Significance of transition between Talchir Formation and Karharbari Formation in Lower Gondwana basin evolution – A study in West Bokaro Coal basin, Jharkhand, India

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Basal part of the Gondwana Supergroup represented by Talchir and Karharbari Formations (Permo-Carboniferous) records an abrupt change-over from glacio-marine to terrestrial fluvio-lacustrine depositional environment. The transition between the two is an unconformity. Facies analysis of the glacio-marine Talchir Formation reveals that basal glaciogenic and reworked glaciogenic sediments are buried under storm influenced inner and outer shelf sediments. Facies associations of the Karharbari Formation suggest deposition as fluvio-lacustrine deposits in fault-controlled troughs. An attempt has been made in this paper to explain the sedimentation pattern in Talchir and Karharbari basins, and the abrupt change-over from glacio-marine to terrestrial fluvio-lacustrine depositional environment in terms of glacio-isostasy.

1. Introduction

Predominantly continental freshwater sediments belonging to the Gondwana Supergroup accumulated during late Carboniferous to early Cretaceous period, are found to occur in a number of isolated basins along several paleo-rift valleys in peninsular India (Chatterjee and Ghosh 1970). The basal unit of the Gondwana Supergroup, the Permo-Carboniferous Talchir Formation, is dominantly glaciogenic, with associated fluvial and lacustrine or marine facies (Ghosh and Mitra 1967, 1975; Casshyap and Qidwai 1971, 1974; Casshyap and Tewari 1982, 1988; Bose et al 1992; Bhattacharya et al 2002). Sedimentological and paleontological attributes of the Talchir Formation are distinctly different from the younger fluvial coal-bearing Gondwana succession (Reed 1928; Ghosh 1954; Dutta 1965; Bhattacharya et al 1989; Mukhopadhyay and Bhattacharya 1994; Sengupta et al 1999). The Permo-Carboniferous sedimentary succession, the lower most part of the Gondwana Supergroup, exposed along Dudhi nala (streamlet) in West Bokaro Coal basin, Hazaribagh, Jharkhand records an abrupt change from glacio-marine Talchir Formation to fluvial coal-bearing Karharbari Formation (Ghosh and Mitra 1967; Bhattacharya et al 1989; Bose et al 1992; Mukhopadhyay and Bhattacharya 1994). Climatic shift is considered to be responsible for such a change (Veevers and Tewari 1995 and references therein). However, in rift-settings, tectonic causes may usher in such abrupt changes in basin morphology and depositional system. In this paper, a re-examination of these two formations and their relationship is carried out in the West Bokaro basin with the aim of constraining the controlling factors that were responsible for such an abrupt change-over.

2. Geological setting

The Talchir Formation in the Dudhi nala section, West Bokaro basin, unconformably overlies the Precambrian basement represented by granitoids and amphibolites (figure 1). The basal part
of the Talchir Formation comprises conglomerates commonly referred to as ‘Talchir Boulder Bed’, and is overlain by a thick succession of greenish sandstone and shale deposited in open shelf environments (Bhattacharya et al. 1989; Bose et al. 1992; Mukhopadhyay and Bhattacharya 1994). Sengupta et al. (1999) reported marine fossil Polyplacophora from this succession. The glacio-marine Talchir succession is overlain by the coal bearing fluvial succession of the Karharbari Formation. The contact relationship between the Talchir Formation and the Karharbari Formation has not yet been properly established. The basal part of the Karharbari Formation is dominated by conglomerates and pebbly-sandstone, whereas the upper part is represented by coarse-grained sandstone with carbonaceous shale and coal partings.

A series of close spaced faults, both normal and reverse, are developed within Talchir sediments close to the contact with Karharbari rocks (figure 2). The attitude of the faults is more or less similar with the attitude of the contact between the Talchir and Karharbari successions. Drag folds are developed in centimetre to metre scale in the vicinity of the faults (figure 3). The bedding dip of basal Karharbari rocks is steeper (20° to 25°, northerly), but becomes horizontal towards the top.

3. Talchir Formation

Three major facies associations may be identified in the sedimentary succession of the Talchir Formation exposed in the Dudhi nala section. These are conglomerate–sandstone facies association (TCS), sandstone–siltstone facies association (TSS) and fine sandstone–mudstone facies association (TSM). Conglomerate–sandstone–silty mudstone association developed as a cover succession over the conglomerate–sandstone association and basement granitoids as well. Fine sandstone–mudstone association occupies the eastern part of the nala section and the upper half of the stratigraphic column of the Talchir Formation.

3.1 Facies analysis

3.1a Conglomerate–sandstone facies association (TCS)

This facies association is represented by jagged breccia (TCS-1), stacked tabular clast conglomerate (TCS-2), massive sandstone (TCS-3), reverse graded conglomerate–sandstone alternations (TCS-4), matrix- and clast-supported conglomerates with angular and rounded clasts (TCS-5.