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Review Paper

Iron ore localisation and its controlling factors in the eastern limb of Bonai Keonjhar belt, Odisha, India

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Abstract

The iron formation of Bonai-Keonjhar belt, Keonjhar district of Odisha is deposited an intra-cratonic basin. Lately the deformational terrain morphology and geochemical factors followed by weathering and supergene processes controlled the localization of iron ore deposit. The tabular and bedded form of iron formation leading to BIF and syngenetic Bedded Iron ores are controlled by flat floor morphology of the basin. Tectonic origin of basins and successive deformations causing folding, faulting, joints, fractures etc could be the deciding factor for iron ore deposits in different forms, which address the epigenetic mode of formation. The easterly sloping topography of the eastern limb of BK belt could facilitate the transportation of weathered fragments of iron formation to be deposited as detrital iron deposits (DID) in the western side along the course of the river Baitarani at Inganjharan and Chamakpur. The size of iron clasts in DID are progressively increased from smaller fragments in the western margin to coble to boulder sized iron fragments near by the source of erosion like in Joda east mine area. The syngenetically formed the brecciated iron deposits of Khondbandh and Bansapani areas are formed syngenetically in a disturbed and turbulent environment.

Keywords: Iron ore localisation, controlling factor, Bonai-Keonjhar belt.

Introduction

The Precambrian iron formation occurs in three localities circumscribing the North Odisha Iron Ore Craton (NOIOC) (Figure-1). The western border of the craton is occupied by Bonai-Keonjhar (BK) belt, a U-shaped synclinorium, which is known as the Horseshoe belt[1]. The iron ore deposits are occurred in various modes in the entire stretch of the belt. Most of the iron formations are bedded in nature and seems to be the earlier syngenetic deposits. Brecciated variety of iron formations are contemporaneous with bedded ones but are limited in occurrence.

However they are found throughout the belt. The transformation of Banded Iron Formation to varieties of iron ores like hard massive ore, laminated ore (hard and soft), friable ore and lateritic ore are due to supergene enrichment for which terrain morphology, deformative forces and leaching processes are responsible. Acharya mentioned that the biscuity ore was considered as primary BIF bands with silica leached out and the massive ore type with very thin laminations convincingly proved to be essentially sedimentary origin[2].

Morey proposed two processes to account for secondary enrichment of iron ore[3]. During the first step the primary, diagenetic or low-grade metamorphic minerals involved oxidation and hydration resulting in loss of volume and increase in secondary porosity and permeability[4,5]. In the second stage leaching of silica, P, Mg and Ca are enhanced greatly due to increased porosity and permeability, which led to finally ore deposit. Morris discussed that the iron ores were formed in BIF in the process of supergene enrichment through chemical weathering[6]. The detrital iron deposits are also sporadically found in and around the belt with some areas like Chamakpur and Inganjhar having dominant occupancy.

Geology

The BK belt comprises of two limbs namely eastern and western limbs, which starts from Chelliatoka (21^{0}44'N; 85^{0}09'E) in the south to Noamundi (22^{0}09'N; 85^{0}29'E) and Gua (22°13'N; 85°23'E) in north respectively. Iron ore deposits in the eastern limb are mostly confined to Noamundi, Thakurani, Joda, Jaribahal, Malangtoli, Jilling, Jajang and Gurubeda sectors (Figure-2). This iron formation belt covering the western edge of the NOIOC overlies the Dhanjori Quartzite[2,7]. Varieties of iron deposits in the area include Banded Iron Formation (BIF), detrital iron deposits (DID), Brecciated Iron Deposits (BID) and bouldery iron deposits.

They comprise of iron minerals of oxide facies such as hematite, magnetite, martite, specularite. Silica occurs in form of chert, jasper and quartz. A synclinorium pattern attesting the general structural disposition of the rocks of the area trends in NNE-SSE direction with low plunge towards NNE. The lithosomes of the region have undergone three phases of fold deformations.

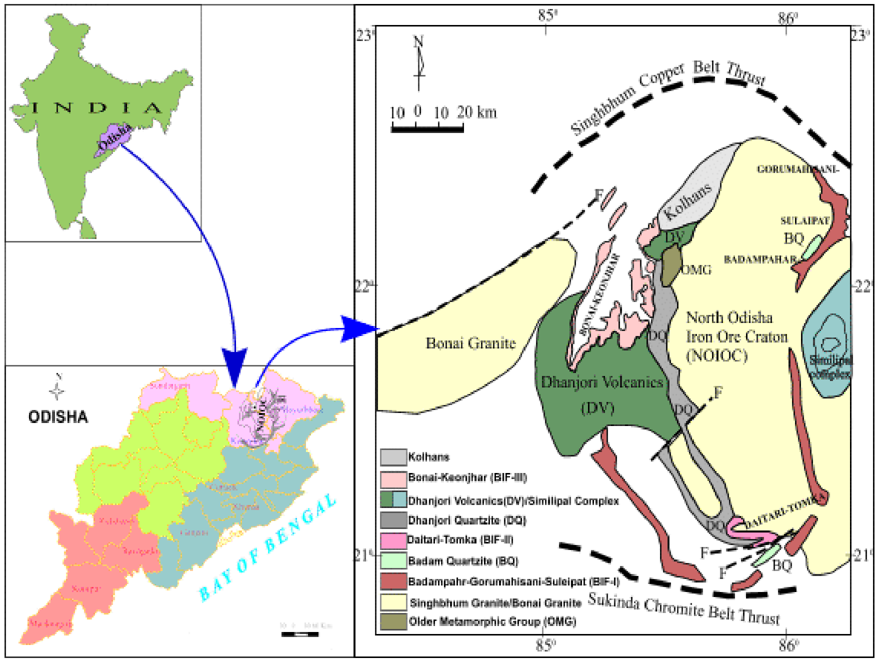

Figure-1: Generalised geological map showing three iron formations encircling the North Odisha Iron Ore Craton (NOIOC)[1].

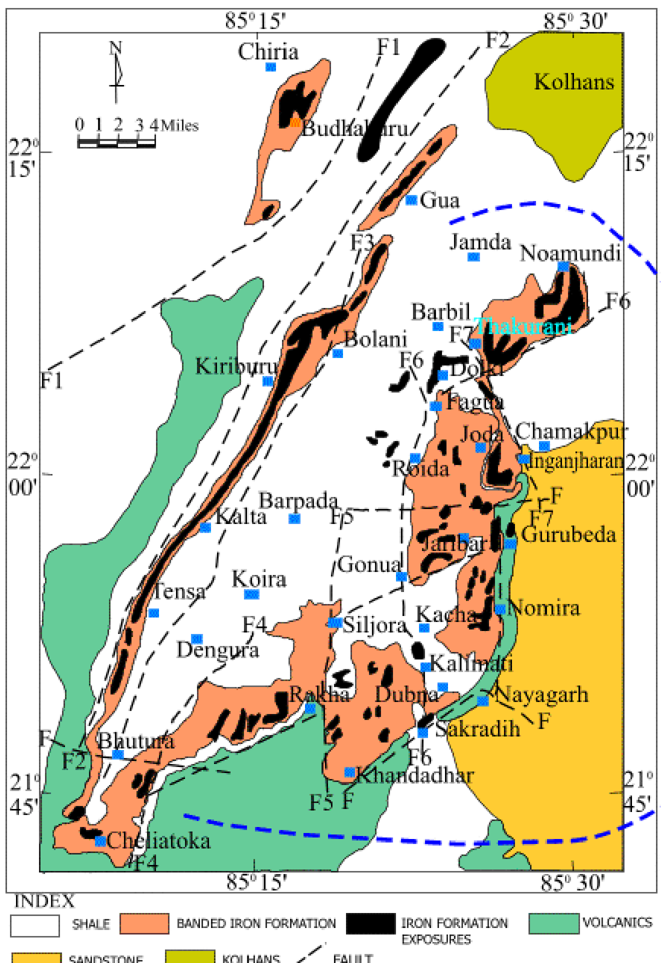

Figure-2: Geological map of Bonai-Keonjhar belt[1].

Controls of ore localisation

The floor morphology of the basin at craton margin is flat to accommodate the iron deposits in tabular and bedded form, which could lead to BIF and syngenetic Bedded Iron ores. The deposition of iron formation with different physical characters, mineralogy and physico-chemical conditions owe their formation in space and time with regard to source, transport medium, migration and deposition of ore constituents in response to changed P.T. conditions and the hydrous medium (Figure-3). The margin of the cratonic massif gave rise to the basin of deposition through a number of processes like spreading, extension, thinning and finally rifting, which advocates a regional structural control for iron ore deposits[8-10].

The BK belt in form intra-cratonic basin having present-day configurational and compositional setting might have received sediments from terrestrial source through continental denudation, sea water through transgression and regression, deep circulation of marine or meteoric water and from volcanic exhalation inside the basin[11]. Tectonic origin of basins and successive deformations causing folding, faulting, joints, fractures etc could be the deciding factor for iron ore deposits in different forms, which address the epigenetic mode of formation (Figure-4). Depository basin formed due to post rifting grabenisation is considered as the stratigraphic control for bedded and banded iron formation particularly banded hematite jasper, while folding, faulting and joints as local structural feature to control over the formation of epigenetic ore types.

Brecciated iron deposits (BID) in limited extensions are found in many locations of the eastern limb of BK belt. In Khandbandh, Khuntapani and Bansapani high grade BID is abundantly occurred and mined. It comprises of fragments of hematite, BHJ and shale of different size and shape cemented by mostly iron rich matrix. The clasts are formed syngenetically during the time of sedimentation-lithification of iron formation by breaking down of bedded or banded iron deposits and remains cemented in the buffer area where they are produced[13]. Iron formation has been fragmented simultaneous with sedimentation process in a disturbed and turbulent depositional environment followed by load pressure and sagging (Figure-5).

The eastern edge of the Eastern limb of BK belt sloped down to touch the River Baitarani at many places, which plays major drainage pattern in the area. The terrain configuration of the adjoining area of the course of Baitarani, one of the major fault planes of the region, controls geomorphologically and structurally as well some variety of ore deposits. The easterly sloping topography of the eastern limb of BK belt might have triggered the transportation of weathered fragments of BIF and iron ore from the iron deposit terrain in the western side. Iron clasts of various sizes and shapes are harvested from the higher provenance to roll down to the low laying areas along valleys and fault planes. Hence detrital iron deposits (DID) are found to be occurred along the course of the river Baitarani at Inganjharan and Chamakpur. Some DID horizons in limited sizes occur randomly at many localities all along the eastern limb (Figure-6). The distant DID from the source rocks have smaller fragments bounded by matrix, while cobble to boulder sized iron fragments are stabled near by the source of erosion like in Joda east mine area (Figure-7).

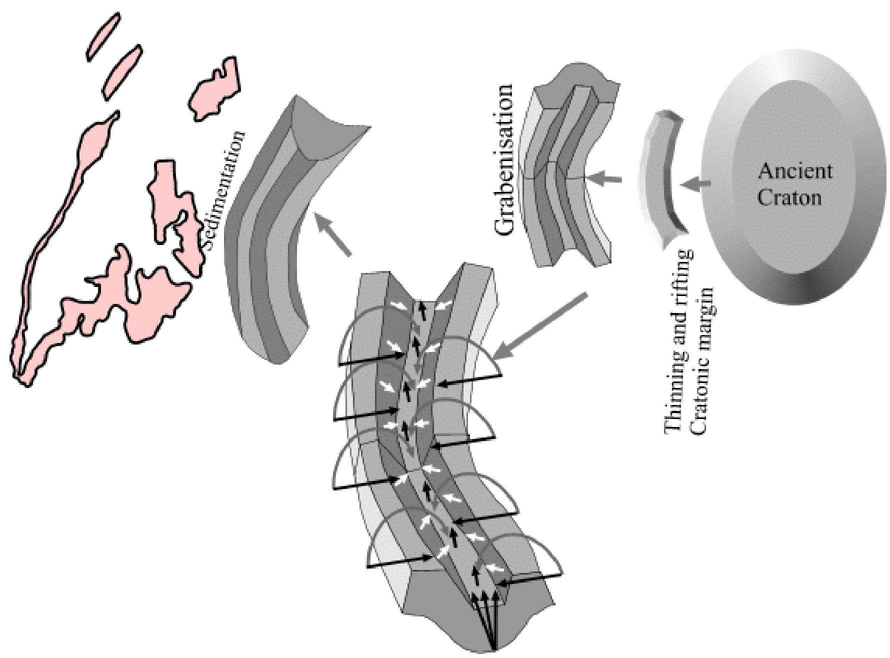

Figure-3: Formation of rift basin, material inflow, sedimentation and deformation controlling the iron formation in BK belt.

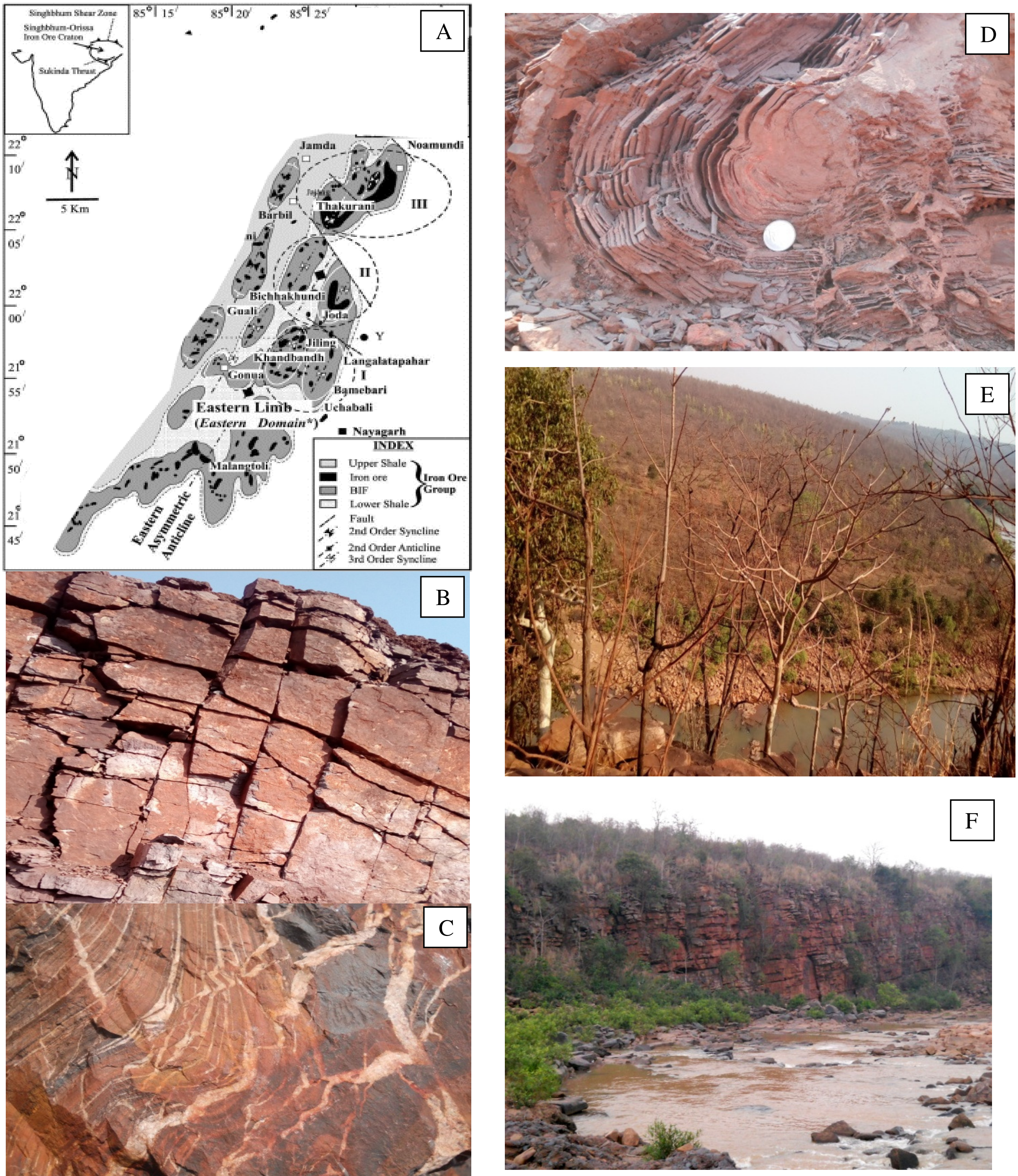

Figure-4: A. Litho-structural map of eastern limb of BK belt showing iron ore deposit[1, 12], B. Joints in iron formation, C. Fractures in BIF, D. Folding in Iron ores, E. and F. Faulting in basin along Baitarani river course.

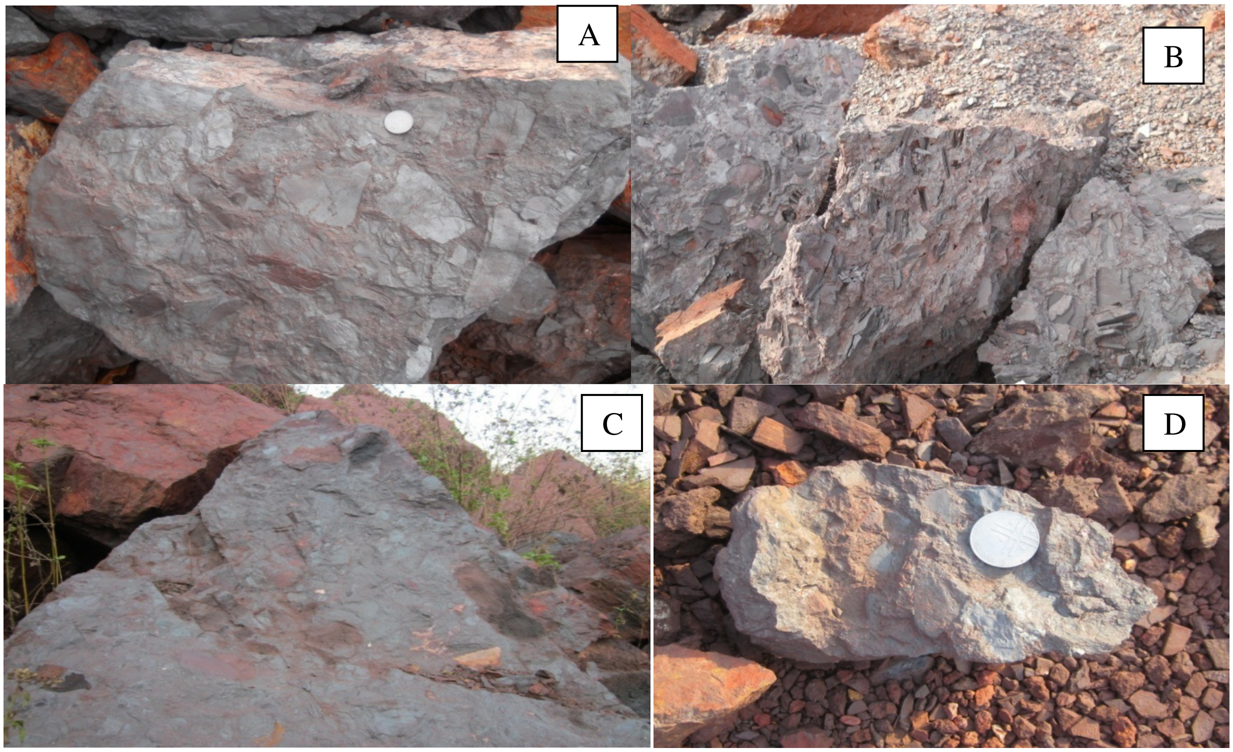

Figure-5: Photograph showing breccias of syngenetically formed hematite bounded by hematite matrix. Clasts are settled with their planar surface in one direction. A. and B. BID in planar and cross sectional orientation at Khondbandh, C. Hematite and goethite clasta in BID at Khuntapani, D. Bansapani BID where iron matrix are mostly altered to goethite.

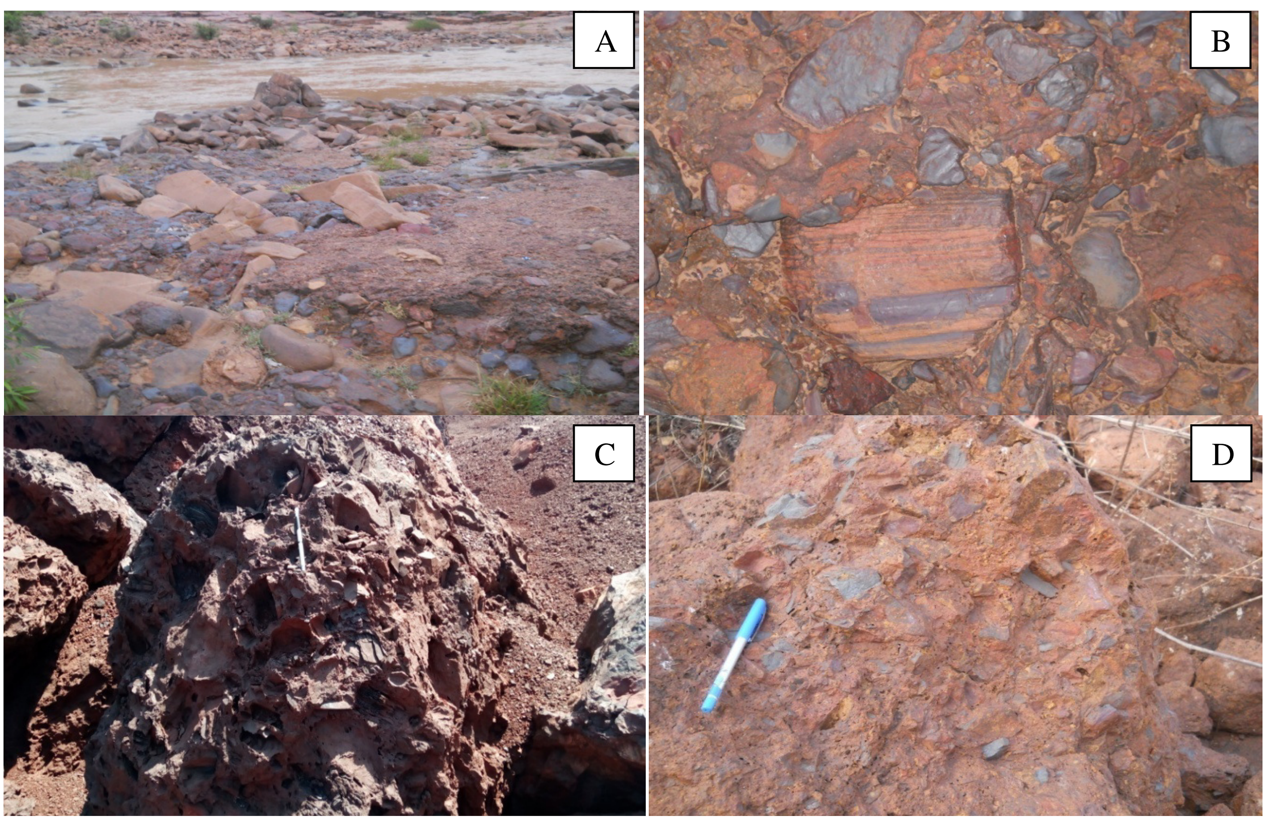

Figure-6: A and B. Inganjharan DID, C. Chakpur DID, D. Thakurani DID.

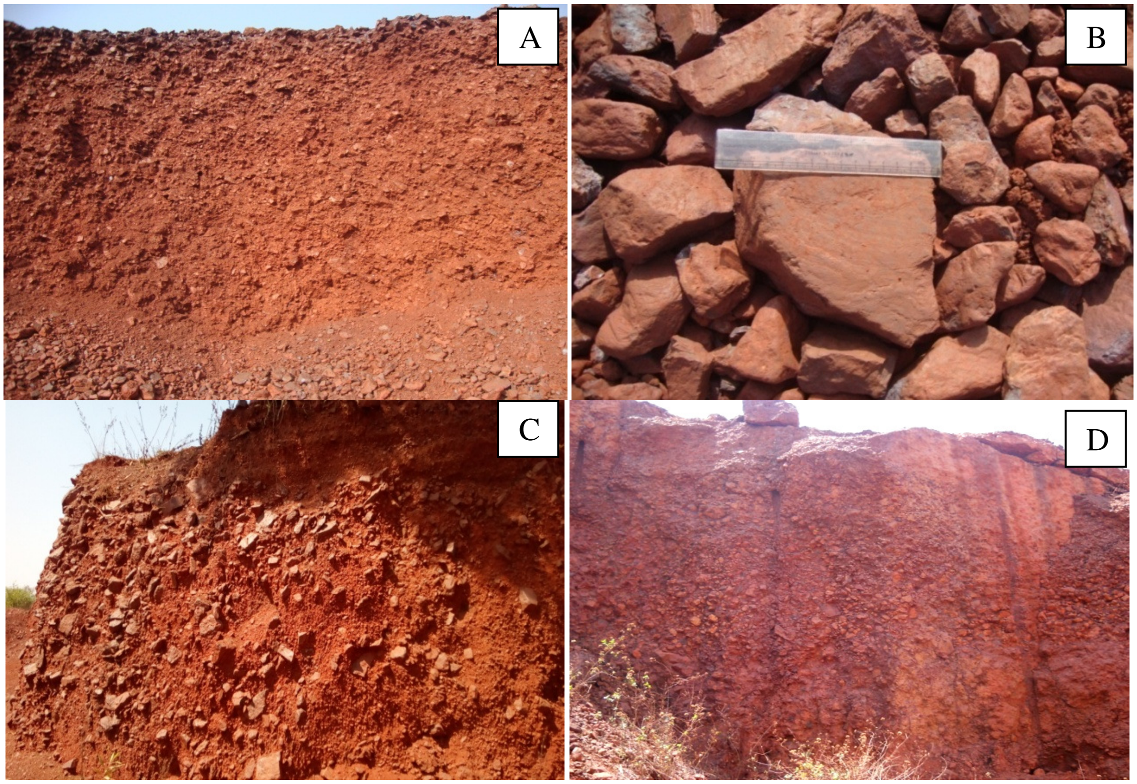

Figure-7: A. and B. Joda East boulder beds, C. Chamakpur, D. Noamundi.

Conclusion

Bonai-Keonjhar belt, a famous iron formation province in Keonjhar district of Odisha, is an intra-cratonic basin where banded iron formation (BIF), iron ore and associated rocks have been deposited under different physico-chemical setting. It is one of the three rift basins surrounding the North Odisha Iron ore Craton that received and modified the material to evolve varieties of iron ores with respect to form, composition, mode of occurrence etc. The iron ore deposits of the basin have been controlled by various factors like deformational/structural, terrain morphological/stratigraphical and geochemical action followed by weathering and supergene enrichment. Banded iron formation in tabular/ stratiform form is deposited syngenetically in flat floor morphology of the basin at craton margin. Iron formations of epigenetic origin are facilitated by successive phases of diformations leading to folding, faulting, joints, fractures etc at local and regional level. The deposition of iron formation with different physical characters, mineralogy and physico-chemical conditions owe their formation in space and time with regard to source, transport medium, migration and deposition of ore constituents in response to changed P.T. conditions and the hydrous medium.

Some of the secondary/later iron deposits are facilitated by suitable sloppy topography, potential weathering, erosion and transportation. Such events could produce horizons of detrital, brecciated and boulder iron deposits at many localities along the eastern limb of Bonai-Keonjhar belt.

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