appreciable amounts in calcites diadochically replacing calcium. But the explanation probably lies in the fact that there is considerable amount of apatite (as bluish green prisms) in these limestones, which might have taken up any available Y and La. It can perhaps be assumed that elements like Y and La preferentially enter the apatite structure than that of calcite when both minerals co-exist in a rock.

A comparative study of the trace elements in the several calcite samples fails to reveal any significant differences which could account for the colour and its variation. It appears as if the colour is not essentially due to any particular element or elements detectable by the spectrographic technique.

Summary and conclusions: Samples of calcites with varied colours from calcite veins and crystalline limestones from Visakhapatnam district of Andhra Pradesh, India, were analysed spectrographically.

All the calcites are rich in Mg, Sr, Ba, Si and Al, while they contain Cu, Pb, Mn and Cr in significant amounts. Zn and V are present in some samples while Y, Sc and Mo are detected in just one sample.

Sr and Ba are considered to be present in the calcite structure substituting for Ca.

The presence of Si and Al, which are not common in calcites, is critically discussed in the light of the known geochemical behaviour of Si and C, and it is postulated that Si (and Al) can possibly substitute for carbon in the carbonate radical of calcite under metasomatic-metamorphic conditions.

V and Cr are surmized to be present as 'disseminated elements' in the calcite.

The absence of Y and La in calcites is attributed to their possible preferential entry into the coexisting apatite in the limestones.

No direct relationship between the colours of the calcites and the trace elements could be established.

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DEPOSITIONAL SIGNIFICANCE OF INTERNAL STRUCTURES IN TURBIDITES OF THE PARSOI FORMATION, SOUTH OF OBRA, MIRZAPUR DISTRICT, UTTAR PRADESH

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Introduction: An arc-shaped belt of Precambrian rocks classified by earlier worker as Transitions or 'Bijawar Series' (see Pascoe, 1950, p. 292; Krishnan, 1968, p. 168) extends east-northeast of Jabalpur and passing eastward through the Son Valley in Mirzapur district, apparently terminates in Palamau district of Bihar. These rocks form the northern part of the Peninsular Archaeans and possibly range from middle to upper Dharwar in age (Pascoe, 1950, p. 68).

The Transition series, renamed as the Parsoi formation (Mathur, 1954) in Mirzapur district consists essentially of argillites with occasional interbeds of dark massive sandstone. The overlying strata comprise a sequence mostly of limestone, banded-hematite-quartzite and brecciated quartzite in ascending order. The Parsoi formation came into prominence when Prof. F. J. Pettijohn, while on a visit to this area in 1957, pointed out for the first time, the presence of graded bedding in the interbedded dark massive sandstone at a place called Hathinala, a little east of the study area, and suggested that these could well be turbidites' (see Kedar Narayan, 1962). Subsequently, a part of the area was mapped by Kedar Narayan (*op. cit.*) who recognised in these rocks, besides graded bedding, a combination of sedimentary structures like flute cast, cross lamination and convolute bedding, and consequently, he also suggested that the Parsoi formation may genetically be classified as turbidites. The present paper on the Parsoi formation of the Obra area describes for the first time the sequence of internal sedimentary structures which have recenty been proposed as a diagnostic criterion of a turbidite. Further, on this basis, an attempt is made to interpret the possible environment of deposition of these rocks in the study area.

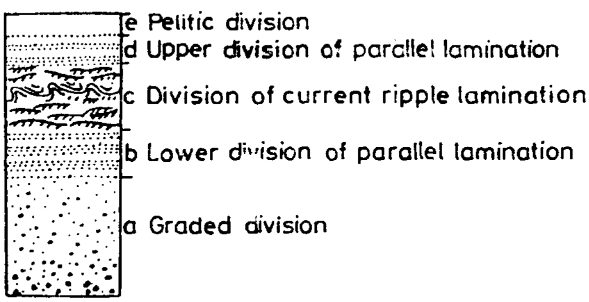

Figure 1. Complete turbidite sequence (after Bouma, 1962).

Internal sedimentary strucrures: Of all the known sediments trubidites form an important group. Turbidites are reported from all over the world irrespective of age from Precambrian to Recent (Bouma and Brouwer, 1964), but the ancient turbidites are of special interest for various reasons. Bouma (1962) as a result of an extensive study of turbidites of different ages from the maritime Alps of France proposed that a facies model of a complete turbidite is composed of five intervals, or more appropriately 'divisions' (Walker, 1967), in a fixed succession as follows from bottom to top (Fig. 1): graded division (*a*), lower division of parallel lamination (*b*), division of current ripple lamination (*c*), upper division of parallel lamination (*d*), and pelitic division (*e*).

The banded argillite unit of the Parsoi formation in this area exhibits at a number of places internal sedimentary structures which occur in a sequence as contained in the facies model. A complete sequence of the model from '*a*' to '*e*' seldom occurs in the study area; on the other hand most turbidites consist of truncated base cut-out sequences (Bouma, 1962, p. 50), especially of the types such as *b-e* and more often as *b-d* and *b-c*. Figure 2 is an illustration of a polished specimen of a banded argillite unit collected from the southeastern bend of Gurmura nala northwest of the village of that name (Lat. 24 22′N, Long. 83 02′E). It includes a sequence of sedimentary structures as follows in ascending order:

1. Lower division of parallel lamination (*b*)
2. Division of current ripple lamination (*c*)
3. Upper division of parallel lamination (*d*)

The lowest graded division *a* of Bouma's model is either missing from this area or the graded bedding in the sandstone is too faint to be seen. The three divisions show lithologic characters as follows:-

Lower division of parallel lamination (*b*): This division generally ranges in thickness from about 1 cm to 45 cm and is characterised by flat and parallel laminations which consist of medium to fine grey sandstone; the light coloured interadjacent parallel lamination, 3 to 6 mm apart, consist relatively of clean sand. The sandstone tends to show a crude gradation from medium-grained in the lower part to fine-grained upwards.

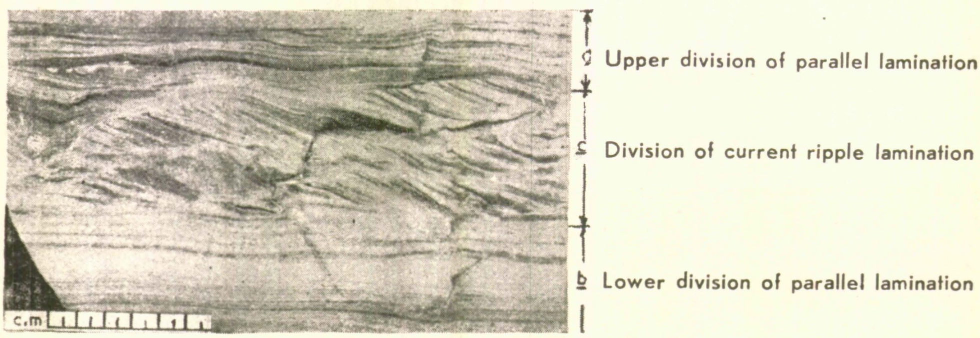

Figure 2.

Division of current ripple lamination (*c*): This interval recognised by the presence of current ripples is about 1 cm to 40 cm thick. The parallel laminations of the underlying division gradually pass upwards into a unit characterised by ripple drift lamination. The forset laminae of ripple drift are clearly visible on the right end of this division (Fig. 2). The ripple drift is mostly truncated towards the upper part and occasionally, such as in the middle part of the division in Fig. 2, the forsets of the ripple laminae are slightly oversteepened or deformed resembling convolute ripple laminations (Bouma, 1962, p. 137). Further upwards the ripple amplitude decreases and ripples give place to parallel laminae. Lithologically, the current ripple laminated division is a very fine sandstone.

Upper division of parallel lamination (*d*): This division which corresponds to Bouma's division (*d*), varies from 3 mm to 5 cm in thickness. The underlying division of current ripple lamination changes gradually upwards into a division characterised by flat and parallel laminations. The laminations are clearly visible, and consist alternatingly of very fine yellowish sandstone and micaceous grey sandstone. These laminae are closely spaced in the lower portion but gradually become apart and less distinct upward. The laminae seem to be overlying on the truncated surface of the underlying division *c*.

The uppermost division (e) in the Bouma's facies model consists mostly of fine silty to clayey pelite but it seldom occurs in these rocks.

Possible depositional environment of Parsoi trubidites: Bouma's (1962) definition of a complete or truncated turbidite has achieved widespread recognition and apprai-sal in recent years (Hubert, 1966; Walker, 1967), inasmuch as the presence of these divisions, all the five, or fewer than five, occurring in a sequence from a through e, could well be regarded as a fairly definitive criterion for deposition from turbidity currents (Walton, 1967, p. 306). Besides this diagnostic sequence of internal structures, the deposits of turbidite show a remarkable gradation in size from coarse to fine both horizontally along the length of the basin away from the proximal end and vertically at any one locality (Kuenen and Migliorini, 1950). A turbidite formation, therefore, is generally similar, though not necessarily identical, throughout the length and breadth of the basin. It can be understood, following Bouma's (1962, p. 98) depositional model, that at the outset the deposit of a very large turbidity current is essentially sandy and coarse and contains all the five divisions belonging to the complete sequence type (*a-e*). As the coarseness of the material and the velocity decrease in the current direction the thickness of the lowermost division (a) decreases and at a certain position, the velocity is so low that the laminated layer of fine sand is laid down at the bottom resulting in the deposition of truncated base-cut sequence *b-e*. The process of decreasing velocity and size of the sediments goes on as turbidity current advances with the result that the base-cutout sequence types *c-e, d-e* and e will be formed successively in the down current direction. In the transverse section of the current, at every position along its length, the same factors which decrease the velocity and particle size are operating, and thus the same succession of the sequence types and decrease in size may be formed. From this depositional analysis it follows that a turbidity sequence is more sandy at the proximal end containing thicker and more frequent interbeds of coarse sandstone, whereas it becomes by and large pelitic in the down current direction at the distal end with relatively fewer and thiner interbeds of fine sandstone. The two turbidites have been distinguished as 'proximal turbidite' and 'distal turbidite' respectively (see Walker, 1967).

The Parsoi turbidites of the study area, as discussed earlier, are essentially pelitic lithologically. Appropriately, Bouma's all the five divisions seldom occur in a turbidite in this area; instead base cut-out sequences are more common in most turbidites, particularly the types from *b-c* and *b-d* (Fig. 2). These characteristics, as also most of those outlined by Walker (1967, p. 32), seem to favour a distal environment for the deposition of Parsoi turbidites.

The internal sedimentary structures corresponding to the five divisions of a turbidite, like any other depositional structure, are a function of flow regime (Walker, 1967) and can be interpreted in terms of available grain size, velocity and deceleration.

Of the three divisons of the Parsoi turbidites shown in Fig. 2, the lower division of parallel lamination (b) corresponds to plane bed with grain movement and has been ascribed to development in the lower part of the upper flow regime. The overlying division of current ripples (c) is analogous to the deposition in the lower flow regime. Division (d) consists of very thin interlaminations of fine silt and mud and, according to Walker (1965), the upper division of parallel lamination is produced, perhaps by continued slow fall-out of material from higher layers in the current through a laminar layer which develops over the floor.

The present paper forms a part of the detailed study of the structure and sedimentation of the Parsoi Formation which is currently under progress.

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STUDY OF THE DISTRIBUTION OF RADIOACTIVITY IN MINERALS OF PENINSULAR INDIA

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Peninsular India is made up of the Archaean gneisses and schists, intrusive igneous rocks and Precambrian sediments, the latter including Dharwarian, Cuddapah and the Vindhyan formations. The distribution of radioactivity in some of these formations is discussed here. In general, primary accessory minerals are responsible for the bulk of the radioactivity of granitic and intermediate rocks; zircon, sphene, apatite, allanite, xenotime, monazite etc. Other possible contributors are hematite, columbite, ilmenite, rutile etc. The uranium and thorium contents of any one mineral species in a particular rock may vary greatly from grain to grain. Metamictization also plays a major role; for instance, a difference in radioactivity of as much as ten times may appear in metamict and non-metamict zircons from the same rock (Larsen and Phaire, 1954). There are also large number of minerals that are found to be radioactive owing to the mechanical inclusions of other radioactive