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NEWS AND NOTES

The Concretions from the Middle Siwalik Group of Eastern Himalaya around Buxa Tiger Reserve (BTR), Alipurduar, West Bengal, India

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Absolutely rounded large boulder rocks sporadically embedded within the sandstone has been reported by the local people as well as by Forest Dept. from the Bajekhola stream, a tributary to Jayanti River, flowing through Buxa Tiger Reserve (BTR), Alipurduar, West Bengal (Fig. 1). These are exposed along both left and right stream-cut sections of the Bajekhola stream (N26°41'44"/E89°39'01" to N26°41'46"/E89°38'59"). Isolated rounded boulders are often found on the stream bed also, which were probably eroded out from the host rock. Examples of such rounded boulder rocks are also available from (a) Sandu, Guizhou Province, China; (b) coast of South Island, New Zealand; (c) Southeast Utah; (d) Dorset, England; (e) Montana, USA, (f) Siwalik from Nepal, etc. Peoples often think them as dinosaur eggs, fossils, extra-terrestrial objects, or any human artefacts. The objectives of the present report are (i) to find out what the reported objects are? (ii) what is the probable reason for the origin of these objects? and (iii) to decipher the spatial extent of such occurrence.

The Buxa Tiger Reserve (BTR), covering 760 sq. km, has been founded in 1983 and later in 1987 declared as National Park. Jayanti River runs N-S through this park. Indo-Bhutan border and Sinchula Hill range lies on the north of BTR, and NH 31C runs parallel on the south of BTR. The entire region is covered by different types of forest ranging from deciduous to evergreen with reported 284 species of birds and 73 species of mammals. The region experiences wet summer and dry winter, where the temperature ranges from 12-21°C in winter and 27-32°C in summer and the region receives very high amount of rainfall during the monsoon (avg. 4100 mm). The area lies at the foothill region of Bhutan Himalaya and the terrain comprises alluvium, sandstone and dolomites. The area is divided into two main tectonostratigraphic zones, Sub-Himalaya and Upper Lesser Himalaya separated by Main Boundary Thrust (MBT) and the Sub-Himalayan sequence is separated from Quaternary alluvium by Main Frontal Thrust (MFT). The Sub-Himalaya consists of Siwalik Group (3-10 Ma) whereas the Upper Lesser Himalaya consists of Manas Fm./Jainti Fm. equivalent to Buxa Fm. (500-525 Ma). Further north the Phuentsholing Fm. (1800 Ma) and Pangsari Fm. (1700 Ma) of Upper Lesser Himalaya; and Lower Lesser Himalayan sequence of Shumar-Daling Group (1816-1865 Ma) occurs.

The area is accessible through the forest road and the Bajekhola stream bed (with permission and guidance from Forest Dept). The stream bed is mantled by different size of angular to rounded boulders (dolomites, sandstone, breccias, cherts, etc.) and coarse to medium sand with a few scattered wooden logs. Moving upstream, the course becomes narrower bounded by vertical cliffs of sandstone on both sides. The sandstone beds are dipping at 35-55° towards N-NE, which

Fig.1. The boulder-like rocks embedded within the medium grained Siwalik Sandstone aligning along the bedding plane and also found on the stream bed. The person standing is 1.57 m.

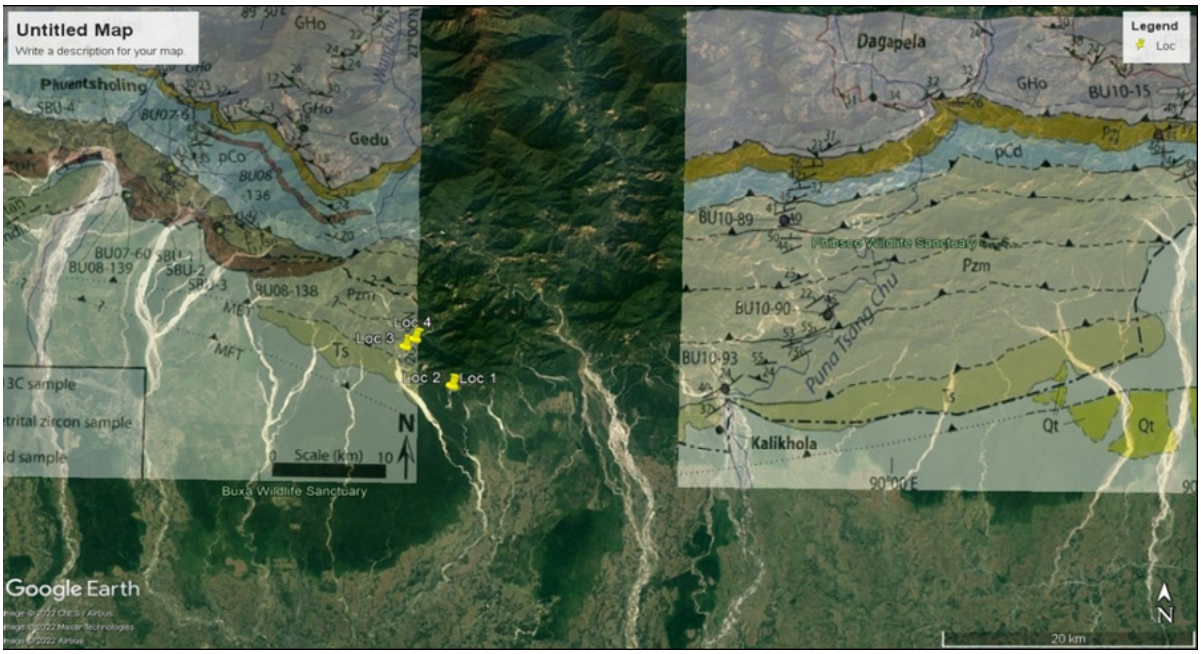

Fig.2. Ts on the map is the Siwalik Group and the locations of present study have been marked as Loc 1, 2, 3 & 4. The white dashed lines have been drawn (based on sandstone outcrop) to show the extent of Siwalik Group in the study area (modified after McQuarrie et al 2013 http://dx.doi.org/10.1016/j.gr.2012.09.002).

hosts the above-mentioned rounded boulders (Fig. 1). The host sandstone is submature and composed of medium grained with lenses of coarse grained sand. Pebbly sandstone occurs occasionally with fossilized woods. Thickness of the beds ranges from 20 to 120 cm with sharp basal contacts and occasional reactivation surfaces. A few beds have been amalgamated to form exceptionally thick beds. Planar stratification and tabular cross stratification are dominant with trough cross stratifications and channel lag deposits. Textural and structural make-up of the sandstone indicate fluvial deposition in very high energy regime with unidirectional paleocurrent. Lithological characteristics, lateral traceability and stratigraphic position of this sandstone resembles that it is equivalent to Middle Siwalik Group (Fig. 2). Around location Loc 1 and Loc 2 in Bajekhola stream, the boulder-like rocks embedded within the above-mentioned sandstone of Middle Siwalik Group have been witnessed (Fig. 2). However, the same has not been found in same sandstone around Loc 3 and Loc 4. Lateral continuity for the presence of these boulder-like rocks is absent, hence it has been pointed out that these rounded boulders is existing very locally.

The boulders are absolutely rounded, oblate and size ranges from 40 cm to 70 cm. They comprise medium to coarse grained quartz and dark mica, the grains don't have specific grain boundaries (through 10X hand lens), hence the shape of the grains could not decipher. The cementation material may be carbonate. However, these objects are harder in comparison to the host Siwalik Sandstone. They occur in specific orientations and are concentrated along the bedding planes often protruding from weathered cliffsides (Fig. 1). They are also characterized by stratifications and these stratifications' orientation and characters absolutely match with the stratifications found on the host Siwalik Sandstone (Fig. 3). At a few locations, it has been found that the boundary between the boulder-like objects and the host rock is not well-defined or sharp in nature, even absent. The same stratification characters and the absence of well-defined boundaries indicate that the boulder-like rocks are part of the host rock formed in-situ and have not been transported. All the above-mentioned facts about the boulder rocks associated with the thick sandstone beds of Siwalik Group indicate they are concretions (Fig. 3). 'Concretions are hard, compact mass or aggregate of mineral matter, normally subspherical but commonly oblate, disc-shaped, or irregular with odd

Fig.3. The characters of stratifications found on the boulder-like rock and host sandstone are same and boulder-like rock don't have sharp boundary contact with host rock indicating in-situ formation. Hammer is 35 cm long.

or fantastic outlines, formed by precipitation from aqueous solution about a nucleus or centre, such as leaf, shell, bones, or fossil, in the pores of a sedimentary or fragmental volcanic rock, and usually of a composition widely different from that of the rock in which it is found and from which it is rather sharply separated' *(Neuendrof, K.K., Mehl Jr., J.P. and Jackson, J.A.; Glossary of Geology, 5th Edu, American Geological Institute, Alexandria, VA, p. 134; 2005)*. They probably formed during diagenesis and shortly after deposition, when calcite rich groundwater circulating through the pores of the sediment. The calcite within the pores acted as cementing material to bind the quartz and mica together, giving rise to interlocking texture. The calcite rich groundwater was circulated from the dolomites of nearby Buxa Fm. In this case they probably formed by concentric growth, where the concretion grows on successive layers of mineral precipitate around a central core causing spherical concretions. However, detail petrographical and geochemical studies are required to decipher the exact reason for the formation of these concretions in Siwalik Sandstone. Further study on these concretions may decipher the paleoclimate and paleoenvironment of the Siwalik Sandstone more specifically.