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SEDIMENTARY STRUCTURES IN PACHMARHIS AND BIJORIS NEAR PACHMARHI, M.P., INDIA

by

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Introduction. The paper deals with sedimentary structures met in the Pachmarhi sandstone and Bijori shales near Pachmarhi in M.P. which forms a part of Central India Gondwana basin. Medlicott (1873) and Crookshank (1936) were the pioneers who explored the geology of the area. However, there have been very few sendimentologic studies. The important one being Saxena (1962, 63, 64) and Verma (1971).

Sedimentary Structures. The Pachmarhi sandstone of the area show a number of well preserved sedimentary structures not seen in the Bijoris. These may be classified as (Potter, Pettijohn & Siever, 1972) :

(I) Current depositional

(II) Current erosional

(III) Deformational

(IV) Biogenic

(V) Chemical

I. Current depositional

(a) Bedding. The thickness of Pachmarhi sandstone varies from 1 to 15 feet though finer laminations are not absent. The lateral variability is not so distinguishable along strike but is quite evident along dip. It is generally of the order of a few inches and is rather irregular in small distances. It is often found to be decreasing towards north. The beds are usually massive in nature.

The bedding is defined by :

(i) compositional banding as evidenced by alternations of iron rich and iron poor bands. This feature at places intersects the bedding,

(ii) presence of pebbles which may be few or in large quantity. The thickness of the pebbly layers varies from about a few inches to more than seven feet (Fig. 1). This leads to the congeomeralic texture in the sandstone, and

Fig. 1

(iii) lithological variation due to the presence of ferruginous siltstone in lensoid shaped bodies parallely oriented to the bedding.

The bedding occasionally shows transgressive relationship. An interesting feeture is the occurrence of pebbles in a regular manner which according to Saksena (1963) are the result of cyclic deposition. The Bijoris show uniformly thick continuous beds having a laminated nature defined by the presence of large amount of micas. The bedding is also marked by compositional banding consisting of alternate dark brown to dirty earthy bands. At places streaks of iron further helps in deciphering the bedding plane. The strike azimuth and dip amount varies considerably in Bijori shales. They are generally found to be dipping north with amount varying between 20° to 47°. They appear to have been folded with the limbs dipping east and west at an angle varying between 34° to 47°.

The thickness of bedding varies from a few millimeter to about one centimeter. It shows a massive nature within. A number of peculiar marking are seen on the upper surface which are cuspate shaped with a dark brownish colouration. These have a crusty nature. The other common impressions consist of parallel lines which appear to be impression of some leaf. In addition to these a number of rounded bodies are contained in Bijoris which have been described under biogenic structure.

(b) Cross bedding. The Pachmarhi sandstones are characterised by the presence of extensive cross-beds. These have been studied by Saksena (1962) in detail.

The cross-bedding is simple and has two types of foreset beds :

(i) The foreset beds with uniform thickness meeting the bottom set bed at an acute angle. This has been referred to a Angular Cross Bedding.

(ii) The foreset beds which do not have uniform thickness—being more on the top than at the bottom. They have truncated top and asymptotic bottom. These have been referred to as Tangential Cross-bedding.

An explanation to the occurrence of both (i) and (ii) types of cross-bedded units in any area has been rendered by Allen (1970). According to him tractive force and the ratio of water depth at crest to water depth of a dunes frontal basin are the controls on a slip slope deposition of ripples and dunes. The crest of the ripple effects the flow separation on the slip slope producing a major turbulent eddy leading to the formation of regressive ripples in front of foreset. The tractive force now controls the movement of grains and if it is less the largest grain roll down travelling furthest and lead to formation of angular cross-bedding. The tractive force now increases and catapults bed load grains into the turbulent eddy "depositing" them on either the lower slopes of the slip slope or in front of it so that angular foreset bed becomes tangential and concave upwards. Similar effects are result of shallowing of basins in front of dune. All the above mentioned processes can well be expected in a shallow basin being fed by heavy loaded streams which have been regarded to have led formation of Pachmarhi sandstone.

An interesting feature in these sandstone is the presence of backset beds which were reported by Saksena (1963). According to Power Jr (1961) these are the result of "antidune" phase of transport of heavily loaded stream. The antidunes according to Allen are "sinuoidal beds and water waves of low amplitude that are broadly in phase with one another—travelling against current reading a wave length of 5-10 mts and a height of about 2 mts after which they break into a plane surface." If such a medium is considered to have led to the formation of these back beds the internal lamination would not be so well preserved as in the case of these sandstones. It therefore appears that a further probe is necessary for proper appreciation of these backset beds.

Ripple marks. Another interesting feature is the ripple mark like structure (Fig. 2) on the bedding plane. These are seen at a

Fig. 2

number of isolated spots preserved generally as hardened ferruginous layer. It is important to note that they point in the same direction of current flow, as the cross bedding occurring beneath them (Fig. 3).

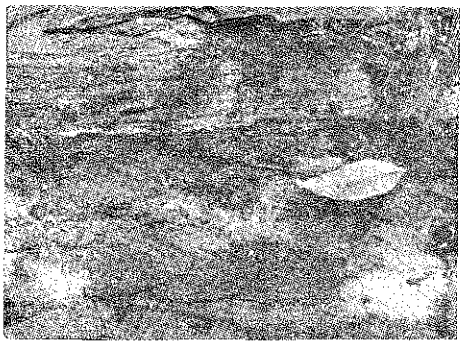

Fig. 3

It is normally expected that in a basin traversed by strong currents where heavily loaded stream deposit their material, ripple marks would not be present as they are formed in calmer conditions. But it is quite obvious that a heavily loaded stream current would gradually dissipiate in intensity so that ripple marks would be formed. The basin of deposition for Pachmarhi sandstone was undoubtedly shallow, about 10′ in depth (Saksena, 1963). Looking at the outcrop of Pachmarhi sandstone it is difficult to visualize the intensity of current flow being the same in such a large area. In a shallow basin presumably somewhat uneven too, a few places of quite deposition are not uncommon, so that the rare occurrence of ripple marks is not ruled out.

II. Current erosional

The only feature that is reflective of some erosion is the varying thickness of bedding along the strike section.

III. Deformational

Among these convolute lamination (Fig. 4) and some load structure (Fig. 5) resulting from differential loading of sandstone over

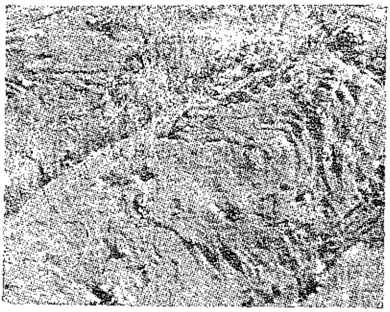

Fig. 4

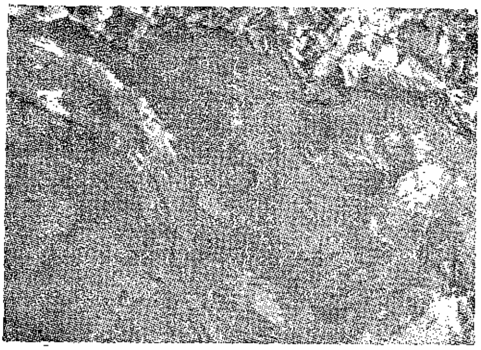

Fig. 5

softer siltstone are seen. It is distinguished by (i) the presence of continuous corrugated laminations and (ii) their involvement within a particular sedimentation unit.

The convolute lamination seen consists of a number of beds which do not show any thickening or thinning prominently. These have been a source of great deal of discussion and are generally ascribed to slumping or sliding under gravity at time or shortly after accumulation of deposit. According to Migliorini (1950) these are "result of dragged laminations due to expulsion of the contained pore water." During diagenesis which is very pronounced in Pachmarch sandstone pore water expulsion did certainly take place but as the sandstone is very coarse grained the permeability would be more so that the drag effect would be less. He is of the view that "convolution arise when formerly cohesionless sand grains become cohesive after deposition and respond to increased shearing due to higher current velocity." The silica cementation in these sandstones which is regarded to be syngenetic appears to have contributed to cohesion of these sandstones. Subordinate occurance of ripple marks in the area perhaps be due to the weekly hydroplastic material that on deformation yield convolute lamination due to vertical suction of the relatively flowing water over the crests and a downward pressure on the trough (Kuenen, 1953).

IV. Biogenic structure

Near the contact of Bijoris with the Pachmarhi sandstone a number of spherical bodies occurs with concentric outer layers. The cores of which are ferruginous and they are of two types :

(a) Consisting of concentric layers of iron rich and poor bands grading gradually towards the kernel into a pinkish coloured core. These concentric bands are interesected by ill defined black coloured radial lines. These bodies are generally elliptical in shape (Fig. 6).

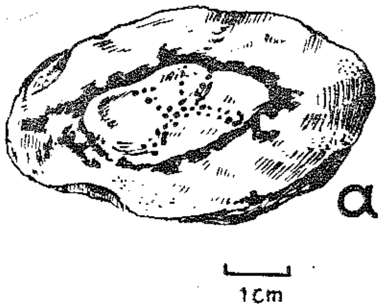

Fig. 6 (a)

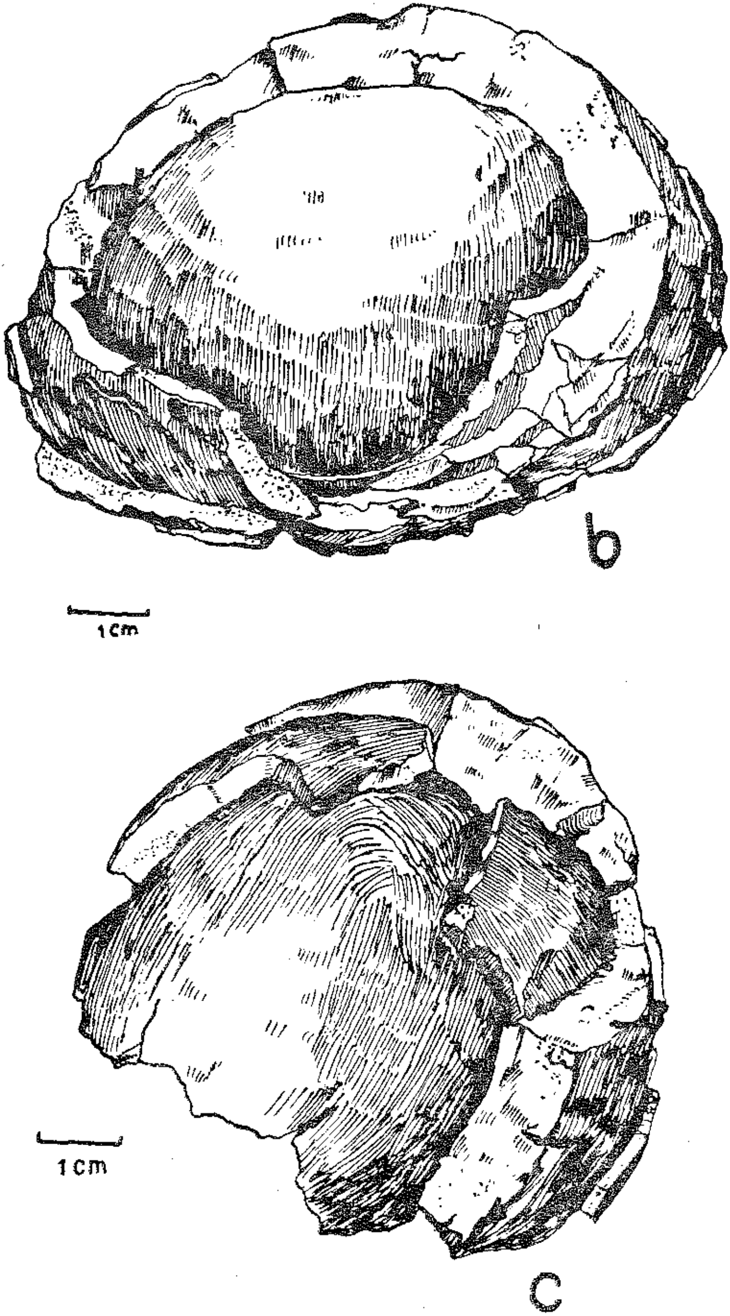

Fig. 6 (b) & (c)

(b) Consisting of broad layers with well rounded fine grained dark brownish black coloured core which has a massive nature. The thickness of the shells decreases towards the kernel and appears to be gradually grading into it.

A common feature in both of them is the absence of any structural aspects continuing into them from the surrounding rock and that the core always separates rather easily from the outer shells.

The former appears to be a some organic body because of the presence of both radial and concentric structure (personal communication from Dr. P. Kalia). The latter is mostly probably a concretionary body. This occurrence is being reported for the first time in India from the Bijoris.

V. Chemical structure

These are quite common in the Pachmarhi sandstone and are reflected on the surface as the result of differential weathering caused due to concentration of iron or silica related to diagenesis. On the way to Jatashanker along the valley hollow features are seen on the northern wall (Fig. 7). These are delineated by bedding and some

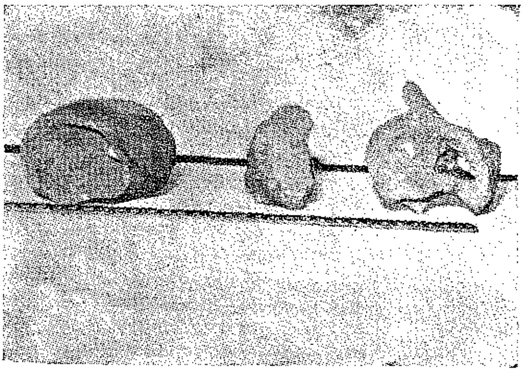

Fig. 7

other regular features (joints) running N-S and can be explained as the result of the Pachmarhi sandstone being composed of some different hardened material more resistant to weathering. On breaking the harder surfaces which have been brought to relief the fresh surface appears shiny. At places it has concentrated giving on almost vitreous appearance. A thin sector of these hardened parts reveals concentration of siliceous cements composed mostly of chalcedony and fine grained quartz though opal is not absent. The high iron content can be easily made out by hand specimen and the petrographic study reveals presence of hemetite and/or hydro-hematite.

Conclusions. From the aforesaid discussion the following conclusions may be drawn.

(1) The primary structural features like cross-bedding showing foreset beds meeting bottom-set beds in the Pachmarhi sandstones from an overloaded rapid moving streams. The monotonous occurrences of cross beds throughout the thickness indicating shallow basin of deposition attests testimony to a gradually subsiding basin.

(2) Post-depositional activities reflected by the occurrence of convolute limination suggest the prevalence of instability even during the deposition of Pachmarhi sandstone though on a relatively much restricted scale.

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