

Preliminary results of lithofacies, biostratigraphy and depositional setting analysis of the Chorgali Formation, Salt Range, Potwar Basin, northern Pakistan

Muhammad, T. Khan and Osman, Salad Hersi

University of Regina, Department of Geology

Summary

The Chorgali Formation occurs in Kalla-Chitta area, Hazara basin, Kohat basin and Potwar basin in northern Pakistan and it is part of a very thick carbonate succession deposited in the Neo-Tethys Sea shelf. The formation conformably overlies early Eocene Margalla Hills Limestone and correlative Sakesar Limestone in the Hazara Basin and Potwar basins. The Chorgali Formation has an upper conformable boundary with late Eocene Kuldana Formation in the Hazara Basin and unconformably overlain by late Miocene Kamliyal Formation in Potwar Basin. The Chorgali Formation is well exposed in the study area; five outcrop sections were studied. The formation has an average thickness of 30 m in the study area. Field and petrographic analyses of the formation led to the recognition of four lithofacies units (Lf1-Lf4). These lithofacies units are: i) Milliolid-bearing mudstone (Lf1), ii) Bioclastic wackestone (Lf2), iii) Bioclastic packstone (Lf3), iv) Bioclastic wackestone to packstone (Lf4) and Planctonic-bearing mudstone (Lf5). The sedimentary features, sedimentary textures and fossil associations of these lithofacies suggested that deposition took place in homoclinal carbonate ramp environment. In the study area, the formation deposited in a low to moderate energy, normal marine environment. The Lf1 and Lf2 represent inner ramp, Lf3 and Lf4 mid ramp and Lf5 represents outer ramp. Absence of intertidal and supratidal facies suggest a subtidal depositional environment. The formation contains several larger benthic foraminifera that are deemed to be good for age determination. Examples of such kind of fossils include *Numulites globulus*, *N. atacicus*, *N. Mammillatus*, *Assilina granulosa*, *A. laminose*, *A. spinose*, and *Lockartia conditi*. These fossils indicate late Paleocene to middle Eocene. The fact that the Chorgali Formation fills in a stratigraphic position between Margalla Hills Limestone (early Eocene) and Kuldana formation (late Eocene, and also contains the above-mentioned index fossils, it can be reasonably indicated middle Eocene age for the formation.

Introduction

The Chorgali Formation is an early Eocene succession which is well-exposed in the Salt Range area of the Potwar Basin, N. Pakistan. This study focuses on the lithofacies, biostratigraphic properties and preliminary interpretation of the depositional setting of the formation. In the study area, the formation has an average thickness of 30 m, conformably overlies the Eocene Sakesar (Margalla Hills) Limestone and unconformably overlain by Miocene Kamlial Fm. (Jurgan and Abbas, 1991; Khatoon et al., 2001; Sameeni et al., 2013; Khan et al., 2017). The Chorgali Formation is economically important for hydrocarbon production and exploration in the region. The previous work has addressed both lithostratigraphic and biostratigraphic properties of the formation. However, these studies were either local or based on incomplete sections. The purpose of this study is to study the Chorgali Fm. in the Potwar Basin and nearby Hazara Basin. We are presenting here the sedimentologic and biostratigraphic properties of the formation in the Salt Range area which is part of the Potwar Basin. The data interpretation presented here are preliminary in nature and still in progress. Three sections (Loc. 1, 2 and 3, Fig. 1) were studied and the formation has an average thickness of 17m. The formation gets thicker northward (e.g., a 45m thick has been measured at the type section in the Chorgali Pass, the type section of the formation, Fig. 1). The thickness reduction in the study area is most likely due to erosion that has wiped out the stratigraphic section between early Eocene Chorgali Formation and the Miocene Kamlial Formation (a member of the Rawalpindi Group which belongs to the Siwalik deposits of the foreland basin). The Cenozoic stratigraphic succession of the study area is summarized in Fig. 2. The Chorgali Formation consists of bioclastic limestone with subordinate shale interbeds. The various lithofacies attributes, biostratigraphic properties and depositional settings are discussed below.

Fig. 1 Location of the study area. The three sections (1, 2 and 3) logged during this study occur in the southern Salt Range outcrops. Map modified from Jamal et al. (2015).

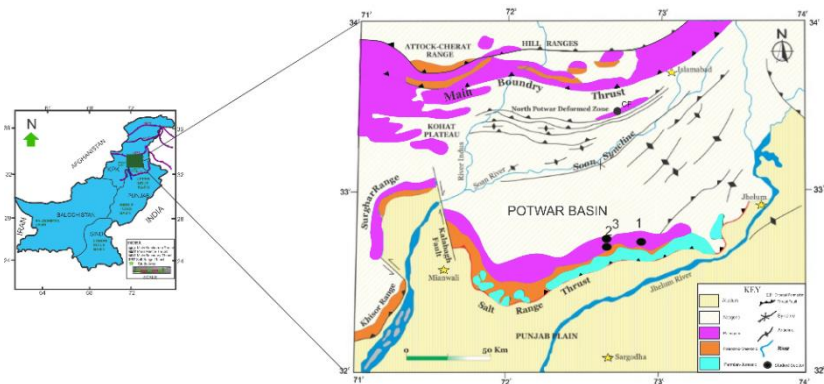


Fig. 2: Stratigraphic chart of the Cenozoic Era of the Salt Range, Pakistan. The Cenozoic succession unconformably overlies the Cretaceous. The Paleocene to Pleistocene strata consist of four groups of which the upper three are separated by prominent unconformities. The Eocene Chorgali Formation (asterisk) lies at the top of the Chharat Group, conformably overlies the Sakesar Limestone and truncated by the Pre-Rawalpindi Group (Miocene) unconformity. Chart modified from Ghazi et al., 2015.

ERA	PERIOD	EPOCH	GROUP	FORMATION
CENOZOIC	Pliocene Pleistocene		S i w a l i k	Lei Conglomerate
				Soan Formation
				Dhok Pathan Formation
				Nagri Formation
	Miocene	Late Middle Early	R a w a l p i n d i	Chinji Formation
				Pre-Siwalik Group unconformity
	Eocene	Middle Early	C h h a r a t	Kamial Formation
				Murree Formation
	Palaeocene	Middle Early	M a k a r w a l	Pre-Rawalpindi Group unconformity
				Chorgali Formation *
Sakesar Limestone				
Nammal Formation				
Post-Cretaceous unconformity				Patala Formation
				Lockhart Limestone
				Hangu Formation

Lithofacies properties of the Chorgali Fm.

The field and petrographic studies of the Chorgali Formation allows recognition of five lithofacies. Their brief descriptions, prominent fossil contents and inferred depositional hydrodynamic conditions are shown in Table 1.

Biostratigraphic dating

The samples collected from the three studied sections were studied under petrographic microscope and fossils were identified from the thin sections. Recognized larger benthic foraminifera (LBF) are deemed to be useful for age determination. Examples of such kind of fossils include *Nummulites globulus*, *N. djodjokartae*, *N. atacicus*, *N. mammillatus*, *Assilina spinosa* and *subspinosa* and *Lockartia conditi*. These fossils indicate an age range of late Paleocene to middle Eocene. The fact that the Chorgali Formation fills in a stratigraphic position between Margalla Hills Limestone (early Eocene) and Kuldana Formation (late Eocene), and also contains the above-mentioned index fossils, it can be reasonably indicated middle Eocene age for the formation.

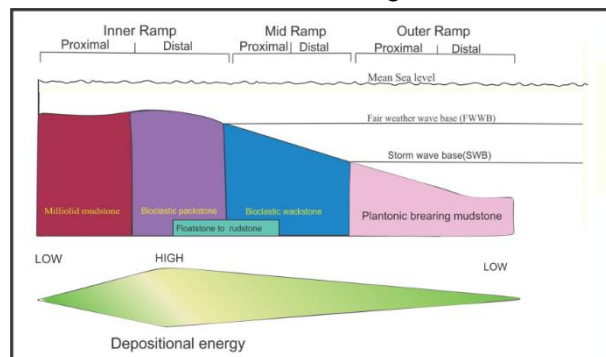
Table 1: Lithologic properties, fossil content and properties of the depositional environment of the Chorgali Formation in the study area.

Lithofacies type	Field properties	Petrographic properties	Prominent fossil content	Hydrodynamic properties
Milliolid mudstone (Lf1)	Off white color, weathers to grey medium to thickly bedded. Lower contact conformable.	Matrix-supported. Foraminifera, algae, bivalve, calcite vein	<i>Nummulities, Assilina, Lockhartia, Alveolina</i>	Low energy, subtidal
Bioclastic wackestone (Lf2)	Off white color, weathers to grey, medium to thickly bedded wackestone.	Matrix-supported. Skeletal fragments algae, lockhartia, bivalve, bioturbated,	<i>Assilina, Nummulites, Lockartia</i>	Low energy, subtidal
Bioclastic packstone (Lf3)	Off white color, weathers to grey, medium to thickly bedded. Larger foraminifera.	Matrix-supported. bivalve, brachiopods, gastropods.	<i>Assilina, Nummulities</i> algae and gastropods	Moderate to high energy, subtidal
Floatstone to rudstone (Lf4)	Light yellow to off white color, medium to thinly bedded limestone. Upper contact is eroded.	Matrix-supported.; Brachiopods, fora, bivalve	<i>Assilina, Nummulities, Lockartia, bivalves</i>	Fluctuating energy, subtidal
Planktonic-bearing mudstone (Lf5).	Off white, weathers to grey, medium to thickly bedded mudstone.	Mud-dominated planktonic organisms green Algae ostracodes	<i>Nummulities</i> bivalves	Low energy, subtidal environment

Depositional setting

The five lithofacies recognized from the studied sections (Table 1) provide a preliminary interpretation for the depositional environment of the Chorgali Formation. The formation accumulated in a low to moderately agitated ramp setting as shown in the figure below (Fig. 3) where lithofacies Lf1, Lf2 and Lf3, Lf4 represent inner ramp and middle ramp respectively. Absence of intertidal and supratidal facies give us indication of a subtidal setting.

Fig. 3: Depositional setting proposed for the Chorgali Formation in the study area.



Conclusions

Three sections that contain the Chorgali Formation were studied. The sections are located in the outcrops of the Salt Range area, Potwar Basin. We have identified the formation contains five lithofacies that include i) Bioclastic mudstone (Lf1), ii) Bioclastic wackestone (Lf2), iii) Bioclastic packstone (Lf3), iv) *Bioclastic* wackestone to packstone (Lf4) and Planctonic bearing mudstone (LF5). Larger benthic foraminifera are present in the formation and deemed to be useful biostratigraphically. They include different species of *Nummulities*, *Assilina*, *Lockhartia*, *Alveolina*, and *Planktonic forams*. These fossils and the stratigraphic position of the formation suggest a middle Eocene age for the formation. The chorgali Formation was deposited in a quiet to moderately agitated ramp environment. The Lf1 and Lf2 represent inner ramp, LF3 and LF4 represent mid ramp and While the presence of planktonic formas suggest that LF5 deposits in outer ramp. Absence of intertidal and supratidal facies suggest that deposition is entirely occurs in subtidal environment.

Acknowledgements

We extend our thanks for Dr. Dr. Shahid Ghazi (University of Punjab, Pakistan), Dr. Muhammad Haneef (University of Peshawar, Pakistan) and Dr. Ala Ghafur (University of Kurdistan, Iraq) for their help during field and/or lab work. The senior author thanks to his parents and brother (Mohammed Sohail Khan) for moral and financial support for my study. Two field assistants, Kamran Khan and Sohaib Khan, are also thanked for their help.

References

- Ghazi, S., Ali, S.H., Sahraeyan, M. and Hanif, T. (2015): An overview of tectono-sedimentary framework of the Salt Range, northwestern Himalayan fold and thrust belt, Pakistan. *Arabian Journal of Geosciences*, 8:1635-1651/.
- Jurgan H. and Abbas G. (1991): On the Chorgali Formation at the Type Locality, *Pakistan Journal of Hydrocarbon Research*; PJHR.,v3(1), p35-45.
- Jamal T. et al., (2015): Microfacies and Diagenetic Fabric of the Chorgali Formation in Bhuchal Kalan, Kallar Kahar, Salt Range, Pakistan: *Journal of Himalayan Earth Sciences* Volume 48, No. 1, 2015. P.14-25.
- Khatoon et al., (2001): The study of some gastropods fossils from Bradrar Bads (Chorgali Formation), Nurpur area, Salt Range (Punjab), Pakistan;v34, p105-111.
- Khan M.Z et al., (2017): Microfacies and Diagenetic Analysis of Chorgali Carbonates, Chorgali Pass, Khair-E-Murat Range: Implication of Hydrocarbon Reservoir Characterization; *PJG*; v 1(1), p18-23.
- Sameeni, S.J., Ahmad. A., Ahmad. N., and Ahsan., N. (2013): Biostratigraphy of Chorgali Formation, Jhalar Area, Kala Chitta Range, Northern Pakistan; *Sci-Int*, v.25(3), p567-577.