CHAPTER IV

GENERAL CHARACTRISTIC FEATURES OF THE SONG TOH LEAD-ZINC DEPOSITS

At least five known occurrences of Pb-Zn mineralization are situated in the western part of Thailand, particularly in Kanchanaburi Province. All Pb-Zn deposits are invariably bounded within the light gray, partly dolomitized, argillaceous limestone. On the large scale, they are therefore referred to as stratabound deposits (Gary, et.al.,1972). To a finer scale, i.e., to that mineralization observed on the mine faces, the forms of the sulfide masses in detail are highly variable. In places, the ores are generally stratiform on a small scale. The sulfides appear to occur as beds that may be finely laminated and extend over some tens of centimeter. Frequently, the sulfides form small cross-cutting veins, and in places, appear to occur as cementing material of collaspe and other breccias. The mineralization is composed predominantly of fine to medium-grained sulfide ores. Galena and minor sphalerite are the principal ores, together with significant amount of pyrite which is the dominant gangue constituent, and other minor or accessory minerals such as Pb-sulfosalts, barite, calcite and dolomite, etc.

Small-scale folds are locally preserved in the mineralized horizons. Some of these folds may be referred to late Palezoic deformation, with axial surface parallel to the regional trends, whereas others are probable sedimentary slump structures.

The stratabound sulfide deposits of Song Toh orebodies were outlined firstly by exploratory drilling programme. Shortly after that another drilling plan was made, especially in the Song Toh North area, to reveal the geometry and dimension of the orebodies as illustrated in figure 35 (Diehl, 1979).

On a broad scale it is clearly seen that in the Song Toh North area the sulfide deposits occur as a series of elongate, subparallel, moderately dipping sulfide lenses within the middle Ordovician, light gray, partially dolomitized, limestone interbedded or intercalated with gray-dark gray limestone. They are grossly conformable with the bedding in the host rocks. The mineralization is composed mainly of fine to medium-grained galena, sphalerite, pyrite, dolomite, barite, plus minor boulangerite, jamesonite and tetrahedrite. Two major lenses are recognized and divided into two groups: the foot wall lode horizon and the hanging-wall lode horizon, separated by the limestone. The former has the strike length of less than 120 m. However, the latter is of much greater strike length and stratigraphic continueity than the former, attaining a maximum thickness of about 25 m and a maximum strike length of about 500 m. It is noteworthy to point out that the edge of the mineralized lodes not only usually become either thining out or being frayed out due to interdigitation of sulfide-rich and sulfide-poor sedimentary rock, they also become steeply dipping to the depth. In addition, sulfide-veins, cavity filling and ore-breccia are irregularly distributed throughout the sequence.

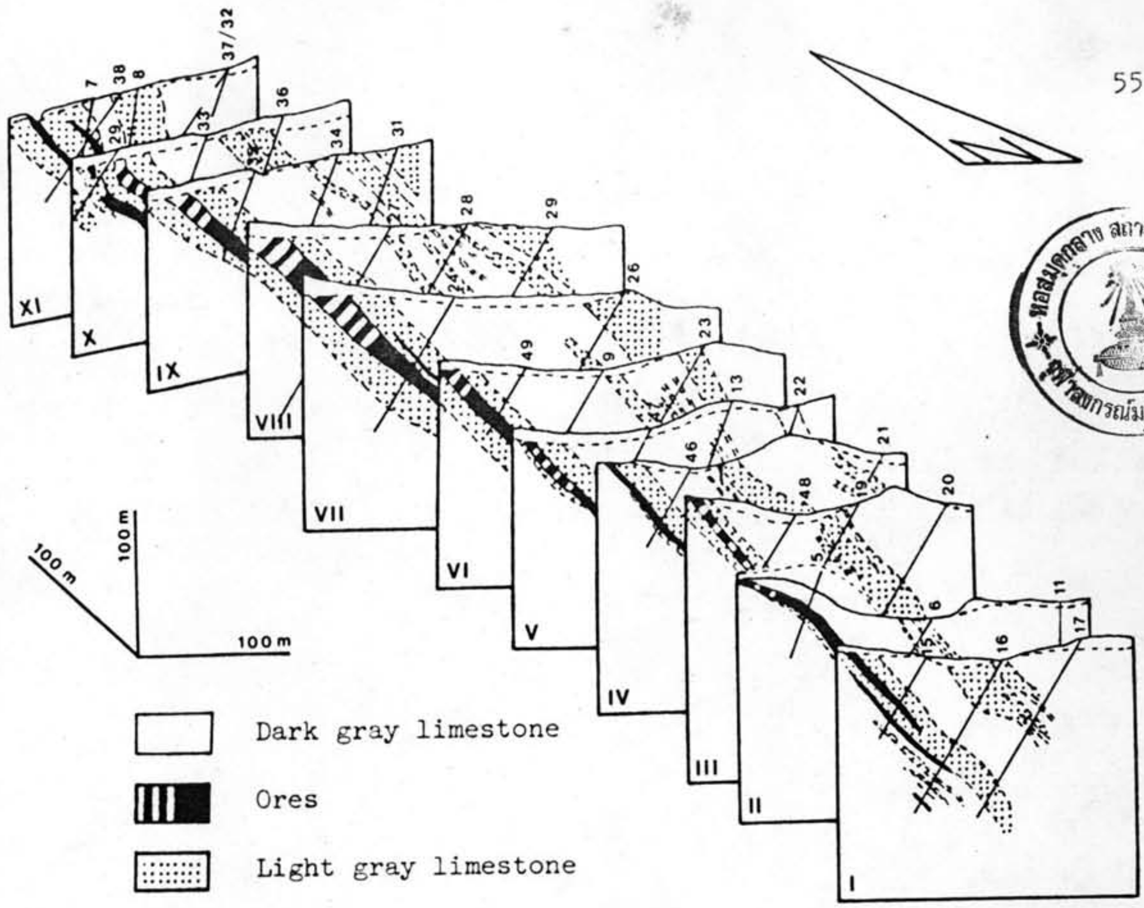

Figure 35 Composite cross sections of the Song Toh North area showing the Pb-Zn mineralization in relation to the carbonate host rocks (Diehl, 1979).

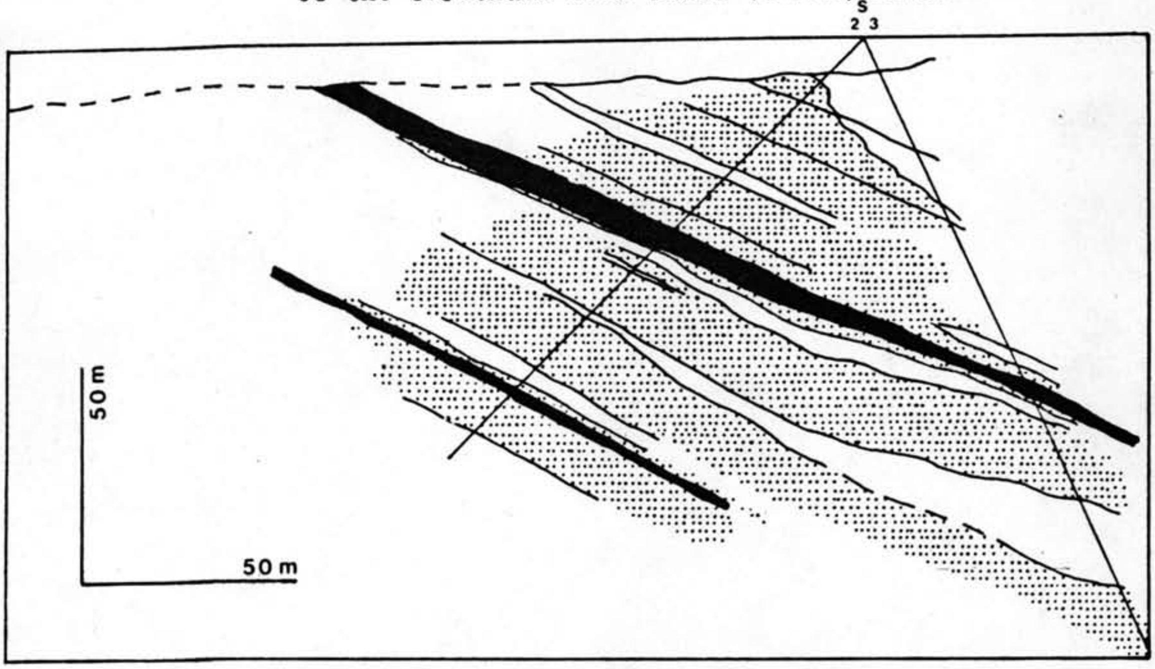

Figure 36 Cross sections of the Song Toh South area showing the Pb-Zn mineralization in relation to the carbonate host rocks.

These characteristic features of the sulfide mineralization are also observed in the Song Toh South area which is situated about 1 km to the south (Figure 36). It is important to note here that the stratigraphic correlation between these two mine area is still unclear.

Particularly noteworthy is the elemental constitution of the sulfide mineralization. It is apperently seen that the princiral metals of the sulfide component of the ores are, in order of importance, iron, lead and zinc. By ignoring the iron and on the basis of plotting of weight percent lead(Pb) versus zinc(Zn), as shown in figure 37, a very conspicuous feature of the diagram reflects in part a general similarity in lead-zinc ratios in many of the sulfide occurences.

4.1 The Song Toh Ores

In view of the degree of mineralization, the Song Toh ores can be divided into two major types, i.e., the high grade ores and the low grade ores. The former is charactistically high metal content usually as high as 50 percent. Contrarily, the later type is characterized by the mineralization of sulfide ores occurring as tiny masses of varying size usually less than 10 cm randomly distributed throughout the carbonate sediments or, in places, as very thinly lenticular bodies mostly arranged discontinuous and conformably with the bedding planes of the host rocks (Figure 38, 39, 40). Furthermore, its metal content is usually less than 0.5 percent.

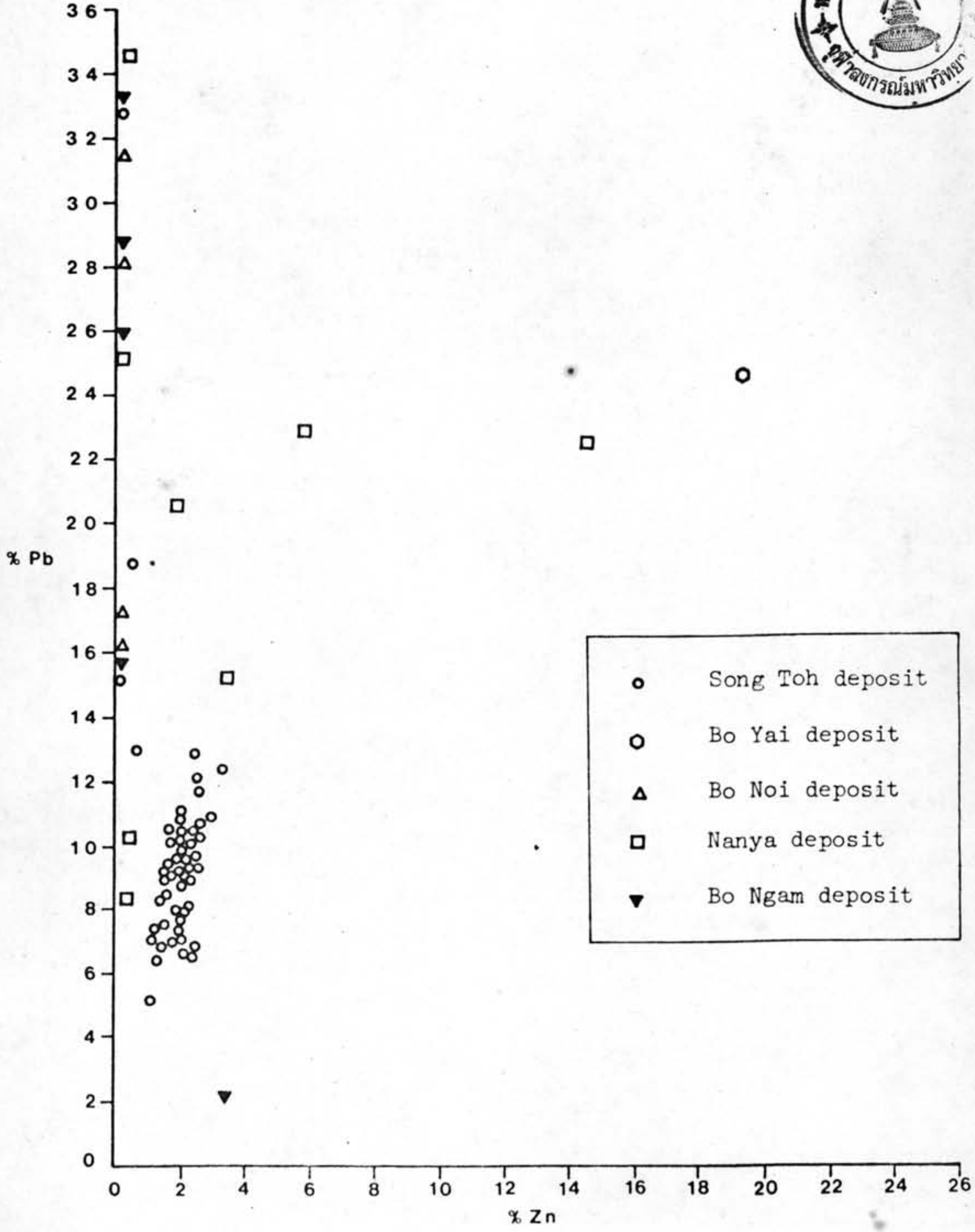

Figure 37 Ratio of lead and zinc from a number of stratabound lead-zinc deposits occurring in Kanchanaburi province.

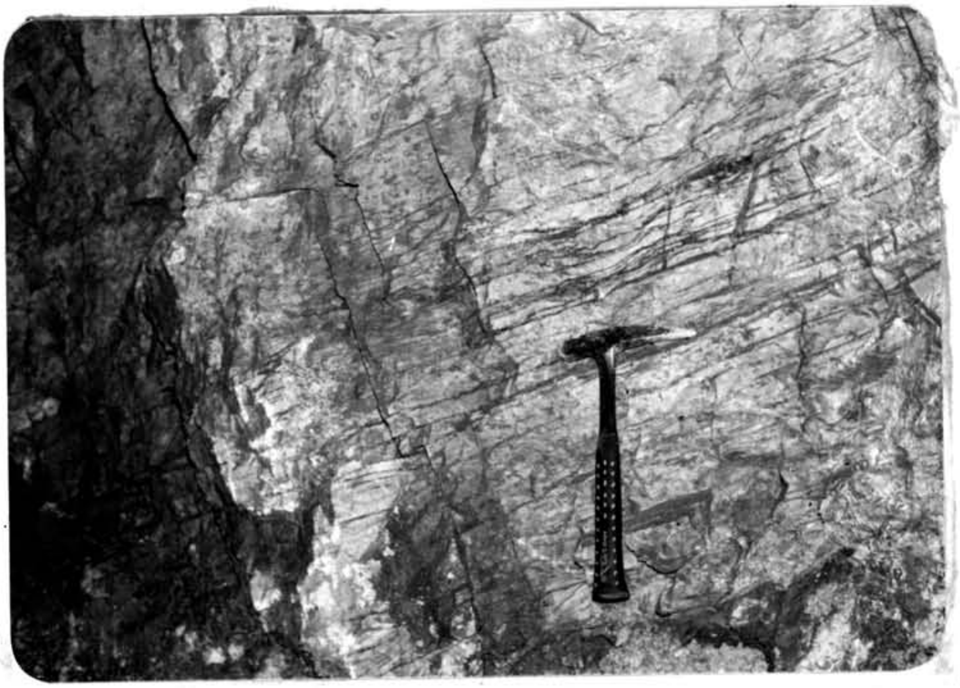

Figure 38 Low grade banded ores showing the concordancies of very thin lenticular sulfide lenses with the bedding of the carbonate host rock.
(Lower ore zone, Song Toh South mine, + 620 m level)

Figure 39 Low grade ore showing a tiny patch of sulfide mass embeded in the limestone host.
(Upper ore zone, Song Toh Sonth mine, + 620 m level)

Figure 40 Low grade ~~ore~~ showing the tiny mass of sulfide ores scattered throughout the carbonate host rock. (Upper ore zone, Song Toh South mine, + 620 m level)

On the basis of the textural patterns proposed by Niggli (1954), the high grade ores can be further subdivided into four categories including the massive ores, banded ores, flaser ores and ore-breccia. The disposition of these ore types has been mapped in detail as illustrated in plate 2.

4.1.1. Massive Ores : They occur as small pockets and lenses of various sizes. In general, the massive ores are 2 m thick on average and have the lateral dimension usually ranging from 5 to 10 m. Apart from local discordancies occasioned by ore-mobilization the massive ore lenses are commonly conformable to the bedding of the sedimentary carbonate host rocks with sharp and smooth contact (Figure 41A andB). However, minor irregularities of the interface between the ore-lens and the host rock are locally not uncommon (Figure 43). Furthermore, the individual lenses generally show no systematic internal structures. However, some of the lenses are referred to as composite bodies, composed of masses of lead-rich and zinc-rich materials (Figure 42). In addition, the lateral edge of an individual lens become branched out due to interdigitation of the sulfide body and the carbonate host rock (Figure 44). It is noteworthy to point out that, the massive sulfide lenses are, in places, folded and remobilized into the crest of folds (Figure 45). Also, they are locally offset by faults (Figure 46). Mineralogically, the massive ores are fine to medium-grained, composed principally of galena, sphalerite and pyrite. Of particularly noteworthy is the occurrence of jasperoid masses which are frequently associated with the massive sulfide lenses (Figure 44 , 47).

(A)

(B)

Figure 41 Lenses of massive ores showing sharp, and concordant boundaries with the carbonate host rock.
(A. Song Toh South mine, + 640 m level ;
B. upper ore zone, + 620 m level)

Figure 42 A pocket of massive ores showing the discordant contact with the carbonate host, probably due to ore-remobilization. (Lower ore zone, Song Toh South mine, + 620 m level)

Figure 43 A lens of massive ores showing minor irregularities along the boundary between the sulfide mass and the carbonate host.
(Upper ore zone, Song Toh South mine, + 620 m level)

Figure 44 A massive ore lens showing its edge being frayed out due to interdigitation of the sulfide body and the carbonate host rock.
(Lower ore zone, Song Toh South mine, + 620 m level)

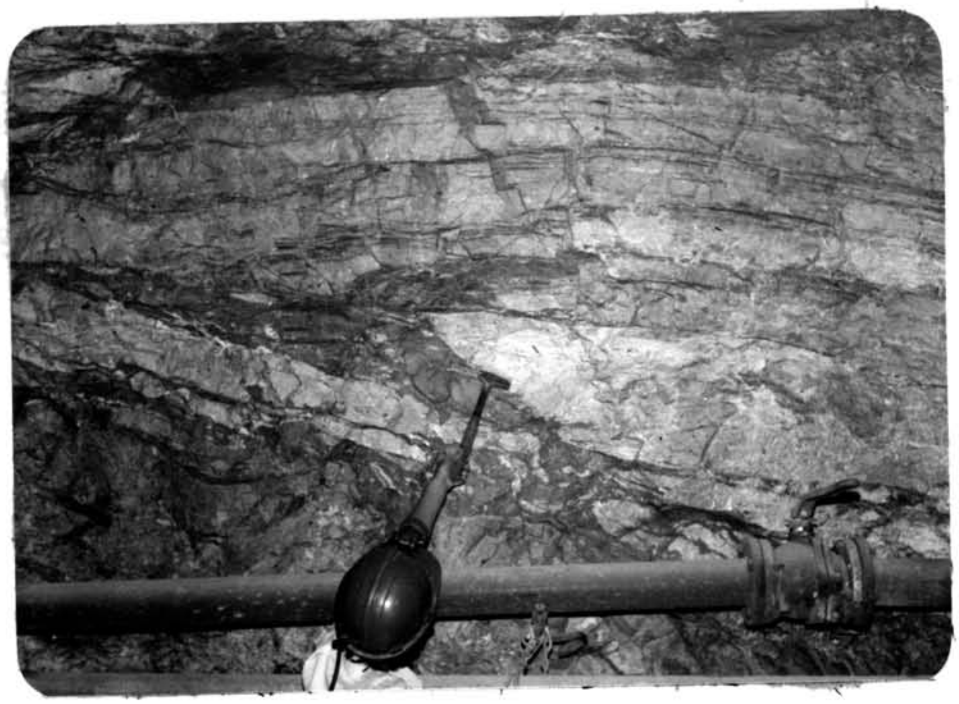

Figure 45 A massive ore lens occurring at the crest of a fold probably due to the subsequent deformational event.
(Song Toh South mine, + 595 m level)

Figure 46 Massive ores offset by a fault.
(Song Toh North mine, + 575 m level)

Figure 47 Massive ores occurring as the composite masses of galena-riched and sphalerite-pyrite riched materials.
(Upper ore zone, Song Toh South mine, + 620 m level)

4.1.2 Banded Ores: They are the most frequent sulfide occurrences observed in the mine area. The thickness of a single band is usually ranging from 2.5 to 30 cm, and the mineralization, is again , on a broad sense, concordance with the bedding of the host rocks. This conspicuous feature of these stratiform sulfide concentrations is clearly observed in both unfolded and folded strata (Figure 48, 49, 50, 51). The banded ores themselves are usually very fine-grained and stratified in apparently perfect parallelism with the associated sedimentary carbonate host. Such stratification is often well developed, individual beds ranging from a few centimeters in thickness down to the most delicate fine laminations, commonly of the order of only few millimeters thick. The compositional stratification may reveal itself through variations in the relative amounts of the sulfide and non-sulfide or through variations in the amounts of the different sulfides themselves, for instances, pyrite-calcite-galena, galena-pyrite, fine-grained pyrite, and pyrite-sphalerite, etc. Furthermore, individual laminae may be continuously traceable for few meters, or, in places tens of meter distance.

4.1.3. Flaser Ores : This ore type is quite common occurring mostly in the ore zone, i.e., the footwall horizon. On a broad sense, it forms lenticular masses of various sizes ranging from 1 to 5 m thick and 5 to 25 m long. Apart from local discordancies occurring particular in the fault zones, the flaser ores are apparently conformable to the bedding of the host rock. In places, some minor masses of them are intercalated in between the massive ore lens and

Figure 48 High grade banded ores are composed chiefly of galena-rich bands alternating with sphalerite-pyrite riched layers. The high grade banded ores are, in turn, conformably overlain by the low grade banded ore. (Upper ore zone, Song Toh South mine, + 620 m level)

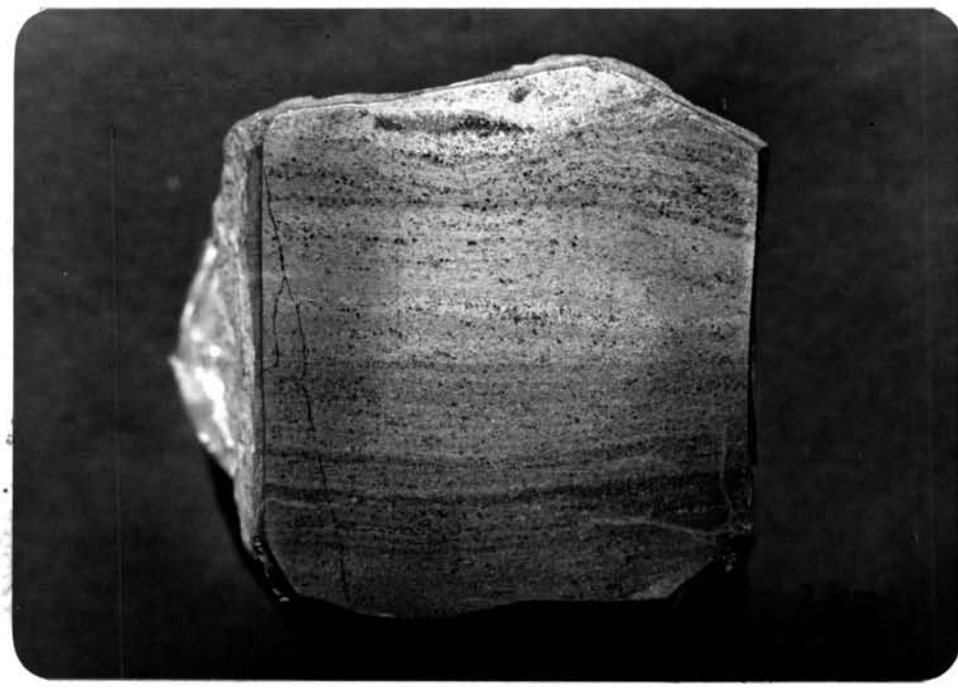

Figure 49 A hand specimen of high grade banded ores showing fine compositional stratifications of various sulfide minerals. (Upper ore zone, Song Toh South mine, + 620 m level)

Figure 50 High grade banded ores showing microfolds of their stratified ores probably due to subsequent slumping. (Lower ore zone, Song Toh South mine, + 620 m level)

Figure 51 High grade banded ores showing their stratified compositional laminae being strongly folded by the subsequent deformational event.
(Song Toh South mine, + 608 m level)

the banded ores (Figure 52). Texturally, the flaser ores are characteristically composed of fragments of light gray, brown, and gray partially dolomitized limestone with lenticular shape and having grain size ranging from 2 to 40 cm (of their largest dimension), and being bounded by massive sulfide matrix (Figure 53 and 54). It is important to note that there is not a single fragment of massive and banded ores occurring as clastic components in the flaser ores. Another interesting feature of the flaser ores is their linear structure conspicuously defined by the perfect alignment of their lenticular limestone fragments.

4.1.4 Ore-Breccia : This ore type usually forms lenticular masses of various sizes. Some of them are 1 to 4 m thick and about 2 to 15 m long. Most of them are usually conformable to the bedding of the carbonate host rock (Figure 55). The ores are composed chiefly of angular fragments of light gray, brown, and gray, partical dolomitized limestone. The interparticle spaces are filled by the sulfide matrix. The limestone breccias are of various sizes ranging from 0.5 cm to 1 m (the largest dimension). In places, the ore-breccia shows a gradational boundaries in relation to the flaser ores (Figure 56).

Figure 52 A minor mass of the flaser ores is intercated in between a small lens of massive ores and the banded ores. Particularly noteworthy is that the mineralization, as a whole, is conformable to the carbonate host rock. (Lower ore zone, Song Toh South mine, + 620 m level)

Figure 53 Flaser ores consisted predominantly of lenticular fragments of light gray limestone wrapped by sulfide matrix, showing a perfectly linear structure.
(Song Toh South mine, + 640 m level)

Figure 54 Flaser ores showing disturbance of its linear structure due to subsequent fault.
(Upper ore zone, Song Toh South mine, + 620 m level)

Figure 55 Ore-breccias, are composed chiefly of limestone breccias cemented by sulfide masses, showing a lenticular body conformably to the host rock.
(Lower ore zone, Song Toh South mine, + 620 m level)

Figure 56 The ore-breccia (top) showing a gradational boundary with the flaser ores (below).
(Song Toh South mine, + 608 m level)

4.2 A Mineragraphic Study of the Song Toh Ores

In this section emphasis is placed on aspects of ore mineral occurrence in the individual ore types described in the chapter IV, and on features related to their post depositional deformation observed from hand specimens and polished sections. Each specimen is accurately located on the mine level plan provided for the purpose (Plate 3). In this present study eleven minerals (ore and gangue) have been identified and categorised according to their relation order of abundance : three in major amount including galena, pyrite, and calcite ; two in minor including spalerite and dolomite ; six in accesory and trace amount including hematite, quartz, sericite, barite, boulangerite and cerussite. It is necessary to point out that the number of minerals recorded may increase as additional ore specimens become avialable. Within this generally simple mineralogy galena, pyrite and sphalerite usually account for more than 95 percent of the total metallic minerals. Table 2 sets out the mineral occurrences. The categories are as observed in this present study and are based upon some 130 polished sections.

4.2.1 Mineralogy and Textures of the High Grade Ores

4.2.1.1 Massive Ores : Mesoscopically this ore type is usually fine to medium-grained polycrystalline sulfide aggregates which are consisted chiefly of galena, pyrite and minor sphalerite with trace amount of sulfosalt (boulangerite). Minor fragments of

Table 2 A list of minerals identified in the Song Toh ores.

1) Major components

Galena PbS : major sulfide ore

Pyrite FeS_2 : major sulfide gangue

Calcite $CaCO_3$: major carbonate gangue

2) Minor components

Sphalerite ZnS : minor sulfide ore

Dolomite $CaMg(CO_3)_2$: minor carbonate gangue

3) Accessory and Trace components

Hematite Fe_2O_3

Quartz SiO_2

Sericite $KAl_2(AlSi_3O_{10})(OH)_2$

Barite $BaSO_4$

Boulangerite* $Pb_5Sb_4S_{11}$

Cerussite** $PbCO_3$

* more complicate chemical formular is expected.

** more abundant as a supergene mineral.

argillaceous and carbonate materials having various sizes ranging from few millimeters to several centimeters locally embeded within the sulfide masses, are not uncommon (Figure 57, 58). As a result, the massive ores usually do not show traces of primarily primitive structures. However, the ores, in places, exhibit a lineation texture defined by the preferred orientation of argillaceous materials (Figure 59). It is of interest to note that the precise nature of the grain boundaries of the sulfide minerals is not clearly recognized and is frequently referred to as nonequilibrium, impingement type. What appears to be early nonequilibrium texture in the lead-zinc ores is microspherical bodies of framboidal pyrite that are found in the ores themselves as well as in the associated sulfide-poor zones.

Microscopically, dolomite frequently occurs as relatively large subhedral-euhedral rhombs with either showing pseudo-poikiloblastic texture or containing zoned inclusions of calcite and sulfide ores (Figure 60, 61). It is noteworthy to point out that the sulfide inclusions are often disposed along the clevages of the dolomite (Figure 62and see also Figure 60). Pyrite occurs in various forms. The so-called colloform and framboidal pyrite are the dominant species. The former is usually coarse-grained and shows internal zonal growth with succession layers marked by differrences in grain size (Figure 63). In addition, many of them also show internal radial

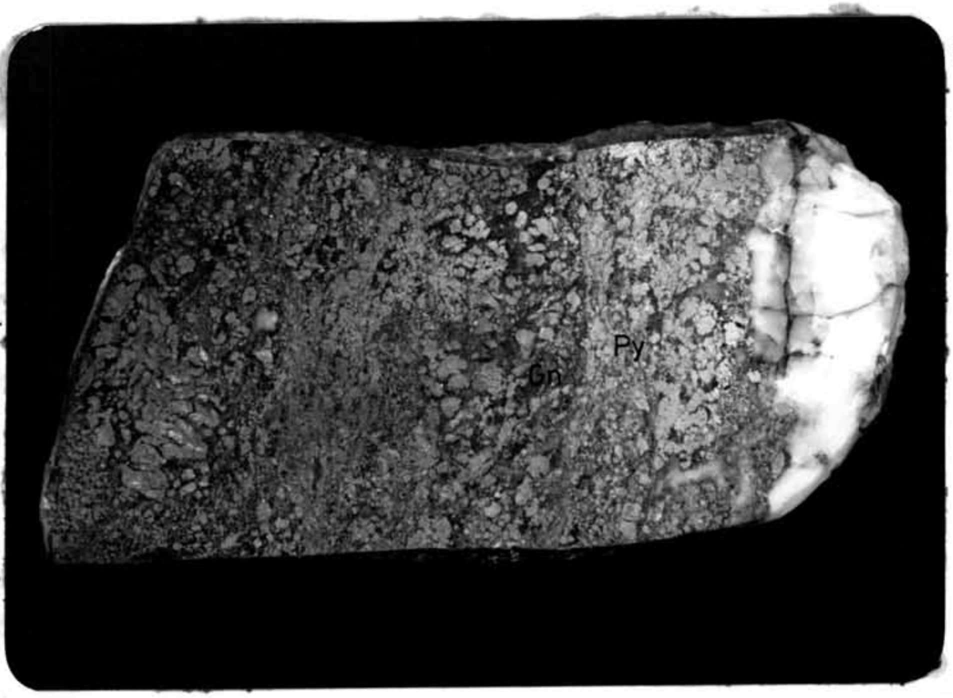

Figure 57 Massive ores-showing variation in forms and grain size of pyrite (Py).
(Song Toh South mine, + 620 m level)

Figure 58 Massive ores showing the occurrence of boulangerite (Bl) as a small patch in massive galena (Gn)-sphalerite (Sl).
(Song Toh South mine, dump area)

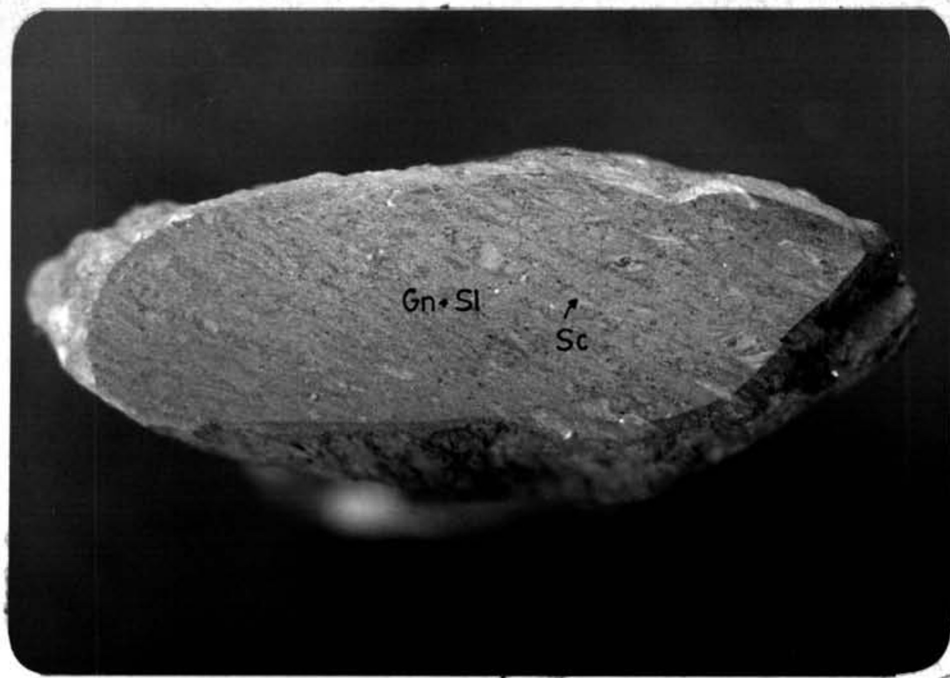

Figure 59 Foliation and lineation in fine-grained massive ores. (Lower ore zone, Song Toh South mine, + 620 m level)

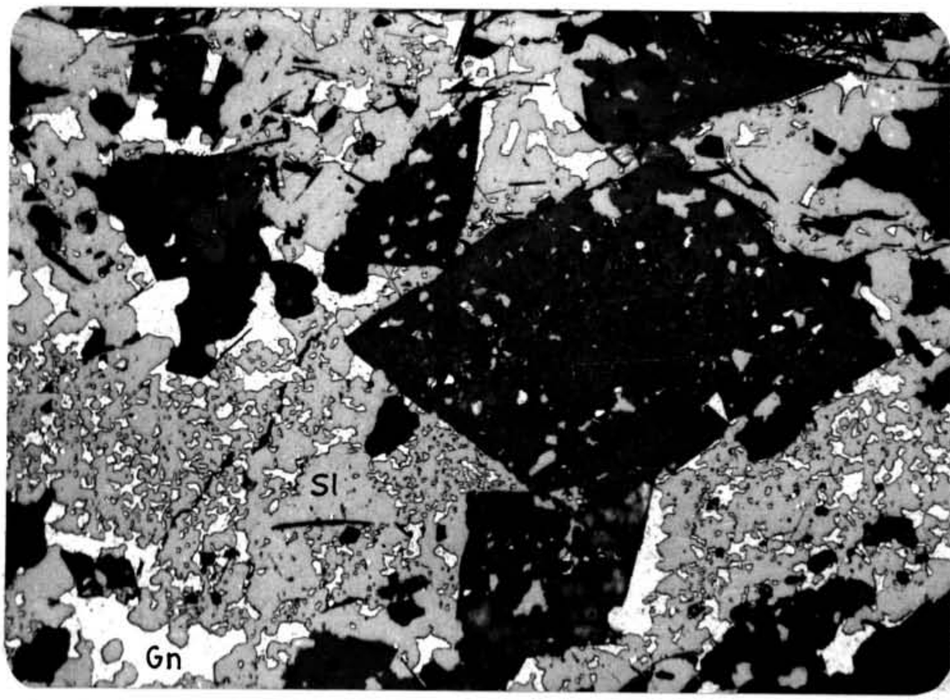

Figure 60 Photomicrograph of massive ores showing poikilitic intergrowth of galena (Gn) and sphalerite (Sl). Dolomite (Dl) rhombs embeded in the sulfide-rich mass display a zoned inclusion.
(Polished section, 240 x , uncrossed nicols)

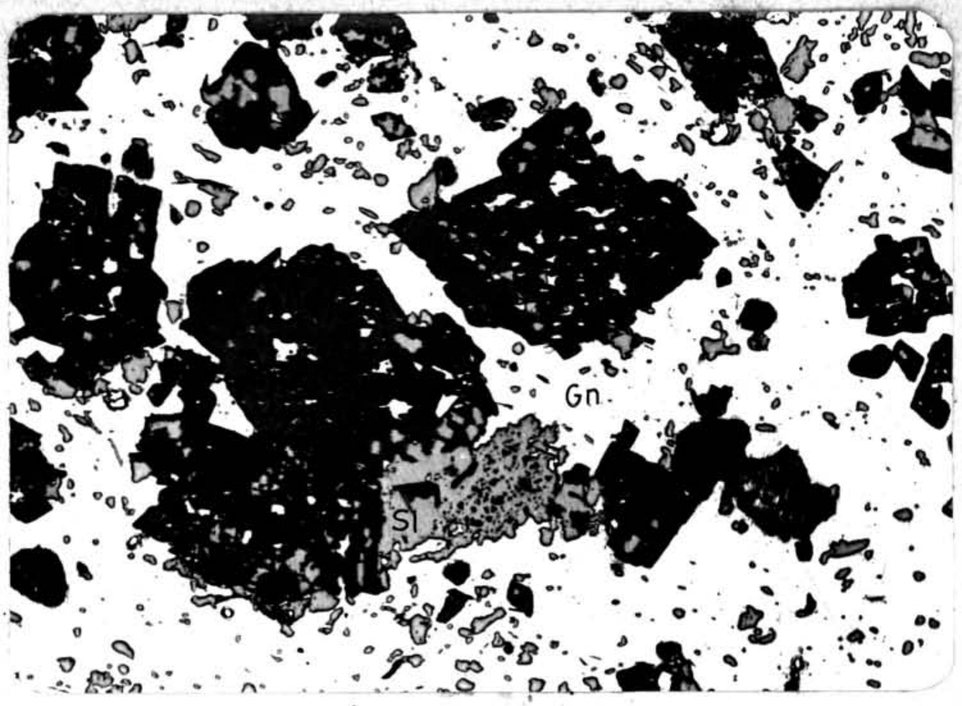

Figure 61 Photomicrograph of massive ores showing the sphalerite (Sl) fragments randomly scattered throughout the galena (Gn) mass.
(Polished section, 120 x, uncrossed nicols)

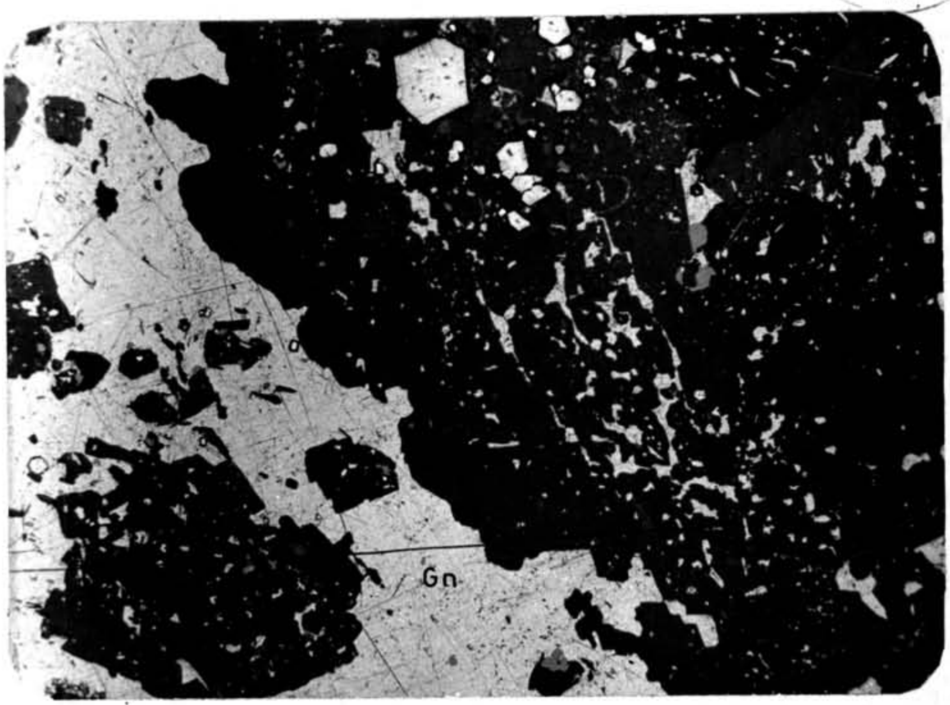

Figure 62 Photomicrograph of massive ores showing the disposition of galena (Gn) and calcite (Cc) inclusions along clevage traces of dolomite (Dl).
(Polished section, 240 x, uncrossed nicols)

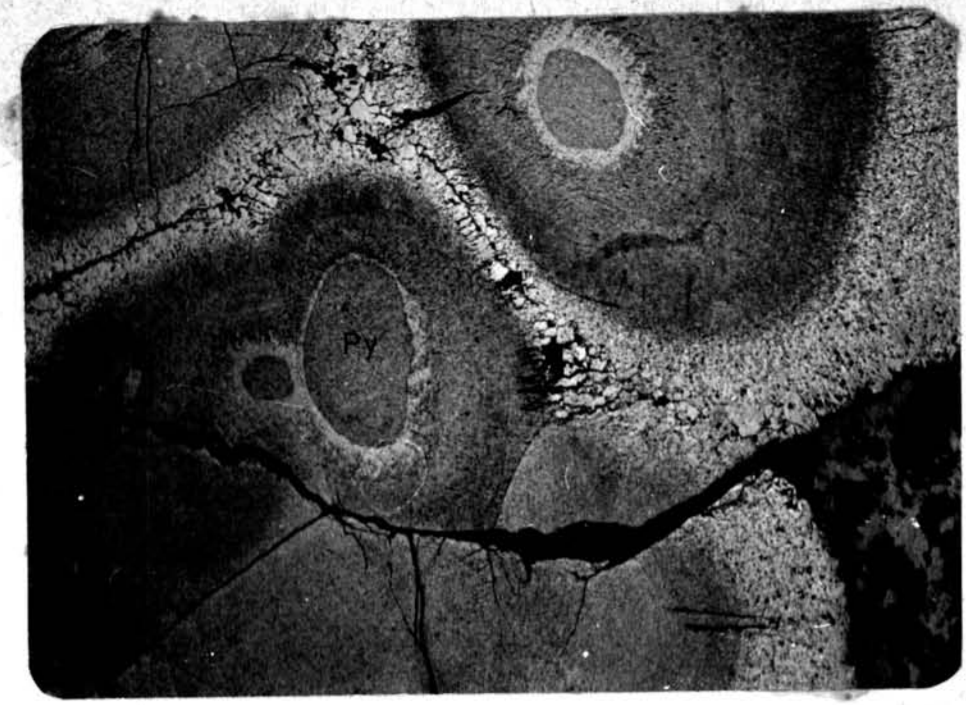

Figure 63 Photomicrograph of colloform pyrite (Py) in the massive ores showing internal zonal growth.
(Polished section, 60 x, uncrossed nicols)

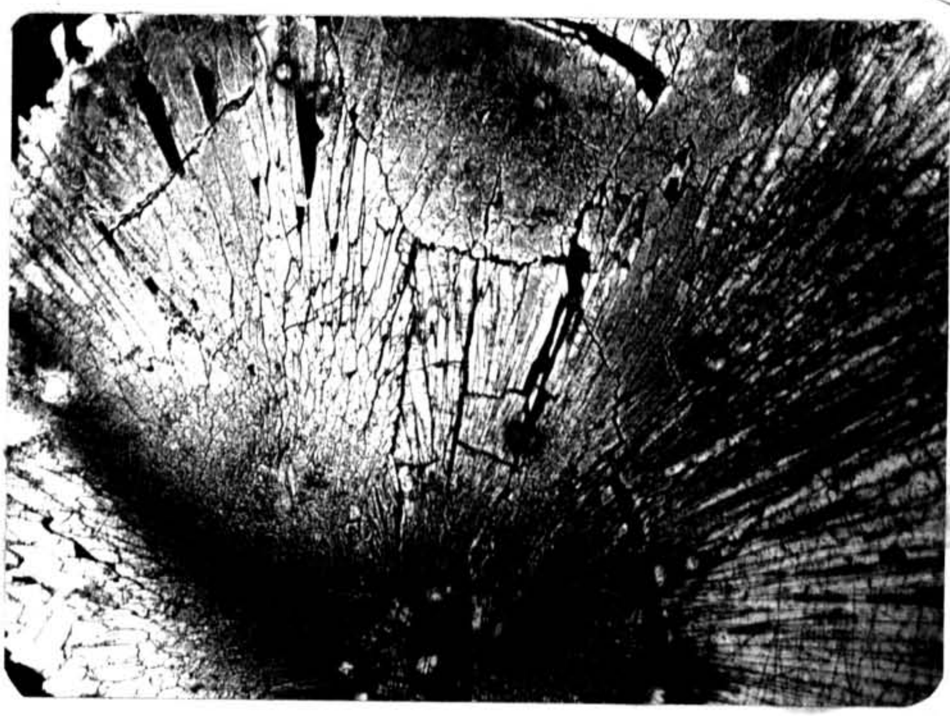

Figure 64 Photomicrograph of colloform pyrite (Py) in the massive ores showing internal radial aggregates and growth of individual crystals.
(Polished section, 120 x, uncrossed nicols)

growth structure (Figure 64). In contrast, the latter is usually fine-grained and has an apparent cellular structure that gives them a somewhat raspberry-like appearance (Figure 65). Particular noteworthy is the subsequent overgrowth of radial pyrite on the framboidal pyrite (Figure 66). Additionally, the framboidal pyrite is often flattened and broken apart where it is associated with the tectonically deformed massive ores (Figure 67). Furthermore, pyrite may locally occur as a single-phase polygonal aggregate with displaying an annealed foam texture (Figure 68) in the carbonate mass. In places, pyrite also occurs as tiny and irregular masses showing mutual intergrowth with galena, probably due to subsequent replacement (Figure 69).

In polished section the sulfide-rich fractions of the massive ores, texturally, seem to occur as simple as cementing material or matrix. In general, galena is the dominant component. Grain boundaries between galena and other components are commonly irregular, but the arcuate boundaries can be locally observed (Figure 62). Moreover, poikilitic intergrowth between galena and sphalerite is not uncommon (Figure 60). In places, sphalerite may occur as fragments of various sizes randomly scattered throughout the galena mass (Figure 61). It is important to note that sphalerite is invarially light in colour and does not show internal reflection. Particularly noteworthy is the substructures developed in the major sulfide minerals-particularly of galena- which have been revealed by treating the polished

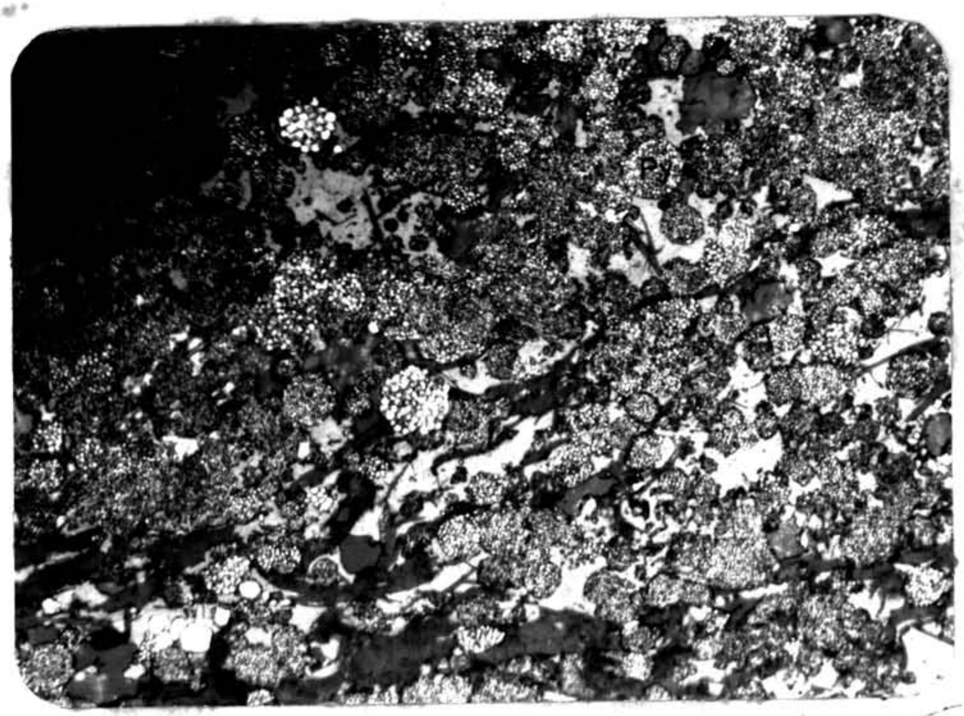

Figure 65 Photomicrograph of framboidal pyrite (Py) in the massive ores showing cellular structure.
(Etched-polished section, 480 x, uncrossed nicols)

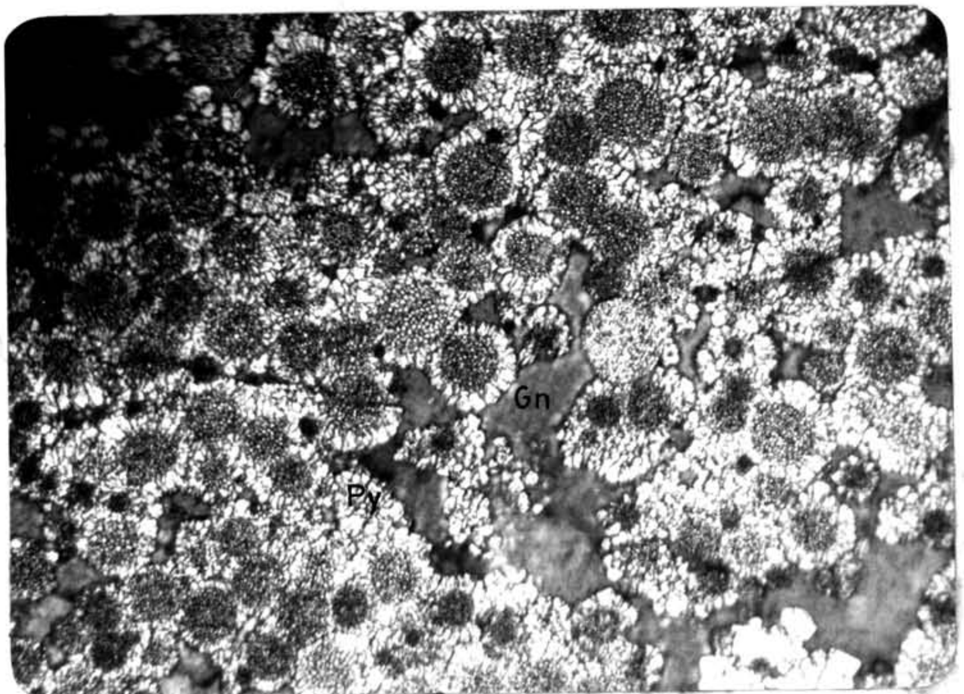

Figure 66 Photomicrograph of framboidal pyrite (Py) in the massive ores showing cellular structure. They are subsequently overgrown by an aggregate of radial pyrite.
(Etched-polished section, 480 x, uncrossed nicols)

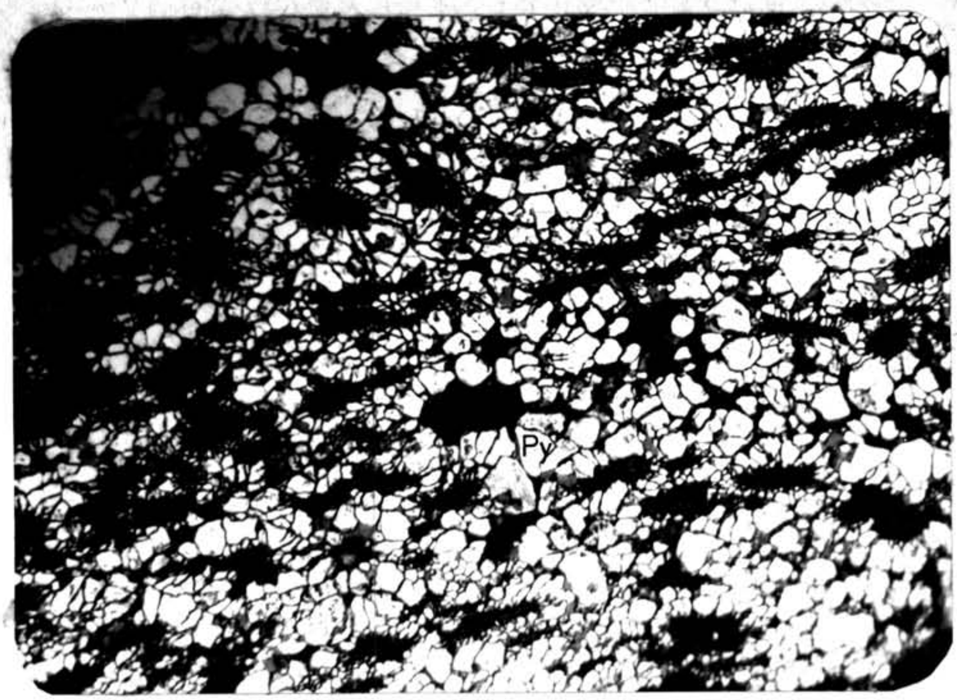

Figure 67 Photomicrograph of framboidal pyrite (Py) in deformed massive ores showing grains being flattened and broken apart.
(Etched-polished section, 480 x, uncrossed nicols)

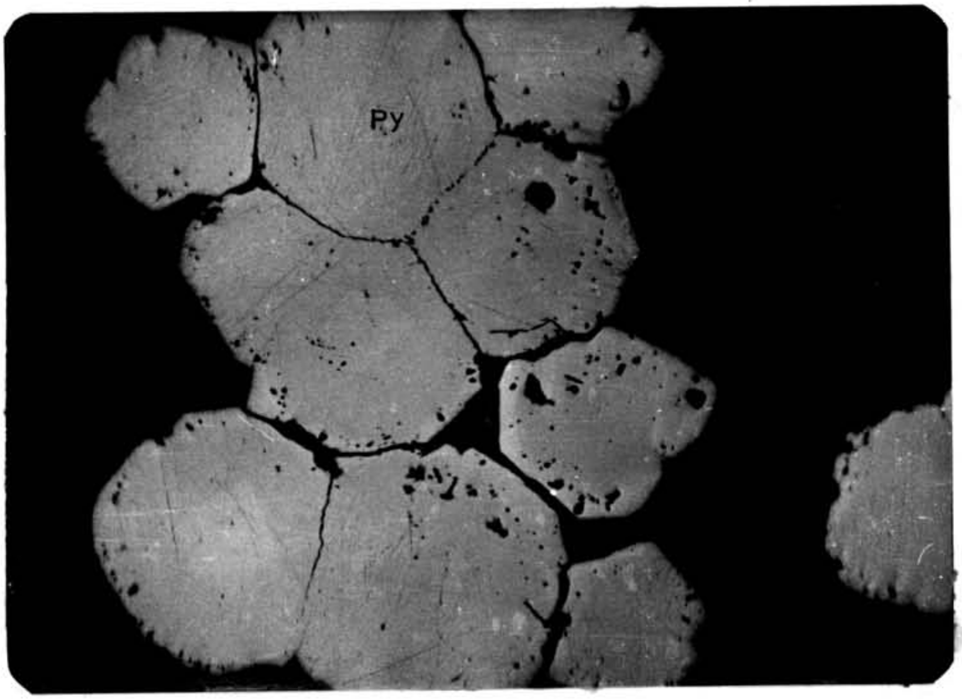

Figure 68 Photomicrograph of a pyrite (Py) aggregate in the massive ores showing an annealed foam texture.
(Polished section, 240 x, uncrossed nicols)

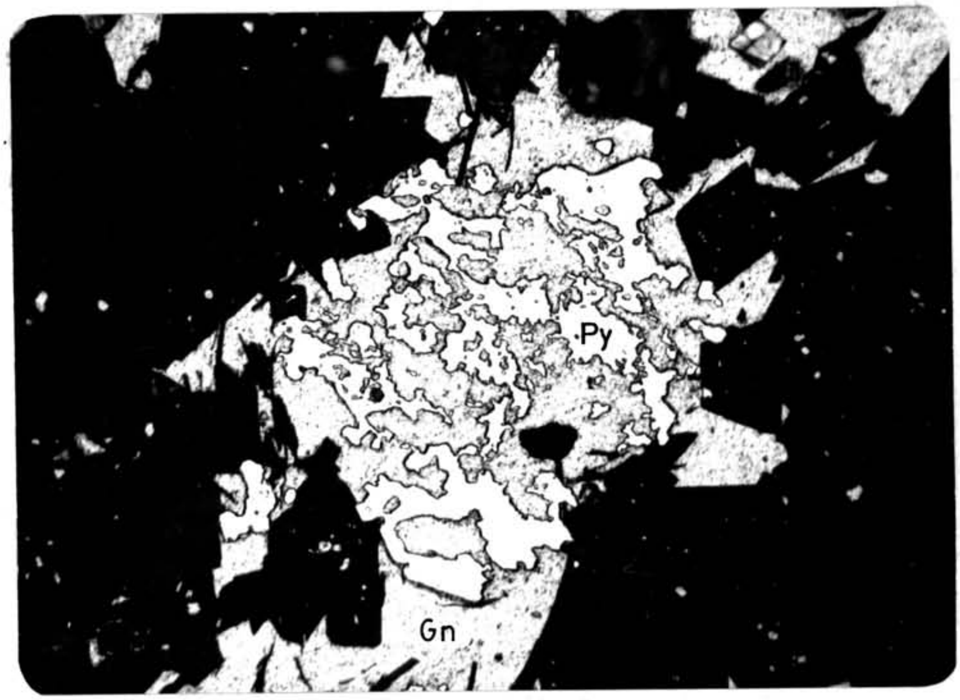

Figure 69 Photomicrograph of massive ores showing the intergrowth of irregular-shaped pyrite (Py) and galena (Gn), probably due subsequent replacement.
(Polished section, 480 x, uncrossed nicols)

sections with appropriate etchants. Galena areas usually possess rather coarse sub-grains showing a polygonal texture with triple-junctions approaching 120° whilst the accompanying sphalerite remain texturally unchanged (Figure 70 and 71). These may represent new grains derived by the subsequent growth of initially developed sub-grains due to plastically deformational event. Boulangerite usually show parallel twining laminae with irregular spacing. Individual twin laminations usually do not extend across the grain but taper off within it (Figure 72).

It is of interest to note that in the relatively gangue-rich mass of the massive ores, a lineation may be locally developed and usually defined by the preferred orientation of inequant crystal such as quartz and sericite, and of elongate carbonate fragments (Figure 73).

4.2.1.2 Banded Ores : This ore type has a well developed compositional layering, with layers usually varying in thickness from a few centimeters to a very delicate laminations. The most common assemblages in these layers are respectively : pyrite with minor sphalerite and galena ; pyrite and sphalerite; galena with minor sphalerite; calcite with minor dolomite, sphalerite and pyrite (Figure 74 and 75). Boundaries between layers are usually sharp, but can also be gradational. An important feature of the layered ores is their folding. Folds are generally very tight and isoclinal with their axial surface parallel to the layering (Figure 76 and 77).

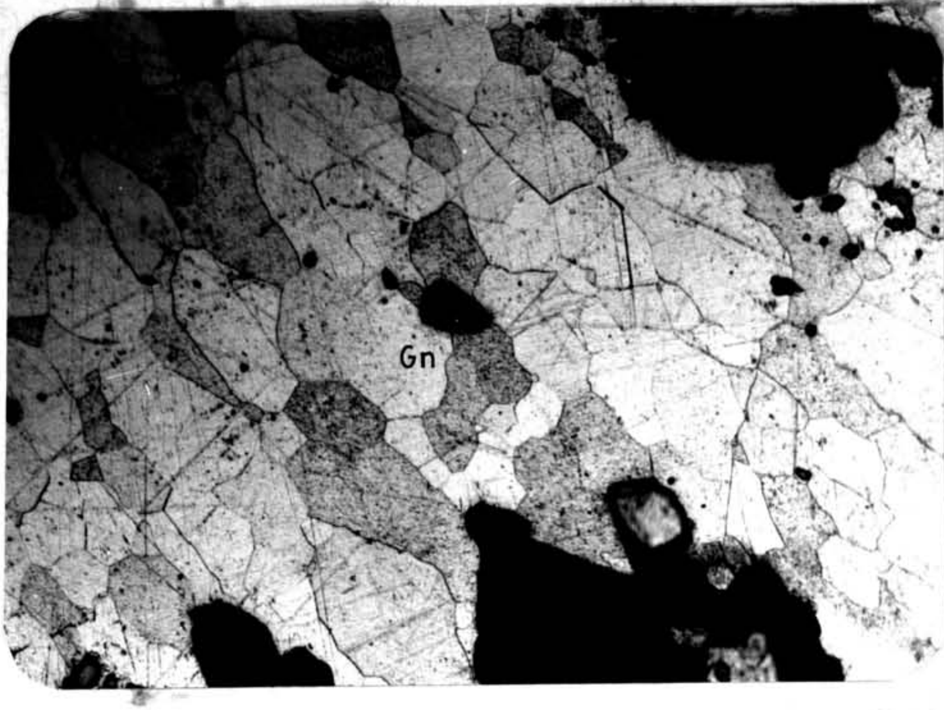

Figure 70 Photomicrograph of massive ores-etching of the galena (Gn)-rich area brings out a fine polygonal recrystallized pattern. (Etched-polished section, 240 x, uncrossed nicols)

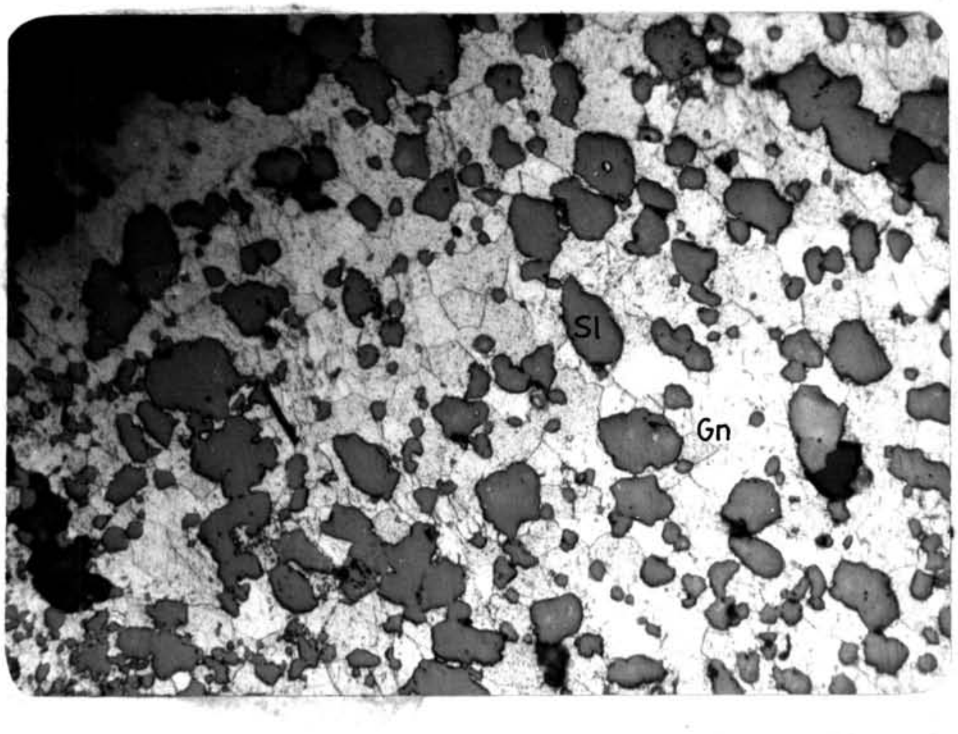

Figure 71 Photomicrograph of massive ores after etching, the galena (Gn) area shows fine sub-grain texture whilst the sphalerite (Sl) fragments remain unchanged.
(Etched-polished section, 480 x, slightly crossed nicols)

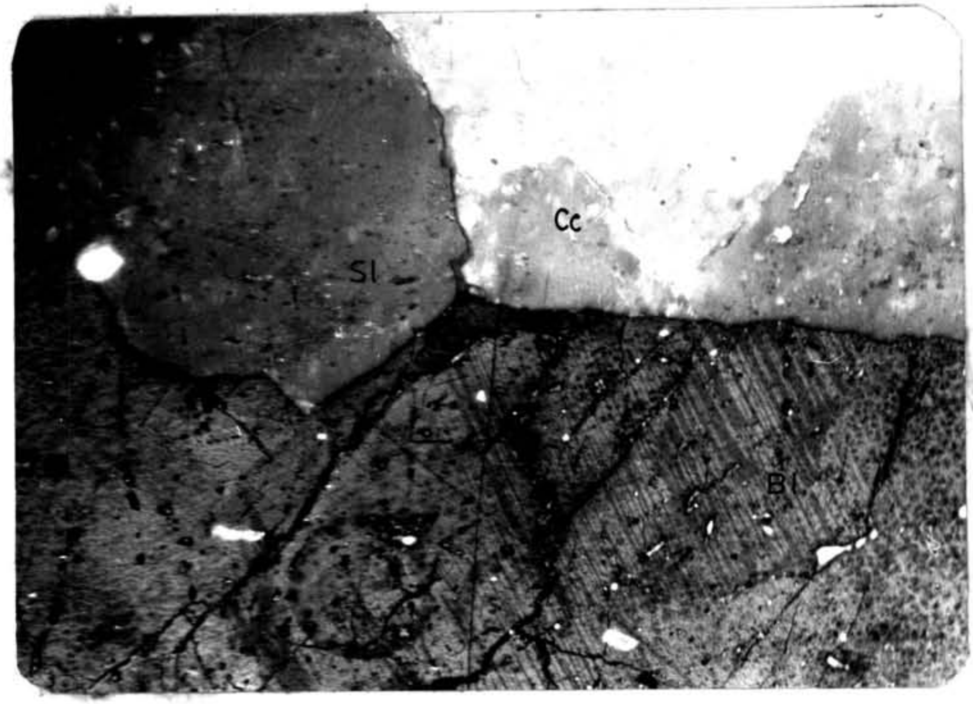

Figure 72 Photomicrograph of boulangerite showing parallel twining laminae with regular spacing.
(Etched-polished section, 120 x, slightly crossed nicols)

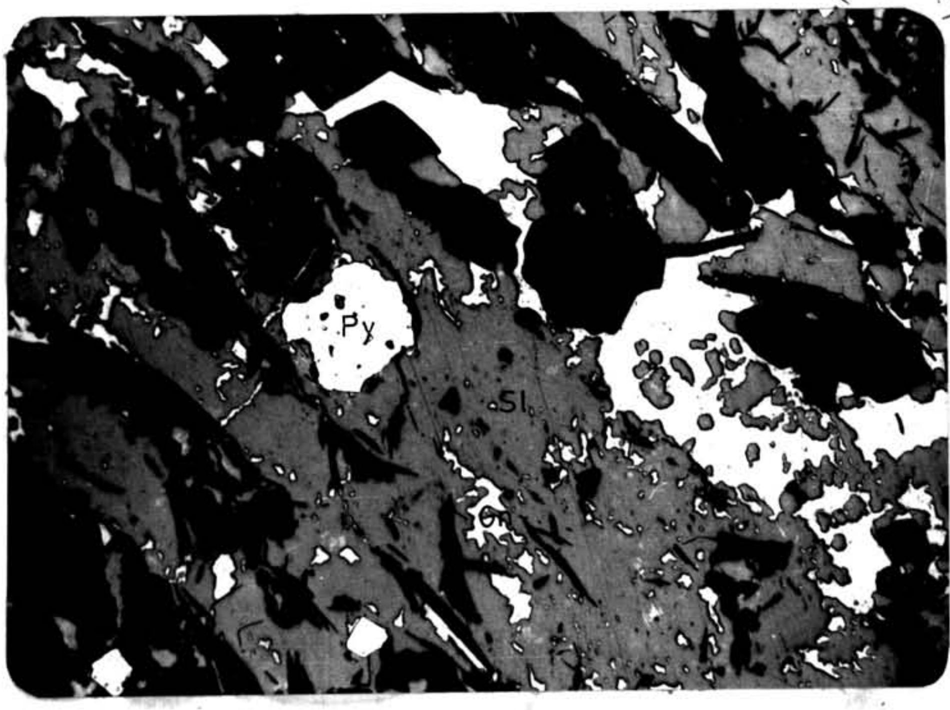

Figure 73 Photomicrograph of massive ores showing a lineation texture defined by the preferred orientation of sericite (Sc), quartz (Qz) and elongate carbonate fragments.
(Polished section, 480 x, uncrossed nicols)

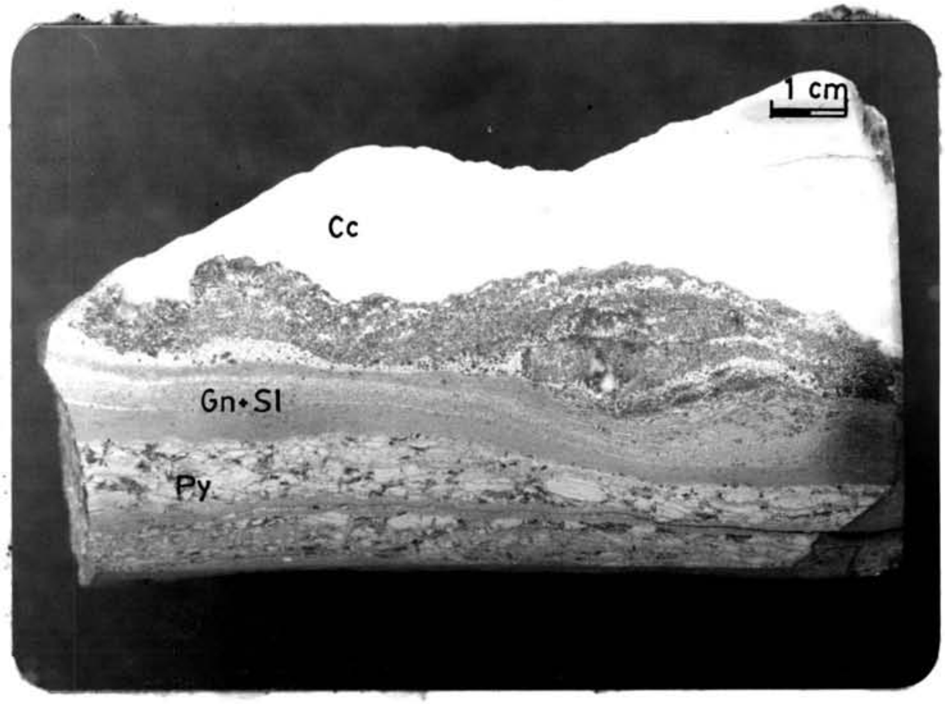

Figure 74 Banded ores showing a compositional layering indicated by variation in grain sizes, colours and mineral compositions.
(Song Toh South mine, + 620 m level)

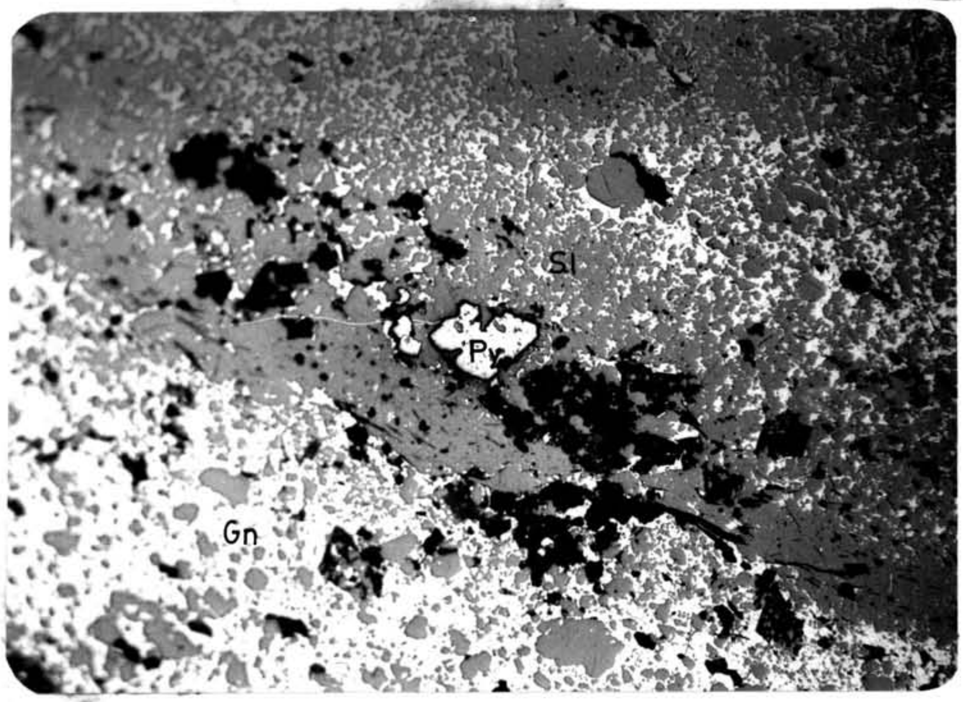

Figure 75 Photomicrograph of banded ores showing a compositional layering demarcated by variation in mineral compositions.
(Polished section, 120 x, uncrossed nicols)

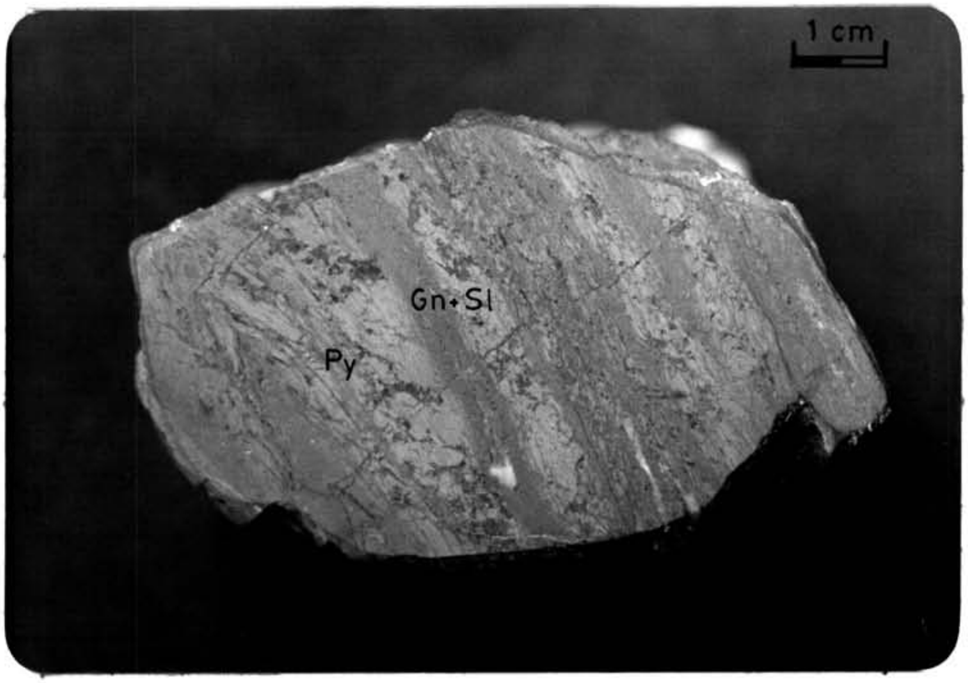

Figure 76 Banded ores showing folds in the layered ore with a foliation developed parallel to the axial surface. (Song Toh South mine, + 620 m level)

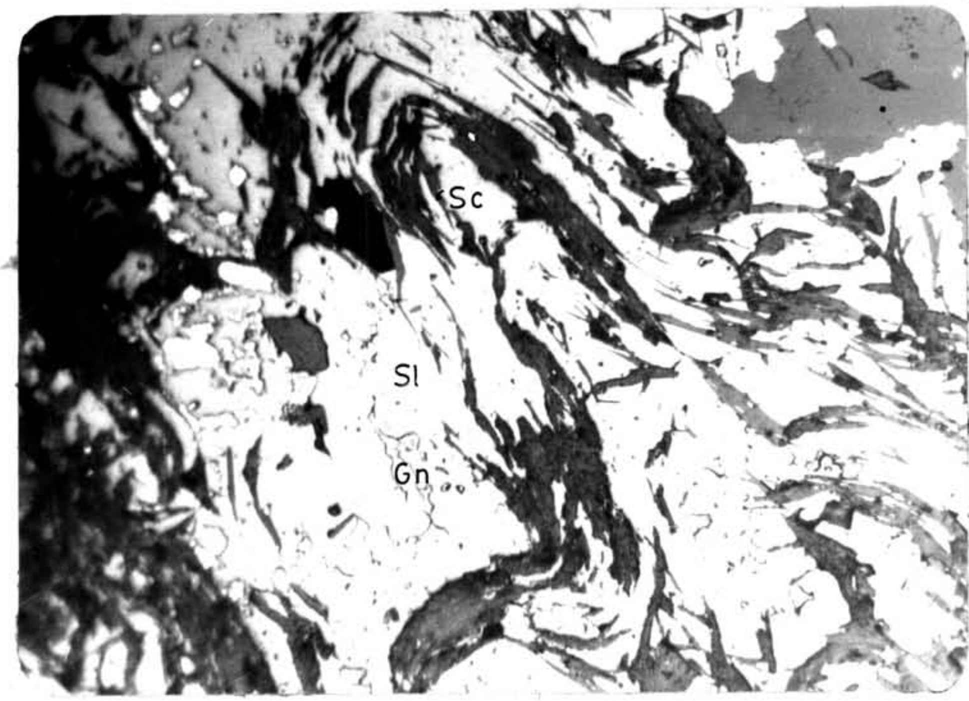

Figure 77 Photomicrograph of banded ores showing folds in the layered ore depicted by vortices of sericite (Sc) laths in sphalerite (Sl) and galena (Gn). (Etched-polished section, 240 x, uncrossed nicols)

Another noteworthy feature of the layer ores is the foliation and lineation which are commonly developed parallel to the direction of the axial surface of the folds or of the layering. The former structure is commonly defined by the preferred orientation of the sericite and of lenticular mineral aggregates (Figure 78 and see also Figure 76), whereas the latter is often defined by the preferred orientation of elongate mineral aggregates (Figure 79).

It is of interest to note that the ore layering itself, in places, wraps around detached fragments of carbonate and argillaceous materials (Figure 80).

Texturally, galena is the most important constituent of the banded ores. It may form irregular mass wrapping around detached grains of sphalerite, calcite and dolomite rhombs. Another most common feature of galena is that it appears to display the poikilitic texture where it occurs as a minor component in the sphalerite-rich layering (Figure 75). Again, it is of interest to note that sphalerite is always light in color and does not show internal reflection. Pyrite commonly occurs as fine-grained framboids, but subidiomorphic grains are not uncommon.

Almost all galena from the banded ores show a sub-structure when etched. The ubiquity of a profuse sub-grain structures are already recrystallized showing perfect foam structure. Similary the associated carbonate fragments also

Figure 78 Photomicrograph of banded ores showing a foliation parallel to the layering.
(Polished section, 120 x, uncrossed nicols)

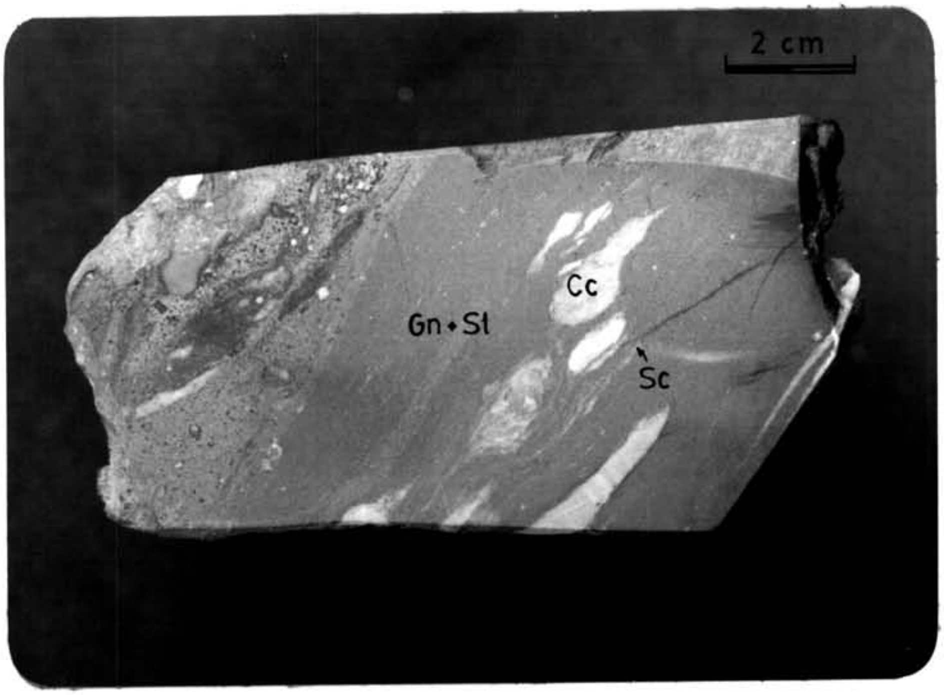

Figure 79 Banded ores showing a lineation structure which is defined by the preferred orientation of elongate mineral aggregates parallel to the layering.
(Song Toh South mine, + 620 m level)

Figure 80 Photomicrograph of banded ores showing ore layering wraps around detached rock fragments.
(Polished section, 60 x, uncrossed nicols)

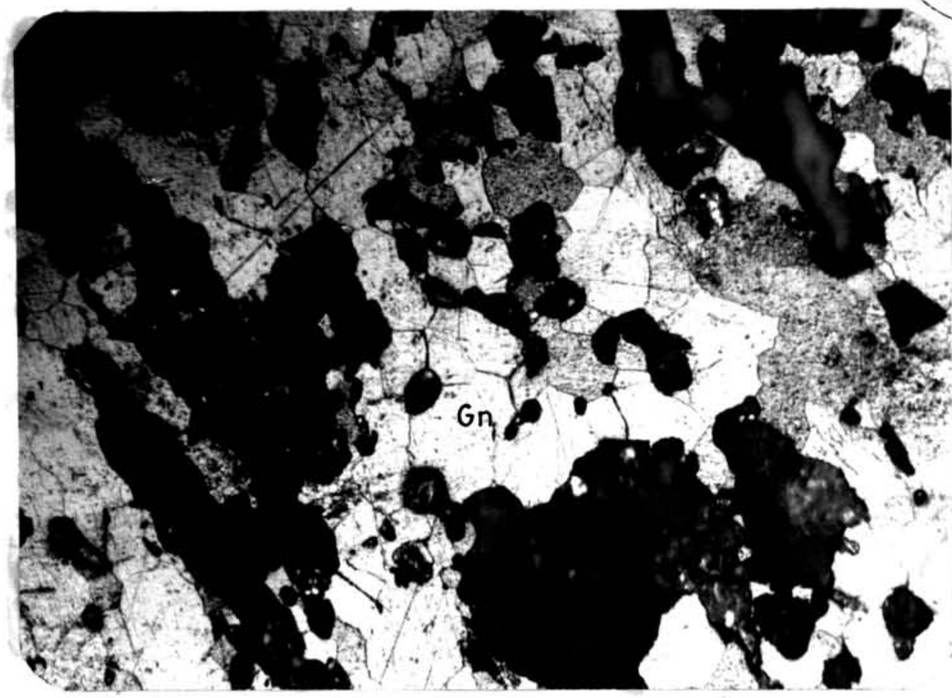

Figure 81 Photomicrograph of banded ores showing perfect foam structure defined by sub-grain aggregates. The associated carbonate fragments also display polygonal texture.
(Etched-polished section, 240 x, slightly crossed nicols)

display polygonal texture probably due to recrystallization (Figure 81).

4.2.1.3 Flaser Ores : Microscopically, galena and sphalerite usually occur as irregular patches wrapping over and under the lenticular sericite aggregates and elongate carbonate fragments (Figure 82). Pyrite frequently occurs as framboidal bodies scattered throughout. However, anhedral grains of pyrite are not uncommon. Galena usually display poikilitic texture with respect to sphalerite. Again, it almost always shows a polygonal sub-structure revealed by etching (Figure 83).

4.2.1.4 Ore-breccias : Microscopically, this ore type is associated of angular rock fragments with their interfragmental spaces being filled up by sulfide masses. In the sulfide area, galena invariably occurs as irregular patches enclosing detached grains of anhedral sphalerite and pyrite. Pyrite also occurs as fine-grained framboidal bodies (Figure 84). Particular noteworthy is that galena almost always displays polygonal sub-structure revealed by etching (Figure 85).

4.2.2 Mineralogy and Textures of the Low Grade Ores

4.2.2.1 Banded Ores : Again, this ore type invariably shows a well developed compositional layering clearly indicated by variation in sulfide-nonsulfide and sulfide-sulfide propotions from layer to layer. Layers are usually very thin varying

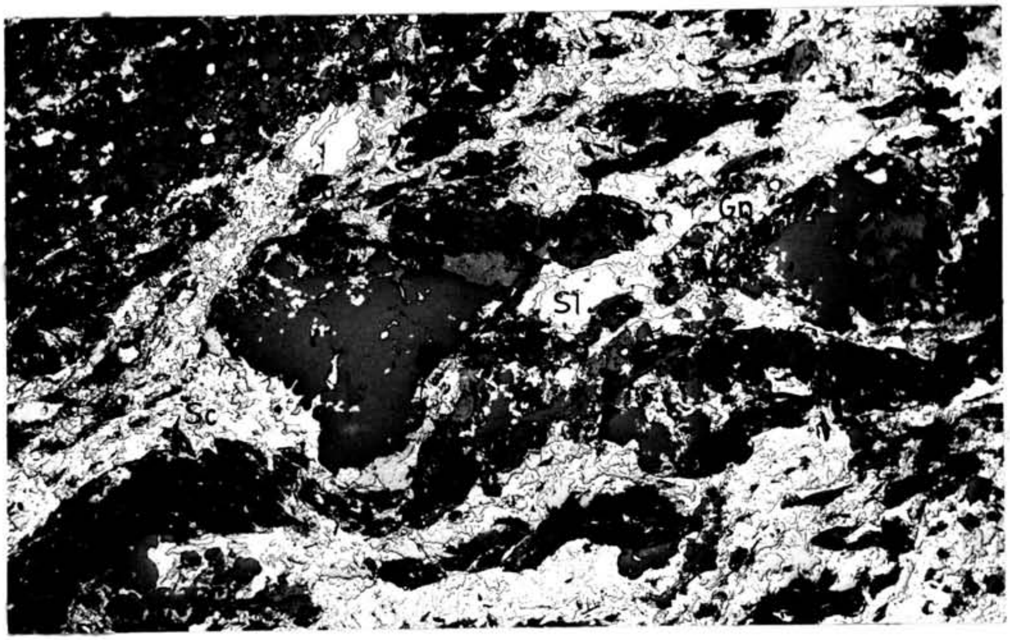

Figure 82 Photomicrograph of flaser ores showing elongate carbonate fragment and lenticular sericite (Sc) aggregate are wrapped over and under by irregular patches of sulfide masses. (Polished section, 60 x, uncrossed nicols)

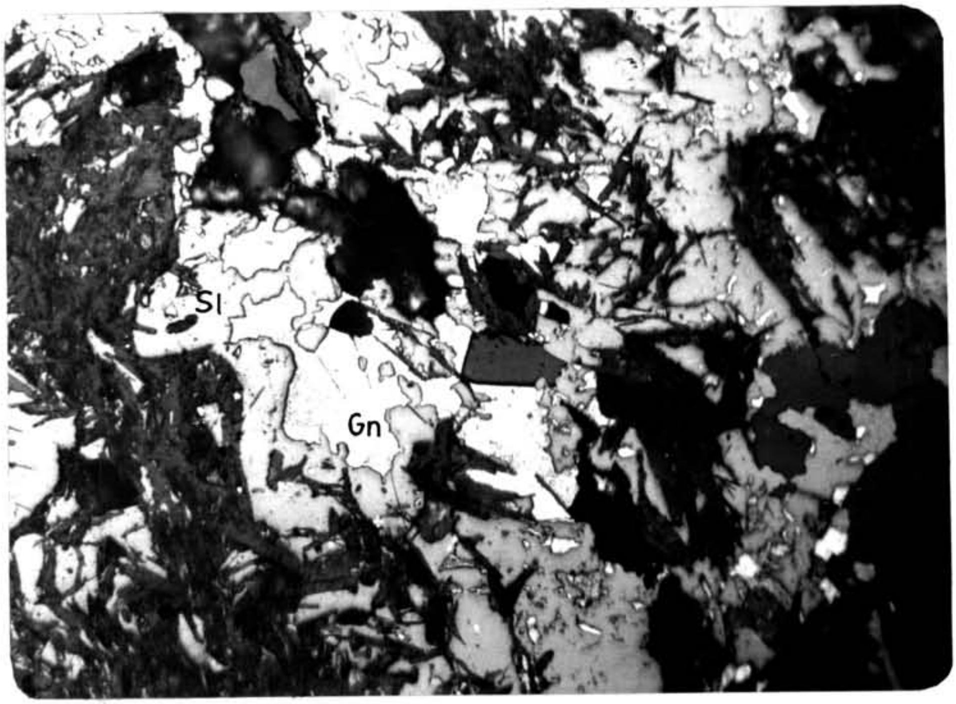

Figure 83 Photomicrograph of flaser ores showing a polygonal substructure revealed by etching. (Etched-polished section, 240 x, uncrossed nicols)

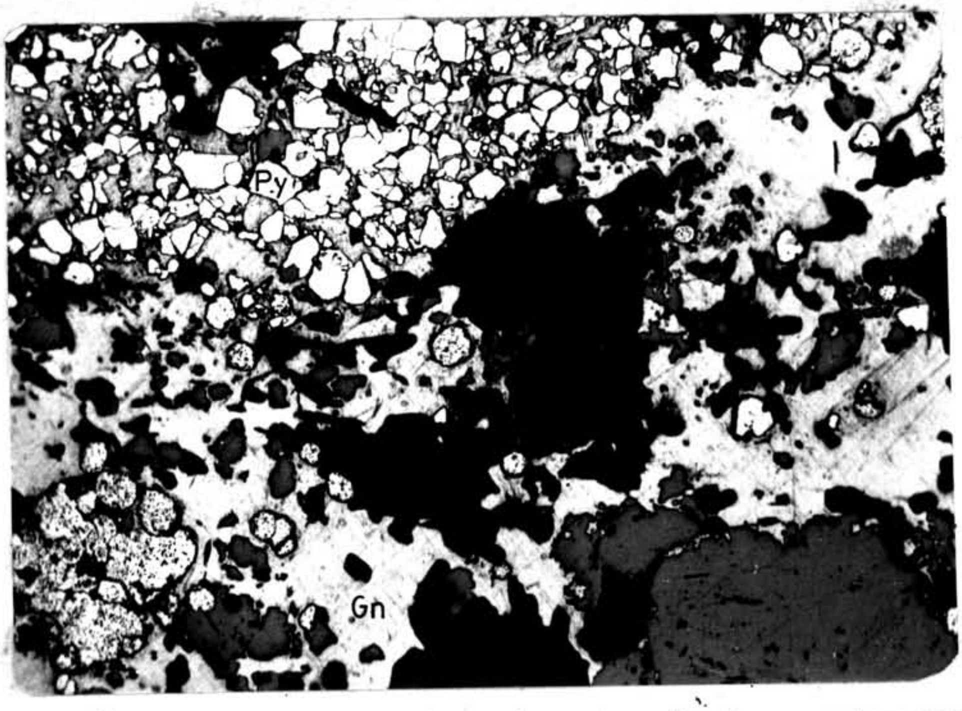

Figure 84 Photomicrograph of ore-breccias showing angular rock fragments embeded in sulfide masses. (Polished section, 240 x, uncrossed nicols)

Figure 85 Photomicrograph of ore-breccias showing a polygonal sub-structure in galena (Gn) area revealed by etching. (Etched-polished section, 480 x, slightly crossed nicols)

from few millimeters down to tenths of a millimeter. Galena, sphalerite and framboidal pyrite are the dominant sulfide constituents. A foliation texture is clearly developed and is defined by the preferred orientation of sericite and of elongate sulfide aggregates (Figure 86). It should be noted that relatively coarse-grained, anhedral pyrite and dolomite rhombs are not uncommon.

4.2.2.2 Disseminated Ores : Texturally, the sulfide ores-particularly galena and sphalerite, are scattered throughout the carbonate host rocks. Boundaries between the sulfide and carbonate material can be, in general, refered to as irregular (Figure 87).

4.2.2.3 Jasperoid : Occurrence of jasperoid has already been mentioned in the foregoing chapter. Microscopically, it is consisted predominantly of hematite and quartz with varying grain sizes from 10-50 microns across. Hematite usually occurs as framboidal grains. Jasperoid commonly contains disseminated galena, pyrite and calcite (Figure 88, 89).

4.2.2.4 Barite-bearing Ores : Recently developed underground exposures have shown that barite-bearing ore occurs as minor lodes associated with the banded and massive ores. However, the lode cannot be laterally traced for a long distance due to the limitation of the development of the tunnel. Mesoscopically, the barite-bearing bands are folded in chaotic directions. In places,

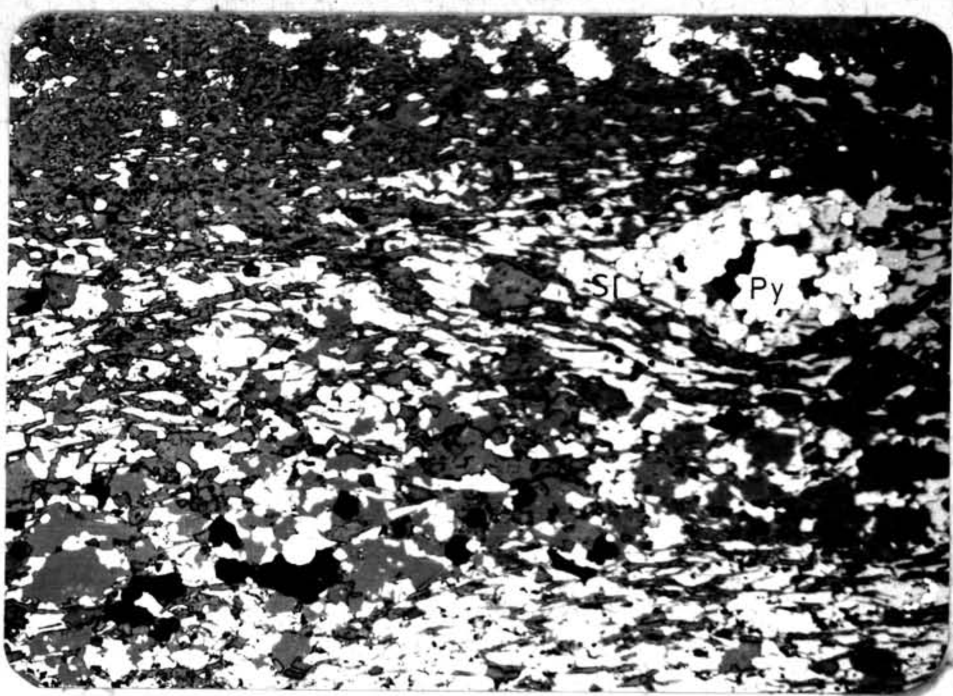

Figure 86 Photomicrograph of banded ores showing a foliated band of sphalerite (Sl) around cluster pyrite framboids (Py) which form augen-like shape.
(Polished section, 120 x, uncrossed nicols)

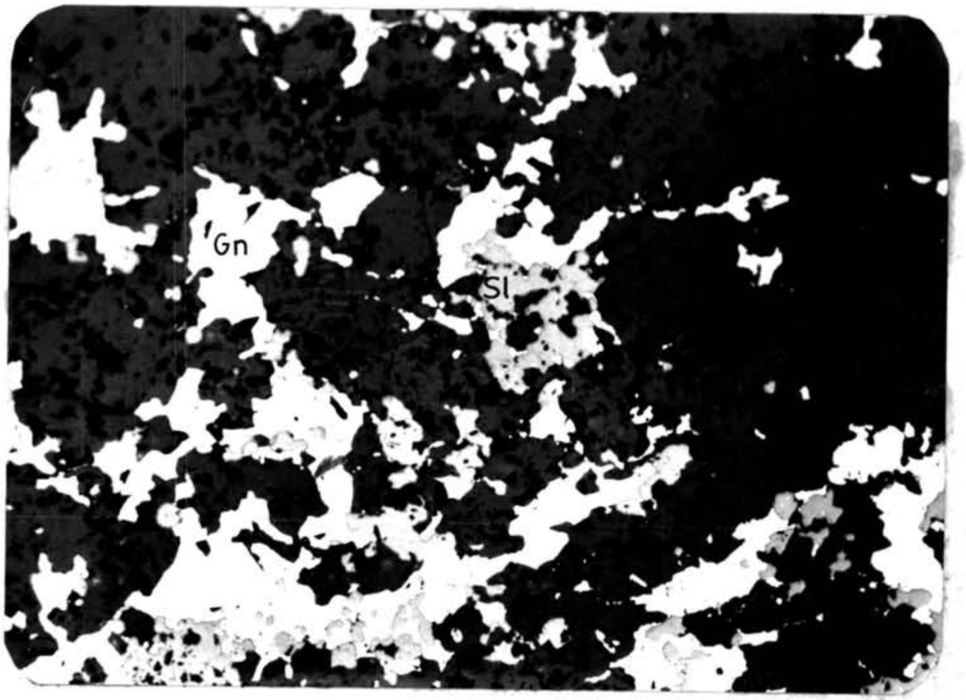

Figure 87 Photomicrograph of disseminated ores showing irregular patches of intergrowth galena (Gn)-sphalerite (sl) are scattered throughout the carbonate host rock.
(Polished section, 120 x, uncrossed nicols)

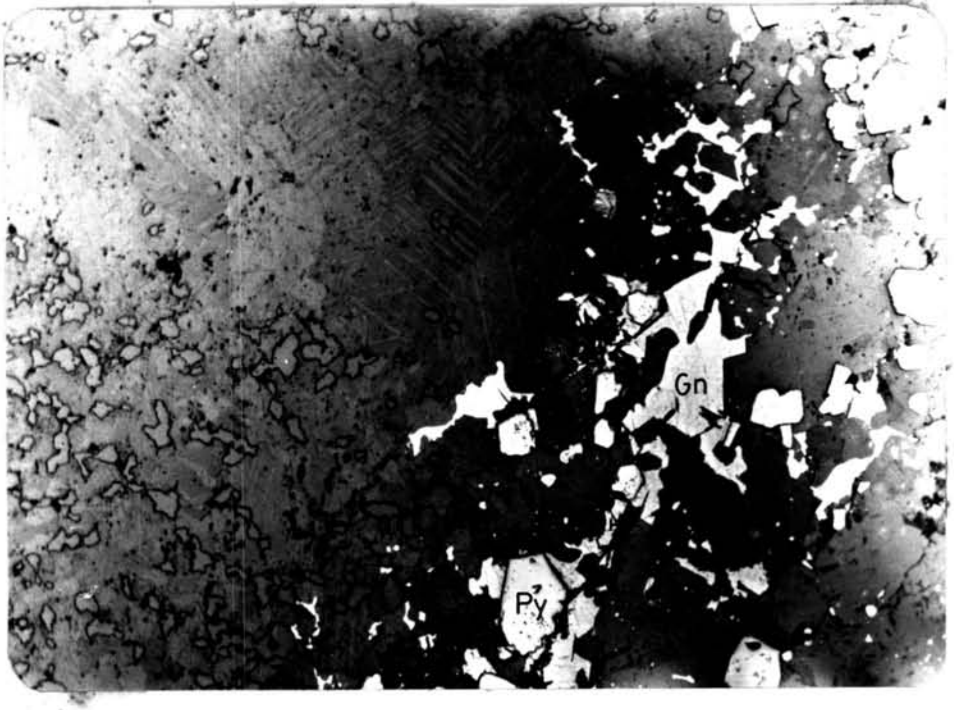

Figure 88 Photomicrograph of jasperoids showing disseminated pyrite (Py) galena (Gn) in between grain boundaries of quartz (Qz) and calcite (Cc). Calcite displays a deformation twin. (Polished section, 60 x, slightly crossed nicols)

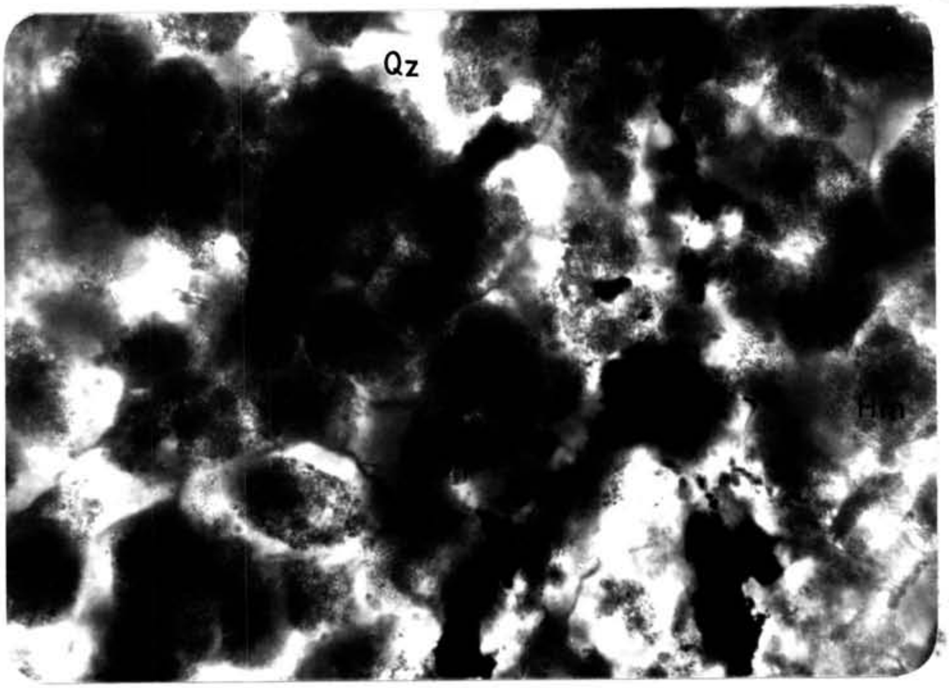

Figure 89 Photomicrograph of jasperoids showing aggregates of hematite framboids (Hm) in recrystallized crystalline quartz (Qz).
(Thin section, 480 x, crossed nicols)

they are brecciated and their fold fragments are scattered through sulfide masses (Figure 90).

In other cases the barite-bearing bands may have been brecciated and the fragments become stretched into lenticular masses floated in the sulfide layers (Figure 91). Microscopically, the barite-rich area is usually fine-grained and show polygonal texture. Authigenic quartz may be locally present (Figure 92).

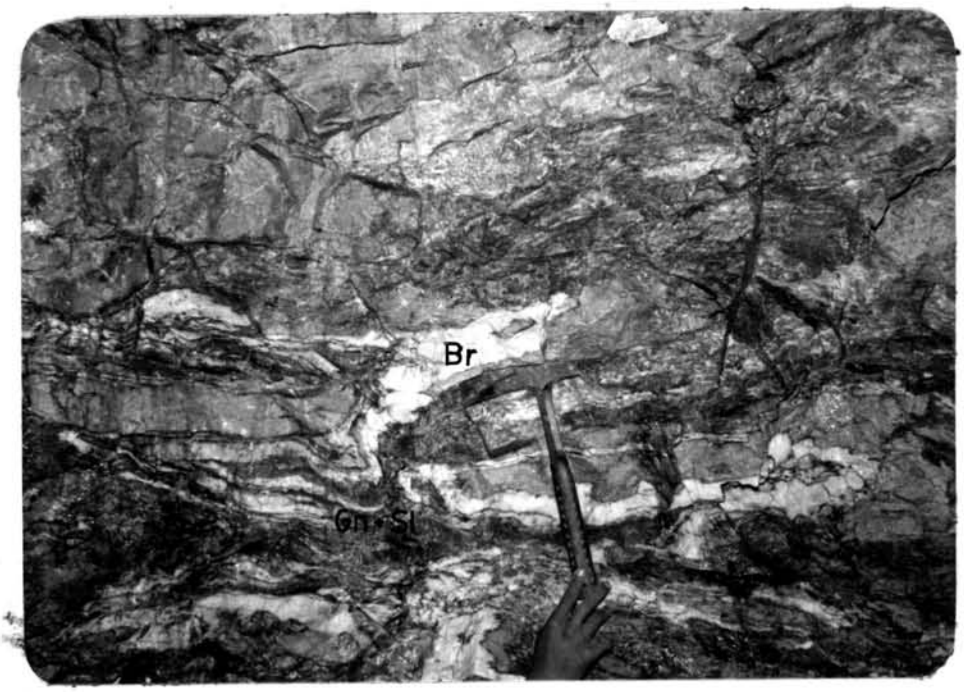

Figure 90 Barite ore (Br) associated with galena (Gn)-sphalerite (Sl) in light gray limestone host. The ore-lode is deformed. (Song Toh South mine, +595 m level)

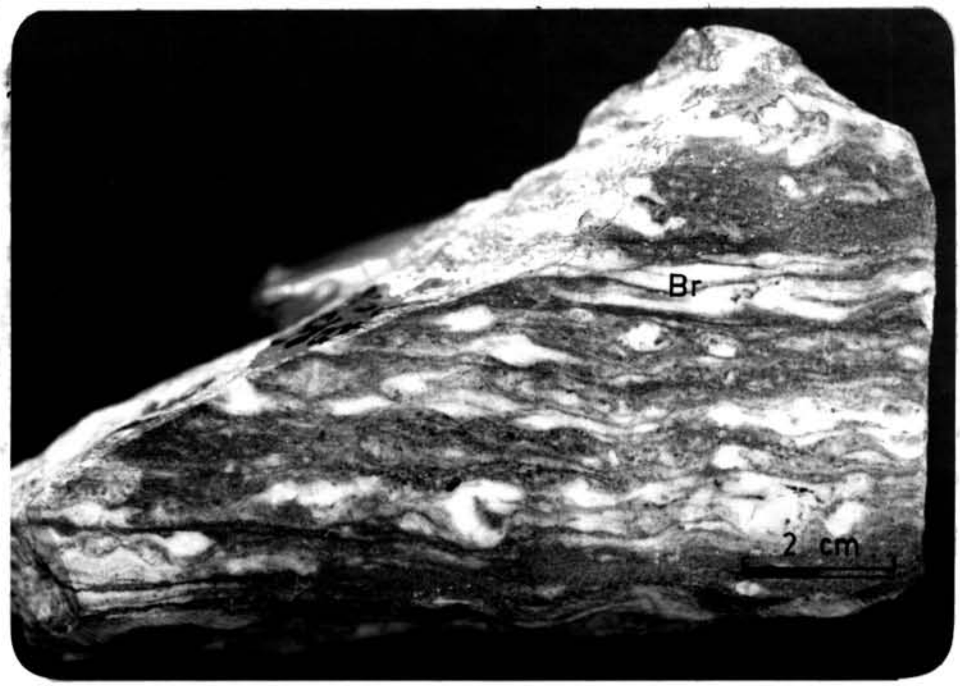

Figure 91 Barite ore (Br) showing a foliation and lineating structure indicated by the preferred orientation of barite augens parallel to the sulfide layers.
(Song Toh South mine, + 595 m level)

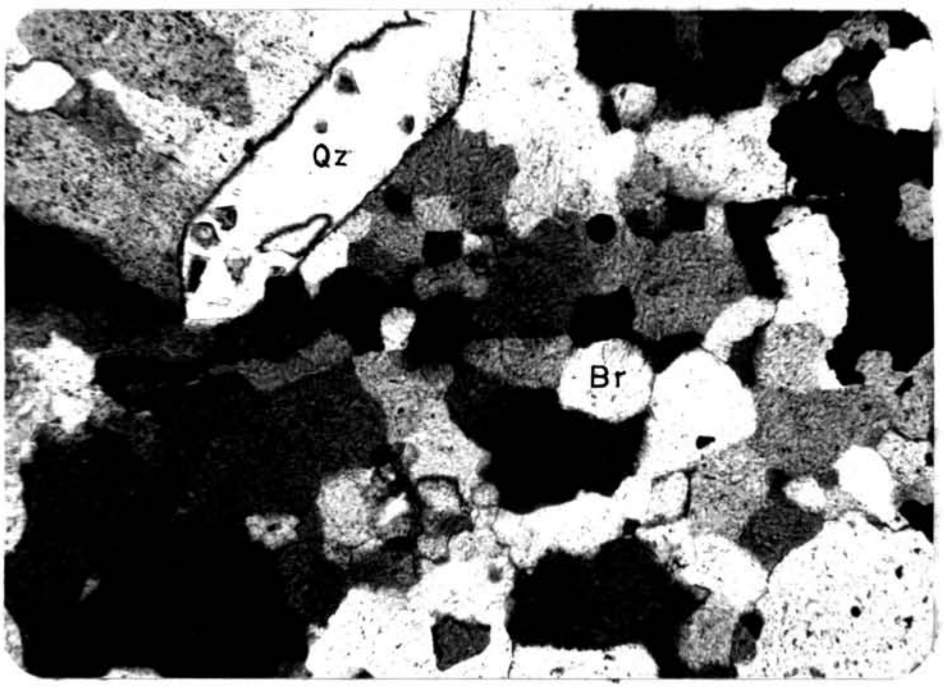

Figure 92 Barite-bearing ore (Br) showing the occurrence of an authigenic quartz (Qz) in polygonal barite matrix. (Thin section, 160 x, crossed nicols)