# MINERAGRAPHIC STUDIES OF SOME SULPHIDE-MINERAL VEINS NEAR THE TRIJUNCTION OF BANKURA, MIDNAPORE AND PURULIA DISTRICTS, WEST BENGAL

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ABSTRACT

Three new occurrences of sulphide-mineral veins are recorded. Mineragraphic studies of the polished ore samples under the reflecting microscope show galena is the most abundant of the sulphide minerals while sphalerite, arsenopyrite, pyrite and pyrrhotite are common. Electrographic contact print of the polished specimens indicates galena is, in some instances, argentiferous. One silver mineral proustite has been identified. Pyrite was the earliest mineral to crystallise. Arsenopyrite started to crystallise later and the time of crystallisation of pyrite and arsenopyrite overlapped. Some deformative force fractured the pyrite and arsenopyrite grains before sphalerite invaded them. Galena replaces pyrite, pyrrhotite, arsenopyrite and sphalerite abundantly, but shows a selective preference for sphalerite. The silver mineral invades galena along grain boundary. The blue-grey quartz has replaced galena quite abundantly; the replacement has often been guided by cleavage planes. Iron from pyrite and arsenopyrite has altered to goethite. Anglesite, an oxidation product of galena, sometimes forms rims around galena veinlets.

## 1. INTRODUCTION

A number of sulphide-mineral veins crop out near the trijunction of Bankura, Midnapore and Purulia districts, amidst pelitic, psammo-pelitic and basic schists. The area is an eastern continuation of the Archaean terrain of Chotanagpur, Singhbhum, Manbhum and Dhalbhum. The earliest reference to the geology of the region dates back to 1823, when Dr. Vosey noted the rocks near Dadhka and Kuilapal as 'mica-schists containing profuse quartz veins'. In the first *Memoir of the Geological Survey of India* (1859) Oldham, Blanford and others gave an account of the 'Geology of Banchoora, Midnapore, and Orissa'. The next important reference is Valentine Ball's *Memoir* published in 1881. After the study of the geology of the whole of Chotanagpur he subdivided the rocks into a metamorphic series and a submetamorphic or transition series. He located some occurrences of ore minerals. The most comprehensive recent report of the geology of the area has been given by Dunn, Dutt and Dey. Dey (1937) noted the occurrence of galena in a quartz vein half a mile WSW. of Kamma (22° 53′ N.; 86° 44′ E.). The present author located three more sulphide-mineral bearing quartz veins in the present area. The detailed mineragraphic studies of these ore veins have been carried out for the first time. The subject of the paper is confined to the description of modes of occurrence, mineral assemblage, textural relation and mineral paragenesis of the ore veins.

## 2. GEOLOGY OF THE COUNTRY ROCKS

The area (22° 57′–22° 45′ N.; 86° 36′–86° 50′ E.) is chiefly constituted of metamorphosed pelitic rocks with an elliptical granite body in the south-west corner and smaller granite outcrops north and west of it. Following zonal concept of variation of metamorphism, four zones of progressive metamorphism (biotite, garnet, staurolite kyanite and sillimanite) have been mapped in the area (Chakravarty, 1955).

The commonly occurring basic rocks and less abundant psammitic, psammo-pelitic and calcareous and ultrabasic rocks have been subjected to isophysical metamorphism with the pelitic rocks.

The sequence of stratigraphical units worked out by the author is, in fact, little different from that established by Dunn and Dey (1942) after the study of Singhbhum and Chotanagpur terrain. The table of geologic succession is presented below together with that suggested by Dunn and Dey, *loc. cit.*, for the region lying north of the Singhbhum shear zone.

| | *Author* | | *Dunn and Dey* |
|---|---|---|---|
| | Alluvium. | | Alluvium. |
| | Laterite. | | Laterite and tertiary grits. |
| | Quartz veins. | | |
| | Pegmatites. | | |
| | Granite and granodiorite gneisses. | | Chotanagpur granite gneiss. |
| | Epidiorites and ultrabasics. | | Dalma lavas (overlap). |
| Iron ore series | Phyllites, ferruginous quartzites and quartzites. | Iron ore stage | Phyllites, quartzites, haematite, phyllites, tuffs and basic igneous rocks. |
| | Mica-schists, quartzites, hornblende-schist, calc-schist, calc-granulites and associated para-amphibolites. | Chaibasa stage | Mica-schist, hornblende-schist with quartz granulite, quartz, schist, tuffs and cherts. |

## 3. Mode of occurrence of the ore veins

One of the sulphide-mineral veins is exposed near Dungrikuli (22° 53′ 25″ N.; 86° 42′ 50″ E.) amidst garnetiferous mica-schists and epidiorite-schists. The foliation dip of the country rock is 50°–55° towards NNW., the vein dips in the same direction. Near this occurrence thin sheets of vein-quartz run parallel to the foliation plane of the mica-schists. Spongy quartz constitute greater portions of this vein. The middle portion of these sheets is seamed with a blue-grey quartz carrying the sulphide minerals.

The other two quartz veins, carrying sulphide minerals, were spotted near Burisal (22° 47′ 30″ N.; 86° 42′ 30″ E.) and Kawatanga (22° 47′ 15″ N.; 86° 42′ 45″ E.) respectively. The country is constituted of garnetiferous mica-schists and quartz-muscovite-biotite-graphite schists which dip at a very high angle of 80° towards SE. The veins run parallel to the foliation strike of the schists. Highly sericitised nature of the schists, acute folding (Pl. XIV, Fig. 1) and occasional presence of silicified breccias suggest the area is in a dislocation zone. Strongly striated rocks with mica streaks, pointing down dip along the striations, are common. The area is a continuation of the dislocation zone indicated by a ridge of siliceous breccia (Rajapahar 969) trending NNW.-SSE. at the south-east corner of the Kuilapal granite-gneiss. Another occurrence of galena mentioned by Dunn and Dey (1937) near Nanna (22° 47′ E.; 86° 36′ E.) was also found out. The only specimen collected was from an old pit. Garnet-sillimanite-muscovite schists constitute the country rock.

Lack of development and prospecting prevent close field study of these deposits.

## 4. Mineralogy of the vein deposits

The quartz veins carrying sulphide minerals are milk-white on surface but they are often seamed with blue-grey quartz. It is with the blue-grey quartz that the sulphide minerals are generally associated. Free sulphur sometimes coats the surface of the veins specially along lines of fractures. Galena is the most abundant of the sulphide minerals, while sphalerite, arsenopyrite, pyrite, pyrrhotite are common. One silver mineral was identified in a specimen from Dungrikuli. Goethite is frequent as an alteration product after pyrite while anglesite rims galena in certain places.

Mineragraphic studies of the polished ore samples were made under the reflecting microscope and some thin sections were studied. The polished ores were tested for silver by electrographic contact print method.

Galena.—The mineral is bright white under reflected light and is isotropic. It is characterised by triangular pits, along the cleavage lines in specimens which have not taken the maximum polish.

Etch reactions: Positive—$HNO_3$, HCl, $FeCl_3$ stains and tarnishes. Negative—KCN, KOH, HgCl.

Electrographic contact print method with galena gave scattered red-violet spots suggesting presence of silver in solid solution. Only in one instance, however, a silver mineral could be identified which will be described later in the paper.

Pyrite.—The mineral is pale yellow in reflected light. Reflectivity high. Isotropic.

Etch reactions: Positive—$HNO_3$ stains slight; fumes tarnish. Negative—HCl, Aq. regia, KCN, KOH.

Arsenopyrite.—The colour of the mineral is white with a creamy tint. Reflectivity in air—51 (Berek's photometer, green light). Usually idiomorphic grains with characteristic rhomb-shaped cross-sections.

Etch reactions: Positive—$HNO_3$ brings out parallel etch cleavage in some grains. Also Aq. regia, KCN, $HgCl_2$ also positive. Negative—HCl, $FeCl_3$, KOH.

Sphalerite.—The mineral is grey (in air), very dark grey in oil. Reflectivity in oil—7 (Berek's photometer, green light). Isotropic. Internal reflection resinous brown.

Etch reactions: Positive—$HNO_3$, Aq. regia. Others negative.

Pyrrhotite.—Pinkish cream in reflected light. Reflectivity rather high. Reflection pleochroism distinct in shades of brownish creamy to reddish brown. Strongly anisotropic.

Etch reactions: Positive—$HNO_3$, HCl, KOH, HI. Negative—KCN, $FeCl_3$, $HgCl_2$. Idiomorphic grains are enclosed in galena.

Silver mineral.—One specimen which gave red-violet contact print of silver, when examined under the reflecting microscope, revealed the presence of a patchy bluish grey mineral. It shows distinct pleochroism from yellowish white to bluish grey. Reflectivity is moderate and the mineral is anisotropic. Intense scarlet red internal reflection masks the grey polarisation colour.

Etch reactions: Positive—$HNO_3$, KCN, $HgCl_2$, KOH. Negative—HCl.

The mineral appears to be proustite.

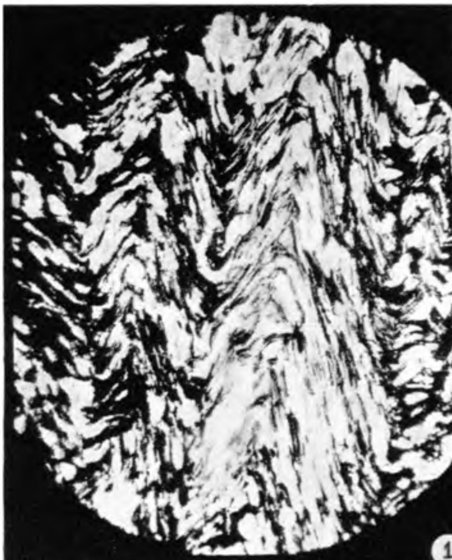
The silver mineral replaces galena from the margin.

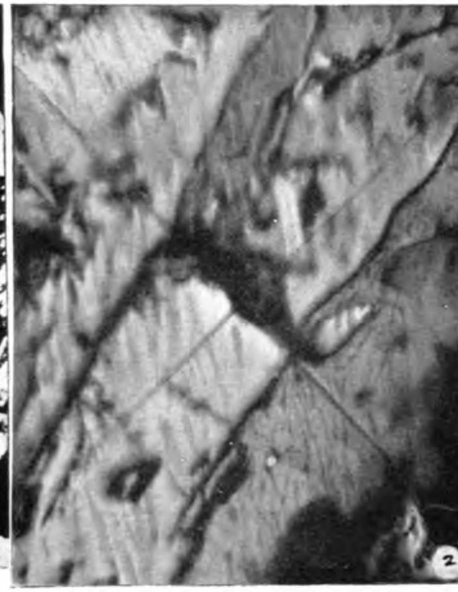
Goethite.—Grey in reflected light with a distinct pleochroism from dull grey to bright grey (in oil). Anisotropic. It shows abundant brownish yellow internal reflection. Negative to all standard reagents.

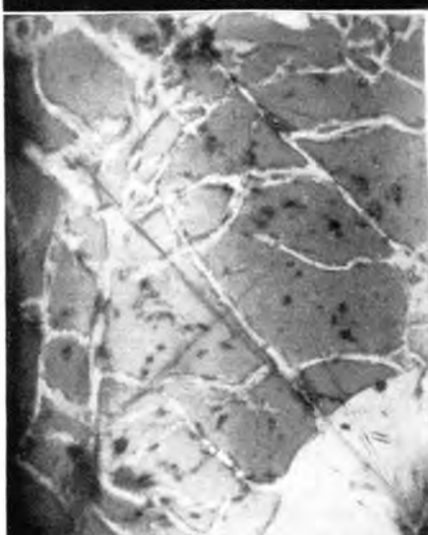
Anglesite.—The mineral is associated with galena. It is colourless in thin section and is characterised by very high relief and moderate birefringence.

## 5. Textural relation and mineral sequence

Idiomorphic pyrite grains are found enclosed within arsenopyrite. Both these minerals are invaded and corroded by sphalerite along grain margins and fractures (Pl. XIV, Fig. 2). Galena replaces pyrite, pyrrhotite, arsenopyrite and sphalerite abundantly, but shows selective preference for sphalerite. Ramifying veins of galena within sphalerite (Pl. XIV, Fig. 3) and relicts of sphalerite grains within galena



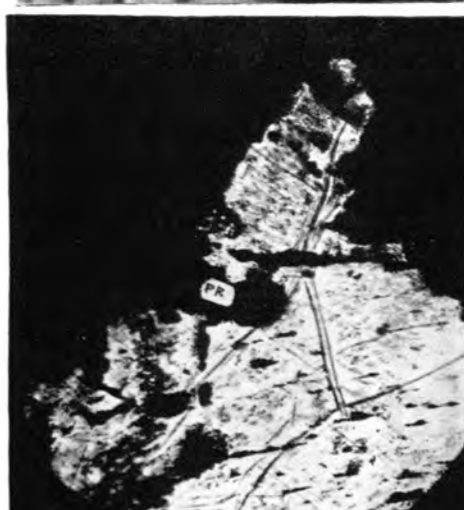




FIG. 1. Acutely folded quartz-muscovite-biotite-schist constituting the country rock. (Thin section × 24.)

FIG. 2. Sphalerite (dark grey) invading shattered arsenopyrite (greyish white) along fractures. (Polished specimen (oil immersion) × 225.)

FIG. 3. Replacement texture, ramifying veins of galena in sphalerite. (Polished specimen × 110.)

FIG. 4. Proustite (*PR*) replacing galena exhibiting triangular pits. (Polished specimen × 360.)

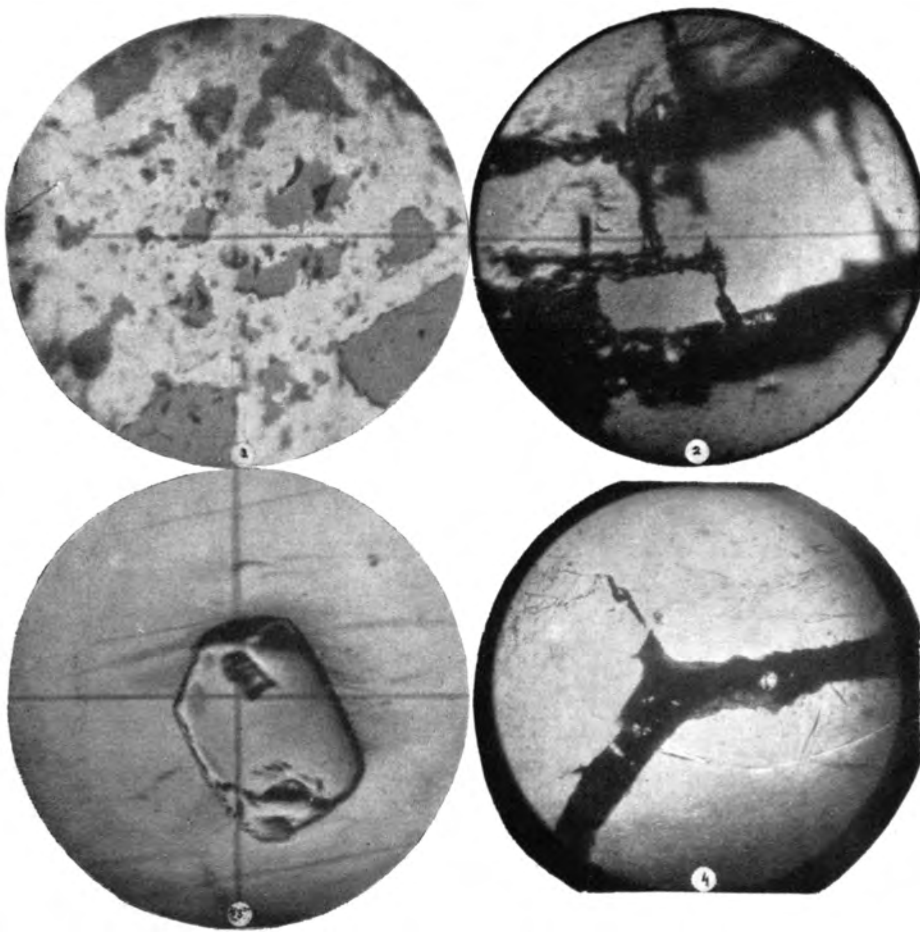


FIG. 1. Advanced stage of replacement of sphalerite (dark grey) by galena (white). (Polished specimen × 180.)

FIG. 2. Blue quartz (dark) replacing galena (white) along cleavage planes. (Polished specimen (oil immersion) × 150.)

FIG. 3. Euhedral crystal of pyrrhotite entrapped in galena. (Polished specimen × 240.)

FIG. 4. Anglesite (light grey) rimming a galena (dark) veinlet in quartz (white). (Thin section × 45.)

(Pl. XV, Fig. 1) are common. The silver mineral invades galena along grain boundary (Pl. XIV, Fig. 4). The blue quartz has replaced galena quite abundantly, often the replacement has been guided by cleavage plane (Pl. XV, Fig. 2), sometimes only irregular patches of galena remain in quartz.

Goethites are occasionally associated with pyrites and galena. Anglesite sometimes forms rim around galena veinlets (Pl. XV, Fig. 4).

Pyrite was the earliest mineral to crystallise. Arsenopyrite formed later and time of crystallisation of the two overlapped. Relation of other minerals with pyrrhotite is not clear. It is found entrapped in galena. Some deformative force fractured these pyrite and arsenopyrite grains before more silica and sphalerite invaded them. The ores were subjected to further deformation causing fracturing of the sphalerite grains in the wake of which galena and the silver mineral crystallised in sequence. The blue-grey quartz crystallised last of all.

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Quartz ———— . . . . ———————————— . . . . . . . . ——————————————
Pyrite        ————————
Arsenopyrite ———— . . . .
Pyrrhotite        . . . . ——————— . . .
Sphalerite                              ——————
Galena                                       ————————
Silver mineral                                   ————————
Anglesite                                                  ——————
Goethite                                                     ———————
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Pyrite, arsenopyrite and possibly pyrrhotite formed at the early stage, the proportion of the minerals varying according to supplies of As and sulphur. The main ore-forming fluid carrying lead sulphide might have brought with it Sb and silver or alternatively became saturated with Sb and Ag from an early formed mineral it may have replaced, and precipitated as proustite. The blue-grey quartz, which is full of dusty inclusions, was the 'residua' of the ore-forming fluid. Iron from pyrite and arsenopyrite have altered to goethite. Anglesite developed from oxidation of galena.

## 6. Origin of the sulphide-mineral veins

It may be of interest to discuss the origin of the mineral veins. Bateman (1947) comments that most lead and zinc ores occur as cavity fillings and replacements formed by low temperature hydrothermal solutions. In the present area, the hydrothermal solutions may be genetically connected with the Kuilapal granite-gneiss and neighbouring small outcrops. Dunn (1942) states, 'It is possible that Kuilapal granite with its neighbouring outcrops is connected with the Mushabani mass of the main shear zone, the associated schists being much tourmalinised around both the granites and being invaded by lead and copper bearing solutions in places.' Scattered occurrences of tungsten, copper and lead-zinc in silver minerals indicate space zoning around the granite outcrops of the area (Chakravarty, 1955). Tungsten (represented by wolframite and scheelite), copper (represented by chalcopyrite and malachite) occur close to granite outcrops whereas Pb-Zn-Ag minerals (represented by argentiferous galena, sphalerite, proustite, etc.) occur further out. Though the structural elements of the area have controlled and modified the zonal arrangement to some extent, still granites appear to be focal points of metasomatic introductions like tourmalinisation, muscovitisation and mineralisation of the area.

The field and laboratory evidences indicate these veins are mesothermal to epithermal fissure filling types. The faults, shear zones and foliation planes of the schists provided favourable channels for the mineralising fluids. The mineralisation started with deposition of silica, followed by pyrite and arsenopyrite and more silica after which other sulphides have been deposited.

## 7. Acknowledgement

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