Tectonic Setting of Mineralization in the Singhbhum Protocontinent, Eastern India

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^{207}Pb / ^{206} Pb dates (3.5-3.6 Ga) of detrital zircon from Older Metamorphic Group (OMG) indicate that crust formation in this region has already been initiated by 3.6 Ga. Crust Evolution and mineralization in Singhbhum Protocontinent appears to have been intimately related to modern style plate tectonics since Mesoarchean. Available Sm-Nd and SHRIMP U-Pb data (ca. 3.1 Ga) suggest that Naushahi and Sukinda chromite, and Baula PGE deposits are oldest mineralization so far reported in this region. Banded Iron Formation (BIF) of the Gorumahisani -Badampahar belt and Deo River section, intruded by 3.12 ± 0.1Ga old Singhbhum Granitoid, are significantly devoid of Mn ore deposits. Predominance of magnetite and chert as primary constituent in BIF of Gorumahisani-Badampahar belt in contrast to hematite-jasper in BIF of the Jamda-Koira belt probably indicates lower O_2 content in the atmosphere during the precipitation of the former. Gold mineralization occurs in Kunderkocha-Gorumahisani Greenstones, which are stratigraphically younger than the Singhbhum Granitoids. Global Neoarchean peak (ca. 2.7Ga) is notably missing in this region. Deposition of U-bearing QPC in different parts of Singhbhum Protocontinent might have taken place after the Neoarchean stabilization and prior to the oxyatmoversion of the Palaeoproterozoic.

Paleoproterozoic Fe and Mn ore deposits in Jamda-Koira belt are certainly younger than the subduction related Bonai magmatic suite. Jamda-Koira belt have been divided into three distinct but conformable formations namely, (tuffaceous) Lower Shale, BHJ and (manganiferous) Upper Shale. Sedimentary textures and structures including stromatolites show that the deposition took place on a shallow shelf within the photic zone and above wave base. Geochemical data indicate that Fe and Mn deposits were precipitated due to the hydrothermal activity under suitable Eh-pH conditions in a mature volcanic arc / active continental margin setting.

Chromite deposits occur mainly in the serpentinised dunite, serpentinised pyroxene peridotites and talc-tremolite schist of Jojohatu-Roroburu, Sukinda and Nausahi, areas. Geochemical data from the Naushahi and Sukinda ultramafic plutonic bodies suggest that parental magma was of siliceous high Mg- basaltic or boninitic

composition. Like Sukinda ultramafic rocks, Jojohatu-Roroburu ultramafic rocks are also possibly correlative with the subduction related volcanism of the Mesoarchaean. A pronounced poverty of chromium in Palaeoproterozoic Ongarbira volcanic suite as compared to Jojohatu-Roroburu ultramafic rocks indicates that they are genetically unrelated. Titaniferous and vandiferous magnetite mineralization associated with gabbro-anorthosite also appears to be supra-subduction zone related.

The arcuate shaped SSZ hosts three types of mineralization: (i) sulfides of copper and other associated metals; (ii) uranium oxide and (iii) apatite-magnetite. Regional geological-geochronological investigations reveal that SSZ does not mark the boundary between the Singhbhum Mobile Belt (SMB) and Singhbhum Nucleus. Paleoproterozoic transpressional tectonics and mineralization along the SSZ evolved through several distinct episodes: (1) the oldest is the tonalite-trondhjemite intrusion of the Older Metamorphic Group, Bonai and Singhbhum Granite that together formed an extensive ensialic basement during the Mesoarchean (3.4-3.0 Ga) which subsequently underwent extension resulting in the outpouring of Gorumahisani Greenstones, followed by extensive Bonai metavolcanism and associated intrusive activity during the Neoarchean. (2) BIF and associated Mn ore deposits of the Jamda-Koira belt, carbonaceous black shale and associated platform and flysch like sediments of the Singhbhum Supergroup along with the phosphates and uranium oxides were deposited during 2.5-1.8 Ga. This was accompanied by intense transpression resulting in: (a) an extensive but short timed subduction related volcanism represented by Ongarbira, Dhanjori and Jagannathpur volcanic suites on the margin of Singhbhum Granitoid Complex; (b) Emplacement of Newer Dolerite dyke swarm with in the Singhbhum Granitoid complex; (c) Subduction related Dalma volcanism, its subsequent metamorphism due to the collision of a suspect terrane, viz. Chotanagpur Granite-Gneiss Complex (CGGC) with the Singhbhum Neucleus took place at the end of the Paleoproterozoic. Cu-Au-U mineralization took place due to the deformation and remobilization along the SSZ around 1600 Ma. (3) A Mesoproterozoic shearing event (ca.1.4 Ga) and U- Cu mineralization episode is also imprinted on the rocks of the SSZ.