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GR Letter

# Reappraisal of the structure of the Western Iron Ore Group, Singhbhum craton, eastern India: Implications for the exploration of BIF-hosted iron ore deposits

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**Abstract**

The middle to late Archean Iron Ore Group rocks occurring along the western margin (the Western Iron Ore basin) of the Singhbhum Granite massif in the Singhbhum craton were deformed during Iron Ore orogeny and are disposed in a horseshoe-shaped synclinal structure in the eastern part of the Indian shield. The Western Iron Ore basin hosts almost all the major high-grade iron ore deposits of eastern India. Contrary to the established view, present analysis emphasizes that the horseshoe fold in reality is a synclinorium consisting of a syncline–anticline fold pair which were later cross-folded along an east–west axis.

Structural analysis in the *eastern anticline* of the 'horseshoe synclinorium' suggests that the BIF hosting the high-grade iron ore bodies are disposed in three linear NNE–SSW trending belts, each showing an open synclinal geometry. Later cross folding produced development of widespread dome and basin pattern at the sub-horizontal hinge zones of these synclinal fold belts. The major iron ore deposits in the eastern anticline at the present level of erosion are preferentially localized within shallow elongated basinal structures only. The axis of the adjoining *western syncline* was similarly uplifted as partial culminations where cross-folded against E–W anticlinal axes. But here, the BIF-iron ore bodies are preferentially localized within elongated domal structures in contrast to the basinal sites in the adjacent *eastern anticline*. Such an inference based on structural analysis could probably be utilized as a *potential tool* for all future explorations, reserve estimation and recovery of the iron ore deposits in the terrain.


*Keywords:* Singhbhum craton; Archean Iron Ore Group; Superposed folds; Iron ore exploration

## 1. Introduction

Most of the high-grade (>60 wt.% Fe) iron ores in eastern India are located within the Archean Iron Ore Group of the Singhbhum craton (Fig. 1). The Iron Ore Group (IOG), occurs within the Singhbhum Granite (>3.1 Ga, Misra, 2006) along its western (Noamundi–Jamda–Koira), eastern (Gorumahisani–Badampahar) and southern (Tamka–Daitari) margins. The deposits occurring in the western (Noamundi–Jamda–Koira–Malangtoli) IOG belt (Fig. 1a) are most significant in terms of number, quality and reserve (*see for reviews* Sarkar, 2002; Sarkar and Gupta, 2005). Recent fieldwork in the Noamundi–Koira valley carried out by us has shown that the mode of occurrence and disposition of these high-grade iron ore deposits are essentially controlled by the pattern of deformation of the IOG rocks. The IOG rocks of the Noamundi–Jamda–Koira valley have been earlier interpreted to have been folded into a major NNE-ly plunging syncline, *the horseshoe syncline*, overturned towards east (Jones, 1934), and cross folded along an E–W axis (Sarkar and Saha, 1962, 1977; Chatterjee and Mukherjee, 1981; Saha, 1994; Mukhopadhyay, 2001; Mukherji et al., 2004). Acharyya (1993) and Sengupta et al. (1997), however, suggested that the BIF, which is the key horizon in tracing out the horseshoe structure, occurs as a gently folded sheet rather than as an overturned syncline.

In this contribution, we document deformation patterns, both in large-scale and mesoscopic-scale from the 'eastern limb' of the '*horseshoe syncline*' (Jones, 1934), between Noamundi and Bamebari, and the 'hinge zone', at Kasia–Guali. Our

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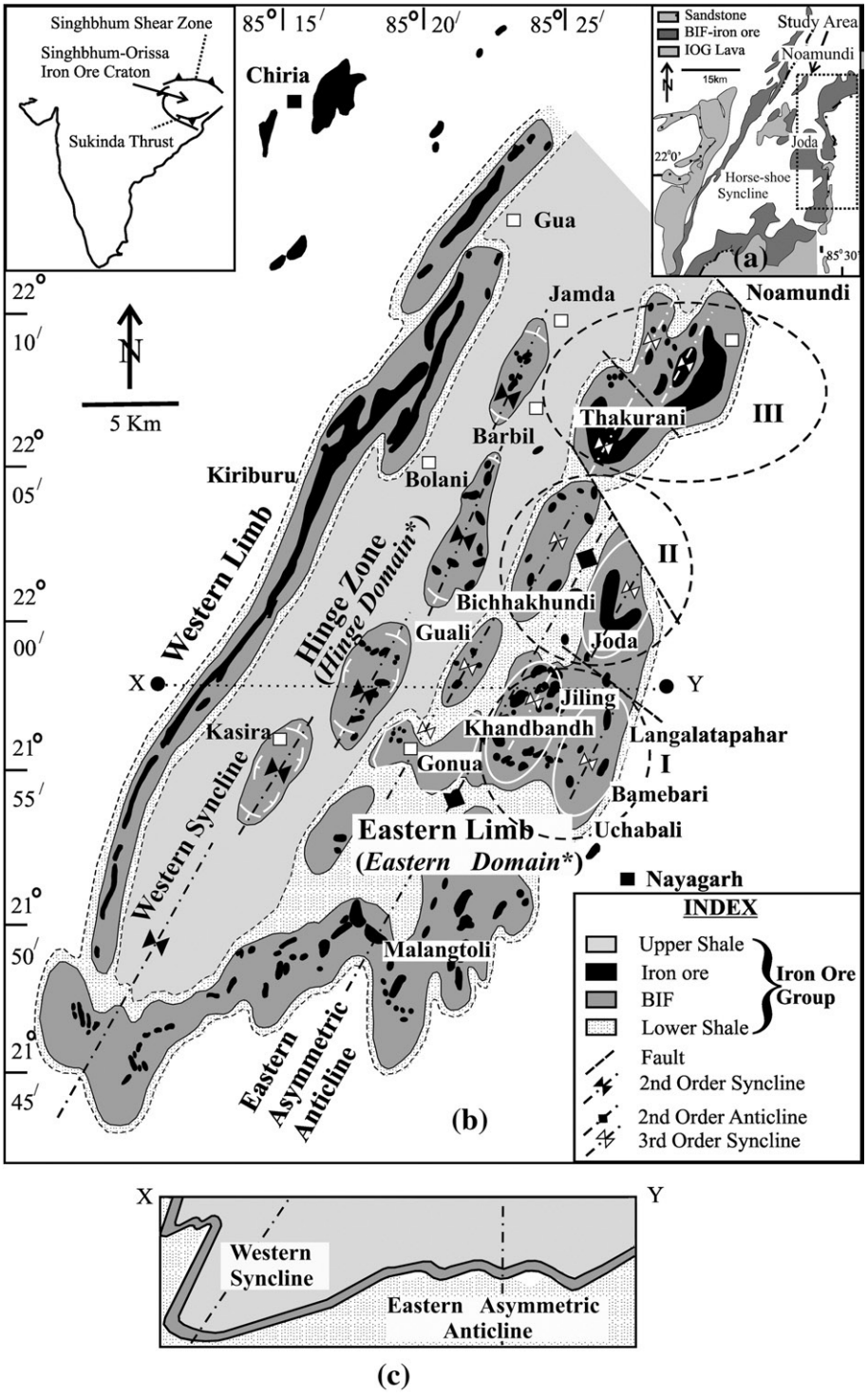


Fig. 1. (a) Map of the Western Iron Ore basin showing the area of study marked by a dotted rectangle. (b) Map of the Western Iron Ore basin showing the distribution of different lithounits of the IOG sequence (modified after Jones, 1934). The terms with asterisk marks are used in the text in place of 'hinge zone' and 'eastern limb'. I, II and III represent different sectors in the 'eastern domain'. The inset map shows the regional location of the Singhbhum Orissa Iron Ore craton. (c) Structural section, drawn along the line X–Y, depicts the large syncline–anticline pair developed within the IOG rocks.

observations mainly on the 'eastern limb' and 'hinge zone of the '*horseshoe syncline*' led to a different interpretation from earlier ideas. Based on the new observations, we present here a model for explaining the megascopic and mesoscale structure of this belt. Our present work also delineates the structural control of the BIF-hosted high-grade iron ore bodies. We demonstrate here the importance of structural analysis in mesoscopic and megascopic scales in predicting the exploration and expansion strategies for a sediment-hosted major economic deposit.