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Occurrence of basemetal mineralization in Potin Area, Subansiri District, Arunachal Pradesh (NE India)

KEYWORDS: Sulphide mineralization, Potin Area, Shear zone, structural control, porphyroblasts, cataclasis.

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ABSTRACT Sulphide mineralization in the Potin Area of Subansiri district, Arunachal Pradesh, NE India has been reported. Mineralization in the area is both structurally and litho-stratigraphically controlled, confined to a shear zone of about 30 mts in width, traversing through garnetiferous quartz- biotite- schist belonging to the Bomdila Group. The sulphides consist of chalcopyrite-pyrite-pyrrhotite and sphalerite. Two episodes of mineralization have been noted. The earlier mineralization is parallel to the foliation plane trending ENE-NSW with a moderate dip of about 35 toward SE direction while subsequent shearing causes cataclasis of the garnet porphyroblasts and forceful injection of most ductile sulphide like chalcopyrite. Comprehensive P & T study of hosts and ore indicate that the host rocks were derived from cataclasis; metamorphosed at a temperature ranging from 478c-522c under variable pressure of >2.5 kb.

Introduction

Reports on sulphide mineralization of Potin area has been found in literature since 1959. The Geological Survey of India (GSI) subsequently carried out exploratory works in phases including drilling in order to probe mineralization potential in the area till 1974-75. Reports indicate that sulphide mineralization in the area was first noted by Laskar (1959), following which Roy Choudhary (1961), Rao and Dias (1963) and Kakoti (1968) of Geological survey of India visited the area to examine the economic potential vis-a-vis extension of the mineralized zone. Exposures of mineralized zone is seen along Kimin-Ziro road section at the northern bank of Ranga river (Lat: 2719/N; Long: 9348/E) and continue across the river bed to the Southern bank for a distance of about 300mts along its strike. The continuation of mineralized zone however, could not be traced further due to the construction of a dam there.

Mineralization in the area is both structurally and lithologically controlled. Structural elements include schistosity plane striking NE-SW dipping about 35 towards SE direction and shear planes developed often making low angle with the schistosity. Lithological variants appears to strictly confine to the pelitic schists or garnetiferrous quartz-biotite schist belonging to the Palaeoproterozoic Potin Formation of Bomdila Group. Mineralization in the area is dominated by chalcopyrite, pyrite, pyrhotite, sphalerite with occasional occurrence of magnetite and arsenopyrite.

Present paper deals with the petrography and mineral chemistry of host and ore mineralogy.

Geological Setting

The exposed lithology in and around Potin belongs to the crystallines of the lesser Himalaya and mainly consists of quartz mica schist and biotite gneiss resting over a narrow patch of Gondwana on a hidden thrust.

The metamorphic assemblages show a well defined foliation and the strike of the foliation plane is regionally NE-SW with moderate to steep dip towards SE. Two generation of folding episodes F1and F2 (D1 and D2 deformational episodes). The F1 folds are characterized by the tight isocinal with highly appressed limbs and thick hinges. This was followed by F2 folds (D2 deformation) which bear a coaxial relationship to the F1 folds. The folding episodes accompanied the metamorphism of the litho units because the dominant foliation of the rocks axial planar to F1 fold. The folding episode postdating the thrusting (D3 deformational episode) of the rocks in the area. The thrust parallel drag and thrust imbrication are also observed at places facilitating avenues for upward movement of sulphide mineralizing solutions.

The present field observations indicate that the study area represents a volcano- sedimentary terrain prior to the metamorphism and exposed to repeated deformational episodes. The folding deformation accompanied the metamorphism which was followed by shearing of the rocks. The shearing movement of the rocks was responsible for the migration of hydrothermal solution and mineralization. It is pertinent to mention here that localization of ore is related to the zone of intense shearing. Regional study refers to the uneven occurrence of sulphides of Ni, Co and Fe in the entire area but significantly their confinement to the sedimentary/ metasedimentary units points towards syn-sedimentary mineralization signature. Thus, the association of sulphides in pelitic metasediments of present study area and in black cherty shales in nearby Yazali area (Das, 1979) has been cited here as exhalative sedimentary derivation of sulphides in marine domain. Stratigraphically, all the mineralized zones are apparently confined to the Palaeoproterozoic Khetabari formation. The Potin formation is, however, the local equivalents of Khetabari Formation (Gopendra Kumar, 1997). Mineralization in the Potin area shows intricate relationship with the deformation pattern of the hosts. The exact location of mineralization is seen between 41 & 42 km post of Kimin-Zero road section on either banks of Ranga River (Fig.1).

The general foliation trend is ENE-WSW with moderate dip of 350 towards the SE direction. The tight isoclinal F1 folds have highly appressed limbs and thick hinges with axial plane dipping to the north-west. These folds are recline type. The second generation F2 folds have a coaxial relationship with the F1 folds and could be seen on cross section with fold axis plunging to NNW direction. The axial plane of F2 folds maintain near orthogonal relationship with F1 folds. The thrust parallel drag and thrust imbrication are also observed at places facilitating avenues for upward movement of mineralizing solutions. Cross fractures indicate a north-south trend and are indicative of southward movement of sequence and accommodation of stress.

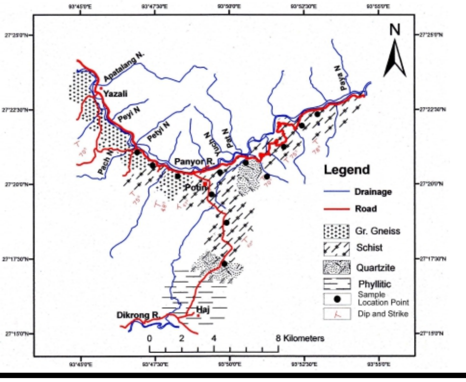

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Fig. 1 Geological map of the study area

Materials and methods

Thirty samples were drawn from mineralized lithounits; both thin sections and polished blocks were prepared for mineralogical study following the standard procedure described by Craig and Vaughan (1981). Five hosts and ore sections were analysed for EPMA at GSI, Kolkata in a CAMECA Sx 100 machine at 20KV voltage; 15nA for silicates.

Petrography of host rock

The sulphide mineralization is hosted by a NNE-SSE to NE-SW trending subvertical sheet about 30mts wide garnetiferous quartz-biotite schist sandwich between granite gneiss to augen gneiss.

Garnetiferous –quartz-biotite schist

The rock is highly sheared, fine to medium grained, dark coloured and shows schistose fabric Thin section study reveals that the rock consists mainly of quartz, biotite and garnet as major mineral components. Some common minor minerals include feldspars (both alkali feldspar and plagioclase feldspar) and apatite. Chlorites are observed as secondary minerals (altered product of biotite). Grains are highly sheared and some smaller grains of quartz are found as inclusion in garnet fractures. Ore microscopy reveals chalcopyrite mineralization along with some streaks of pyrhotite. Garnets are characterized by very high almandine contents (72.7% to75.8%) and very low grossular contents with little zonation. The almandine contents show an increasing order from core to rim in the analyzed samples. Mn contents of the garnets are relatively low (upto 1.4 mole %).

Biotite as primary phase is medium to coarse grained platy in nature and is associated with quartz. Biotite exhibit pleochroism(X=Y= yellowish brown, Z= pale yellow) and parallel extinction except for some bent crystals, which show wavy extinction. Chloritization of biotite is also observed.

Although gneisses, quartzites, phyllites and gneissic rocks occur in the area but these rocks are barren.

Results and Discussion

Sulphide Mineralogy and texture

Megascopic studies of the fresh sample show association of sulphides with silicate gangue. The sample show prevailings occurrence of chalcopyrite with abundant sphalerite & pyrhotite. These basemetal sulphides are mostly confined to the pelitic schist comprising of quartz-biotite-schist belonging to the Palaeoproterozoic Potin Formation of Bomdila Group.

Mineralogical study was carried out on polished sections which indicate presence of three varieties of minerals, either in polyphase/or in monophase assemblages.

Mineralogical study reveals presence of the following minerals:
Sulphides:- Chalcopyrite, pyrrhotite, sphalerite, pyrite
Associated opaques Limonite, hematite
Silicate gangue Garnet, Mica, Quartz
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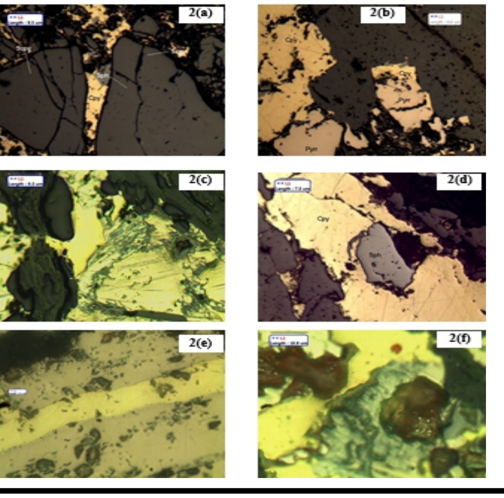
Among sulphides chalcopyrite and pyrrhotite generally occur as major phases in almost equal proportion and sphalerite in minor quantities; pyrites pulverized to form finer angular fragments. Most of these minerals show recrystallization, replacement texture or vein filling textures or even intergrowth. The schlieren ore formed by pyrites appears to be a hardened variant. Relative hardness and Vickers' hardness show that at low temperature near surface condition, pyrite has considerably greater hardness in comparison to the chalcopyrite and pyrrhotite and thus shows brittle deformation while both pyrrhotite and chalcopyrite having almost equal hardness deform plastically (Craig and Vaughan, 1981). The fractures in garnets and occasionally in quartz often heal up with chalcopyrites. However, chalcopyrite micro veins of third generation are present within recrystallized pyrrhotites of second generation(Fig2e). Migration of sulphides toward grain boundaries or intergrannular spaces of hosts is common in samples drawn from shear planes.

The silicate gangue like garnets mostly suffers brittle deformation, forming fractures while micas often show decussate structure. The fractured garnets often heal up with chalcopyrite (Fig2a) However, chalcopyrite microveins of later generation are present within pyrrhotites of earlier generation. In certain sections sulphides are found along grain boundaries and /or intergrannular spaces of sulphides.

Chalcopyrite is mostly xenomorphic granular aggregate; show wide range of variations in their grain size. It is deep brass yellow with high reflectivity(Fig2b). Pyrrhotites are creamy to pinkish brown and strongly anisotropic; colour is distinct from creamy brown to reddish brown(Fig2b). Sphalerite mostly occurs as coarse to medium grained, anhedral to subhedral crystal. Although it is isotropic, it occasionally shows anisotropic characteristics, probably due to iron content in the crystal structure. Sphalerites are grey to yellow or brown in thin sections but may not be uniform and show both cataclasis as well as metamorphic recrystallization. They also replace pre-existing chalcopyrite/pyrite.

Silicate gangues are mostly almandine garnet, quartz and biotite. Chloritization of biotite is also observed. Among sulphides, chalcopyrite and pyrrhotite occur as major phases in almost equal proportion while sphalerite is in minor quantities, often develop within chalcopyrite. Isolated sphalerites are though rare, but present(Fig2d) Pyrites are pulverized to form schlieren ore due to shearing(Fig3a) and also pyrites are diffused in silicates(Fig2f). Chalcopyrite and/or pyrrhotite often show recrystallization, replacement, vein filling or even intergrowth with associated pyrrhotite(Fig2c). The silicate gangues like garnet and quartz mostly suffer brittle deformation by developing fractures while micas often show decussate structure. The fractures in garnets and occasionally in quartz often heal up with chalcopyrites. However, chalcopyrite micro veins of third generation are present within recrystallized pyrrhotites of second generation. Migrations of sulphides toward grain boundaries or intergrannular spaces of hosts are common in samples drawn from shear planes(Fig2b) The sulphides-oxide ores in the association follows the schistosity plane and show similar structural alignment with the hosts. However, there is a minor remobilization episode caused by subsequent tectonism that transects the early generation ore at high angle followed by a minor episode of micro channel formation and impregnation.



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2(a) Schlieren pyrites (Scpy), Sphalerite (Sph) and Chalcopyrite (Cpy) as fracture fillings in garnet (Gr) porphyroblast.

2(b) Sulphide patches along foliation plane.

2(c) Replacement of pyrrhotite and associated minor covellite.

2(d) Euhedral crystals of pyrrhotite (Pyrr) with chalcopyrite (Cpy), sphlaerite (Sph) are common in the constituent in the constituent ore association

2(e) Chlacopyrite (Cpy) vein in pyrrhotite (Pyrr).

2(f) Pyrite diffusion/exsolution in silicates.

Conclusion

- Mineralization in Potin area is in garnetiferous quartz- biotite-schist belonging to Bomdila Group of Potin Formation (equivalent to Khetabari formation).
- Consistent occurrences of sulphide ores with metasedimentary rocks in Potin and nearby locations support a close relationship with sedimentary environment.
- Structural control is prominent.
- Repeated tectonism and at least three distinct episodic movements through shear zone developments seem to be the valid proposition in the bulk mineralization; circulation of mineralized solutions through shear fractures enhances the mineralization phenomena.
- Metamorphism has obliterated original texture as well as mineralogical composition since the evaluated geobarometric-geothermometric parameters are sufficient to alter the texture and the mineralogy (2 - 2.5 kb pressure and 4780C - 5600C temperature).

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