SEM-EDS Study of Metal Rich Metasedimentaries in Part of North Singhbhum Mobile Belt, Jharkhand

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Abstract- Mesoproterozoic metasedimentary rock of Chandil Formation of North Singhbhum Mobile Belt, eastern Indian craton are enriched in polymetallic mineralization such as radioactive minerals (U), precious metals (Au) and REE associated with iron oxide. Scanning Electron Microscope with energy dispersal spectroscopy attachment used for qualitative and semi-quantitative or quantitative compositional analysis of samples. SEM-EDS studies of metasedimentary rocks of Chandil Formation reveal that the area is dominantly composed of magnetite, hematite, ilmenite, goethite, pyrrhotite, pyrite and chalcopyrite. The mineralization in the study area is structurally controlled and occurs along with the shear and foliation plane. Oxide and sulfide mineralization also present within the mineralised vein. The paper presents the details on the occurrence of polymetallic mineralization in the Kantaldih Bandhdih area of North Singhbhum Mobile Belt eastern Indian craton.
Keywords – polymetallic mineralization, NSMB, iron oxide, SEM, EDS

I. INTRODUCTION

The North Singhbhum Mobile belt of Singhbhum craton is made up of metasedimentary and metavolcanic rocks extending nearly 200 km in roughly E-W arcuate trend and exceeding 50 km in width is sandwiched between the Southern Singhbhum Granite Craton and the northern Chhotanagpur Granite Gneissic complex [1-5]. The study area is part Chandil Formation forms a northern segment of this mobile belt composed of quartzite, phyllite, and carbonaceous phyllite. This northern segment of NSMB hosts various gold occurrences and prospects viz. Babaikundi, Parasi, Lawa, Mayasera, Rudiya, etc. Promising uranium mineralization (Fe-Cu-U-Au-REE) associated with iron oxide breccias is reported [6] from the Chandil Formation. The radioactive brecciated carbon phyllite and ferruginised quartzite along an E-W trending regional shear/fault zone recorded 90-770 ppm U_3O_8 between Kantaldih and Bandhdih. The region is interesting for the metallogenic point of view it is one of the important metallogenic provinces of India. Even then it is not blessed with Late Archean Bonanza. The study of the deposits of the area is very sketchy and warrants detail and comprehensive study which throw light on many aspects of these deposits for the further exploration and better exploitation.

II. GEOLOGY

The metasedimentary assemblage of rocks belonging to Chandil Formation of mesoproterozoic age [7-9] in the northern part of North Singhbhum Mobile Belt (NSMB) eastern Indian craton is exposed around Kantaldih Bandhdih in Seraikela Kharswan district of Jharkhand (Fig. 1). The east-west trending Tamar Porapahar Shear Zone lies in the north, separate it from Chotanagpur Granite Gneiss Complex (CGGC). The intracontinental riftogenic Dalma Volcanic [9] rocks lie in the southern part of Chandil Formation and separate it from Singhbhum Group of rocks (Fig. 1). These metasedimentary grouped under Singhbhum Group by earlier workers[10,11]. However, studies carried out by Bose (1994)[12] first to separate it from the southern segment. This post-Dalma belt of metasedimentary and metavolcanic rocks is termed as Chandil Formation by Ray et al. (1996; cf.Acharyya, 2003)[13-14] constitute by quartzites, mica schists, carbonaceous phyllite, weakly metamorphosed acidic volcanic and volcanoclastic rocks [15,12,13,16,17,7,14,9]. The northern contact of Dalma Volcanic is faulted and having regional strike fault with east-west trend this lineament becoming NE-SW near the study area. The study area is known for the occurrences of uranium, precious metals and rare earth element with iron oxide breccias (Cu-U-REE-AU) is reported along the intersection of these faults [6].

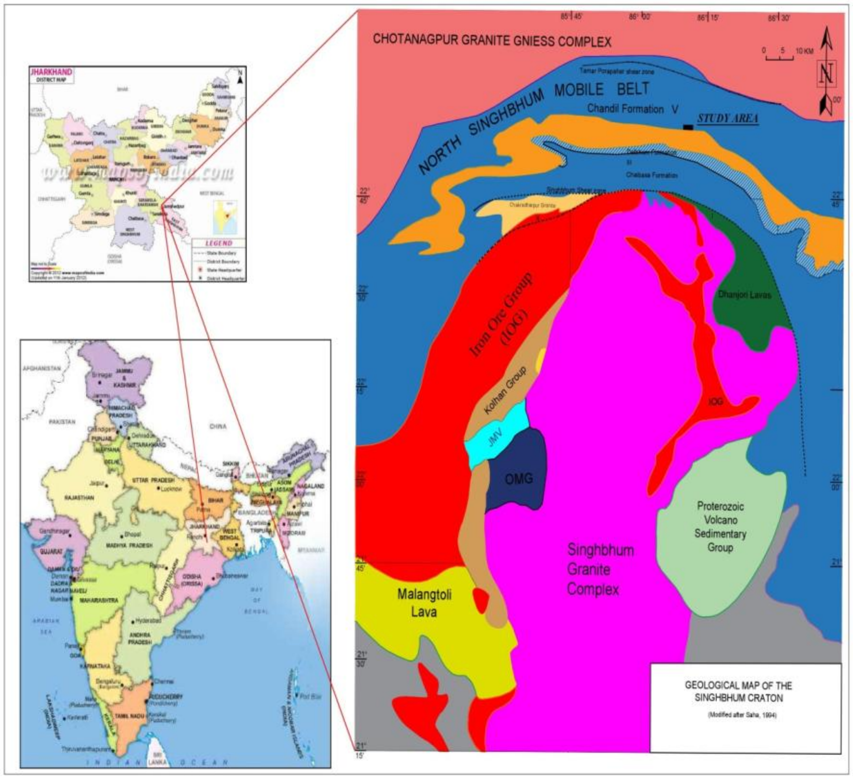


Fig. 1 Geological map of Singhbhum Craton showing the location of North Singhbhum Mobile Belt and Study area.(Modified after Saha 1994)[18]

III. METHODOLOGY AND WORKING

The Scanning Electron Microscope (SEM) is one of the most popularly used instruments for the identification and analysis of the microstructure, morphology and chemical composition. It produces images of a sample by scanning it with a focused beam of electrons. The electrons interact with atoms in the sample, producing various signals that can be detected and that contain information about the sample's surface topography and composition.

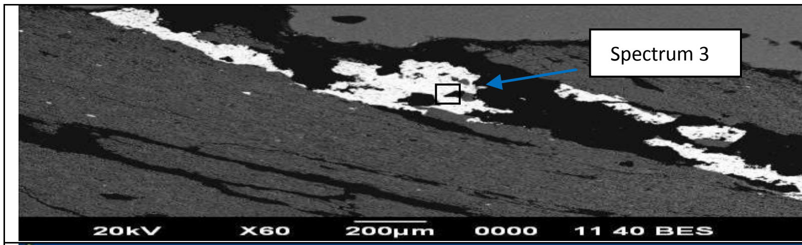
Incident electrons that are elastically scattered through an angle of more than 90° are called backscattered electrons (BSE) and yield a useful signal for imaging the sample. The yield increases strongly with the atomic number of the sample. Therefore, the contrast in the BSE image can reflect the distribution of heavy or light elements.

SEM with EDS attachment can be used for qualitative and semi-quantitative or quantitative compositional analysis of samples. When a beam of electron interacts with the sample electrons in the sample atoms inner-shell are excited, outer electrons transit and produce X-rays with characteristic information about the elements. Through X-ray energy dispersal spectroscopy (EDS), compositional information can be examined.

SEM analysis was carried out using the JEOL-JSM-6390 LV machine in Central Instrumentation Facility, Birla Institute of Technology, Mesra. For this thin polished sections of representative rock samples prepared and coated with Platinum to produce conductivity.

IV. PETROGRAPHY AND ORE MINERALOGY

The Macroscopic and microscopic study of the different rock samples from the study area has been done. Based on the macroscopic and microscopic study, the different rock units occurring in the area have been identified. The study area dominantly composed of phyllite, quartzite, carbonaceous-phyllite. The rock types are identified based on mineralogy in the field. The rocks preserves the structural records of past events like shearing, lineation and schistosity, etc. The ore microscopic study of the thin polished section performed under high-resolution microscope with image analyzer attachment in advanced petrography lab of University Dept. of Geology Ranchi University, Ranchi. Studied samples show the presence of magnetite, ilmenite, hematite, goethite, pyrite, and pyrrhotite.



spectrum 3	
Element	Weight%
O K	40.76
Fe K	59.24
Totals	100

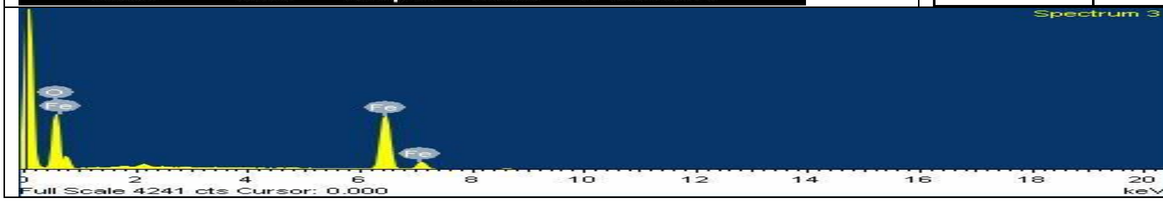
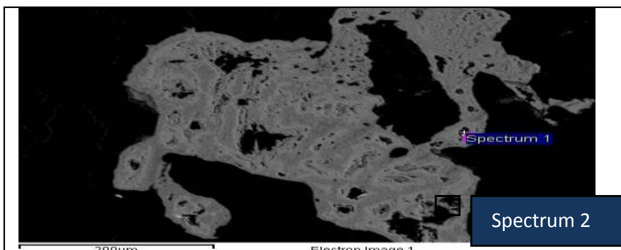
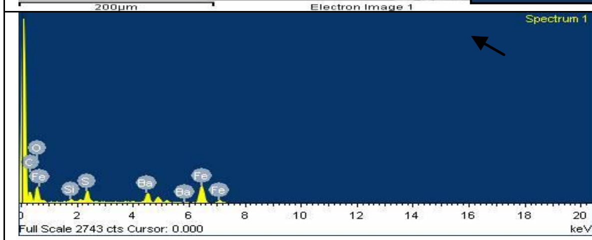


Fig. 2 SEM- EDS analysis of representing magnetite associated with carbonaceous matter



spectrum 1	
Element	Weight%
C K	27.85
O K	27.23
Si K	1.06
S K	4.23
Fe K	21.52
Ba L	18.11
Totals	100

spectrum 2	
Element	Weight%
O K	39.95
Si K	2.62
Fe K	57.27
Cu K	0.16
Totals	100



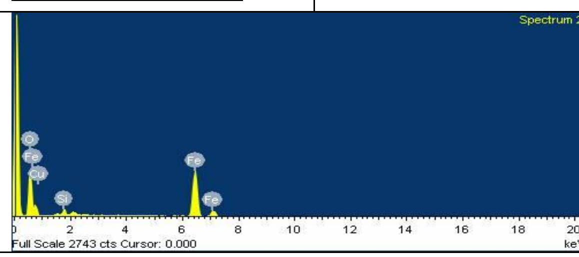
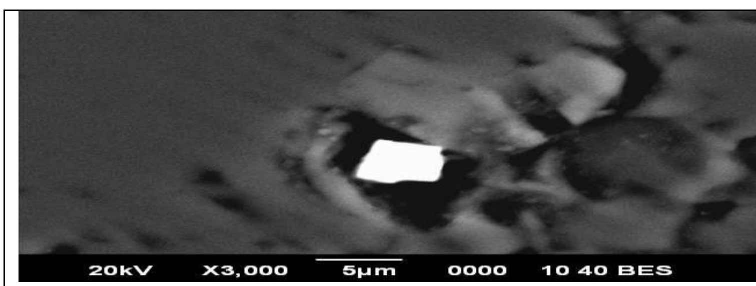


Fig.3. SEM- EDS analysis showing association of low S and Cu bearing Fe



Element	Weight%
C K	14.41
O K	16.23
Si K	2.22
S K	8.08
Fe K	1.11
Pb M	57.94
Totals	100

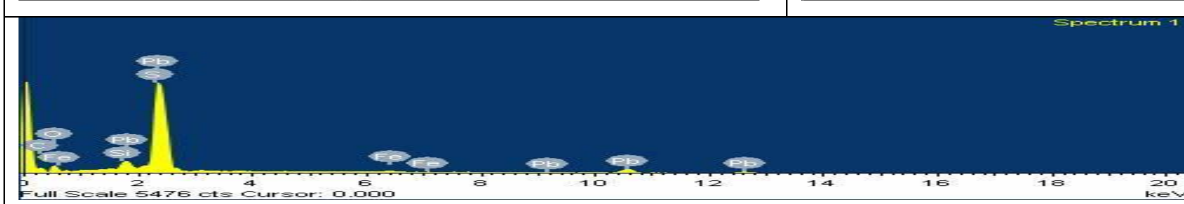


Fig. 4 SEM- EDS analysis of sample indicating presence of galena

V. SEM-EDS STUDY

SEM and EDS used for analysis of the microstructure, morphology and chemical composition of the samples. The samples are dominantly composed of iron oxides and sulfide. The iron oxides are represented by Magnetite (Fig.2), ilmenite, hematite and Goethite. The sulfide phase represented by pyrite, chalcopyrite, and pyrrhotite. The pyrite, chalcopyrite and pyrrhotite are found in association (Fig. 3). The galena grain also find in the study which is not observable in the ore petrographic study (Fig.4)

Magnetite and hematite are the most abundant iron oxide minerals found in the studied samples. The transformation of Magnetite is commonly observed in the samples along the plane of weakness. Magnetite contains both ferrous and ferric iron, easily transforms at low temperatures. Hematite is often a result of the replacement of magnetite, in the process called martitisation. Oxy alteration of iron oxide and sulfide is also observed in some samples by the process called limonitisation.

VI. DISCUSSION AND CONCLUSIONS

The study of iron oxide and sulfide samples shows a different variety of textural and microstructural features for the ore minerals. The high resolution of SEM and EDS reveal more detailed aspects of these features along with chemical information.The study area is dominantly composed of magnetite, hematite, ilmenite, goethite, pyrrhotite, pyrite and chalcopyrite. The mineralization in the study area is structurally controlled and occurs along with the shear and foliation plane. Mineralization and limonitization also takes place present within the mineralised vein.

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