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DISCOVERY OF STROMATOLITES FROM THE NEOPROTEROZOIC BLAINI CAP CARBONATE, JANTAWALGAON, BHIMTAL AREA, UTTRAKHAND, INDIA

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ABSTACT

The present contribution deals with the discovery of stromatolites from the Blaini cap carbonate of the Nanital area from a locality which is called Jantawalgaon. The limestone horizon from which the stromatolite has been reported has a disputed stratigraphic position and therefore a detailed study helped in properly placing the unit where it belonged. This study includes detailed sedimentological analysis, facies analysis and sequence stratigraphic analysis which helped in properly positioning the litho-unit. The association of calcareous nodules and micro faults along with petrographic study provided the depositional environment for the Jantawalgaon limestone unit. Earlier this unit was placed within the Jaunsar Group but the present study suggests that this litho unit belongs to the Blaini Formation of the Krol Belt.

KEY WORDS: Stromatolites, Jantawalgaon Carbonate, Krol Belt, Blaini Formation, Bhimtal

INTRODUCTION

The northern state of India, the Uttarakhand, is bordered with Nepal in the east, China (Tibet) in the north, Himachal Pradesh in the west and Uttar Pradesh in the south.Uttarakhand is divided into two divisions, the Garhwal region on the west and Kumaon region in the east.

The Lesser Himalaya, a physiographic subdivision, is bounded in the north by Higher-Himalaya and in the south by Sub-Himalaya. Geologically, the Lesser Himalaya is bounded by two west to east running tectonic planes, the northern one is called Main Central Thrust (MCT), the southern one as Main Boundary Thrust (MBT). These tectonic planes are northerly dipping in Kumaon region.

Lesser Himalaya is divided into Inner Belt (in the north) and Outer Belt (in the south). Most of the rocks of Lesser Himalaya are Proterozoic in age bearing few marine transgressive units of Phanerozoic age. The younger horizons got tectonically sandwiched within the Proterozoic strata during the Himalayan Orogeny. These litho-units are confined to Permian, Cretaceous and Eocene in age. During several years of investigation in the Lesser Himalaya, a vexed problem of the geology of the Kumaon region relates to the existence of major volcanic flow units (the Bhowali Volcanics and the Bhimtal Volcanics) within the siliciclastic succession of Quartzite and associated facies. This succession has been designated as Nagthat Formation by Valdiya (1988). These litho-units are exposed in the vicinity of Bhowali and Bhimtal townships within the Nainital district of Uttarakhand. In addition to these litho-units, there is another pink coloured siliciclastic unit which is exposed in a number of road sections such as Nainital-Bhowali road, Bhowali-Jeolikot- Kathgodam road and Bhimtal-Kathgodam road sections. Due to its unique pink colour, this lithounit can be easily demarcated in the field.

The Nagthat Formation, the most noteworthy siliciclastic unit of the Jaunsar Group (Valdiya, 1980), is exposed in the northwest Kumaun Lesser Himalaya. This sequence consists primarily of orthoquartzite with minor amounts of synsedimentary basic lava flows. There are several points of views on its depositional environment. The Nagthat quartzite has been assigned a fluvio-deltaic environment by Rupke (1974), while Srikantia & Bhargava (1974) considered it to be molasse facies with no definite depositional environment assigned. Valdiya (1980, 1981)

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suggested that the Nagthat siliciclastic rocks represent shallow tidal sea environment. The Blaini Formation overlies the Nagthat Formation.

We report here the occurrence of columnar stromatolites in the Neoproterozoic Blaini Formation exposed in Jantawalgaon (lat. 29^{0}21'16.53" N and long. 79^{0}32'03.58" E) trending NW-SE which is 5 km away from Bhimtal town. In Jantawalgaon, dolomite limestone, sandstone, and shale are alternately exposed and characterized by severe shearing as the sequence is extensively jointed, folded, faulted, and contains a considerable number of siliceous and dolomitic veins. This horizon occurs just above the Nagthat Formation.

GEOLOGICAL SETTING

Auden (1937), Heim & Gansser (1939), Fuchs & Sinha (1978), Valdiya (1980) and Singh & Rai (1983) established the stratigraphy and geology of the Kumaun Himalaya. Mandal *et al.* (2016, 2019) conducted follow-up research on structural and tectonics to porvide a better understanding of the Lesser Himalaya. Das *et al.* (2021) gave a vivid idea about the tectono-metamorphic evolution of Lesser Himalaya.

Valdiya (1980) categorised Bhimtal succession under the Jaunsar Group. Pant & Shukla (1999) discussed the aspect of sedimentation of the Nagthat Formation. However, pebbly quartzite of Bhowali rests over the trap and may be equivalent to the Blaini Formation because of a typical bouldary and greywacke nature in association of grey sheared shales and limestone bands (Merh 1977; Shah & Merh 1978). General stratigraphy is after Validya (1980, 1988; Fig. 1). He mapped the Nagthat Formation under the Jaunsar Group and divided it into upper and lower formal units. Jantwalgaon succession overlies the Bhimtal volcanic and quartzites of Bhowali (Table 1), (Plate 1A,B).

STROMATOLITE: DESCRIPTION AND ITS SIGNIFICANCE

World's oldest trace of life is well preserved in the form of stromatolites. Stromatolites are biosedimentary structures that consist of layered mounds, columns, and sheet-like structures. They were formed by the deposition of calcareous layers by cyanobacteria and other microbial

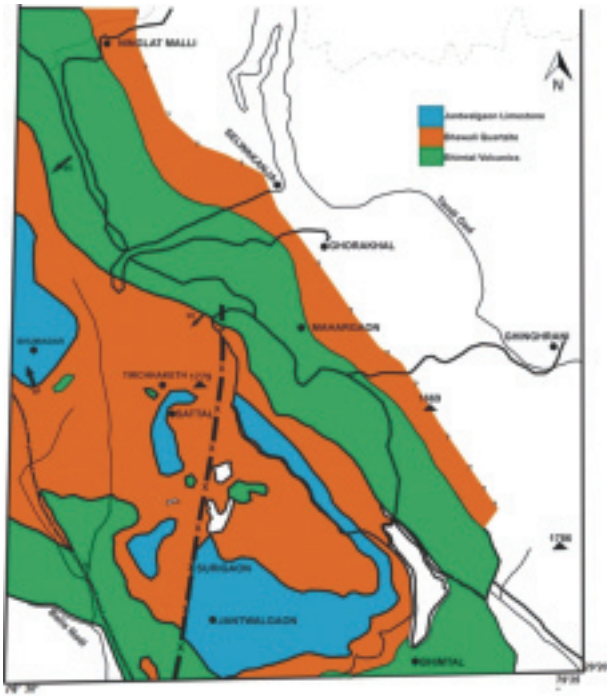

Fig. 1. Geological Map of the study area (Modified after Valdiya, (1988)

Table 1: Lithostratigraphy of the Nainital area (After Valdiya, 1988). The Position of Jantwalgaon Limestone Unit is questionable

Times rock unit	Formal Unit		Stratigraphic Unit
Mussorie Group	Tal Formation		
Krol Formation			
Blaini Formation			
Jaunsar Group	Jaunsar	Upper	Lariakanta Quartzite Formation (Nagthat Formation)
Bhumiadhar Formation (Chandpur Formation)			
Betalghat Formation (Mandhali Formation)		Lower	Jantwalgaon Limestone Unit ??
Bhowali Quartzite Unit			
Bhimtal volcanics Unit			--------- Salari Thrust----------
Amritpur granite (1900 + 100 m.y.)			----------MBT----------
			Lower Siwalik

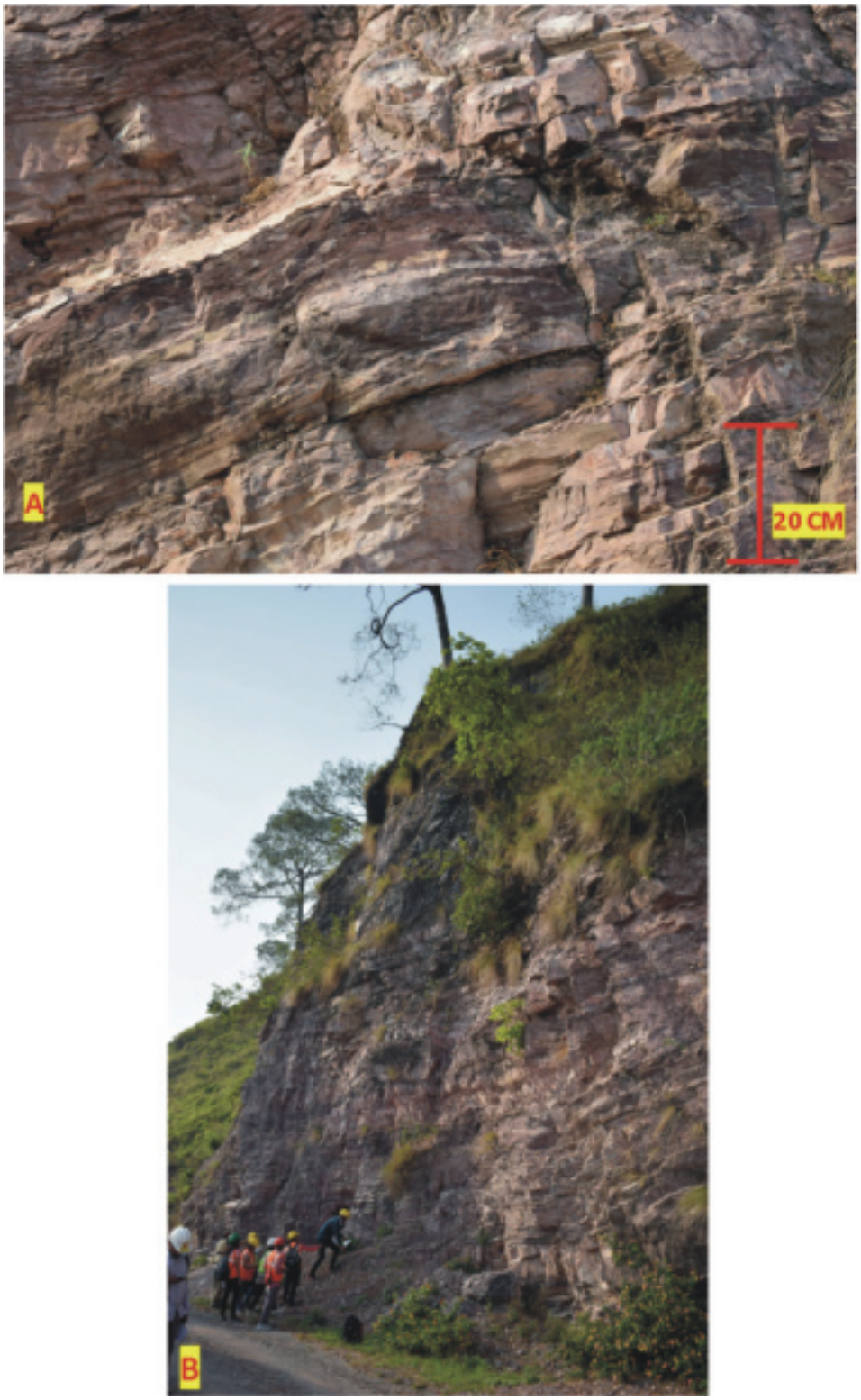

Plate 1: A. Field photograph showing carbonate beds in which columanar stromatolite is found (Scale=20 cm), B. The entire sucession of the Jantawalgaon carbonate unit exposed in a road section

Plate 2: A. Polished slab showing columnar stromatolite column
B. Close-up view of A with clearly visible dark and light lamination
C. Compressed calcerous nodules in chocolate coloured shales
D. Microfacturing in carbonate layers (Scale- Coin of 5 Rupees)

communities that lived in a variety of environments ranging from the shallow shelf to lakes, rivers, and even soils. Stromatolites are found all over the world is almost all ages of rocks but they are fairly common in Proterozoic rock sequences.

Specimens of pink to maroon colour dolomitic limestone that consist of stromatolite were collected in Jantawalgaon (Plate 2, A & B) which are characterized by micritic veins.

In sedimentology, palaeontology and stratigraphy, stromatolites have much usage. They are the indicators of-

- Shallow marine zones.
- Ancient depositional environments and paleosalinities,
- Age, particularly in Proterozoic succession.
- Ancient tidal ranges that help in determination of rates of sediment accumulation,
- Paleolatitudes of past biotic activity.

DISCUSSION AND CONCLUSIONS

There has been dispute about the stratigraphic position of this carbonate lithounit which is exposed in the vicinity of Jantwalgaon area. Valdiya (1988) considered this lithounit to be a lenticular lithounit lying between Bhowali quartzite and Betalghat Formation (= Mandhali Formation). Discussion with previous workers who have mapped the area suggested that this lithounit may be a part of the Nagthat Formation which is usually dominated by the pinkish to reddish sandstone. This confusion about the stratigraphic position was evaluated by us and on the basis of regional correlation and stratigraphic contact relationship, we suggest that this limestone unit characterizes a strong correlation with pink limestone of the Blaini Boulder Bed which have a stricking resemblance with the global "Cap Carbonate" as a de-glaciation event of the Varanger Glaciation. In our view, this lithounit occurs as an on-lap extension of the cap carbonate over the Nagthat Formation. Although this carbonate unit occurs as overlying lithounit above the diamictite lithounit of the Blaini Formation in the Pangot area as well as in the Kailakhan and Alukhet area which lies about 2 to 3km away, as a lateral distance from the Jantwalgaon area, where the diamictite is not exposed.

We therefore suggest that the following lithostratigraphic position for the Jantawalgaon Carbonate unit should be as follows (Table 2):

Table 2: Revised Stratigraphic succession of the Nainital area for different geotectonic units and sedimentary succession

Stratigraphic succession of the Jantawalgaon Carbonate unit	
Jantwalgaon Limestone	(Blaini Cap carbonate)
Pangot Member	(Blaini Diamictite)
Lariakanta Quartzite	Nagthat Quartzite
Bhumiadhar Formation	Chandpur Formation
Betalghat Formation	Mandhali Formation
Bhowali Quartzite	
BhimtalVolcanics	
----------Salari Thrust----------	
Amritpur Granite	

1. The occurrence of stromatolites in the Jantwalgaon area of Bhimtal is one of the most significant findings of recent times that clearly represent the occurrence of biogenic structures in the post-Nagthat succession of Lesser Himalaya.
2. Although, the stratigraphic position of the Jantwalgaon horizon is not very well defined in the field, however, the contact relationship with the existing lithology clearly shows that this horizon occurs above the Nagthat strata. The absence of Blaini diamictite in this area may be due to facies variation over large stretch or due to tectonic reasons.
3. A comparison of the Jantwalgaon carbonate faies with that of pink siliciclastic facies of the Nagthat Quartzite horizon and than that of the Bhowali Quartzite show very district facies from each other. Even in Petrographic thin sections, the type of grains and cements etc. look very different from each other, suggesting thereby that all these successions are way different from one other.
4. The stromatolites show well developed columns with laminations and are without any deformation (Plate 2, A & B).
5. The strata also shows the development of calcareous nodules which have been stretched due to ductility of shales (Plate 2-C).
6. A few shaly horizons show, microfaulting which suggests compressional brittle deformation in these horizons (Plate 2-D).

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