ON THE NATURE OF THE BASAL CONGLOMERATE OF THE SEMRI SERIES IN THE SON VALLEY

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Earlier workers who did pioneering study on the Vindhyans have nowhere mentioned the basal conglomerate of the Lower Vindhyans as a tillite. In recent years many workers have drawn attention to the glacial nature of the basal conglomerate. The present author, who has had the opportunity to map portions of the vast Son Valley tract, does not find any evidence of glaciation in the basal conglomerate. He has discussed the evidence of glaciation put forth by the recent workers, who refer to the basal conglomerate as a tillite, and finds that the evidence points only to a near-shore environment of deposition. He therefore supports the suggestion already made by the older workers that the present limit of the Vindhyans in the Son Valley more or less marks their original southern limit, and concludes that no tillites are present in the Lower Vindhyans.

INTRODUCTION

Pioneering study on the Vindhyans of the Son Valley was done by Mallet (1869), Oldham *et al.* (1901) and Auden (1933). These workers, although they had covered large tracts of country and gave a regional picture of the Vindhyans, had nowhere suggested or pointed out the resemblance of the conglomerate at the bottom of the Lower Vindhyans (which was referred to as the basal conglomerate) to a tillite or boulder bed.

In recent years Dubey and Chaudhary (1952), Chaudhary (1953), Ahmad (1955*a*), Law (1954, p. 69), Ahmad (1955*b*, p. 157) and Dubey and Mishra (1956) have all drawn attention to the glacial nature of the basal conglomerate of the Semri Series (Lower Vindhyans). The study of the basal conglomerate has assumed much importance within the past few years because of the light it may throw on a Pre-Cambrian (Vindhyan) glaciation in India. Although many processes other than glacier ice have been recognized as capable of forming till-like deposits, for example, landslides, earthflows, mud-flows, solifluction, flow till activity, subaqueous slumping and sliding, subaqueous deposition and deformation by floating ice, all the above workers are of the same view in regarding the conglomerate bed to be a tillite, formed by glacial origin. The occurrence of Pre-Cambrian boulder beds reported in other parts of the world like Australia, America and Africa might presumably have prompted these workers to such a conclusion.

Schermerhorn and Stanton suggest (1963) that 'tillite' is a genetic term and should only be applied to rocks whose glacial nature has been established beyond doubt. They use the term 'tilloid' for rocks of non-glacial origin which resemble tillite in appearance. The 'tilloid' formations of geosynclinal extent formed of submarine mud-flows, according to these authors, appear to be confined only to late Pre-Cambrian basins.

The main considerations in regarding the basal conglomerate as of glacial origin by these workers appear to be (1) the haphazard arrangement of the pebbles in the matrix and their unassorted nature with regard to size and weight, (2) absence of stratification, (3) high ranges in sizes of rock fragments, (4) undecomposed and remarkably fresh nature of the felspar grains and (5) presence of glacial striae or grooves.

The author during the field seasons of 1964 and 1965 mapped areas between long. 80° 55′ and 81° 30′ and lat. 24° 00′ and 24° 15′ in the Son Valley on the one inch to a mile Survey of India topographic sheets (Nos. 63 D/16, 63 H/4 and 63 H/8). The glacial nature of the basal bed of the Semri Series is discussed here with the observations the author made during the field work.

In the area under study the basal stage of the Semri Series is exposed at three places. All the three occurrences were carefully examined by the author. The best development of the basal conglomerate is seen in the Son river section at Deolond. It is also seen in the Banas river, but it is not so well developed. In the Bachaha and Kudri nullah sections to the NW of Tikwa at the bottom of the basal beds, in the place of a conglomerate, a few thin pebbly bands are seen.

Considering the various points raised by the proponents of a glacial origin for the basal conglomerate one by one, the author has not noticed any unassortment or haphazard arrangement in the basal beds anywhere as alleged by Law (1954). A perfect gradation in grain size, with the coarse conglomerate (or pebbly bands) passing through a sandstone and finally to a shale is seen in all the sections. The conglomerate everywhere grades to a sandstone and is profusely cross-laminated at the top. Ripple marks were also observed in the conglomeratic quartzite at Bakayili and in the Kudri and Bachaha nullah sections.

According to Van Houten (1957), 'the unsorted and unstratified nature of a deposit need not necessarily point to a glacial tillite. These features are also characteristic of mud-flows, the only difference being that these lack the facets which distinguish the boulders of glacial boulder beds. Mud-flows, it must be said, are characteristic features of volcanic activity. The porcellanite stage, though it is dominantly composed of volcanic material, the total absence of them in the basal stage, the perfect gradation in grain size, and its well-bedded nature, etc., precludes the possibility of their being "mud-flow" deposits.'

These, it must be emphasized, are applicable only to areas where the unassortment or haphazard arrangement is observed.

Newell (1957, p. 1572) states that 'submarine slide deposits are characterized by poor stratification and poor sorting and in stratigraphical record submarine slide deposits are much more abundant than are tillites'. Dott (1959), however, suggests that 'absolute criteria for distinction of sliding from glacial processes are difficult to discover. Both produce very poor sorting of clasts, both can conceivably produce faceting and striation of pebbles. Only a preserved glacial pavement overlain by extensively poorly sorted non-marine till-like material seems unequivocal. Several other examples have been challenged recently so that clearly most ancient "tillites" and glacial periods must be regarded with suspicion until critically re-analysed'.

Stratification, although apparently not seen well at the bottom because of the coarse nature of the pebbles, becomes quite characteristic not much above the bottom beds.

If the high ranges in the size of the fragments are considered, in a basin of deposition, sorting of clastic material according to size occurs in the zone of accumulation; the coarsest material is deposited close to the boundary of erosion (margin of the basin), farther away finer grained material is deposited. So far wherever the glacial nature of the basal beds is reported, they are all generally along the margins of the basin whether be it at Bundelkhand or in Son Valley. In the words of Mallet (1869) the Kymore conglomerate 'resembles the base conglomerate of the Lower Vindhyans in the Son Valley, and both are supposed to be littoral beds approximately marking the original limits of deposition'. Pascoe (1959, p. 511), who also expresses a similar view, states: 'Both in Son Valley and in Bundelkhand, there are indications that the present limit of the Lower Vindhyans is not very far from that of their original extension.' According to Borooah (1962, p. 75), 'In the northern area of the Son Valley the junction of the metamorphics suggests an original limit of deposition of the Vindhyan sediments in about their present positions. The bottom beds are constantly found at the boundary and certain coarse deposits at this horizon thicken to the south presumably because they represent fans built where torrential streams debouched from the high land to the south.' The presence of coarse clastics and the pronounced northward thickening of the sediments, observed by the author, only supports the suggestion already made by Mallet (1869), Pascoe (1959) and West (1962). This naturally accounts for the large-sized boulders present occasionally at the bottom of the basal beds.

If high range in sizes of the fragments is taken as a criterion for glacial nature, then in the area of study at the base of the Red Shale Series, the Semri Series and the Upper Vindhyan outliers boulders of the size of a foot or more are occasionally observed. Can all of them be regarded as of glacial

origin because they all contain boulders of big sizes? In that case three periods of glaciation are to be accounted between the Red Shale Series and the Upper Vindhyans.

As far as the undecomposed nature of the felspar grains is concerned, when the granite gneiss itself forms the source and basement rock for the basal beds, is it not natural for them to contain felspar grains derived from them? In the area of study even the beds of the porcellanite stage (Trappoids of Mallet) were found to contain grains of fresh felspar. In no case can they be regarded as of glacial origin. Freshness of felspar and dominantly coarse texture are also indicative of mechanical weathering, rapid erosion, short transport, rapid burial and little reworking.

The author has not noticed any faceting or any striae in the hard and otherwise lithologically very stable vein quartz pebbles which dominate the rest in abundance in the composition of the basal conglomerate. The cracks or fracturing, seen in the vein quartz which indicate disturbance prior to deposition, can very easily be mistaken for glacial grooves or striae. Gussow (1956, p. 235) suggests: 'Striations, faceted and striated boulders and polished surfaces are common features along the shores of large bodies of water that freeze in winter. They are not evidence of glaciation and can result from the rafting of seasonal ice by wind or tide. This action grinds off the boulders and pebbles in the frozen beaches and striates the bed rock.'

Over a greater portion of the Son Valley the basal bed is in the nature of a conglomerate, though at some places it is replaced by a breccia. Oldham *et al.* (1901, p. 13) record the occurrence of an angular breccia at Tarka (long. 82° 9′ E. and lat. 24° 23′ N.) in the eastern portion of the Son Valley which he regards to be an old talus deposit. According to him 'the disintegrated rock at the foot of the hill sides having been covered up by subsequently added deposits without having been washed away or sorted by stream action'. Auden (1933) also suggests a scree origin rather than transport by water for the breccia rock at Kheona. It is believed that during the deposition of the Vindhyans there stood to the south a land barrier—an ancient Archaean hill range (Satpura protaxis of Fermor) limiting the deposition of Vindhyan sediments to the south (Pascoe 1959). Had there been glaciation at that time there ought to have been widespread glacial deposits, like the Talchir boulder bed, throughout the Son Valley, which appears not to be the case.

It is interesting to note that the basal conglomerate at some places is mature mineralogically and at some places is immature. Bhattacharjee *et al.* (1964) state that in the whole of the Son Valley mineralogical (lithological) immaturity in the basal conglomerate is seen only near Sihawal (long. 82° 14′ E. and lat. 24° 34′ N.); to the east and west of it the conglomerate is mature. This statement is not in conformity with the occurrence of breccia reported by

Auden (1933) at Kheona to the east of Sihawal. The textural and mineralogical immaturity around Sihawal is explained by the authors by postulating a 'basement ridge' from which pebbles were dumped very near their sources (subaqueous sliding ?). It is tentatively concluded by the author that the breccia might have been derived from the sides of more or less steep hills very close to the margin of the basin.

The basal conglomerate near Sihawal was identified as a tillite by Chakrabarti (1961, pp. 68–70) on the basis of the following evidence: (1) disrupted framework of the conglomerate in which the pebbles float in a sand-clay matrix; (2) poor sorting; (3) lithological heterogeneity of the pebbles; (4) high percentage of pebbles with flat-iron shape; and (5) long axes of the pebbles showing a preferred orientation. Bhattacharjee *et al.* (1964) are of the opinion that 'of all these evidences only the flat-iron shape of the pebbles may be considered as diagnostic of glacial action'. According to them all the other evidence only shows that the conglomerate is immature. They have referred to it only as the basal conglomerate everywhere and not as a tillite.

The vast extent and lithological persistence of the basal conglomerate over large areas, the absence of slump structures or contorted fragments in them, rules out the possibility of their formation by submarine mud-flows as suggested by Schermerhorn and Stanton (1963, p. 231) for late Pre-Cambrian tilloids.

Conclusion

In the area the author covered, the bottom-most bed of the Lower Vindhyans is a mature conglomerate. This does not show any resemblance to a tillite or tillite-like rock. It is also found from published accounts that over a greater part of the Son Valley the bottom bed is a conglomerate. The earlier investigators who covered large tracts of the Son Valley and who did the pioneering work on Vindhyans have not pointed out the resemblance of the basal conglomerate to a tillite anywhere.

The coarse clastics, the pronounced thickening of the sediments northwards and the absence of any inlier of Lower Vindhyans to the south of their present limit amidst the Gondwanas (none has so far been found or reported), establishes the fact that the present limit was more or less the original southern limit of the Vindhyans. The author agrees with the view expressed by earlier workers that the basal conglomerate marks the marginal portion or original limit of the Lower Vindhyan basin in the Son Valley.

Despite the reported apparent resemblance of the basal conglomerate to a tillite in some isolated patches, viewed regionally, the conglomerate represents only a near-shore environment.

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