Lithofacies, Depositional Environment and Age of the Upper Gondwana Succession of Salbardi Area, Amravati District, Maharashtra and Betul, Madhya Pradesh

ASHOK K. SRIVASTAVA and RUPESH S. MANKAR
P.G. Department of Geology, SGB Amravati University, Amravati – 444 602
Email: Ashokamt2000@hotmail.com

Abstract: The Gondwana succession of Salbardi area (lat. 21°25'15" N: long. 78°00'00" E) is ca. 128 m thick, dominantly arenaceous lithounit. The succession is represented by diverse lithological variations and good preservation of sedimentary structures. Four lithofacies have been identified in the succession on the basis of detailed field and megascopic observations viz. (i) thickly bedded, cross and parallel bedded sandstone lithofacies (ii) thinly bedded, multistoryed cross and parallel bedded sandstone-clay lithofacies (iii) concretionary sandstone lithofacies, and (iv) pebblyferous lithofacies. The lithofacies architecture of the succession is interpreted to reconstruct the depositional environment which ranges from point bar to channel floor of braided river system.

The age of succession is suggested to be Early Cretaceous on the basis of field evidences and lithological correlations.

Keywords: Gondwana, Sedimentology, Early Cretaceous, Lithofacies, Concretions, Maharashtra.

INTRODUCTION

A small patch of NE-SW trending Upper Gondwana succession along with the Lameta is exposed in Salbardi area (lat. 21°25'15" N: long. 78°00'00" E), constituted together by districts Amravati, Maharashtra and Betul, Madhya Pradesh (Fig. 1). The succession, though showing good preservation of sedimentary structures, variable lithological units and grain size variations have not received much attention for sedimentological investigations. However, field based preliminary sedimentological details were documented about one and half centuries back (Blandford, 1869). Subsequent specific work on the area is inadequate and mainly focused on regional set-up, of which, the Salbardi is a small patch of Gondwana in the vast Deccan Trap province. Significantly, it includes a hot spring (Saxena, 1987; Ravi Shanker et al. 1991). Recently, petrological and geochemical studies have been attempted by Rawale (2004).

In the present work, detailed sedimentological study of the Gondwana succession has been carried out which includes identification of various lithounits, preparation of detailed litholog and facies architecture. Emphasis has been given to reconstruct the depositional environment on the basis of field and megascopic observations. Discussion has also been made to assign a precise age to the Gondwana succession.

GEOLOGICAL SETTING AND AGE

The Gondwana sediments of the Salbardi and adjoining area are tectonically exposed due to Salbardi fault, trending roughly ENE-WSW. The entire area is criss-crossed by several minor faults, which makes the stratigraphy of the area complicated. However, Archaean quartzo-feldspathic gneiss and granitic gneisses make the basement, above which, the upper most part of Gondwana along with the Lameta are tectonically exposed, surrounded by the widespread Deccan Trap (Table 1, Fig. 1). The Gondwana is mainly represented by medium to coarse-grained arenaceous unit with well developed sedimentary structures. Borehole data of the Salbardi area suggest that, the Gondwana extend up to 288 m depth (Ravi Shanker, 1991). The Lameta is mostly represented by chertified limestone, medium to coarse grained sandstone and intraformational breccia. It is unconformably overlain by basalts of the Deccan Trap.

The age of the Gondwana succession is still a matter of discussion. Pascoe (1959), in general, considered the inliers
of Gondwana, exposed near Ellichpur (Achalpur) as equivalent to Kamthi (?Mahadeva) of Triassic. Among these inliers, significant and laterally traceable exposures lie at Bairam- Belkher area (lat. 21°16'- 21°22'N: long. 73°37'- 77°31'E), and the study area i.e. Salbardi, apart from 2-3 minor exposures in nearby areas. Bairam- Belkher area lies about sixty kilometers west of Salbardi area. The main criteria to correlate these inliers with Kamthi and Mahadeva by Pascoe (1959) are the lithological similarities. However, in the recent studies, the Gondwana successions of the Bairam and Belkher area, have been assigned Early Cretaceous age on the basis of rich and varied megafossil assemblage (Srivastava et al. 1995, 1996, 1999, 2001, 2003 and Gawande, 2003).

The Salbardi Gondwanas are more correlatable to Bairam-Belkher Gondwanas because of the following reasons:

i) The Gondwana inliers of Bairam, Belkher and Salbardi area are tectonically exposed due to a single major fault.

ii) All the three inliers are overlain by the reddish-brownish-greenish sands of the Lameta.

iii) The top most part of Gondwana succession at all the three places are represented by similar pebbleriferous horizons.

Hence, the Gondwanas of the Salbardi area are most possibly Early Cretaceous in age.

**LITHOLOGICAL SETTING AND FACIES ARCHITECTURE**

The Gondwana outcrop of Salbardi area represents ca. 128 m thick column of dominantly medium to coarse grained sandstone followed by clay and pebbleriferous horizons (Fig. 2). The sandstone is whitish, yellowish-brown to brown, medium to coarse grained, compact to friable in nature. The whitish sandstone is comparatively hard due to silica cementation, whereas the brownish and yellowish sandstone with ferruginous cement is mostly friable in

<table>
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<th>Age</th>
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<tr>
<td>Quaternary</td>
<td>Soil and alluvium</td>
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<tr>
<td>U. Cretaceous</td>
<td>Deccan Trap</td>
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<tr>
<td>U. Cretaceous</td>
<td>Lameta</td>
<td>Sandstone, shales and limestone</td>
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<tr>
<td>U. Cretaceous</td>
<td>Upper Gondwana</td>
<td>Sandstone, siltstone, conglomerate and clay</td>
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<tr>
<td>Archaean</td>
<td>Quartzo-feldspathic gneiss with dolerite intrusions</td>
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**Table 1. Stratigraphic succession of Salbardi area**
nature. The quartz grains are mostly angular to subangular. Clay, restricted to certain horizons in sandstone, show pocketed or lenticular interbedded occurrence. It is yellowish-pink, grey to brown lithounit having a tendency to break in elongated fashion. The pebbliferous horizons cover the upper part of succession. It is brownish to reddish, matrix supported gritty-conglomeratic, hard unit containing sub-rounded to subangular pebbles of quartz and feldspar.

Under microscope, the sandstone is represented by quartz, feldspar and minor amount of mica and lithic fragments. The quartz grains are angular to subangular and predominantly monocrystalline showing poor sorting. The feldspars are mainly orthoclase though albite, microcline are also identified. Mica is present in the form of biotite and muscovite. Quartz-feldspathic schist as lithic fragment constitute a very minute quantity. The cement is siliceous to ferruginous in nature. Digenetic features include concavo-convex contacts between the grains, corrosive boundaries, authigenic silica growth, replacement of silica by ferruginous cement and bending of mica flakes.

On the basis of detailed field data, lithological variations and megascopic characteristic of the rocks, four lithofacies have been identified, which are as follows:

(i) Thickly bedded, cross and parallel bedded sandstone lithofacies

(ii) Thinly bedded, multistoryed, cross and parallel bedded sandstone-clay lithofacies

(iii) Concretionary sandstone lithofacies

(iv) Pebbliferous lithofacies.

All the four lithofacies are distinctly identifiable in the field and are stacked vertically in stratigraphic order. The details of the lithofacies are as follows:

**Thickly-bedded, Cross and Parallel-bedded Sandstone Lithofacies**

This lithofacies is about 55 m thick, predominantly arenaceous unit showing well developed large scale cross and parallel beddings (Fig. 3A). Its lower boundary is sharp, faulted and rests on Archaean quartzo-feldspathic gneiss which is locally intruded by dolerite dykes. The boundary is exposed in the Maru River channel near the hot spring. The upper boundary is gradational with the overlying sandstone-clay lithofacies. The lithounit is well exposed along the Maru River channel and also on the pedestal track to Jungheri village. The beds are 3-7 m thick and mostly dirty white, brownish to yellowish in colour, medium to coarse grained, compact to friable in nature. Sorting is moderate and percentage of matrix is low. Occasionally, the grains show a gradation in size from medium sand up to the size of gravel in vertical profile, forming thin granular horizons of sub-angular to sub-rounded quartz and feldspar.

**Thinly-bedded, Multistoryed, Cross and Parallel-bedded Sandstone-clay Lithofacies**

This lithofacies is about 30 m thick, represented by multistoryed, cross and parallel bedded sandstone-clay lithofacies (Fig. 3B). Because of poor cementation and alteration of feldspar, the sandstone is friable. The unit also shows good preservation of large scale cross and parallel beddings similar to previous lithofacies; however, the bed thickness is only 1 to 3 m. Sorting is moderate. It is well exposed in the north of Maru River on pedestal track to Ghorpend village and also near the Cave Hill. The lithofacies shows interbedding of lenticular or pocketed occurrences of small yellowish-pink, grey to brown clay bodies, which
Fig.3. (A) Thickly bedded sandstone exposure showing cross and parallel beddings. (B) Thinly bedded, multistoryed sandstone. (C) Sandstone showing rich preservation of ferruginous concretions.
Fig. 4. (A) Clustering of ferruginous concretions. (B) Close up of isolated concretions - filled with whitish sand (left), central hollow space due to weathering (right). (C) Surface view of the mud cracks in concretionary sandstone.
are well exposed near the Cave Hill. Ferruginous concretions and ripple bedded surfaces are also present.

Concretionary Sandstone Lithofacies

This lithofacies is characterized by 25 m thick column of medium to coarse grained, angular to subangular dirty white sandstone with abundant concretions (Fig. 3C). The concretions are mostly spherical to cylindrical, ferruginous sandy structures with a general diameter of 2 to 4 cm, whereas, the length may range up to 8 cm in cylindrical forms. The concretions may be hollow or filled with the same material as of the host rock. Its occurrences are mostly solitary but sometime give an appearance of group due to clustering of more than two solitary concretions (Figs. 4A and B). Some spherical concretions show brownish, yellowish or whitish coloured concentric layers in the transverse sections. The lithounit also shows rich preservation of mud cracks (Fig. 4C) and large scale cross beddings. The lithofacies is mostly monotonous in vertical profile showing good preservation of mud cracks and ripple laminations. It is mostly formed in the upper reaches of the alluvial plain, where river show extensive braided characters (Reineck and Singh, 1980). Pettijohn (1984) also included such cross bedded, medium to coarse grained sandstone in his model of point bar environment. Recent point bar deposits showing planar and trough cross bedded sandy facies are reported from Yamuna and Ganga Rivers (Singh and Khan, 2000; Tiwari et al. 2004).

The overlying 30 m succession is thinly bedded, multistoryed, cross and parallel bedded sandstone-clay lithofacies. The entire lithofacies is well marked by cross and parallel beddings. The grains are mostly medium to coarse, subrounded to subangular in shape. The bed thickness is highly reduced compared to the underlying lithofacies and ranges between 1 m to 3 m, which may be due to successive overlapping of channel bodies, resulting in the development of multistoryed sandstone unit. The clay bodies make interbedded or pocketed occurrence ranging in thickness from 50 cm to 2 m and lateral traceability up to 20 m. Cross and parallel bedded natures of sandstone and clay interbeddings indicate a braided channel environment of deposition for this lithofacies as proposed by Reineck and Singh (1980) and Mill (1996). Similar lithofacies has also been reported by Tiwari (1995) from Late Triassic Gondwana of the Son Valley.

The concretionary sandstone lithofacies constitute 25 m succession above the multistoryed sandstone-clay lithofacies. It is very distinctive in the field showing rich preservation of spherical to cylindrical ferruginous concretions occurring solitary as well as in clusters. The grain size and texture are similar to those of the previous lithofacies. A few medium grained sandstone surfaces shows good preservation of mud cracks and ripple laminations. However, cross bedding is also present. This lithofacies is interpreted as a product of channel environment, showing intermittent phases of deposition. Similar facies architecture i.e. sandstone-clay interbeddings, low scale parallel laminations, iron concretions have been reported from braided fluvial reservoir of Krishna-Godavari Basin (Kotha, 2002). The presence of mud cracks at different vertical intervals is an evidence of repetitive aerial exposure of
lithounit. Presence of cross bedding and large scale ripple laminations and mud crack horizons may indicate a seasonal variability of water flow. Similarly, the abundance of ferruginous concretions and a few thin brownish to reddish-brown, flat ferruginous horizons may also be considered as an indicative of subaerial processes (Krzyoszkosiki, 1993). The brownish to yellowish colouration may be due to the weathering of iron-bearing silicate minerals within the sandstone during shallow burial diagenesis (Von Houten, 1973).

The pebblerous lithofacies is the top most 25 m lithounit showing a sharp contact with the underlying concretionary sandstone lithofacies, whereas, the upper contact is abruptly terminated by soil. It is represented by flat-bedded pebbly sandstone bodies of 1 to 3 m thicknesses. The pebbles are dominantly of quartz and feldspar and
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Mostly range from 5 to 10 mm in diameter; however, cobbles are also present. Due to poor cementing, loose flat debris of pebbles and cobbles form a common appearance in the field. The facies shows the tendency of large scale cross bedding. This lithofacies is also interpreted as a produced of channel floor environment (Pettijohn, 1984; Miall, 1978, 1984 and 1996). The provenance was not very far away from the site of deposition, as most of the grains are subangular to subrounded in shape. Similar pebblierous lithofacies have been reported from the alluvium of Krishna-Godavari Basin and interpreted as channel floor deposit (Kotha, 2002).

Based on the detail lithofacies analysis, the Upper Gondwana succession of Salbardi area is interpreted as point bar and channel floor deposition of braided river system. Similar lithofacies are also reported from coeval Upper Gondwana succession of Bairam and Belkher area with same interpretation (Srivastava et al. 2004).

Acknowledgement: Financial assistance received in the form of a major research project (F-31-194/2005/SR) awarded to one of the authors (AKS) by University Grants Commission, New Delhi is thankfully acknowledged.

Fig. 6. Lithofacies association in vertical column.

References


(Received: 27 August 2007; Revised form accepted: 7 December 2007)