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Mineralogical and geochemical characteristics of the Noamundi-Koira basin iron ore deposits (India)

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India is one of the richest sources of iron ore deposits in the world; and one of them is located in the Noamundi-Koira basin, Singhbhum-Orissa craton. The geological comparative studies of banded iron formation (BIF) and associated iron ores of Noamundi–Koira iron ore deposits, belonging to the iron ore group in eastern India, focus on the study of mineralogy and major elemental compositions along with the geological evaluation of different iron ores. The basement of the Singhbhum-Orissa craton is metasedimentary rocks which can be traced in a broadly elliptical pattern of granitoids, surrounded by metasediments and metavolcanics of Greenstone Belt association. The Singhbhum granitoid is intrusive into these old rocks and to younger, mid Archaean metasediments, including iron formations, schists and metaquartzites and siliciclastics of the Precambrian Iron Ore Group (Saha et al., 1994; Sharma, 1994).

The iron ore of Noamundi–Koira can be divided into seven categories (Van Schalkwyk and Beukes 1986). They are massive, hard laminated, soft laminated, martite-goethite, powdery blue dust and lateritic ore. Although it is more or less accepted that the parent rock of iron ore is banded hematite jasper (BHJ), the presence of disseminated martite in BHJ suggests that the magnetite of protore was converted to martite. In the study area, possible genesis of high-grade hematite ore could have occurred in two steps. In the first stage, shallow, meteoric fluids affect primary, unaltered BIF by simultaneously oxidizing magnetite to martite and replacing quartz with hydrous iron oxides. In the second stage of supergene processes, deep burial upgrades the hydrous iron oxides to microplaty hematite. Removal of silica from BIF and successive precipitation of iron resulted in the formation of martite- goethite ore. Soft laminated ores were formed where precipitation of iron was partial or absent. The leached out space remains with time and the interstitial space is generally filled with kaolinite and gibbsite, which make it low grade.

Massive iron ores are devoid of any lamination and usually associated with BHJ and lower shale. The thickness of the massive ore layer varies with the location. The massive iron ore grades in to well-developed bedded BHJ in depth. Blue dust occurs in association with BHJ as pockets and layers. Although blue dust and friable ore are both powdery ores, and subjected to variable degree of deformation, leading to the formation of folding, faulting and joints of complex nature produce favourable channels. Percolating water play an important role in the formation of blue dust and the subterranean solution offers the necessary acidic environment for leaching of quartz from the BHJ. The dissolution of silica and other alkalis are responsible for the formation of blue dust. The friable and powdery ore on the other hand are formed by soft laminated ore. As it is formed from the soft laminated ore, its alumina content remains high similar to soft laminated ore compaired to blue dust.

Mineralogy study suggests that magnetite was the principal iron oxide mineral, now a relict phase whose depositional history is preserved in BHJ, where it remains in the form of martite. The platy hematite is mainly the product of martite. The different types of iron ores are intricately related with the BHJ. Hard laminated ores, martite-goethite ore and soft laminated ore are resultant of desilicification process through the action of hydrothermal fluids.

Geochemistry of banded iron-formations of the Noamundi-Koira iron ore deposits shows that they are detritus-free chemical precipitates. The mineralogical and geochemical data suggest that the hard laminated, massive, soft laminated ores and blue dust had a genetic lineage from BIF's aided with certain input from hydrothermal activity. The comparative study of major elemental composition of the basin samples and while plotting a binary diagram, it shows a relation between major oxides against iron oxides, in which iron oxides is taken as a reference oxide (Mirza, 2011). On the other hand, by plotting a binary diagram between chemical index of alteration (CIA) and other oxides while taking the samples of lower, middle and upper shales. It reflects an immobility and mobility of ions during partial and complete weathering processes (Mirza, 2011). Geochemical data indicate that BIF are in general detritus free chemical precipitates. $Fe2O_3$ content of BHJ are varies in between 36.6% to 65.04%. In hard laminated ore, $Fe2O_3$ content varies from 93.8% to 96.38%, Soft laminated ore varies from 83.64% to 89.5% and laterite ore varies from 53.5% to 79.11%. $Fe2O_3$ content in Martite- Goethite ore varies from 86.38% to

89.42% and blue dust having 90.74% to 95.86% and all other oxides like SiO_2, $Al2O_3$, CaO, MgO, K2O, Na2O are decreases. Major part of the iron could have been added to the bottom sea water by hydrothermal solutions derived from hydrothermally active anoxic marine environments. The presence of intacalated tuffaceous shales pointing towards the genesis of iron, which could have leached from sea floor by volcanogenic process. Iron and silica of BIF were provided by the hydrothermal solutions emplaced at the vent sites situated at the Archean–Mid Oceanic Ridges.

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