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Mineralisation of gold at Ajjanahalli Prospect, Tumakuru district, Karnataka

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Gold is one of the most important economic minerals of our country and therefore, prospecting of gold is carried out in various parts of our country. The major prospecting of gold is carried out in Neo-Archean Dharwar Craton area. The investigated area of gold prospect is located Ajjanahalli, Sira town of Tumakuru District of Karnataka, India. It is a part of 57C/9 toposheet prepared by Geological Survey of India (G.S.I.) and lies within the rectangular grid bounded by latitudes 13°42′55″ to 76°43′15″E and is designated as Block-F by GSI for convenience. Detailed mapping on scale 1:2000 is done using handhold GPS over an area of 1200 sq m. Drilling of four borehole was done with total depth of 558.2 m. The area comprises of meta-basalt, BIF (banded iron formation), meta greywacke, meta-argillite with minor ferro-dolomitic bands with basic dykes and quartz, carbonate veins of Chitradurga Group of Dharwar Super group. Moderately plunging tight isoclinals folds pre-dominate the terrain. The mineralisation is basically within the sheared sulphide and carbonate facies. BIF shows developing of quartz-carbonate veins that show lesser but fair amount of mineralisation zone occurring along the parallel shears within the BIF.

Key word: Ajjanahalli, mineralisation, banded iron formation, Dharwar Supergroup, gold.

INTRODUCTION

The economy of a country greatly depends on the economic minerals it possessed, therefore it is important for a country like India to have knowledge about the minerals it possesses and their occurrence. Fortunately, India is having a few gold occurrences in its Precambrian rocks. These areas are being mined and prospecting of gold is a going process till today. The study area of Tumakuru district of Karnataka is a part of 57C/9 toposheet prepared by GSI and lies within the rectangular grid bounded by latitudes 13°43’0” to 13°43”35’N and longitudinal 76° 42”55’ to 76°43’15’E. The investigated area Ajjanahalli is a small village of Tumakuru District which belongs to Bangalore South Division and is situated 77 kms towards N from district headquarters Tumakuru, 25 kms from Sira and 154 kms from state capital Bengaluru.

The study area forms a part of the Chitradurga Schist Belt and is designated as Block-F by GSI for convenience and covers an area of 1200 sq m. It falls under the Precambrian Western Dharwar Supergroup and comprises a sequence of meta-sediments and meta-volcanic rocks of Chitradurga Group of Western Dharwar Supergroup and younger intrusive (Ballal, 1980; Sundaramurthy *et al.*, 1983). In this part of Chitradurga schist belt, a great detailed of work has been done in the past to understand the geology, geochemistry, economic geology and geochronology (Bruce Foote, 1882; Iyer, 1899; Wetherell, 1904). The eastern part of the Chitradurga schist belt was considered to be of pre to early synclinal sediment, metamorphosed under medium to high grade (Jayaram *et al.*, 1964). It was followed by green schist facies of rocks having meta-volcanic rocks and younger meta-sediments.

Viswanatha (1960) considered that the Archean Javanahalli series has been trusted over the Proterozoic rocks of Chitradurga belt by a high angle reverse fault. Some recent detailed and systematic geological mapping was carried out by Ballal 1980, who brought out litho-succession followed by Ramakrishnan *et al.* (1981). After

Figure 1: Political map of Karnataka with districts and mark showing the district headquarter of the district of the study area.

Table 1: Regional stratigraphy of Western Dharwar Craton (WDC) (after Swami Nath and Ramakrishnan, 1981).

Proterozoic Mafic Dykes
Charnokckites (2500-2600 Ma)
Younger Granites (2600 Ma)

DHARWAR SUPERGROUP (2600-2800)	CHITRADURGA GROUP	Ranibennur Supergroup	Greywackes with BIF, polymict conglomerate, Mafic-felsic volcanics
		Vanivilas Supergroup	Manganese and iron formation, stromatollitic carbonates, biogenic cherts ,pelites, quartzites and polymict conglomerates (basin margin) — Mafic-felsic volcanics with BIF, phyllites (basin centre)
			Talya/Kaldurga Conglomerate, meta-basalts and siliceous phyllites of Jagart valley
		Disconformity	
	BABABUDAN GROUP	Mulaingiri formation	BIF with phyllites and rare ultramafic sills
		Santeveri formation	Metabasalts, felsic volcanics (Galipuje felsite) ultramafic schists,layer basic complexes, siliceousphyllites, cross bedded quartzite (kaimara,Tanigebail)
		Allampura formation	Metabasalt, gabbros, ultramaficschists, local BIF, phyllites, cross bedded quartzite (lakya)
		Kalasapura Formation	Metabasalt, gabbros, ultramaficschists, phyllites, quartzites, basal quartz pebble comglomerates (kartikere conglomerates)
Deformed angular unconformity			
Peninsular Gneiss with Tronjhemite-Granodiorite Plutons (>3000 Ma)			
Intrusive/Tectonic Contact			
SAGUR GROUP (3100-3300 Ma)			Ultramafic-Mafic Layered Complexes, Tholeiiticamphibolites, Komatitiites, BIF
			Quarzites, Pelites, Marble and Calc-Silicates Rocks
Intrusive/tectonic contact			
Gorur Gneiss (3300-3400 Ma)			

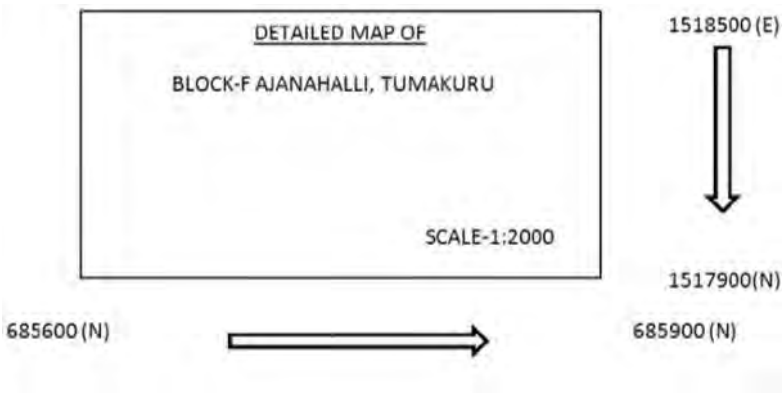


Figure 2: Diagrammatic representation of a toposheet of the study area.

the successful completion of several mining activities encourage by extensive old working earlier, this area came to highlight for some detailed exploration of gold (Au) associated within shear zone and also in BIF.

The study area as mentioned earlier comprises of meta-volcanic rocks (meta-andesite, pyroclastic pillowed, variolitic and carbonated meta-basalt) and meta- sedimentary rocks (BIF, argillites, meta-greywacke, ferro-dolomite) which are intruded by Bukkapatna granite, gabbro dykes and quartz veins. Two major bands are intricately folded and repeated as a number of parallel bands. The meta-volcanic rocks are found in the southern parts of the area in small mounds and also in the plains. Argillites-greywacke occupied the northern part of the area and Bukkanapatna granites are found in the eastern part of investigated area.

MATERIALS AND METHODS

Detailed mapping on a scale of 1:20000 is done with the help of handheld GPS over an area of 1200 sq m. The block is under the prospecting phase for gold and other associated metals, occurring basically in the sulphide facies within the BIF. A traverse was carried out in a more or less rectangular grid with an interval of 100 m, whereas in some cases it is reduced up to a few meters and hence confining at around 50 m or so. The regional foliation trends N-S to N 15°E-N 15°W the dips are steep towards east or west

Taking the attitudes of rock layer and coordinates of rock layers with the help of a Brunton compass and a handheld GPS, a detailed map is prepared (Figure 3).

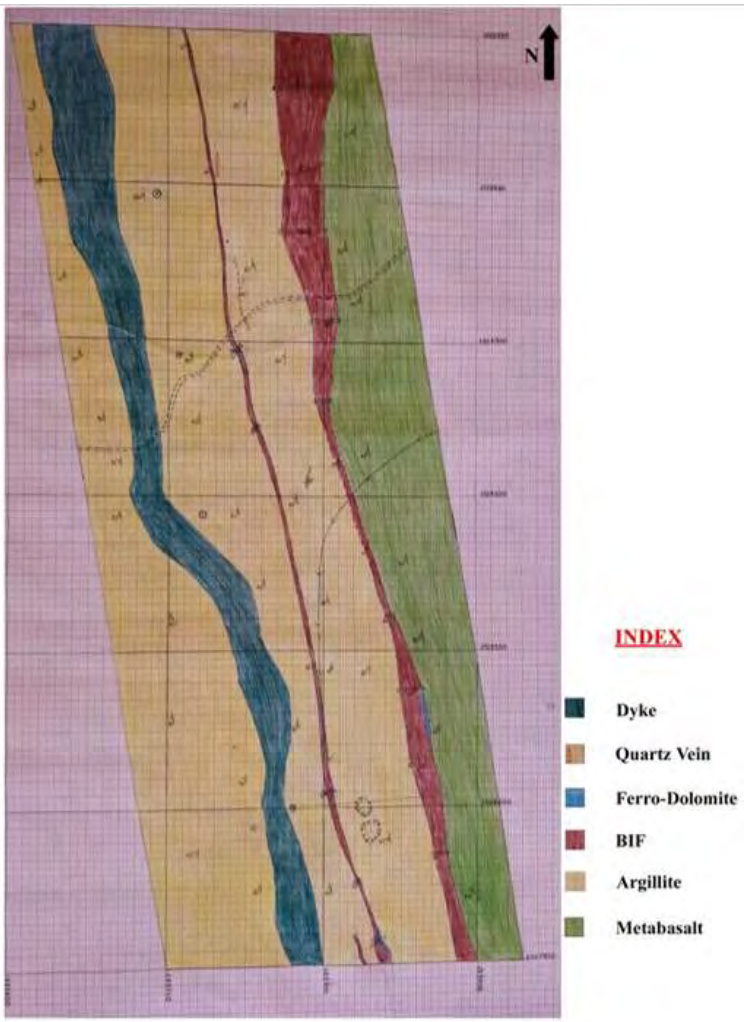
Rock samples are taken from the trenches which were already dug by GSI and also taken from the litho-contacts which were encountered while transverse mapping. The rock samples were taken to laboratory for studying their physical and mineralogical composition.

The meta-volcanic rocks which occupy the core of the antiform consist of mainly pyroclastics, pillowed, variolitic and carbonated meta-basalts, thin meta-andesite and impersistent thin ferro-dolomite bands. The meta-basalts are greenish in colour, fine grained, hard and compact. They are also found as massive boulders with well-developed schistosity. The meta-basalts when viewed under a petrological microscope show the presence of chlorite, chertified quartz, muscovite and feldspar which shows schistosity (Figures 12 & 13). The meta-volcanic rocks were overlain by meta-sediments. The meta-sediments comprise of BIF and argillites. The BIF are a good structural marker and clearly document the folds in the area. The width of the bands varies from 2 m to nearly 50 m. They are well bedded, the bedding being due to rhythmic deposition of silica and iron rich layer of light and dark colours. The thickness of the band varies from a few mm to as much as 3cm.They are very hard, dark coloured and compact. The iron in the BIF occurs in oxide, carbonate and sulphide facies. The predominant iron minerals are oxide facies and mostly magnetite. In sulphide facies, the iron minerals are pyrite and pyrrhotite and minor chalcopyrite. Mineralogically BIF comprises of iron oxide and chertified quartz (Figures 4 & 5). Numerous structures like folding and boundins were observed (Figure 8). From the polished section of BIF associated minerals of gold like arsenopysite and pyrite were observed. The BIF is overlain by the argillites-greywacke which are dark to light green in colour and they composed of quartz, ore minerals, chloride and sericite.

These layers were intruded by two basic intrusive of trend E-W and N-S and quartz vein trending N-S. Width of these dykes varies from 10 m to 20 m. They are massive, bouldery, compact and medium grained and they are of gabbroic composition. The bookshelf or dominos structure which is observed in the granite when viewed under a petrological microscope confirm the shearing action in the study area (Figure 11).

Following the old working in the quartz veins where free gold is present in the northern slope of Gavigudda by the localites hills over a strike line of 100 m, present work was being done on the basis of it. The old workings were of 20-30 m depth within the zone of oxidation in the hillock that lies in a range of 620 to 650 m R.L. the surficial expression depicts that the gold recovery was done in the zone of weathering, taking expression over

Figure 3: Detailed map of Ajjanahalli Gold Prospect.



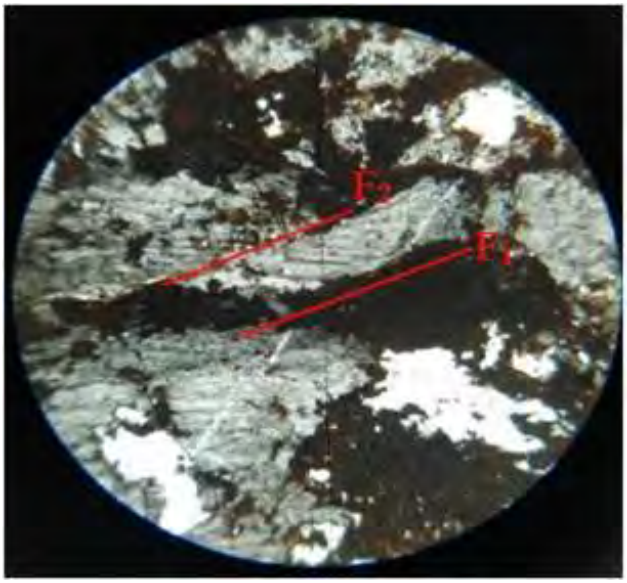


Figure 4: BIF showing parallel set of faults (represented by two red lines) with silica veinlets under plane polarised light.

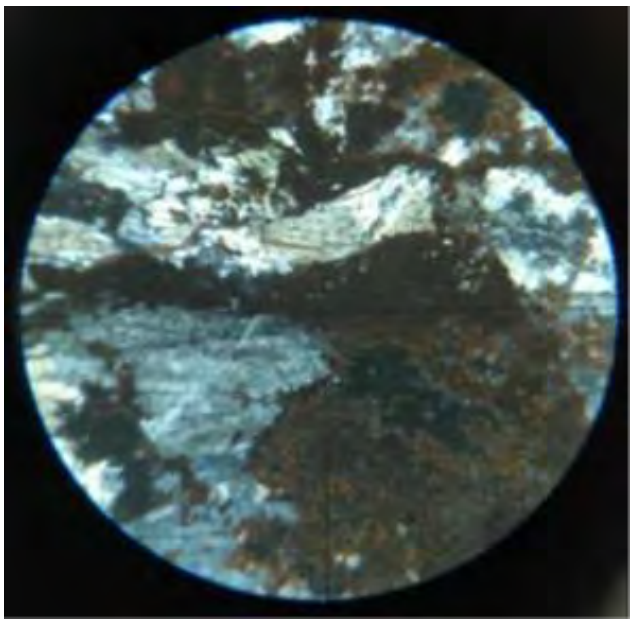


Figure 5: BIF showing parallel set of faults with silica veinlets under cross polarised light.

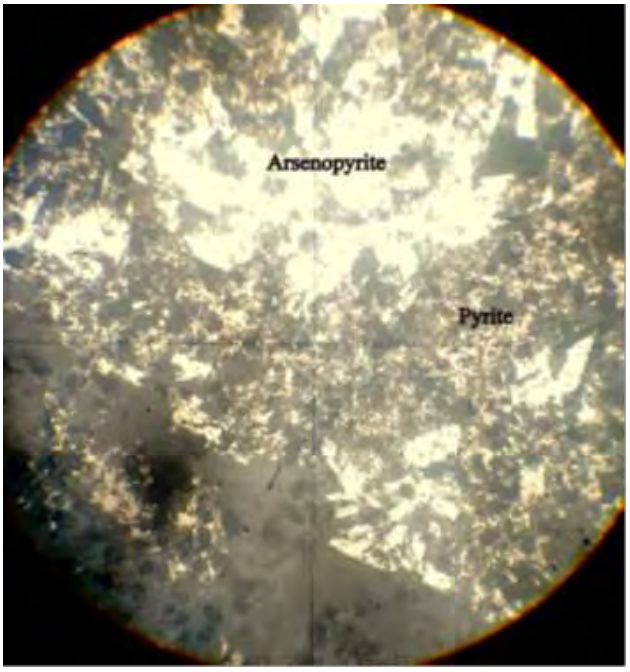


Figure 6: Polished section showing arsenopyrite and pyrite association in BIF under PPL.

Figure 7: Ore body (BIF) showing bandings and fold with gold in association and other minerals are localised within it.

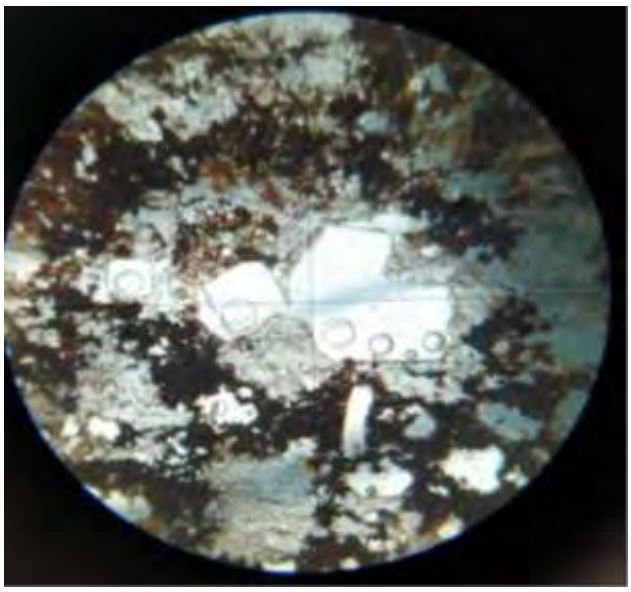


Figure 8: Photomicrograph showing sheared and fractured boudins in BIF under PPL.

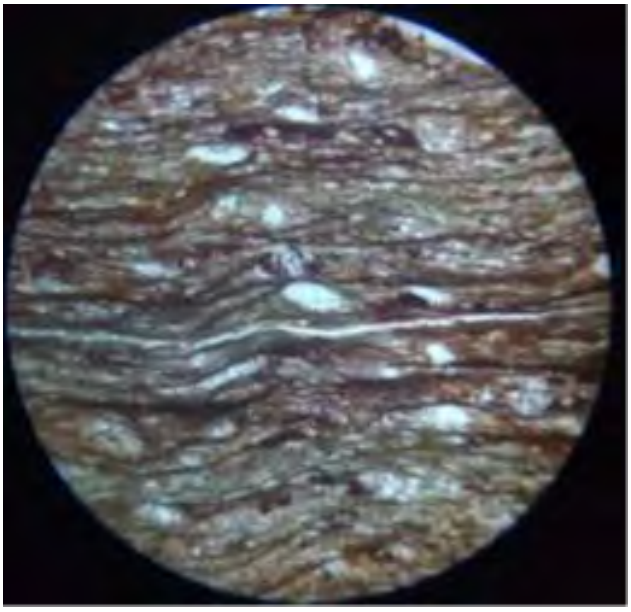


Figure 9: Argillite showing sinistral sheared grain along with carbonate vein under plane polarised light.

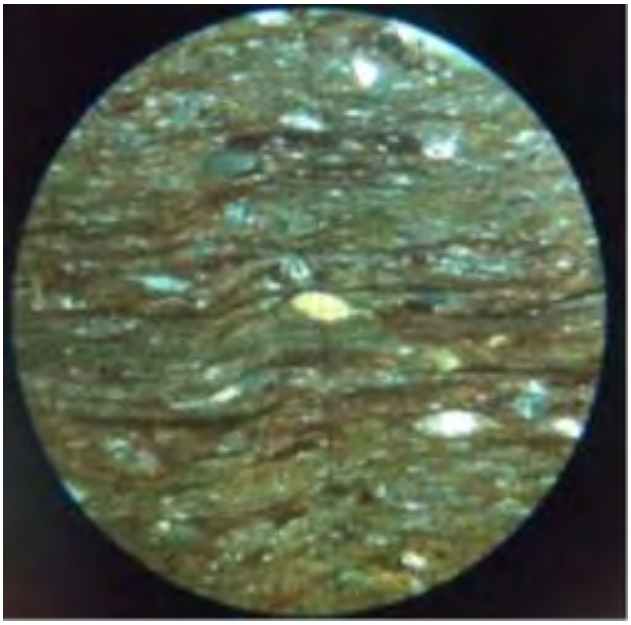


Figure 10: Argillite showing sinitral sheared grain under crossed polarised light.

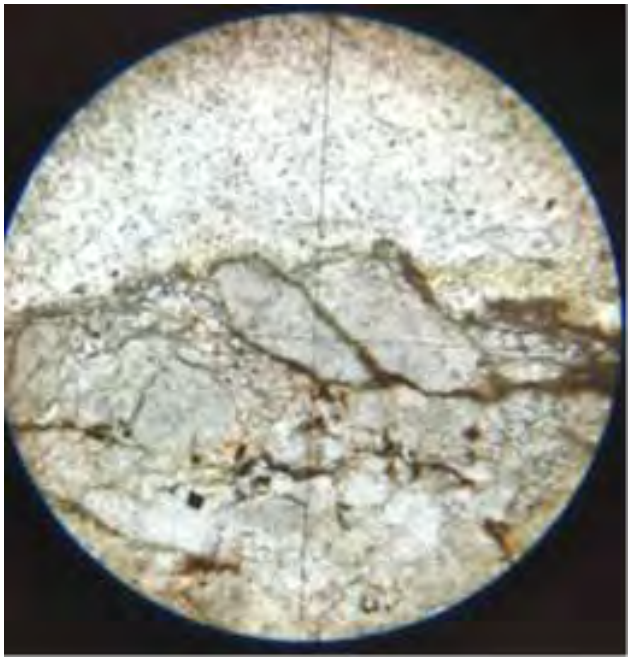


Figure 11: Picture showing book-shelf or dominos structure in sheared granite under PPL.

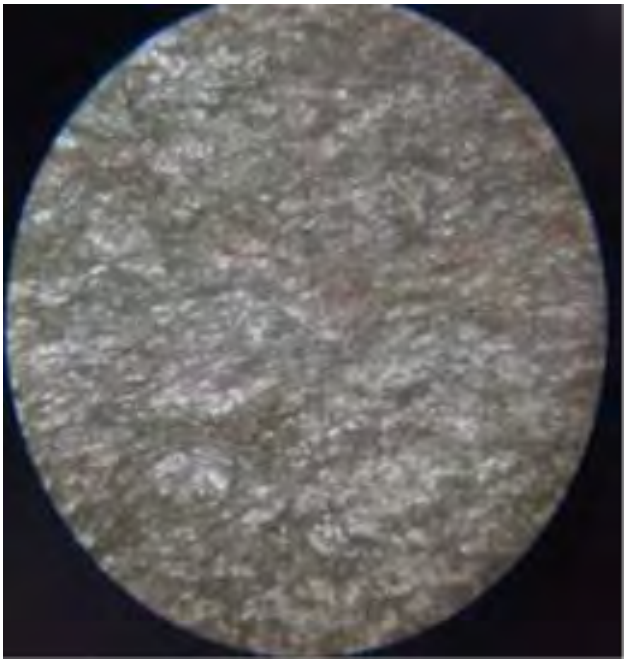


Figure 12: Metabasalt under Plane polarised light.

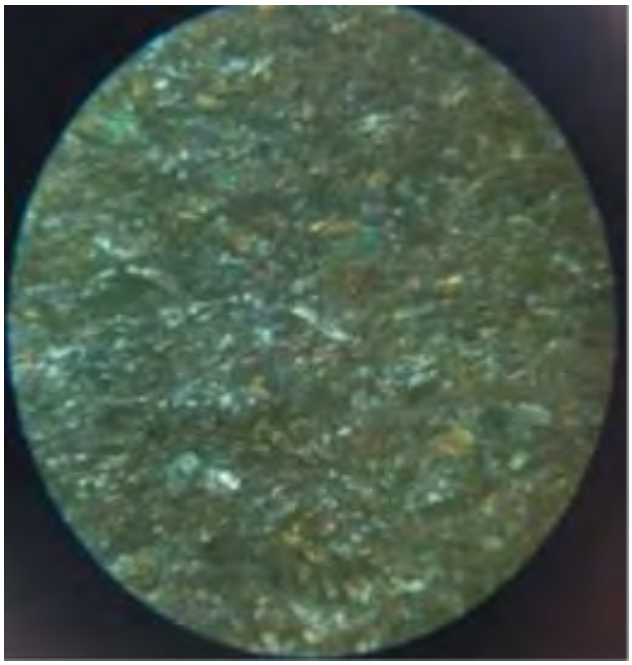


Figure 13: Metabasalt under crossed nicol.

Figure 14: Doleritic dyke under PPL.

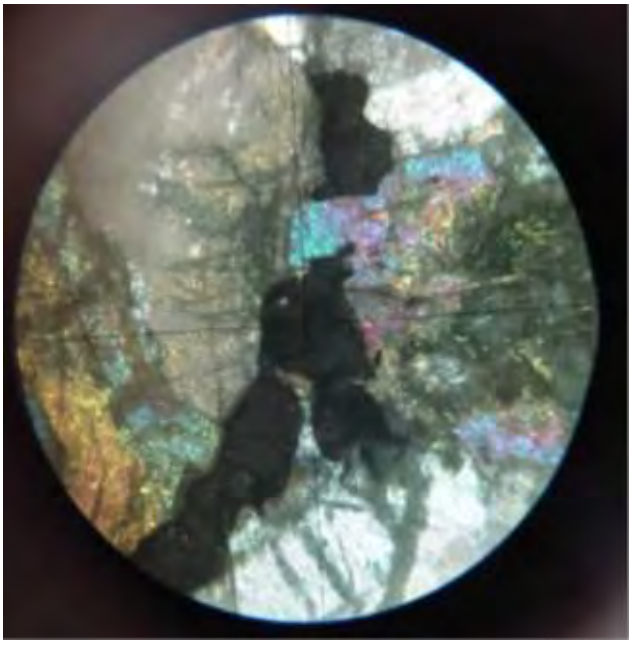


Figure 15: Doleritic dyke under crossed nicol.

the surface and recovery was done by ancient method of panning.

Result and Discussion

The record of large scale mapping and mine developing policies adopted by Nungdydurg Mining Company indicates mineralisation is within sheared sulphides and carbonate facies-BIF showing developing of quartz carbonate veins with stringers, specks and dissemination of pyrite, pyrhotite, arsenopyrite and minor chalcopyrite. However, meta-basalt and argillites on being transverse by quartz-carbonate veins shows lesser but fair amount of mineralisation.

In decreasing order of persistence, the BIF got a good persistence followed by the meta-basalt and argillites. The mineralisation is much better in the fold closure of the antiformal folds and is relatively lean on the limbs. The mineralized zones are concordant with the attitude of enclosing rocks.

Phenomenon such as sericitization, muscovitization, carbonitization and chloritization are observed within the zone of shear with quartz veins and veinlets running parallel to the strike of BIF. These episodes are syn to para with reference to 2nd generation of folding.

Available data from mineralogical studies shows arsenopyrite exhibiting different stages of development. Composite grains of pyrhotite-chalcopyrite are also noticed. Some amount of minor chalcopyrite is found to exist in exsolue phase within pyrhotite. A size varying from 5 micro m to 50 micro m of gold having high refractive index noticed in thin section. Gold is also observed in the native form as irregular shaped cluster in the gangue in carbonate facies. Occasionally native gold mimics the morphology of pyrhotite.

Borehole data indicates about an intimate association of sulphide mineralisation of gold particularly within the sheared portion of BIF. Some borehole exhibits, massive sulphide veins varying it from 10 to 40 cm and appreciable amount of gold is characteristically observed within BIF that are rich in arsenopyrite.

From the studies it has been confirmed that the nature of mineralisation is hydrothermal in origin and epigenetic in nature, also it characteristically high amount is observed in the zone of shear than in the unsheared portion and that the mineralization of gold is structurally controlled. While correlating, it can be fairly understood that the intensity of shearing plays major control over gold and arsenopyrite mineralisation. Other factor such as different stages of development of arsenopyrite and trace elemental studies depicts that event of shearing and remobilisation phenomenon are also one of the major control of mineralisation in Ajanahalli area.

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