CHAPTER II

GEOLOGY

The sedimentary sequence of Ordovician rocks, comprising mainly of carbonates, with many mineral deposits can be traced discontinuously over a relatively long distances in the north-northwest/south-southeast trend from Malaysia over western and northern parts of Thailand to Burma (Figure 2). This indicates that the potentially interesting ore carrier has a very wide distribution.

This Ordovician sequence reported by Koch (1973) can be compared with the "Thung Song Series" of southern Thailand, Setul Formation on Langkawi Island of Malaysia, and Pindaya Group of upper Burma or Mawson Series.

It may be noted here that within the Ordovician carbonates a widespread lead-zinc mineralization with accompanying silver, and barite occur, the origin of which may be sedimentary and/or hydrothermal (Koch, 1973).

2.1 Regional geological setting.

In the past, very little was known about the geology of the western part of Thailand. The first known geology of the area was published as a cross-section of the Khwae Yai-Khwae Noi area north of Thong Pha Phum region by Credner (1935). The section runs from Sri Sawat in the east through the Burma border containing general lithological data with little stratigraphic information except for

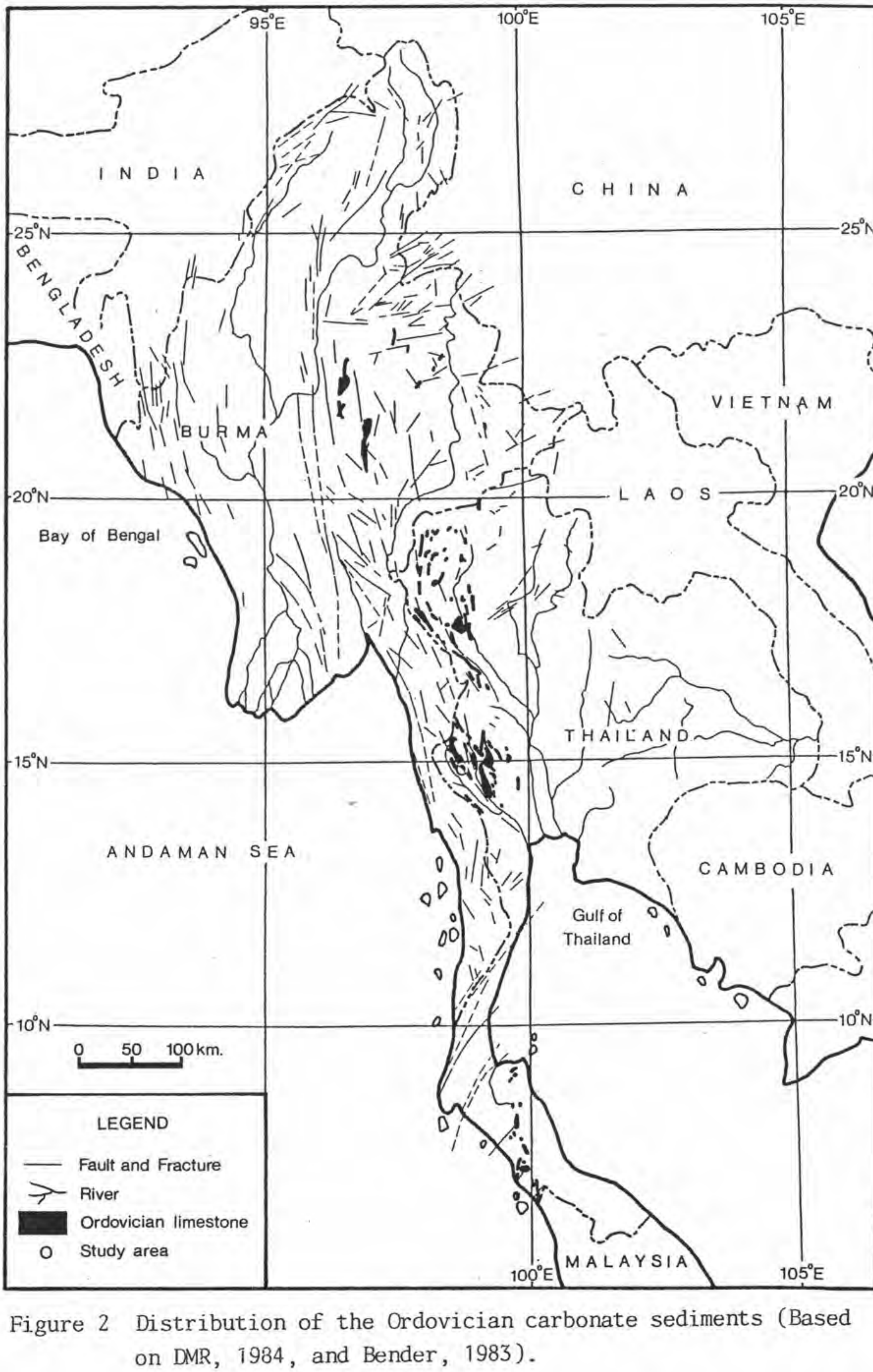

Figure 2 Distribution of the Ordovician carbonate sediments (Based on DMR, 1984, and Bender, 1983).

the classification of the Permian carbonates (Hagen and Kemper, 1976).

Brown, et al.(1953) presented a first general geological map of Thailand with the scale of 1:2,500,000. The Ordovician, Permian and Mesozoic carbonates were grouped together under the name Ratburi limestones. The Cambrian as well as phyllite were not presented.

Duncan (in Brown, et al., 1953) described a fossil locality near Ban Na Suan north of Sri Sawat on the Khwae Yai river as Tentaculites elegan and Styliolina clavula of Silurian Period following Reed (1915) who found northern Shan States of Burma.

During 1968 to 1969, geologists from the Department of Mineral Resources (DMR) reported a good Ordovician fauna in the area of Ban Pak Kaeng Riang about 30 kilometres south of Sri Sawat and 60 kilometres southeast of Thong Pha Phum. The fossil assemblages are trilobites, orthocerids, and bryozoa as well as unidentifiable ostracods of probably Silurian or Devonian Period.

Bastin, et al. (1970) described Ordovician orthocerids, nautiloids, conodonts, trilobites, brachiopods, and echinoderms, Silurian graptolites, and some spiriferids (identified by Wolfart) which are probably Permian Period in the area of Khao Bo Rae east of Thong Pha Phum.

The first comprehensive geological investigation of Sri Sawat-Thong Pha Phum-Sangkhlaburi area of Changwat Kanchanaburi was conducted by the German Geological Mission (GGM) during 1968 to 1971, and reported by Koch in 1973. The strata in the area comprise of about 3,000 metres mostly marine metasedimentary and sedimentary rocks, their ages range from Cambrian to Jurassic, locally covered by fluviatile Cenozoic sediments. The marine sedimentary basin forms part of a geosynclinal tract the so-called Yunnan-Malaya Geosyncline which extends from Yunnan in the north to Malaysia in the south. It is noteworthy that turbidites of Lower Carboniferous Epoch and a Late Carboniferous Phase is also indicated. There is also evidence for Triassic and post-Triassic orogenies, and Late Cenozoic faulting. Several granites, as yet not positively dated, occur in the area. They are Khwae Yai granite (Triassic?), Central granite (Paleozoic?), and Pilok granite (Triassic?).

The regional geology of Thong Pha Phum area of Changwat Kanchanaburi (Figure 2.1) can be subdivided in three aspects, namely, stratigraphy, geological structure, and igneous rocks as follows:

2.1.1 Stratigraphy.

Cambrian Rocks.

The lowest series, Cambrian rocks, in the east and northeastern parts of Thong Pha Phum area consist of fine- to coarse-grained sandstones, phyllite, sericite slate, biotite-muscovite schist and biotite schist with occasional intercalations of calcsilicates. Stratigraphically, these rocks are considered to be Cambrian in age because they are underlying the Ordovician sequence.

The quartzitic rocks, generally brownish gray, light gray, and dirty white with disseminated pyrite cubes, are confined to the lower part of the sequence, whereas the metamorphosed shaly and calcareous intercalations are in the upper part of the sequence. The

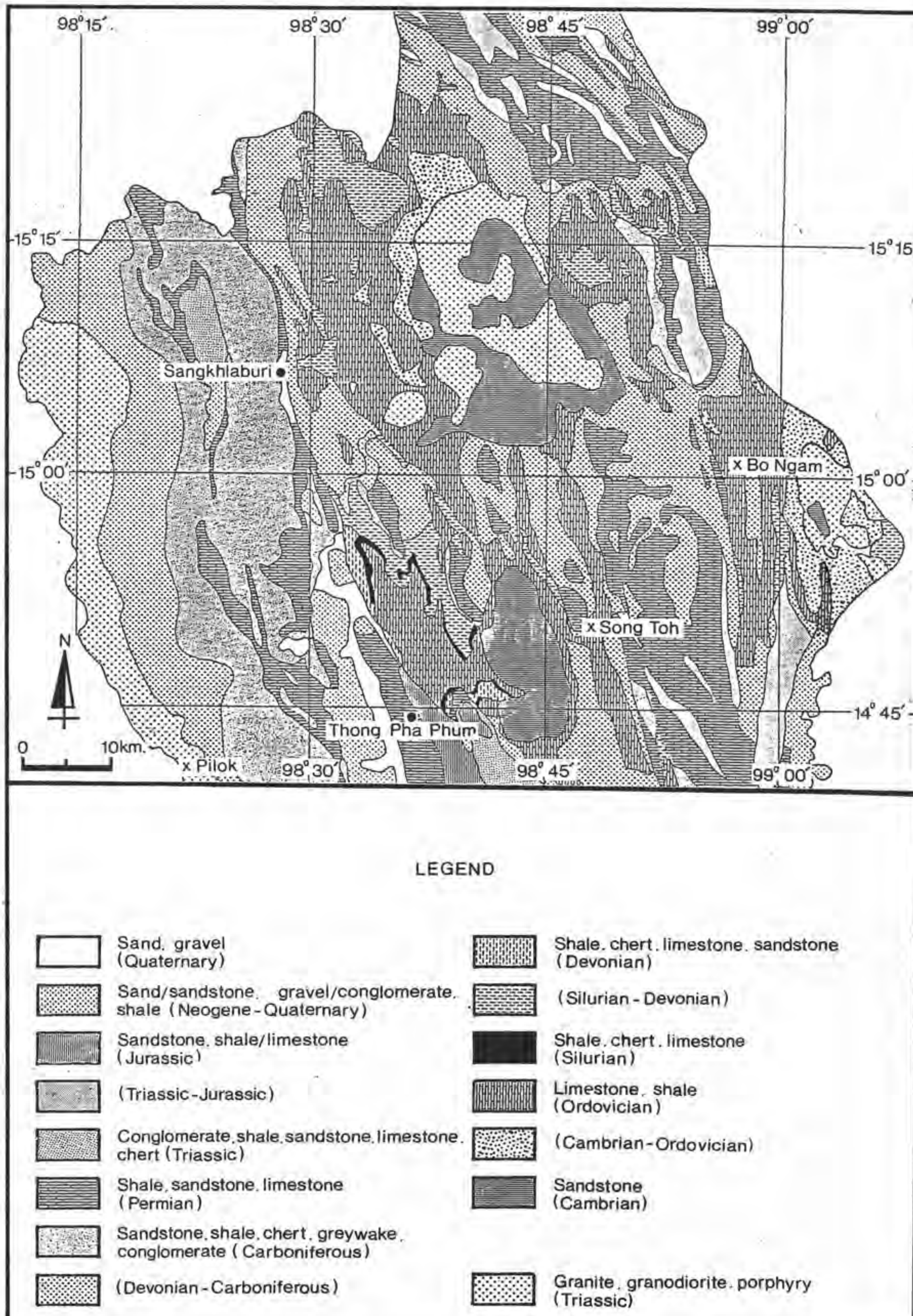

Figure 2.1 Geological map of the Thong Pha Phum area (Modified after GGM, 1972).

phyllitic rocks grade into the sandy and calcareous Ordovician rocks. Therefore, it may be concluded that this clastic complex started well back in Cambrian Period continuing to a certain degree into the Ordovician. The lower contact of the Cambrian unit has not been found but the sequence might be at least 1,000 metres thick (Koch, 1973; Hagen and Kemper, 1976).

Ordovician Rocks.

The Ordovician series consists mainly of carbonate sequence, overlying conformably the Cambrian rocks. The basal part of the sequence is fine to coarse clastic showing cross-bedded in carbonate rocks, whereas most part of the sequence is fine-grained carbonate rocks with some argillaceous intercalations. Reef limestone occurs in some areas. Towards the top of the sequence, there is a decrease in carbonate content while the fine- and medium-grained clastic contents increase. A series of finely sandy and micaceous shale terminates the Ordovician part of the stratigraphical section (Koch, 1973; and Hagen and Kemper, 1976).

Silurian Rocks.

The Ordovician-Silurian contact is poorly exposed, and it is expected that there is no lithological break between rocks of these two different Periods. The lithological characteristics in the lower part of the Silurian sequence are fine clastic sediments, black colour, finely stratified, and graptolite shales approximately 60 metres in thickness. The graptolite faunas of Lower Silurian Epoch are Climacograptus cf. medius TOERNQUIST, and Rhaphidograptus toernquisti (Elles and Wood), and Diplograptus sp. of Llandoverian age (Bastin, et al., 1970). The upper part of Silurian sequence is shale with minor intercalations of nodular and/or lenticular limestone (Koch, 1973), or flaser limestone (Hagen and Kemper, 1976) of approximately 120 metres thick. It is noted that, there is no major change of facies from Ordovician to Silurian Period (Koch, 1973; Hagen and Kemper, 1976).

Devonian Rocks.

The base of Devonian sequence is characterized by dark, calcareous shale with tentaculites and graptolites without any noticeable break with the underlying Silurian shale. The major part of Devonian sequence is sandy shale, graywacke, and nodular limestone. The upper part of the sequence is soft greenish shale which grades into shale of Lower Carboniferous Epoch. The fossils of the sequence are trilobites, brachiopods, tentaculites, graptolites, and conodonts. The total thickness of the Devonian sequence is approximately 450 metres (Hagen, 1970; Koch, 1973; Hagen and Kemper, 1976).

Carboniferous Rocks.

The Carboniferous sequence is consisting mainly of clastic rocks of sandstone, shale, chert, graywacke and conglomerate. In the western and northwestern parts of Sri Sawat area the shales frequently contain mostly well rounded phenoclasts of up to 10 centimetres. Fragments of quartzitic sandstone, quartzite, slate, chert, phyllite and granite are the most frequent components of the phenoclasts. The sequence clearly shows flysch-like characteristics of turbidite. The thickness of this clastic sequence is estimated to be approximately 200 to 400 metres (Koch, 1973).

Permian Rocks.

The Permian sequence of mostly carbonate rocks conformably overlies on the Carboniferous rocks. The sequence is characterized by limestones with strongly dolomitic and bituminous in some areas with numerous silicified layers in the lower part of the sequence. Fossils of the sequence are brachiopods, corals; and fusulinids and other foraminifera. In the northwest of Thong Pha Phum area, the appearance of transgressive sequence (coarse and probably marine conglomerate) replaces the lower part of the carbonate sequence. The thickness of this Permian sequence is approximately 200 metres (Koch, 1973; Hagen and Kemper, 1976).

Triassic Rocks.

The limestone conglomerate forms the base of Triassic rocks in the western region of Changwat Kanchanaburi. The phenoclasts are mainly of Lower and Upper Permian carbonates. Associated with the basal conglomerate are some carbonates containing conodonts fauna of Anisian age, some sandstones and shales containing Halobia and/or Daonella. The total thickness of the sequence is at least 200 metres (Koch, 1973; Hagen and Kemper, 1976).

Jurassic Rocks.

Conformably overlying on the conglomerate sequence of Triassic rocks is a very fine-grained Jurassic carbonates of up to 300 metres in thickness. These carbonates are generally light brown to light gray in colour, well bedded, containing some microforaminifera. No clastic component is present in the carbonates (Koch, 1973; Hagen and Kemper, 1976).

Tertiary to Quaternary Sediments.

Tertiary-fillings of larger valleys occur in different parts of the region, and may exceed a thickness of 200 metres. The sediments consists of gravel, sand, loam and calcareous tuff (Koch, 1973).

2.1.2 Geological structure.

The Paleozoic rocks were folded in pre-Jurassic times. The rigid Cambrian quartzite was only slightly folded, whereas less rigid Ordovician and younger rocks were broadly folded. The result was a system of northwest striking synclines and anticlines of Paleozoic rocks which were covered by the Mesozoic carbonate conglomerate. Block faulting with two main faults trend resulted from tension occurred during the Early Tertiary Epoch. The older system of normal faults follows the northwest strike of the anticlines in the Paleozoic rocks, some show considerable displacement. The younger fault system strike perpendicular to the older system. Part of the movement on the younger system was right lateral. In the western part of the Thong Pha Phum area there was also vertical movement which has divided the Tertiary river terrace into three terrace levels. Consequently, the younger fault system was last active in the Late or post-Tertiary Epoch (Hagen and Kemper, 1976). The younger fracturing affected practically the Sri Sawat area, including Upper Tertiary to Pleistocene sediments. It determines much of the present day morphology. In many cases, especially following Khwae Yai and Khwae

Noi valley zones, the young fracturing seems to be the result of the rejuvenation of "scissors faults" from the post-Jurassic orogeny (Koch, 1973).

2.1.3 Igneous rocks.

There are several granite batholiths within Thong Pha Phum area which can be classified according to their localities as Khwae Yai Granite, Central Granite, and Pilok Granite (Koch, 1973) as follows:

The Khwae Yai Granite, a fine- to medium-grained, finely porphyritic biotite granite occurs 20 to 30 kilometres upstream the Khwae Yai river from Amphoe Sri Sawat. The age of this granite is regarded as Triassic, and no accompanying mineralization is known so far.

The Central Granite is a biotite granite, fine- to medium-grained, occasionally porphyritic, and slightly stressed. It is exposed in the mountain east and southeast of Amphoe Sangkhlaburi, often covered by metasediments. It intruded metasediments and sediments of Lower Paleozoic, causing an anatexitic mantle of sometimes considerable thickness. Pegmatitic quartz veins from this granite contain varying amounts of hematite, copper or lead. Barite veins near the Khwae Noi might also belong to this succession. A scattered stibnite mineralization occurring in the northern part of the region is most probably connected with this granite as well. It is not clear, to what extent a lead-zinc mineralization of the Ordovician carbonates is due to or influenced by this intrusive body. The age of the granite is not definite, possibly Paleozoic.

Pilok Granite is a porphyritic biotite-muscovite granite, medium- to coarse-grained, extends roughly north-northwest/ south-southeast direction, cropping out in the Thai-Burmese border range. Associated with it are aplitic and pegmatitic dikes, some of which have been altered to greisen. The granite intruded metasediments and sediments of Carboniferous and older Period which are steeply folded. An extensive tungsten-tin mineralization, accompanied occasionally by gold, occurs, and is connected with veins injecting the granite as well as its overburden (Brown, et al.,1953). The age of the granite is still unknown, possibly Triassic in parts.

2.2 Geology of the Song Toh Mine area.

2.2.1 Stratigraphy.

The sediments and metasediments in the vicinity of Song Toh Mine can be generally classified into three main stratigraphic units (Diehl and Kern, 1981), notably, the Cambrian-Lower Ordovician Unit, the Lower-Middle Ordovician Unit, and Upper Ordovician-Lower Silurian Unit.

The Cambrian-Lower Ordovician Unit is the oldest stratigraphic unit occupying the western part of the area (Figure 2.2.1). This rock unit is characterized by the association of sericite-chlorite schist, phyllite with intercalated and interbedded of quartzite, phyllite or argillaceous limestone, shale, and calcareous slate. The schistosity of sericite-chlorite schist as well as the attitude of associated rocks are approximately oriented in the north-south direction dipping 45 degree east. In the vicinity of Khao Tu Kalo the Cambrian-Lower Ordovician Unit is covered by thick gossan.

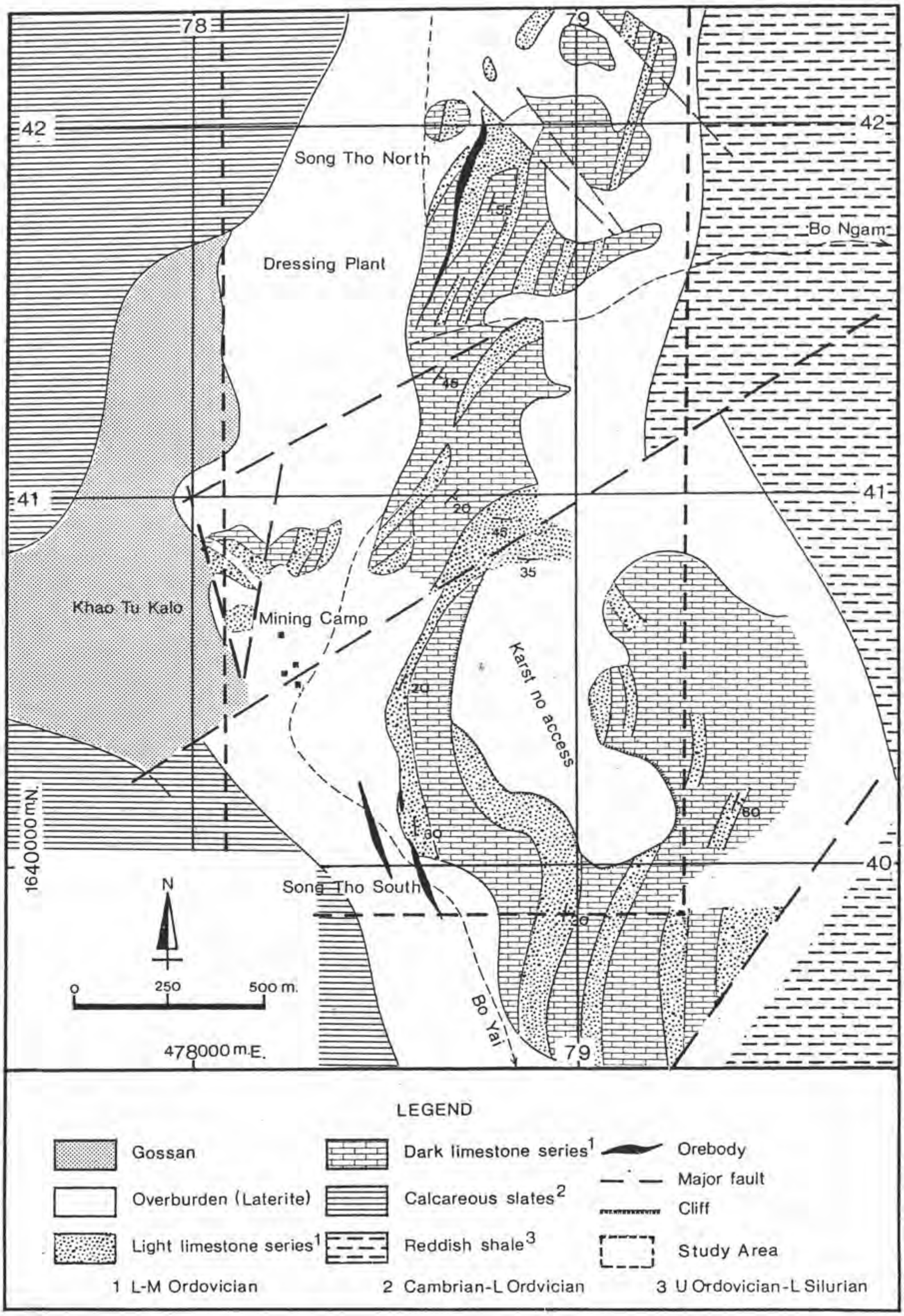

Figure 2.2.1 Geological map of the Song Toh Mine area (Diehl and Kern, 1981).

The second stratigraphic unit, Lower-Middle Ordovician Unit, is mainly exposed as a north-south oriented belt in the central part of Song Toh area (Figure 2.2.1). This rock unit is characterized by the interbedding of light and dark gray carbonate sediments ranging from limestones, dolomitic limestone, dolomite to argillaceous limestone. It is noted that, this carbonate unit is also intercalated with some thin layers of shale. The contact between the Cambrian-Lower Ordovician Unit and Lower-Middle Ordovician Unit can not be observed due to the present of lateritic soil cover. It is noted that, lead-zinc mineralization is associated with light carbonates.

Further east, the area is underlain by the Upper Ordovician- Lower Silurian Unit. The lithological characteristics of this unit are the association of black, laminated shale, siltstone, mudstone and intercalated with argillaceous limestone of approximately 120 to 200 metres thick (Koch, 1973; Hagen and Kemper, 1976). The contact between the Lower-Middle Ordovician Unit and Upper Ordovician-Lower Silurian Unit can not be observed due to the present of lateritic soil cover.

2.2.2 Geological structure.

The geological structures of Song Toh Mine area will be considered under three main headings, namely, fold, fault, and fracture.

With respect to fold there is a main anticline of en echelon type oriented in the north-northwest/south-southeast plunging towards the south-southeast. Besides, there are another two sets of minor fold. The first set is parallel to the regional fold axis, whereas the second set is oriented almost perpendicular to the first one.

The contour diagramme of attitudes of bedding in carbonate-host rock of Song Toh Mine area is presented in Figure 2.2.2a.

The Song Toh Mine area has been offset by at least two sets of both normal and reverse faults with steep dipping and small displacement. The trends of this two fault sets are northeast-southwest and northwest-southeast, and the rose diagramme of the fault systems in this area are presented in Figure 2.2.2b. The normal faults are believed to be formed by local extension mechanism during or after the folding events (Permthong, 1982).

In addition to the fold and fault, all the sequences in the area show well developed, steeply or vertically dipping fractures. There are at least two main aligment of fractures, namely, northeast-southwest trend, and northwest-southeast. These fractures are presumably release and ac-joints formed during or after the folding events. The rose diagramme of joints occurring in the carbonate-host rock in the Song Toh Mine area is presented in Figure 2.2.2c (Permthong, 1982).

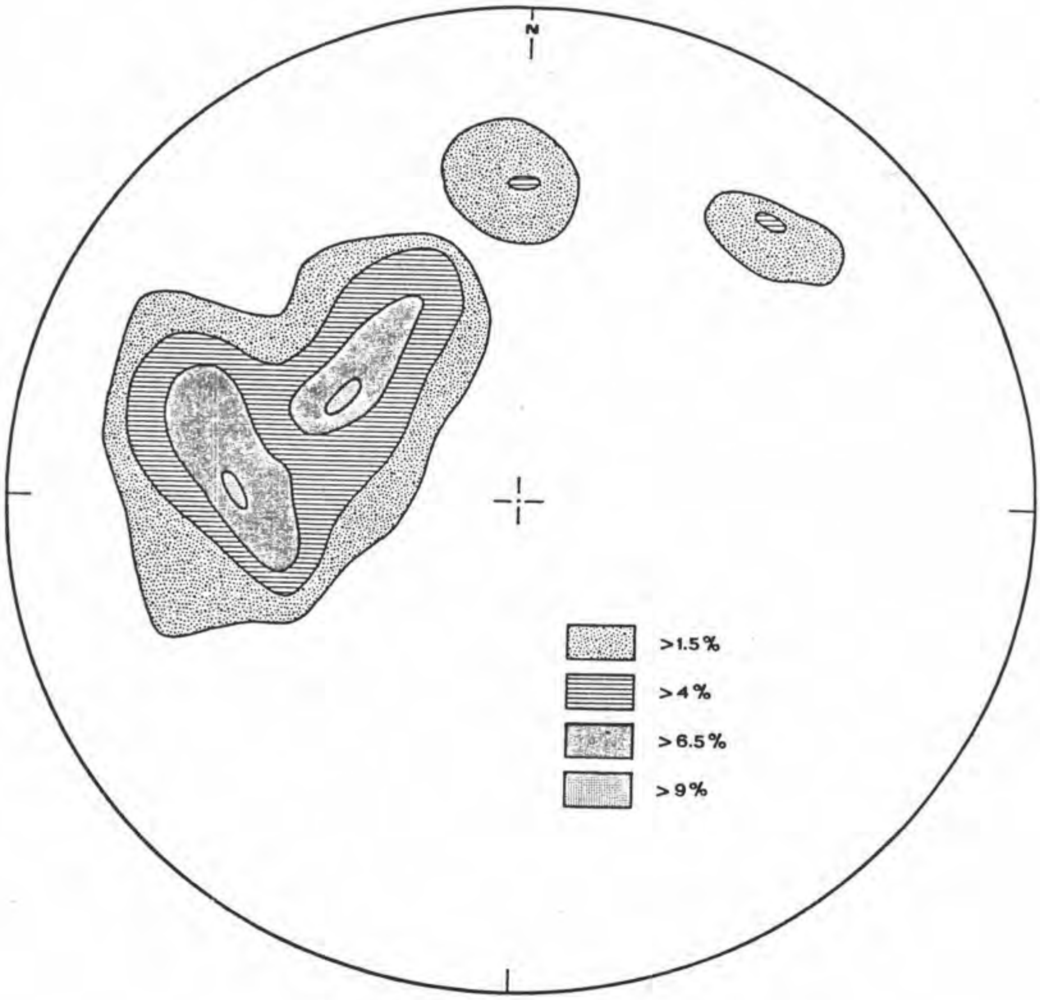

Figure 2.2.2a Contour diagramme of attitudes of bedding in carbonate host rock of the Song Toh Mine area.

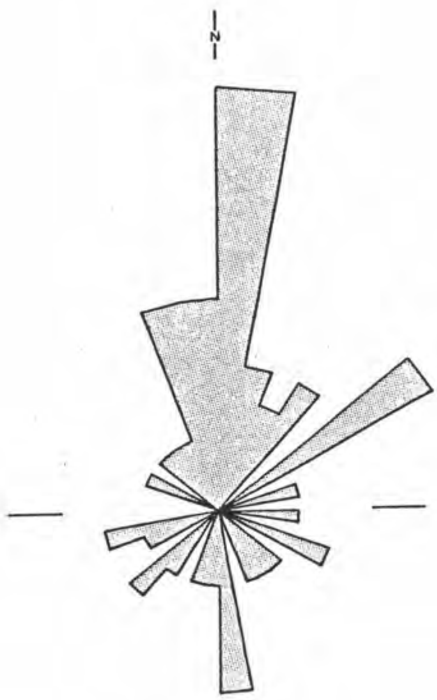

Figure 2.2.2b Rose diagramme of fault systems in the Song Toh North Mine area (Permthong, 1982).

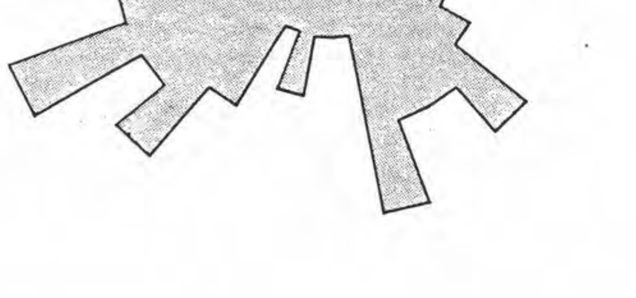

Figure 2.2.2c Rose diagramme of joints occurring in the Song Toh North Mine area (Permthong, 1982).

2.3 Mineralization of the Song Toh deposit.

The lead-zinc deposit at the Song Toh Mine is in the form of galena and sphalerite association. The host rock is Lower-Upper Ordovician Epoch consisting of gray to dark gray argillaceous nodular limestone interbedding with light gray to white limestone of totally 450 metres thick. The attitude of the host rock is mainly oriented in the north-south direction dipping to the east (Suksa-nguan, et al., 1986).

The Ordovician carbonates of the Song Toh Mine area is a part of Sino-Malayan mountain range extending from Yunnan passing through the western part of Thai-Burmese border down to south Malaysia.

The lead-zinc deposit in this area are consist of primary ores of galena and sphalerite mostly occurred as strata-bound type (Permthong, 1982) in light gray to white carbonate-host rock. Associated gangue minerals are pyrite, barite, quartz, dolomite, calcite, and clay whereas the secondary oxidized ores are cerussite, smithsonite, hemimorphite, and hydrozincite (Suksa-nguan, et al., 1986).

2.3.1 Characteristics of the deposit.

The Song Toh lead-zinc deposit, at present, is consists of three separate small ore deposits, namely, Song Toh North, Song Toh South, and Song Toh Southwest as follows:

The Song Toh North deposit.: The ore zone of this deposit is oriented approximately in the north-south direction with moderate dipping to the east. The average elevation of the ground surface is approximately 620 metres above the mean sea level. The geometry of this ore zone is about 650 metres long, about 250 metres wide, and about 5 metres thick in average. The maximum thickness of the ore zone is located in the central part of the gentle folding structure. The total reserve of this deposit is approximately 1.28 million tons, with the ore grade of 11 per cent of lead and zinc metals. The lead/zinc ratio is about 2.5:1. Up to present, approximately 450,000 tons of ores have been exploited (Suksa-nguan, et al., 1986).

The Song Toh South deposit.: The deposit is approximately 1 kilometre to the southern direction of Song Toh North. The ore zone is oriented approximately in the northeast-southwest direction with gentle dipping to the southeast. The average elevation of the ground surface is approximately 650 metres above the mean sea level. The ore zone is consisting of three main ore layers. The maximum length and width of the ore layers are 350 metres with 4 to 5 metres thick. The total reserve of the deposit is approximately 1.5 million tons with the ore grade of 8 per cent of lead and zinc metals, and the ratio of lead and zinc is about 4:1. Up to present, approximately 1 million tons of ores have been exploited (Suksa-nguan, et al., 1986).

The Song Toh Southwest deposit.: The deposit is located in the western direction of Song Toh South. The major geological structure of the area is overturn anticline with the fold axis plunging to the southeast. The Song Toh Southwest deposit is confined to the west flank of the anticline, whereas the Song Toh South is confined to the east flank. The ore zone is consisting of three main ore layers and are all oriented parallel to the northwest-southeast trend with steeply dipping to the east. The maximum length of ore layers is approximately 400 metres, and the width of approximately 150 metres with average of 3 metres thick. The ore reserve is approximately 1 million tons with the grade of 8 per cent of lead and zinc with the ratio of lead and zinc is 7:1. The deposit is in the initial phase of development (Suksa-nguan, et al., 1986).

2.3.2 Ore types.

Evidences from both micro and macro fabric investigation of Song Toh deposits, Diehl and Kern (1981) recognized three different ore types, namely, layered galena-sphalerite ores, massive sulphide ores, and disseminated sulphide ores as follows:

The layered galena-sphalerite ores.: Though not stratiform at a small scale, they are more or less conformable in the carbonate-hosted. In general, the ore occurs as a sequence of sulphide lenses and layers more than banded ores in a strict sense. However, due to the imbricate arrangement of layers and lenses, the mean grade remains fairly constant over a major cross-cut. Sulphide layers or veinlets are mostly related to primary sedimentary structures such as algal mats, and bedding fissility. Ores are very fine-grained. Galena is the predominant sulphide, often forming the matrix which encloses the other ore minerals. Usually galena and sphalerite are so intimately intergrown.

The two generations of pyrite have been observed. Well-preserved framboids of 8 to 25 micrometres in diameter as matrix inclusions were formed at first, and usually occur in clusters or form thin layers. The rounded or subhedral grains of pyrite occurs as matrix mineral, whereas galena often contains patches of fahlore and various sulfosalts which are too small to be studied properly under the microscope. However, some of these inclusions were identified by microscope as boulangerite, pyrargyrite, bournonite, tennantite, and freibergite, the silver-rich component of fahlore. A major part of the antimony and silver content of ores is attributed to these minerals. The predominant gangue minerals are white barite, white or reddish calcite-dolomite, and silica which occurred as very fine-grained and intimately intergrown.

<u>The massive sulphide ores.</u> (more than 60 per cent of sulphide in the rock at a megascopic scale): They form small but compact orebodies several metres thick and 10 to 20 metres long. In contrast to the more rigid host rock, the massive sulphide ores is plastically deformed and folded in some places at a small scale (centimetres to decimetres). In this case, primary ore structures are mostly destroyed, and the sulphide minerals, especially galena, are rolled out. The fragments of host rock in sulphide matrix are common due to boudinage. Typically the sulphide minerals are interwoven with authigenic phyllosilicates. The mineralogy of these ores is similar to that of the banded ores. However, the pyrite and/or barite

contents may be up to 30 per cent. Reddish or black chert nodules are a major constituent of the ores.

<u>The disseminated sulphides ores</u>.: They occur mostly in the vicinity of the orebodies. In many cases, the disseminated ores can be traced over several hundred metres in a carbonate bed. The sulphides commonly occur along small fissure faults, bedding fissility, and stylolitic surfaces. The grade of the disseminated sulphide ores is less than 5 per cent with lead and zinc metals contents, whereas galena is usually the predominant sulphide mineral.

Kuchelka (1981) has classified the Song Toh deposit into three different types of mineralization, notably, banded ores, high grade lenses ores,and disseminated ores.

a) <u>Banded ores.:</u> The thickness of single band ranging from one to several inches. Mineralization is roughly concordant with host rock. With great variation in grade and thickness over short distances on strike there is, however, a statistical compensation of metal content with the distance of more than 50 metres. The occurrence of this ore type is most frequent.

b) <u>High grade lenses ores.:</u> The metal content is as high as 50 per cent. The single lens show approximately 20 metres long with the thickness of up to 5 metres. The structures of sedimentation disappear completely due to the fact of remobilization followed by recrystallization.

c) Disseminated ores (poor ore, less than 5 per cent metal content).: It shows no alteration of original bedding of the host rock. This ore type is found at lateral limitations of banded ores as well as between single ore bands with fine-grained (about 0.1 millimetre). The intergrowth of galena and sphalerite goes far as 10 micrometres. The ratio of lead and zinc metals averages 2.5:1 with the higher zinc contents occur occasionally.

Permthong (1982) has divided the Song Toh ores into two major types, based on the degree of mineralization, namely, the high grade ores and the low grade ores. The high grade ores are characterized by high metal content (usually as high as 50 per cent), whereas the low grade ores are characterized by the mineralization of sulphide ores occurring as tiny masses of varying sizes (usually less than 10 centimetres) randomly distributed throughout the carbonate sediments or, in places, as very thinly lenticular bodies mostly arranged discontinuous and conformably with the bedding plane of the host rock with the metal content of usually less than 0.5 per cent.

On the basis of the textural patterns, Niggli (1954) has proposed the high grade ores into four types, namely, massive ores, banded ores, flaser ores, and ore-breccia. The characteristics of these four types of the high grade ores for Song Toh Mine area were reported by Permthong (1982) as follows:

a) Massive ores.: They occur as small pockets and lenses of various sizes (2x5 to 10 square metres), commonly conformable to the bedding of the sedimentary carbonate-host rock with sharp and smooth contact, and no systematic internal structures. In places, massive sulphide lenses are folded and remobilized into the crest of folds and locally offset by faults. Mineralogically, the massive ores are fine- to medium-grained, composed mainly of galena, sphalerite and pyrite. Of particularly noteworthy is the occurrence of jasperoid masses which are frequently associated with the massive sulphide lenses.

b) Banded ores.: The thickness of a single band is between 2.5 to 30 centimetres, and the mineralization is concordant with the bedding of the host rock. The banded ores are usually very fine-grained and stratified in apparently perfect parallelism with the associated sedimentary carbonate-hosted, and the stratification is often well developed. The compositional stratification may reveal itself through variations in the relative amounts of the different sulphides themselves. The individual laminae may be continuously traceable for few metres, or, in places tens of metres distance.

c) Flaser ores.: This ore type is quite common in the ore zone and forms lenticular masses of various sizes ranging from 1 to 5 metres thick and 5 to 25 metres long. Generally, the flaser ores are conformable to the stratification of the host rock. In places, they are intercalated in between the massive ore lenses and banded ores. The flaser ores are texturally characterized by fragments of light gray, brown and gray partially dolomitized limestone with lenticular shape and having grain size ranging from 2 to 40 centimetres, and being bounded by massive sulphide matrix.

d) Ore-breccia.: This ore type forms lenticular masses of various sizes conformable to the stratification of the carbonate-host rock. The ores are composed mainly of angular fragments of light gray, gray, partially dolomitized limestone. Limestone breccia clasts are various sizes ranging from 0.5 centimetre to 1 metre, and the interparticle spaces are filled by the sulphide.

For low grade ores, Permthong (1982) has subdivided the ores according to mineralogical and microscopic characteristics into four types as follows:

a) Banded ores.: This ore type shows a well developed compositional layering indicated by variation in sulphide-nonsulphide and sulphide-sulphide proportions from layer to layer with various thicknesses from a few millimetres down to tenths of a millimetre. Galena, sphalerite and framboidal pyrite are the dominant sulphide constituents. A foliation texture is clearly developed and defined by the preferred orientation of sericite and elongate sulphide aggregates. Relatively, coarse-grained, anhedral pyrite and dolomite rhombs are not uncommon.

b) Disseminated ores.: Texturally, the sulphide ores, especially galena and sphalerite, are scattered throughout the carbonate-host rock. Generally, the boundary between sulphide and carbonate material can be referred to as irregular.

c) Jasperoid.: Microscopically, it is composed mainly of hematite and quartz with various grain size ranging from 10 to 50 micrometres across. Hematite usually occurs as framboidal grains, whereas jasperoid commonly disseminated with galena, pyrite, and calcite.

d) Barite-bearing ores.: From underground exposures, barite-bearing ores forms minor lodes can not be traced a long distance due to the limitation of the development of the tunnel, and associated with banded ores and massive ores. Mesoscopically, the barite-bearing bands are folded in chaotic directions. In places, They are brecciated and their fold fragments are scattered through the sulphide masses. In other cases the barite-bearing bands may have been brecciated and the fragments become stretched into lenticular masses floated in sulphide layers. Microscopically, the barite-rich area with locally authigenic quartz is usually fine-grained and shows polygonal texture.