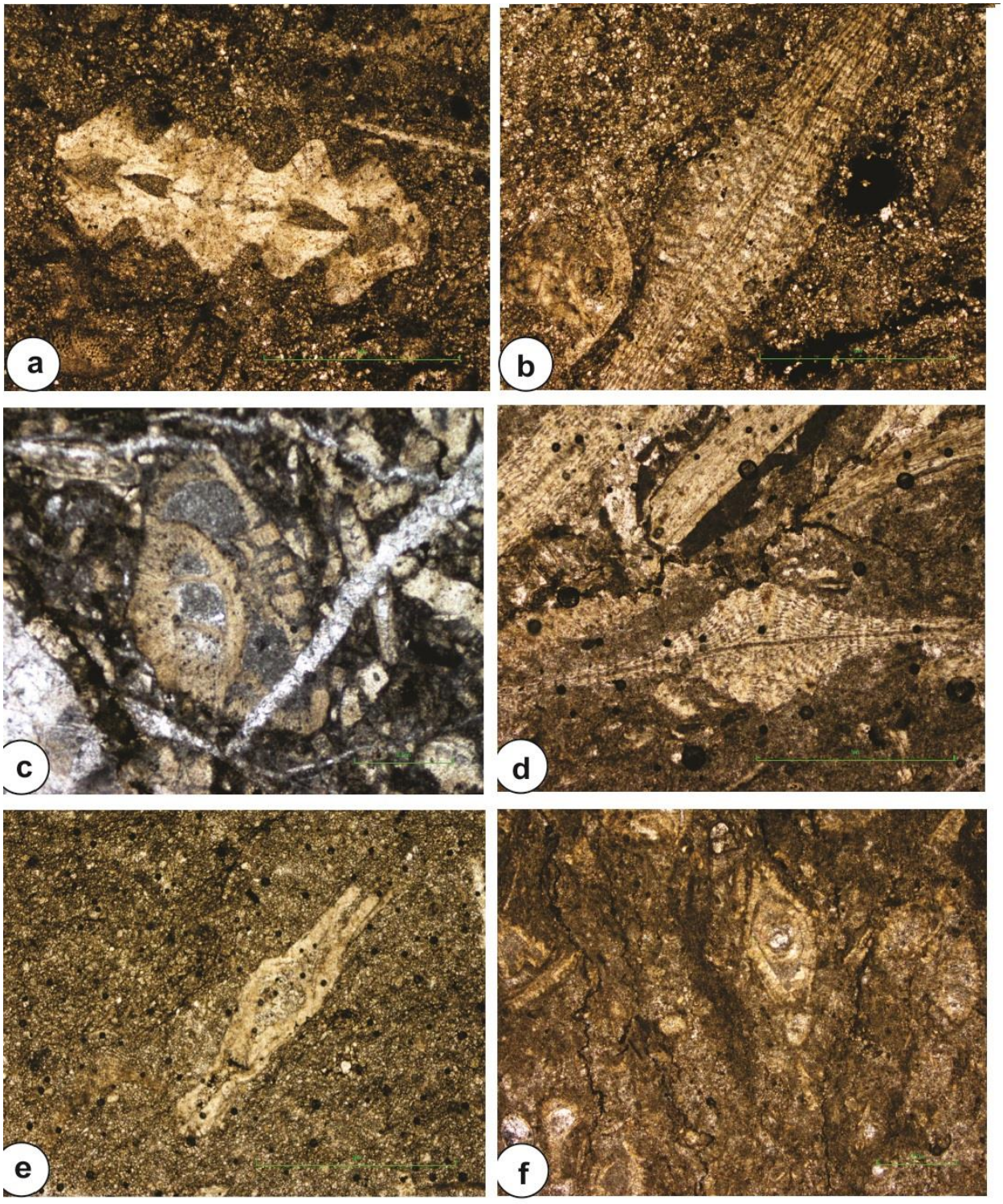

Plate 2 a) Assilina subspinosa, b) Discocyclina sp., c) Lockhartia conica, d) Discocyclina sp., e) Ranikothalia sindensis, f) Miscellanea julietta.

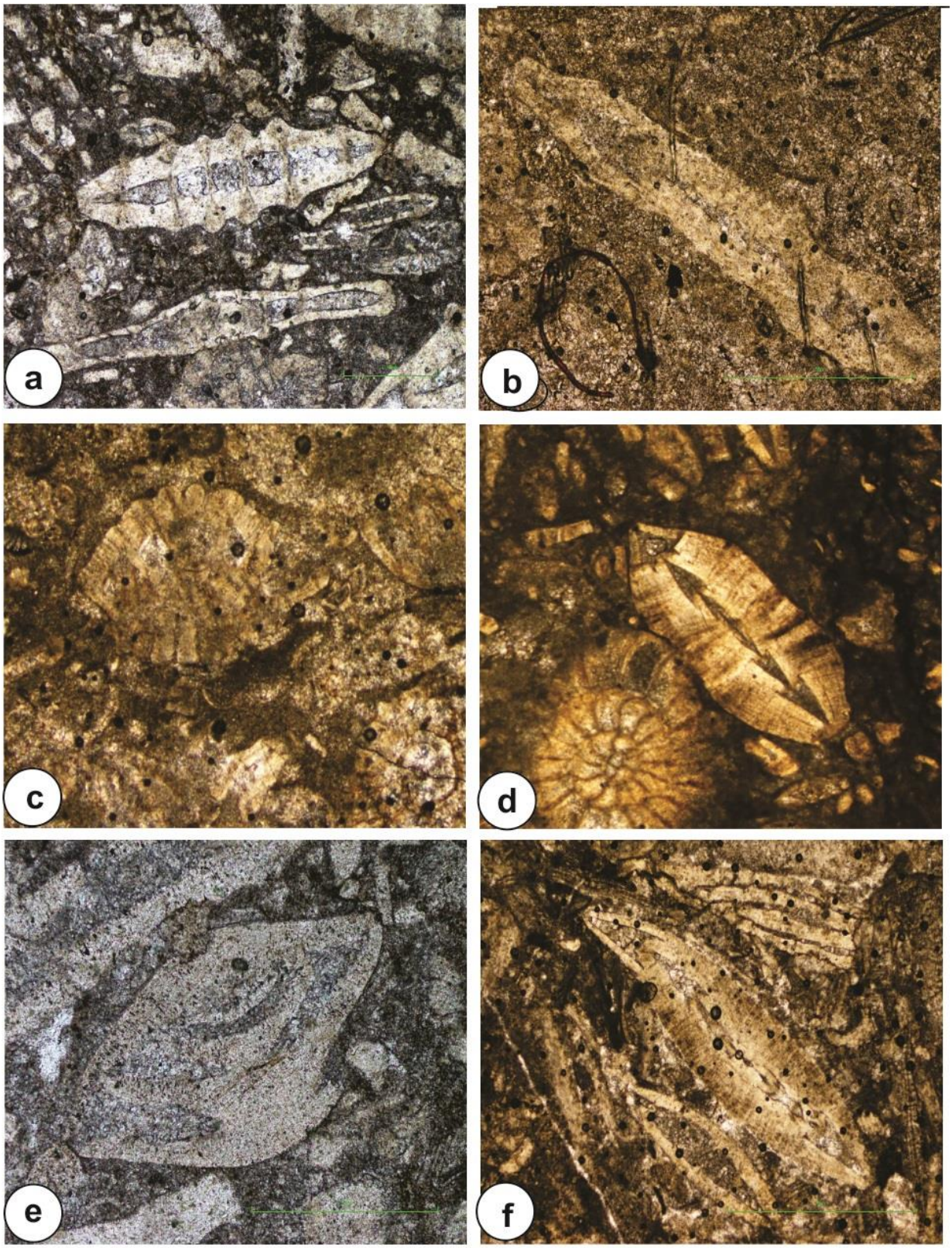

Plate 3 a) Assilina subspinosa, b) Operculina patalensis, c) Rotalia trochidiformis, d) Assilina Laminosa, e) Kathina selveri Smout, f) Assilina spp

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