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Primary sedimentary structures in the porcellanites of Panda Valley, Bhaunathpur, Lower Vindhyan Basin, district Garhwa (old Palamu), Jharkhand

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ABSTRACT

Panda Valley consists of a thick pile of sediments in which there are three distinct porcellanite horizons, Lower Porcellanite (LP), Middle Porcellanite (MP) and Upper Porcellanite (UP), with abundant sedimentary structures. The principle types of sedimentary structures noted in the Porcellanite Formation are discussed and an attempt has been made to interpret its depositional environment. The sedimentary structures are suggestive of deposition of sediments in low to moderately high energy, shallow to moderately deep waters in moderately stable tectonic environment.

INTRODUCTION

The Vindhyan Supergroup is the largest Purana basin of the sub-continent and is one of the best preserved Proterozoic sedimentary sequences. The Vindhyan basin covers a large area in the eastern, central and the western India. Nearly four percent of the total basin area covering the eastern extremely falls in Bihar and Jharkhand, where lower two sub-divisions of the Vindhyan Supergroups are exposed. The Bhaunathpur area of the Garhwa district forms the southwestern part of the Vindhyan basin in Jharkhad. As for as age of the Semari Group is concerned, it is variable. Tugarinov et al. (1965) assigned 1400 Ma age for the Lower Semari and 1140 Ma for Uper Semari. Nautial (1986) assigned Upper to Middle Algonkian age for Semari (940-1300 Ma) while in 1988 assigned Late Algonkian (900-1000 Ma).

Different types of primary structures recognized in the porcellanites provide direct evidence about their depositional environment and lithification. A systematic description of primary structures in porcellanites from Bhaunathpur area has been presented here. The purposes of this paper are to establish (i) the condition of deposition and (ii) the dynamism of the environment of chemical precipitation of porcellanites that developed a variety of primary structures.

The Porcellanite Formation of the Panda Valley area (83°32'30" to 83°41'00" N latitudes and 24°27'30" to 24°30'00" E longitudes, Survey of India, Toposheet No. 63p/11) forms the easternmost extremity of the lower Semri rocks of the Son Valley (Fig. 1). Genesis of the porcellanites has been debated for a long time. Hatch and Well (1926) said that the porcellanites were formed by silicification of tuffs. Homes (1928) said them as thermally metamorphosed rocks.

Oldham et al. (1901) suggested volcanic origin for these rocks, which was subsequently supported by several workers (Auden 1933; Mehrotra and Srivastava 1977). However, Mehrotra and Srivastava (1977) noted that cross-laminations are very rare in porcellanites of central Son Valley region, but Dube (1982) and Tiwari (1987) have reported frequent cross-laminations in the Panda Valley around Ketar and Nawadih villages. Ahmad (1962) suggested glacial origin for these rocks. However, Dube (1982) and Tiwari (1987) observed solfateric action responsible for formation of porcellanites, which are silicified shales.

The sediments show distinct primary sedimentary structures. The primary structures indicate normal order of superposition of various litho-units, i.e., the younger in the dip direction.

The important primary features commonly present in porcellanites are massive bedding, bedding, parellel-laminations, cross-laminations and rain prints etc., and some diagenetic features like sag structure and tectonic breccias. These structures provide clues to depositional environment (Gross 1972). Folding and jointing are very common in those rocks.

STRATIGRAPHY AND LITHOLOGY

The Semri Group of the Lower Vindhyan is underlain by Archaeans and overlain by the Kaimur Group of the Upper Vindhyans. It is divided into the Basal Formation and Porcellanite Formation. The Porcellanite Formation, the second oldest unit of the Semri Group, conformably rests on the Basal Formation (Table 1). It contains three distinct porcellanite horizons *viz.* Lower Porcellanite (LP), Middle Porcellanite (MP) and Upper Porcellanite (UP),

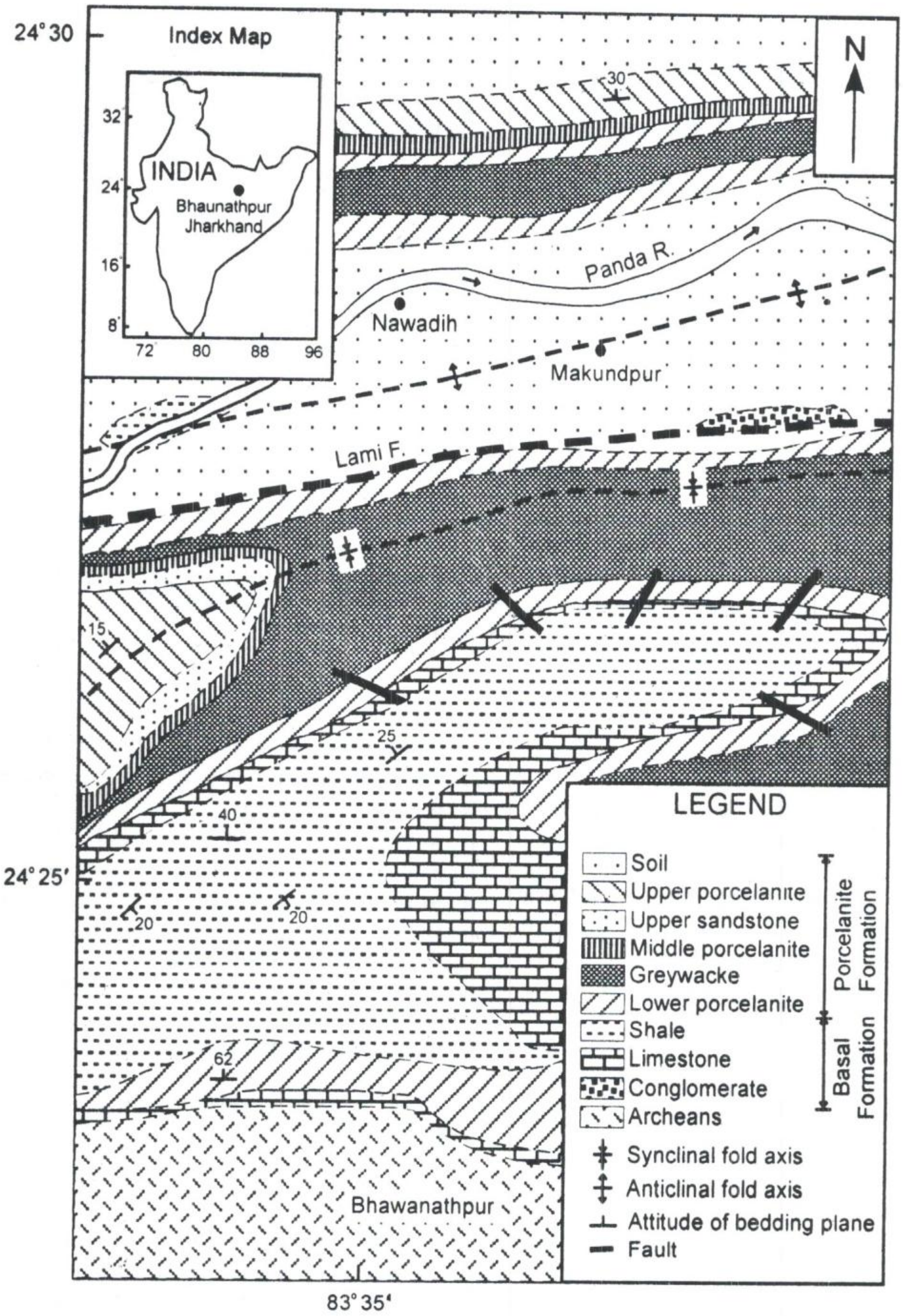


Fig. 1: Location and geological map of Bhaunathpur, District- Garhwa, Jharkhand, India.

Table 1: Stratigraphic succession of the Panda Valley, Garhwa, Jharkhand.

Vindhyan Supergroup	Semri Group	Porcellanite Formation	Upper Porcellanite (120 m)	1140 Ma
			Feldspathic sandstone	
			Middle Porcellanite (15 m)	
			Grewacke	
			Lower Porcellanite (80 m)	
			Shale	
		Basal Formation	Kajrahat Limestone	
			Basal Sandstones and Conglomerate	1400 Ma

which are separated by sub-greywacke and feldspathic sandstone beds, respectively. The best exposure of the porcellanite rocks are seen near the villages Newadih and Ketar. The Lower Porcellanites are hard, tough and compact and are characterized by complete absence of joints. They are about 80 m thick and are best exposed in the scarp section north of the Panda Valley and Muskania Hill. The Middle Porcellanites, unlike the lower one, has a glassy appearance and show splintery fractures. They are about 15 m thick and are well-exposed to the northwest of the Singhitali Village and also in the Panda Valley. Numerous joint sets showing secondary mineralisation form the characteristic features of this unit (Fig. 2a). The Upper Porcellanites are extremely tough and fine-grained rocks varying in surface appearance from argillaceous to nearly opaline and smooth. They are the thickest of the three bands (about 180 m) and are present in the northwest portion of the Panda Valley. The colour is grey to dark grey. The individual sedimentary units of these rocks are massive (thickness varying from 25 cm to 2 m), parallel laminated (1 to 4 mm thick, Fig. 2d) or bedded (1 to 1.5 cm, Fig. 2e). Cross laminations (Fig. 2f) are best developed to the northeast of the Ketar Village.

SEDIMENTARY STRUCTURES

The primary sedimentary structures observed in the porcellanites of the Panda Valley are:

(a) Massive bedding
(b) Parallel laminations
(c) Parallel bedding
(d) Cross-beddings (cross-laminations)
(e) Rain prints
(f) Sag structure
(g) Intraformational breccias

Massive bedding

Thick homogenous beds, often devoid of internal structures, have been described under this heading. Massive bedding is quite common in the Lower as well as in the Upper Porcellanites (Fig. 2a and b). Such rocks are not persistent. They often break with conchoidal fracture.

Parallel laminations

Parallel laminations are very common features of these porcellanites. They are present in both in the Lower and the

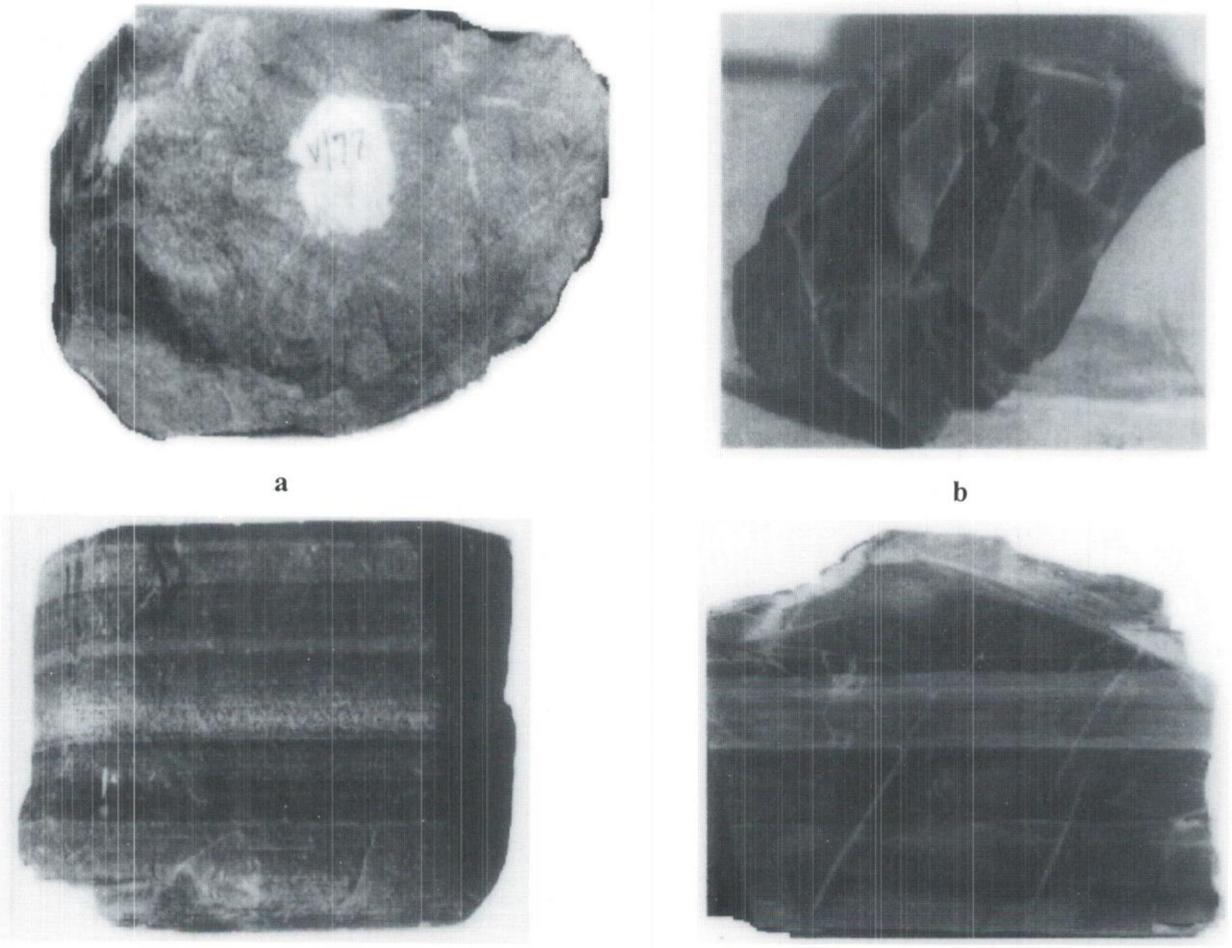


Fig. 2: a and b- Massive Porcellanites, c and d- Parallel Laminated Porcellanites (Fig. continued to the next page).

Upper Porcellanites. They are persistent and have thickness ranging from 0.5 to 1.00 mm. At places 0.3 cm to 1 cm thick lenticles occur between the horizontal beds. The colour varies from white to buff. These laminations, according to bedding-lamination terminology modified after Reineck and Singh (1967), are of the type parallel, plannar and continous (Fig. 2c and d). There is no textural variation in between the individual lamine. In upper porcellanites, the laminae are present within the individual bands, and their colour vary according to the colour of the bands. The thickness of laminae varies from 1 to 3 mm. Here also the lamination is due to textural variation.

Parallel bedding

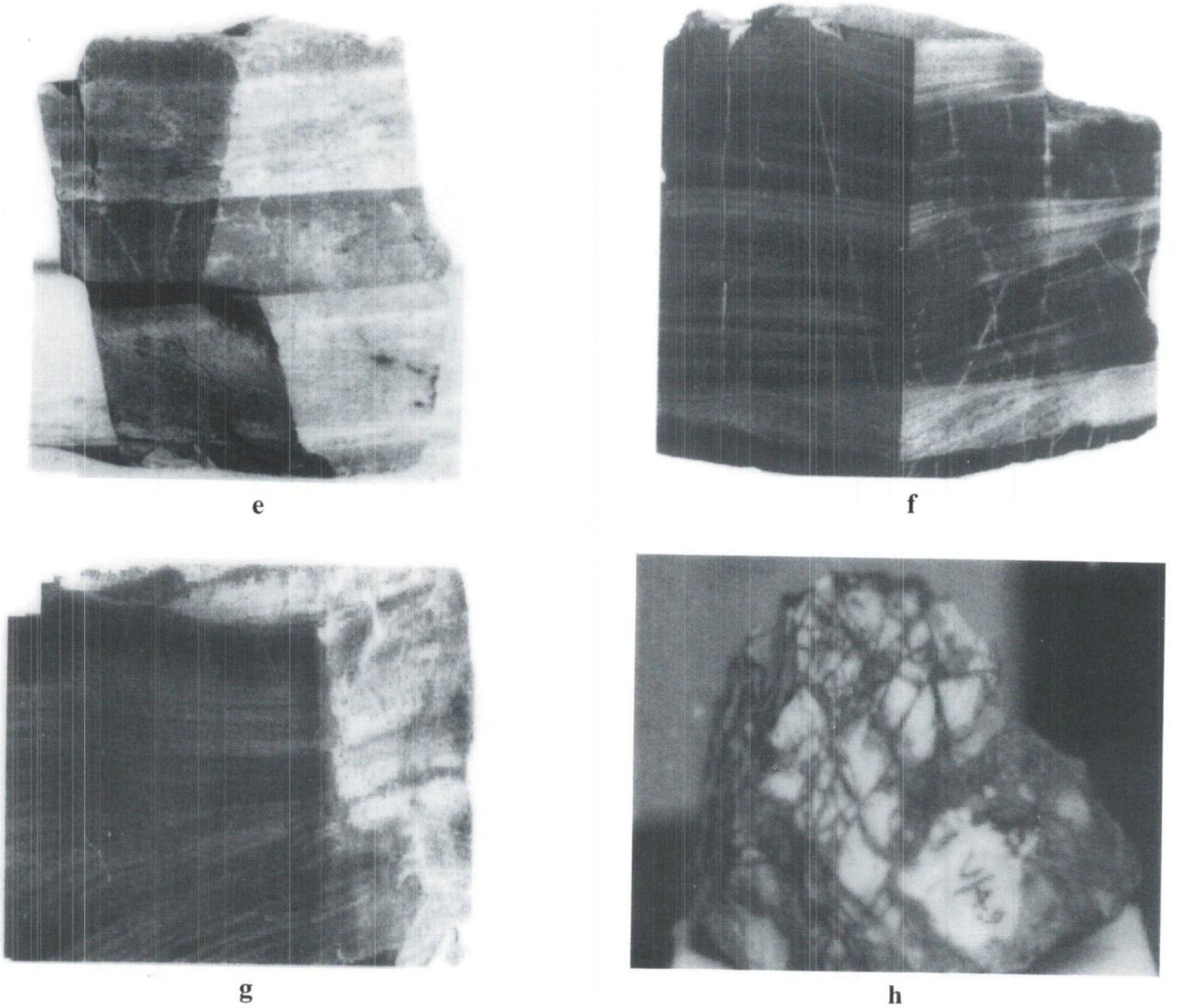
The beds having parallel boundary surfaces for a considerable length are described under this heading. Bedding thickness ranges from 1 cm to 12 cm or even more (Fig. 2e). The individual bands have no textural variation. However, the colour varies from white to grey. The contact between individual laminae or bed is very sharp. The weathered faces of the porcellanites show different shades of grey, limonitic brown to dark brown colour. In some cases, the unaltered relict of the fresh porcellanites have retained all the original structures. The banded structures are the most common features of both the Lower as well as Upper Porcellanites.

Cross-beddings (cross-laminations)

Cross-stratifications (current beddings) are frequently found in the siliceous porcellanites. They are very common and persistent (Fig. 2f). The thickness of individual cross laminae vary from 1 to 2 cm. They apparently are tabular with foresets inclination varying between 15° to 20°. It has only been found in the Upper Porcellanites. The lower surface of each set is either non-erosional or plannar. Normally, the strata within the sets are strictly concave.

Rain prints

Rain prints are present in the porcellanites of Bhaunathpur. They are present in the river bed of the Dulhar Nala.



e f g h

Fig. 2: e- Parallel bedding, f- Porcellanite showing cross-laminations around Ketar, g- Sag structure and h- Tectonic breccia.

Sag structure

Sag structure formed by compaction is seen in cross-section. The finer laminae in porcellanite bands collapsed and sagged due to the load of overlying sediments (Fig. 2g). The collapsed laminae are sandwitched between undisturbed porcellanite bands.

Intraformational breccias

Some intraformational breccias are found at the top of the Muskania Hill. They are red in colour indicating the presence of iron in good amount. In such breccia tabular or equidimensional pieces of chert and banded hematite jasper are randomly oriented and enclosed in a fine-grained cherty matrix (Fig. 2h). Intraclasts in breccia are generally angular. This is indicator of major disturbance in the basin. It appears that wave or current action or subaqueous disturbance broke up partially consolidated layers of porcellanites. These breccias appear to have been formed by the breaking up of masses of semi-consolidated sediments, which were subsequently transported as mudflows or by slumpage and sliding along bottom slopes.

GENETIC SIGNIFICANCE OF SEDIMENTARY STRUCTURES

The various sedimentary structures observed in the Porcellanites of the Panda Valley, Bhaunathpur suggest that the environment of sedimentation was fluctuating.

A lamina can be regarded as the smallest megascopic layer in the sedimentary sequence (Campbell 1967). The degree of the preservation of the laminations indicates that the sediments were deposited at a slow pace, below wave base level, in quite waters, which are nearly devoid of bottom dwellness. Coloured lamination forms only in shallow environment. Parallel contacts between different beds (plannar beddings) suggest the repetition of similar depositional conditions. The rhythmic changes occur in beds composed of two or more laminae of different composition. It seems that shallow water depositional conditions prevailed at least for sometime, during the sedimentation of the Porcellanite Formation. They may also be formed due to diagenesis.

Massive bedding is used to describe more or less homogenous looking sediments. It might be the result of strong bioturbation activity. Animal activity results in mixing of sediment completely and in the destruction of primary layering giving it the appearance of homogenous mass. But in the present case such homogeneity is the result of inorganic processes that is when the water is drained out during compaction and also due to solfateric action which might have caused the strong generation of gas bubble moving upward and causing the destruction of bedding (Tiwari 1987).

Cross-bedding is also suggestive of prevalence of shallow water, moderate to high energy depositional environments. Regarding the shallow water origin the author's contention is in broad harmony with the views of Allen (1963; 1982), De Raaf et al. (1977) and Chaudhri (1998). According to Reineck and Singh (1967) deposition on inclined surfaces of beaches and bay is also responsible for cross-laminations. Lithotectonic characters of the sedimentary assemblages suggest that the cross-lamination may be the result of migrating small currents.

CONCLUSIONS

The primary features in porcellanites of Bhaunathpur area are the indicators of being deposited in aqueous media and well reflected due the presence of massive bedding, lamination, bedding and cross-lamination. Shallow water condition of deposition is indicated by the presence of cross-laminations. The presence of parallel laminations indicates quiet water condition. The cross-bedding is indicator of water turbulance and current action and mostly a result of deposition from migrating small currents. It is also indicated by tectonic breccias. Different types of small scale sedimentation features suggest reworking and agitation of sediments in a shallow depositional environment.

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