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The Puzzle of the Girujan Clay Formation

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Abstract : *The Girujan Clay Formation of Miocene age belongs to Tipam Group . This Formation holds significance in the fact that it reaches upto 2300 meters in thickness at places, which is quite rare and is characteristically mottled in colour. The clay acts as a seal or cap for the oil fields preventing the oil from dissipating . However, not much study has been carried out in this formation as compared with its underlying Formations such as Tipam Sandstone Formation ,Barail Formation etc. The Girujan Clay has intervening sand bodies which are known to be bearing oil . It is dubious to believe that the origin of Girujan Clay is down to the usual fluvial processes . However, no author has been able to come up with a sound substitute regarding the origin of the unit. The paper presents a glimpse of the currently available opinions on the issue and by nature is a review paper.*

Keywords :Clay, Miocene, mottled, fluvial

Introduction : In Assam & Assam – Arakanbasinal area, Girujan clay Formation overlies a sequence of massive sandstone known as Tipam Sandstone and is overlain unconformably by Dupitila Formation. Towards the end of Tipam Sandstone deposition, there developed a series of N-S to NE-SW trending compressive structures in the basinalarea . During the growth of these structures, the Girujan Clay Formation was deposited in the synclinal lows . The name Girujan Clay was given by P.Evans after a small stream at Digboi in Assam. It belongs to Tipam Group of Miocene age. In Cachar area as indicated by seismic and well data from the Katakhalsyncline , the Girujan Clay Formation is named as Govindpur Formation. The Girujan clay Formation in the eastern and northeastern parts of the shelf was deposited in structural lows. The most prominent structural depression was formed in KumchaiManabhum area in front of the Mishmi uplift, where the Girujan clay Formation attains a thickness of about 2300 meters.

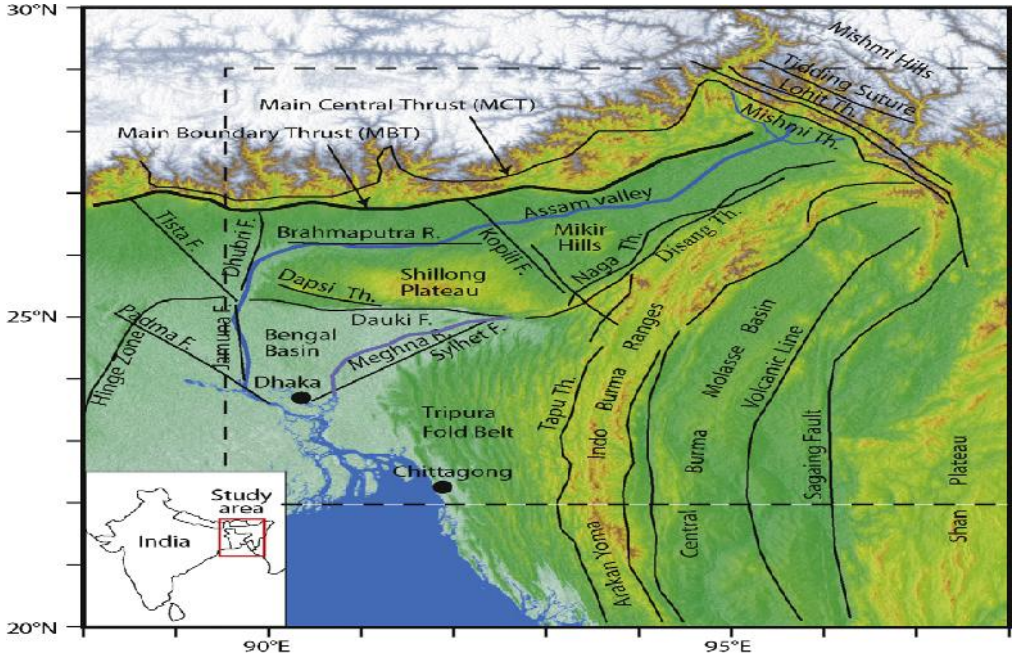

Fig 1: Major structures of the study area

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The Girujan Clay Formation is composed primarily of mottled clays and sand bodies. At places fossil wood and lignite are also found to occur within this formation.

There are questions that are still left unanswered regarding this Formation. They include

1) What is the source which can produce the huge deposits of Girujan Clay Formation in the order of 2300 m & 1800 m in the Upper Assam Shelf & Fold thrust belts respectively ?
2) What is the chemical characteristics of this Formation ?
3) What is the depositional environment ?

This paper aims at shedding some light into the geological puzzle at hand and a brief insight into the work done has been put forwarded.

Methodology : In order to illustrate the scopes of study in the Girujan Clay Formation, different research papers have been consulted and a brief review of the work has been presented.

Discussion: In the Shelf area, the GiruJan Clays forms a wide outcrop to the west of the Dhansiri valley between the latitudes $25^0 39'$ and $25^0 54'$ N. This outcrop has not been examined in any detail. The dips are very gentle and the total thickness of the beds exposed may not be more than 100 m to 200 m. About 300 m of Girujanclays , underlain by about 600m of Tipam sandstones have been reported to be exposed on the eastern fringes of the Mikir Hills, but no Girujans have been seen in the ONGC's Dhansiri Valley well at Barpathar. To the northeast, a thin band of mottled clays first appeared in the ONGC's Mariani well. This increases in thickness at the expense of the (Tipam) sandstones to about 720 m and becomes full fledgedGirujans from about Lakwa. Northeastwards , the thickness increases further to around 960 m in the OIL well near Jorajan and to 2560 m in OIL's well near Talap.

Northwestward, the thickness reduces rapidly over the Nahorkatiya oilfield and the Girujans have only a thin presence over Tengakhat. The Girujan clays thus have a significant presence in the shelf zone over only a limited area on the eastern(and possibly also the northeasterly) slopes of the gravity high which roughly outlines the Basement Spur.

In the Kohimasynclinorium, upto 700 m of Girujan Clays has also been locally recognized in the Hari and Lubha river area, and a thin development on the east flank of the Tukbai anticline. Elsewhere, the Tipams were believed to be overlain directly by the Upper DupiTilas. There is a good deal of lithological similarity between the Girujans and the Upper DupiTilas , and the possible presence of a thin strip of Girujans being present can not be ruled out altogether from this intervening area. Moreover, since the Surmas- Tipams – Girujans had already undergone some folding, uplift and erosion before the deposition of the DupiTilas, there could be a lot more Girujans (and Tipams) present in the synclinal and other depressions than is apparent from the pattern of surface outcrops. In fact, ONGC's Gobindapur well, on the eastern flank of the Badarpur – Hilara line of folding, is believed to have penetrated nearly 1650 m of Girujans, which is much more than what is prevalent in the regional outcrops.

The Girujan Clays represent inland deposition either as a thin rim to the Tipam Sandstones or in a deeper basin of its own, as in northeast Assam . At any point of time therefore, the Surmas were being deposited near the basin centre, the Tipam Sandstones towards the basin margin and the Girujan Clays further inland[1].

The Girujan assemblage contains some algal bodies of fresh water origin [2]. Within the heavy mineral suites, there is some indication of the source of the sediments. The rich chromite – zircon indicates that these may have derived their materials in part from the Barails or from the same source of the Barails. Chromite is associated with ultrabasic rocks and its occurrence in the Himalaya is known. Absence of typical marine plankton in the sediments suggest that they were deposited in a fresh water environment which is also supported by the estimated values of low formation salinity ranging from 1000-6000 ppm (equivalent sodium chloride salinity). The predominant red silty clay of the Girujan Clay Formation is a thick deposit with a large areal extent and uniform character. The red clay beds associated with fluviatile deposits are considered indicative of heavy rainfall followed by hot dry season [3]. The red colour of the clay is due to the oxidation of

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thedisseminated iron in sediments under these conditions to ferric oxide which causes staining of the sediments.

Epoch	Lithostratigraphic Groups	Units/ Formation	Thickness (m)	Major Lithological Types
Recent Pleistocene	Dihing	Alluvium[1] Dhekiajuli[1]	1300 – 2000	Unconsolidated sands with clay and lignite sands
		Unconformity		
Pliocene	Dupitila	Namsang Beds	0 – 1000	Poorly consolidated sandstones with clay and lignite sands
		Unconformity		
Miocene	Tipam	Girujan clays	100 – 2300	Mottled clays with sandstone lenses
		Tipam Sandstone (Upper Middle)		
		(Lower not subdivided)	300 – 500	Essentially arenaceous sequence
			100-200	Sand/Shale alterations sequence
	? Surma[2]		100-200	Arenaceous sequences Sandstones with shale and grit beds
		Unconformity		
Oligocene	Barail	Not subdivided	500 – 1200	(Upper part: Mudstone/shale with sandstone bed and coal bands) (Argillaceous sequence) (Lower Part: Sandstone with shale bands) (Arenaceous sequence)
Eocene[3]	Jaintia	Kopili Alterations	280-500	Splintery Shales with sandstone and fine grained sandstones with coal bands
		Sylhet Limestone (Prang,	350 – 450	Splintery shales with sandstone and limestone bands
		Nurpuh,	60 - 170	
		Lakadong)		
		Therria		Sandstone, calcareous sandstone and limestone
		Unconformity		
		Precambrian Granitic Basement		

Note: 1. It is difficult to distinguish these two rock units. From regional geological consideration, an unconformity could, however, be inferred between them.
2. Development of the Surma Group, which is extensive in the type area of Surma Valley in the Upper Assam shelf area. 3. Including Palaeocene rocks.

Tertiary succession of Upper Assam shelf sediments, after Handique et al (1989)

The sand layers in between Girujan Clay Formation represent high energy flows. Electrologs indicate the presence of channel fills, point bars and superposition of channels indicating frequent lateral shifts . The representative facies indicate presence of seasonal river systems that resulted in flood plain deposits with laterally shifting channels that were fed by seasonal discharge. Very little correlation exists between various sand bodies[4].

However, Bhattacharyya, 1979[5] suggested that the clay minerals are the products of subaerial weathering [6]developed over a mature topography. Good response to K saturation by the loss of expandable layers would indicate derivation of these clays from acid igneous/metamorphic rocks[7] while its poor response supports the contention that presumably these clays originated from alteration of some pre existing rocks or their reworked products . Accordingly possibilities of volcanism in early Girujan times or earlier can't be ruled out. Clay minerals formed by alteration of K rich mica tend to take in fixed K in the structure and as a result a greater part of the expandable clay layers collapse to form illite.

Conclusion: While most workers have inclined towards a fluvial origin for Girujan Clay, it is still dubious as such a thick deposit of clay is unlikely to occur through a simple fluvial process. Possibilities of large scale mud volcanoes can't be ruled out .In order to solve the problem of origin of Girujan Clay Formation, a thorough study is required. A clay unit extending in thickness upto 2300 meter is a quite rare phenomenon. Granulometricstudy , heavy mineral analysis , petrography of the intervening sandstone units, clay mineralogy study, geochemistry of the Formation and isotope analysis are needed to come up with a more detailed picture .

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