REPORT

ON THE

INVESTIGATION OF ORE DEPOSIT IN THAILAND

1963

OVERSEAS TECHNICAL COOPERATION AGENCY

Foreword

We were dispatched by the Overseas Technical Cooperation Agency of Japan, as a Survey Mission of the Japanese Government, to Thailand for a period of about 3 months from the latter part of November 1962 to investigate the mineral resources in northern Thailand.

This book contains our report of the findings of this survey tour based on our investigation in Thailand and data gathered by us. The object of the present survey was to study the feasibility of constructing an iron and steel mill in Thailand in addition to our main object of inspecting non-ferrous mineral resources in Thailand.

We would like to express our deep appreciation for the kind assistance and cooperation extended us by the officials of the Royal Department of Mines of Thailand and all others concerned with this project who have enabled us to complete the inspection within a short period as scheduled and with much success.

1963

Survey Mission on Mineral Resources in Thailand

Leader: Masao Sagawa

Report on Investigation on Mineral Resources in Thailand

1. Introduction

1-1 Period of Investigation

The Survey Team for investigation of mineral resources in Thailand, covered by this report, was dispatched for a period of about 3 months from the end of November 1962 to the end of February 1963, when the climatic condition in Thailand is the most favourable for field work.

1-2 Objects and Districts of Investigation

The objects of investigation, decided by the talks with the Industry Minister of the Thailand Government during his stay in Japan, were mainly non-ferrous mineral deposits and the districts covered were the northern part of Thailand, comprising Chieng Mai, Lamphoon, Lampang and Chieng Rai prefectures and a part of the central Thailand, comprising Petchaboon, Uttaradit, Phrae and Nan prefectures. We had set up an outline of areas to be surveyed and the schedule of survey, according to the data supplied by the Royal Department of Mines of Thailand. With the strong wishes of the Royal Department of Mines of Thailand proposed later, however, we had to increase the number of survey members and revise the investigation plan to meet increased work for study on the possibilities of developing iron and steel industry. Afterwards, we changed and added some districts to the original list of districts for investigation after arriving in Thailand according to the opinion of the Royal Department of Mines of Thailand.

1-3 Survey Team

The survey team was composed of 9 persons, consisting of 7 mining geologists, as the main members, and Mr. Takebayashi,

technical official of the Mine Bureau, Ministry of International Trade and Industry, and Mr. Furukawa, engineer of Japan Consulting Institute, both of Japan. The names of team members are as follows:

Masao SAGAWA	Mitsui Mining & Smelting Co., Ltd.
Yoichi TAKEBAYASHI	mentioned above
Yasumi FURUKAWA	ditto
Sakae ICHIHARA	Nippon Mining Co., Ltd.
Tadao AOYAMA	Nittetsu Mining Co., Ltd.
Shigeaki KAWABE	Dowa Mining Co., Ltd.
Motoo NISHIHARA	Toho Zinc Co., Ltd.
Mitsuo YASUNAGA	Mitsubishi Metal Mining Co., Ltd.
Koichi SHINODA	Sumitomo Metal Mining Co., Ltd.

The Royal Department of Mines of Thailand has afforded a valuable assistance to the survey team by not only assigning geological and mining engineers to our survey as guides and interpreters in addition to as caretakers of survey activities but providing us with 4 vehicles of "Land Rover" type. These engineers of the Royal Development of Mines are:

Mr. Akanist Suvanasingha, Geologist

Mr. Chalerm San-ome, Mining Engineer
(accompanying Yasunaga-Shinoda party)

Mr. Suvit Sampattavanija, Geologist
(accompanying Kawabe-Nishihara party)

Mr. Suchit Puwakool, Geologist
(accompanying Ichihara-Aoyama party)

1-4 Acknowledgement

We are much obliged to the incessant and earnest co-operation given by the officials of the Royal Department of Mines of Thailands, Mr. Vicha Sethaput, Director General, Mr. Kaset Pitakpaivan, Geology Section Chief, and, above all, Mr. Din Bunnag, who was appointed the official in charge of the survey.

We should like to express our appreciation also to those Thailand officials who worked hard as either Junior Geologists or Mining Engineers.

Our survey could not have been completed so successfully in a so few number of days were it not for the earnest assistance and cooperation extended by these gentlemen, to whom we should like to express our whole-hearted appreciation.

2. Outline and Summary

2-1 Objectives of Investigation

Thailand has long been well known as a country enriched in mineral resources. The major mining activities in this country, however, had been limited to the mines of tin and tungsten in the southern peninsula, and to the Pirok tungsten mine in Kanchanaburi and the Mae Lama tungsten mine in Mae Hongson, both in the central and northern Thailand. In very recent years, gypsum, antimony, manganese, flourspar and tin mines have been developed in the central and northern parts. But the number of developed mines is so far only a few, and many other deposits have only been left undeveloped after being prospected in small scales on their outcrops.

Our survey was mainly directed to the geological survey. Although we could not try such methods as the stripping, trenching, pitting and others in our investigation on account of the too limited period allowed, we did our best to survey as many deposits as possible and also to observe geology of as wide areas as possible around these deposits, so as to gather data covering the overall picture of mineral resources in Thailand. The field investigation was conducted on the known mining areas under the prearranged course decided between the Royal Department of Mines of Thailand and our team. Altogether 70 ore deposits were investigated. These ore deposits are given serial numbers, which are used both in the text of this report and in Fig. 60.

Remarks: Of the ore deposit numbers, No.26 consists of No.26 and No.26'. And annexed Fig. 60 is consolidation of Figs. 21, 58 and 59 which, therefore, we did not annex to this report.

2-2 Ore Deposits and General Geology, Especially in Relation to Igneous Rocks

Fig. 60 shows the outline of distribution of igneous rocks, and the strikes and dips of sedimentary rocks.

Remarks: Sedimentary rocks with no explanation are those of the middle-upper part of Paleozoic formation, and those belonging to other ages have explanation with simple code. For example, 'red' indicates 'reddish sandstone, shale bed', and 'amp' indicating 'amphibole serpentine rock'. Though there exists in

Petchaboon district a formation which is considered to be younger than the Paleozoic formation, it has no explanation.

2-2-1 Sedimentary Rocks

The base rock of the districts investigated consists of the alternations (with limestone intercalated) of sandstone and slate, considered to belong to the middle and upper parts of the Paleozoic Era. They strike generally North by East. These layers are extensively distributed, some parts of which seem to be folded repeatedly, and slate frequently altered to phyllitic rock.

The sedimentary formation, which is unconformity with these middle and upper parts of the Paleozoic formation but frequently appearing with the same strikes and dips as these, is a series of conglomerate, sandstone and shale beds of the colors such as red, reddish brown or purple. These beds also contain limestone. At Wang Nua of Lampang, the beds form a monoclinic structure which dips to the east (Fig. 16), and they are covering gneissose granite and gneissose rocks with unconformity. At the mountain pass of Thoen-Li, too, the beds show an extreme folding where it runs from north to south. Such formation exists in a fairly big scale at the region near the boundary with Laos in the eastern part of this surveyed area. Some parts of this reddish shale layer also show a sign of certain kind of phyllitic appearance (Near Sa in Nan or the area between Sa and Rong Kwang).

Under the surface of the hill to the west of Patchaboon, there exist alternating beds of sandstone

and shale of light color, the strike of which being from north to south, sometimes running with sheet-like porphyrite.. At the Friendship Highway running between Lomsak and Pisanulok, there contain plant fossils. Although these beds seem to be one group of beds accompanied by igneous activity of porphyrite and other volcanics, we cannot fully clarify relations between those and andesite and its agglomerate exposing wide at the same hill/nor the relation between those and the reddish conglomerate bed which seems likely to cover the volcanics.

2-2-2 Investigation on Mineralization by Granite in the Western District

This area is the northward extension of the well-developed folding in the Peninsula. As in the case of the southern part, the biotite granite is intruding along the axis of the folding of the middle and upper palezoic formations in this district. Along with the granite intrusion in these districts, such as Chieng Mai, Lampoon and Lampang, many tin, fluorspar and antimony deposits are formed. Especially, the flourspar deposits have been discovered and developed recently and are in two types, the metasomatic type (Fig. 6) and fissure-filling type. The granite which holds these deposits contains a lot of white mica, showing a good contrast to biotite granite at the outside of the ore zone. It is probable that this is an alteration phenomenon caused by the mineralization acted along with the formation of ore deposits.

There separately exist many manganese deposits along Highway No.5 in the southern part of Lamphoon Prefecture, and some of them are of igneous origin but others may

not. The country rock carrying these deposits are shale or slate beds which are considered to be of the middle and upper parts of the Paleozoic formation. We could not find out any outcrop of igneous rocks near the deposits. As to the occurrence of these manganese deposits, further investigation should be made.

2-2-3 Mineralization acted along with Porphyrite and Andesite at Lampang and A. Long, Phrae

We found out many deposits of copper, lead, zinc and antimony probably accompanied by porphyrite and andesite in the southern Lampang Prefecture and A. Long in Phrae Prefecture, especially near Ban Pin Railway Station. Each deposit is of the vein type and all of them are small, but it is noteworthy that they are numerous. Moreover, we found out granite exposed in a part of A. Long. Probably it has a certain connection with the antimony deposit.

2-2-4 Asbestos deposits lying to the east of Uttradit City

This is a special district where serpentine rock have developed well due to the metamorphoses of amphibolite, pyroxinite and others. Asbestos deposits are well developed in these surpentine rocks. We believe that we may able to discover more asbestos deposits, if we extend our survey up to the upper stream of Mae Nan where ultra basic rocks exist.

2-2-5 Ore Deposits in the Hills to the West of Petchaboon City

The Mae Nam Pa Sak Valley in Petchaboon is running from north to south along the scarp which forms the western extreme of the Korat plateau. West to the valley there extend

from south to north hills consisting of porphyrite, andesite and agglomerate with the sandstone and shale formation as the bed rocks. These hills have flat heads. Judging from the rock boulders found half-way up the hill ranges, it seems likely they are composed of reddish sandstone and conglomerate. In the andesite and porphyrite, there are occurred such deposits as gold, copper, lead and zinc, each of these deposits consisting of small veins. Though no large deposit has been found out, we dare say the place will be prospective for copper deposits. The same kinds of porphyrite and andesite as these are exposed dotting around the cliffs in the Piedmont region in the west and southwest boundary of the Korat Plateau. They are worthy of attention as the igneous rocks possibly accompanied by ore deposits.

2-2-6 Non-Metal Deposits in the vicinity of Lampang City

According to this survey we confirmed existence of considerably vast deposits of bentonite and diatomite separately existing around Lampang Basin. Also it was found out that volcanic rocks such as andesite, liparite and others are distributed in a rather vast area together with basalt. It is probable that the study of geology around the Lampang basin will afford a contribution to the knowledge of the Post-Pliocene history in this region.

2-3 Investigation Results and Summary Opinion

2-3-1 Nature of Survey

We carried out the survey of localities of ore deposits, 70 places in all, as mentioned above, and at the same time, made general investigations of geology as much

as possible. Our survey, however, was limited to the surface observation of deposits and accordingly, was only preliminary. In Thailand there is few data on geology available, and in addition, we had only a limited time for survey. Yet, we are happy we could complete our scheduled survey at any rate, and are able to submit a report. We hope that this report would contribute to the future investigation and expedition on the mineral resources in Thailand.

Now we would like to present some suggestions about how to carry out future investigations and about what are problematical points.

2-3-2 Ore Deposits to be prospected and developed

The fluorspar deposits at Doi Tao in Chiengmai and at Ban Pha Phlu in Lamphoon are now under development and prospeting, which we believe must be continued. We suggest that antimony deposit at Doi Pha Khan of A. Long of Phrae can be effectively prospected and developed by means of trench, pit and drifting.

2-3-3 Copper, Lead and Zinc Deposits associated with Andesite, Porphyrite and other igneous rocks.

We have investigated many of these deposits near Petchaboon City and A. Long. Although we could find no deposit prospective in quantity and quality, further investigation, especially the basic geological study, should be made first of all. At the south-east of Thoen of Lampang, the deposits associated with quartz porphyry are also found. As like this, these neutral volcanic rocks are very extensively located and numerous in number, we believe that further study should be made on the relation between these rocks and

ore deposits.

2-3-4 Some Suggestions for prospecting Ore Deposits

Through our investigation, we can point out that granite, gneissose granite, andesite, ultra basic rock or others have some connection with the ore deposit formation. Moreover, these rocks are widely distributed. Therefore, it is necessary to know more clearly about the details of distribution of these igneous rocks and their relation with ore deposits. For this purpose, it is necessary, we believe, to study the general geology of the area first, putting special emphases on the following points.

2-3-4-1 The systematic collection of data in regard to geology, especially their manifestation on maps, that is to say, the geological map should be drawn up as soon as possible.

2-3-4-2 Determination of stratigraphy of strata, classification of formation groups and correlation rock faces of beds.

2-3-4-3 As the practical method, geological mapping in the mass mineralization area along with some prospecting of ore deposits will be useful.

More precisely, the areas to be taken up will be as follows:

a. US Army-Topographical Map, 1/250,000, Map of Lampang
(whole area)

b. " " Map of Chieng Mai
(east half of area)
Map of Li
(north-west corner)

c. US Army - Topographical Map of Muang Petchaboon (whole area)

Detailed maps for this purpose will be:

d. 1/50,000 - 1/100,000 scaled map which will hold Ban Pin Railway Station in A. Long in the center.

e. 1/100,000 map for the area to the east of Uttaradit City where the ultra basic rocks exist.

It will also be necessary to make geological surveys on some of the mining areas together with topographical survey of 1/10,000 - 1/15,000 scales.

2-4 Conclusion

In view of above, we conclude that the general public should be encouraged to find out more ore outcrops to obtain more knolwdge on the ore deposit distribution, and, at the same time, geological surveying by the means mentioned above shall be carried out to clarify the relation between the geology and ore deposits as well as their occurrences and based on these knowledges acquired, prospecting of new deposits and also prospecting and developing of the already-known deposits shall be pushed further on.

3. Chieng Mai and Lamphoon District

3-1 Summary

The area investigated in this district was mostly the area along the highway between Bangkok and Chieng Mai.

There widely developed over this district the alternation of slate and sandstone of the Kanchanaburi system. The slate appears in phyllitic and sometimes has thin beds of limestone intercalated. The direction of strike shows south to north.

At the area between Hot and Mae Sariang it is likely, though not confirmed, that this alteration is forming a gentle anticline structure.

Included in this Paleozoic formation, biotite granite is developed, most important of which is a rock body outcropped between Hot and Mae Sariang, 50 - 60 km in width, running south to north up to the northern part of the area, bearing tin deposits at Ban Bo Kaes. This granite, at its eastern margine, often shows gneissose granite structure, but the relation between this gneiss and the gneissose rocks west of Chieng Mai is not known clearly. Also at Doitao located on the Ping River running along the south-eastern border of Chieng Mai Prefecture, there exists a small granite body with fluorspar deposits. And there is another narrow granite body running along the eastern border line of Lamphoon and Lampang Prefectures and farther north along the boundary of Chieng Mai and Lampang. This granite runs south-westward down to the vicinity of the manganese deposit at Ban Mae Taun. All of them are biotite granite bearing tin, fluorspar and antimony deposits. Near the deposits, we observed them distinctly becoming muscovite granite, and sometimes biotite granite there has phenocryst of feldspar of a considerable large size and shows the porphyritic form.

In the alternation of slate and sandstone, there occur many manganese deposits, some of which show a beded deposit, and others thin quartz veins. According to the Geologic Reconnaissanse of the Mineral Deposits of Thailand, 1953 (P.37), most of the already-known manganese deposits in Thailand are associated with Korat Series. A further study must be made

on the country rock of manganese deposit in this district. Indeed, there are exposed well reddish sandstone beds at the mountain pass between Thoen and Li, but it seems that this sandstone beds are situated rather in the upper part then that of manganese bearing beds (refer to introduction).

We cannot point out so far the origin of these manganese deposits. We can consider some of them have been formed syngenetically with sedimentary rock, but others not. At any rate, we could not find out, in the neighboring area, any igneous rock, which is considered to have some connection with deposit formation.

3-2 Manganese Deposits No.1 - No.5

No.1 BAN MAE TUEN Figs. 1, (1),(2),(3),(4) and (5)

Manganese

Location: T. BAN MAE POK, A. Li, Lamphoon
102 km from CHIENG MAI city along a highway, and across NAM MAE LI off the highway, is the mine. Truck drivable up to the mine. This is the largest manganese mine in this district and now under developing and mining.

Geology: The geology around the deposit consists of black slate, and sometimes it has slight lineation structure and small folding. The strike is nearly N 80°W or EW, with a dip of 30°S.

Deposit: The deposit consists of beded deposit lying nearly horizontal, and extending for 160 m north-south and 160 m east-west, with an average depth of 7 m. The deposit is exposed along the gentle slope of a hill, and its foot wall consists of slate. This slate

rock exists almost in conformity with the deposit. Along the slate bed is found thin layers of manganese. Judging from these occurrences, this manganese deposit is believed to have been formed syngenetically.

Ore: Most of the ores are brown-black massive psilomelane, and a fibrous texture is seen in part.

Ores can be classified into the high, middle and low grades according to manganese contents contained. The high grade ore exists mostly in the lower part of the deposit. The high grade ore is made a fine ore of an average of 77 per cent of MnO_2 by crushing and hand picking after being mined, and then is sent to Bangkok for use for dry battery manufacture.

Ore Reserves: The deposit was prospected by pittings at each 40 m from north to south, and at each 50 m from east to west, totalling 32 pittings. The depth of pitting ranges 3 m - 15 m. The average depth of the deposit is found to be 4.8 m. As the specific gravity of the ore is about 3.0, the ore reserves are:

$$\frac{160^{m} \times 160^{m}}{2} \times 4.8^{m} \times 3.0 = 184{,}000 \text{ m.t.}$$

The low grade ore is not included in this ore reserve, and the high grade ore is about 30 per cent of the above quantity.

Remarks: As mentioned above, this deposit is presumed to be a bedded deposit formed syngenetically, but it is

not yet clear whether the manganese was supplied by the action of hot spring or it was reprecipiated from stream water which dissolves manganese from the older formation. But it is difficult to consider it to be manganese placer or a residual deposit, judging from the condition of their existence.

Assay

Sample No.	T.Fe	MnO_2	Mn	SiO_2	S.	Al_2O_3	P	Cu	Place
S-8	9.18	56.66	35.89	-	-	-	-	-	
S-9	6.50	60.81	39.52	-	-	-	-	-	
S-11	7.45	47.60	31.00	-	-	-	-	-	
S-13	9.36	27.61	19.58	-	-	-	-	-	Pit F-2
S-14	11.15	44.22	29.37	-	-	-	-	-	F-2
S-16	5.54	63.31	44.96	-	-	-	-	-	
S-17	10.41	53.88	34.81	-	-	-	-	-	F-2
S-19	7.39	31.61	21.03	-	-	-	-	-	C-2
S-21	17.00	22.19	17.04	-	-	-	-	-	A-2
S-42	5.05	63.67	42.06	2.26	0.018	2.11	0.071	tr	) Cone
S-43	3.82	-	22.48	1.58	0.019	2.24	0.094	tr	

No.2 BAN HUEY HAEN

Figs. 2, (1), (2) and (3) Manganese

Location: T. BAN HUEY HAEN, A. LI, LAMPHOON

BAN HUEY HAEN is 130 km from Chenmai along a highway. The mineral deposit exists on a hill, 3 km to the west of this village.

History: Once this deposit was prospected, but it has never been developed since then.

Geology: This hill is composed of silicified slate weakly mineralized by manganese. Its strike is N 20°E with a dip of 50°SE at its north-western part, but N 80°W and 50°N in the south-eastern part. A sand-gravel bed is covering this slate bed. The sand gravel bed is composed, from the bottom, of a 80 cm gravel bed, 1 m muddy sand bed, and sand bed on the top. This is what we observed at the north-western part.

Deposit: In the sand gravel layer mentioned above, are pebbles, 1-3 cm in diameter, of hard manganese ore. These sand-gravel beds bearing manganese ore extend for about 800 m from north-west to south-east with an average depth of 8 m.
At a point 300 m up a hill situated in the N 70°W direction from the above mentioned sand gravel deposit, we found out a stain, caused by manganese, in the silicified zone of slate. It is probable that manganese ore at the upper part had been eroded and deposited in the sand-gravel beds at the lower part. The ore seems to contain much iron but a little manganese.

Conclusion: Judging from the result of six pittings prospected into the sand-gravel beds and the surface condition of the deposit, we believe that this deposit is not prospective.

Assay of Stocked Ore

Sample No.	T.Fe	Mn	S	SiO_2	A_2O_3	P	Cu
S-41	21.06	22.48	0.042	11.30	6.07	0.410	tr

No.3 BAN PA PHAI

Fig. 3, (1),(2),(3) and (4) Manganese

Location: T. BAN PA PHAI, A. LI, LAMPHOON

BAN PA PHAI is 120 km from Chieng Mai City along a highway. The mine is situated 5 km to the east of this village. Car can be driven up to the mine.

History: The mine is now under prospecting by means of one trench and 27 pittings. The average depth of pittings is 1 m.

Geology: The geology in the vicinity is composed of slate and silicified rock striking N 30° - 60°E with a dip of 50° - 60° NW. In the light of the result being obtained from pittings and trenching, the slate is gently folded and in part crushed by disturbance. At the west end of the mine district, it is running to N 8°E, and there is a fault dipping 88°SE. A sand gravel bed including manganese gravel is covering this old formation.

Deposit: There are recognized two kinds of deposits from the occurrences of ore; that is, (1) the outcrop of primary deposit and (2) secondary sedimentary deposit of residual deposit-type.

(1) It is a primary deposit lying in slate in the form of lens, and is cut off by a fault in its western part, and in addition, the dislocated part is completely eroded. The eastern extended part of the outcrop is also shaved off.

(2) On the hill, pittings are being carryed out 27 in all, and the pittings in the central part are prospected into a fine sand gravel bed, but there we could not find out any manganese gravel. The manganese gravel is 1 m - 30 cm in diameter, and is mainly sedimented near the primary deposit or in the district where the topography makes a change. A-7, B-7, C-7 and D-2 among the said pittings disclose manganese gravel, but the other pittings not. The whole quantity of manganese gravel is assumed to be 20 per cent of all the quantity of sand gravels. Therefore, the content ratio is very low.

Conclusion: This deposit is not prospective. Even the sand gravel bed has a low grade value. It will probably be difficult to find any large mine in the neighborhood, either.

No.4 BAN MA KOK

Fig. 4, (1) Manganese

Location: T. BAN MAKOK, A. PA SANG, LAMPHOON

About 36 km from Lamphoon along a highway there is Ban Wai village. Driving further 1.5 km to Ban Ma Kok and walking about 0.5 km., we can

reach the deposit.

History: There is only one trench excavating, 18 m long, at the flank of the hill.

Geology: This district is composed of the sedimentary rock of silicified slate at the lower part and brown-grey sandstone at the upper part. The salte strikes N 10° - 30°E with a dip of 50°SE - 45°SE, gently folded. Sandstone is also silicified and is cut off by fine quartz veins. The quartz veins run mainly in N 20°W, with a dip of 40°W.

Deposit: Lenses of psilomelane ore are occurred in the slate bed. The lenses are not continuous completely, but crushed up and are cut by quartz veinlets. The quartz veinlets are extending into country rocks. No manganese deposit is seen in sandstone, but sandstone is also silicified and is cut by quartz veinlets.

It may be summarized that this deposit consisting of lens-shape psilomelane ore occurred near the contacting line of silicified slate and sandstone bed.

Generally, its mineralization is so weak and its deposit is small.

Assay

Sample	T.Fe	Mn	SiO_2
S-45	20.82	3.63	52.10

No.5 BAN WANG ROAN

Fig. 5, (1) Manganese

Location: T. BAN WANG ROAN, A. BAN HONG, LAMPHOON

At 85 km along a highway from Chieng Mai City is BAN WANG ROAN. Driving further about11 km from this village up to the bank of the NAM MAE LI, crossing it and walking about 500 m, one can get to the deposit.

History: There exist a few trench excavatings by native people on the slope of a hill.

Geology and Deposit:

The country rocks are yellow-grey colored slate, striking N 20°E with a dip of 20°NW. Over the hollow portion of the hill slope, there exists a sand gravel layer about 1 m deep. The sand gravel bed contains manganese ore gravel, but only about 5 - 6 per cent.

The ore is composed of pyrolusite mixed in psilomelane ore, and its quality is very low.

As the scale of the deposit is very small, further prospecting may not be worthwhile.

3-3 Fluorspar Deposit No.6 - No.9

No.6 BAN PHA PHLU, Fig. 6, (1) and (2) Fluorspar

Location: T. BAN PHA PHLU, A. BAN HONG, LAMPHOON

The deposit is located 82 km from CHIENG MAI City along a highway.

History: The deposit was found out a few years ago, and

has been worked intermittently. But it was purchased by the present owner who has produced 1,000 tons of fluorspar per month since the middle of last year.

Geology: The deposit is located on a hill 150 m high from the level of the highway. The country rocks are not exposed well. According to the limited observation on the outcrop and pittings at the north-western part of the deposit, it is composed of slate, limestone and sandstone in that order from the lower bed. Slate strikes N 40°W, and dips 40°SW. It forms a monoincline structure. But there is observed a folding structure at a ravine in the north-western part of the deposit. Also we observed there a small fault running along the axis of the folding, and in addition, we observed weak metasomatic mineralization of dioxide manganese at the shearing zone.

A part of slate is phyllitic and its schistosity is N 2°W and 60°SW dip. The limestone is of saccharoidal and is lying in slate, as a form of a small lens, in its exposed part at the above mentioned glen. Sandstone exists on the western side of the deposit in a form of rather coarse grain and generally it has been affected by silicification which had taken place at the time of formation of the fluorspar deposit.

Deposit: (a) Scale and Shape of Deposit.

The shape of the deposit confirmed on its outcrop

and the result of pittings is of nearly H form. Now we will call that of the west side the first ore body, that having lateral extention from east to west the second ore body, and the last existing in the eastern part the third ore body. The first ore body is now mainly under working and its scale is the largest. Strike N 30° - 40°W, dip 80° SW, presumably. Maximum width 80 - 100 m. Extention 500 m. The second ore body strikes N 70°E. Width 50 - 60 m. Extention 250 m. The third ore body strikes the same as the first one. Width 25 m (approximately). Extention 400 m. These are the figures already confirmed.

(b) The first ore body: It is under mining. Judging from its structure, the sandstone in the country rocks was crushed and there are observed a matasomatic texture around breccia which has been crushed up. The brecciated part has become fluorspar. On the base of it the argillization is seen, and in the clayey zone a spotted shape of fluorspar is formed. The mineralization action is divided into two stages as follows:

First stage:

In the shear zone of N 40°E, there observed the action of silicification and black fluorspar deposition. They were crushed up and brecciated.

Second stage:

There took place silification again, together with the formation of fluorspar cutting into the

fluorspar of the first stage, and is distributed in a network form of a small scale. At the end of its mineralization, cracks were filled with compact milky quartzite. The upper part of the ore body is covered with the gravelled fluorspar, 1 m - 1.5 m thick.

(c) The second ore body and the third ore body. Regarding these ore bodies, the relict texture of country rocks remains, as it was, in the shape of potatoe, despite the strong silicification action in the first stage, and the fluorspar content there is poorer than the first ore body.

It is presumed from the above investigation that the ore solution went up along the sheared zone and replaced sandstone to form the deposit. Therefore, the shape of the ore body may be governed by that of sandstone. And the fact that the mineralization action in the latter stage was weak and/or the mineralization action in the vicinity of the deposit was weak, in general, will serve somehow when the development toward the lower part of the deposit be suggested.

Ore and its quality:

As we have already pointed out, quartz has been formed repeatedly in this deposit several times, so that the deposit contains silica in a comparatively large quantity.

The quality of fine ore produced at present is at the standard of CaF_2 90%.

Assay data of stock pile of fluorspar

Sample	Assay T.Fe	CaF_2	SiO_2	S	Fe_2O_3	pb	FeO
S-7	0.55	85.75	1.10	0.700	0.78		None

No.7 BAN DOITAO. Fig. 7, (1), (2). Fluorspar

Location: T. BAN DOITAO, A. HOT, CHIENG MAI
At about 130 km to the south of Chieng Mai city along a highway is Ban Mae Tun and by farther 28 km along a local road drive on can reach the mine. It takes 6 hours by car from Chieng Mai.

History: The mine produced in the last 3 years 10,000 ton of crude fluorspar ore, containing about 90% of CaF_2. The products have been mined from the outcrop of fluorspar vein downwards. At present, a new development is being carried out by digging a prospecting drift in the lower part of the vein.

Geology: The deposit area is a small hill composed of muscovite granite whose crystal is somewhat coarse. Somewhere off the deposit is observed plenty of biotite of the porphyritic form but a little of muscovite. At the point 5 - 6 km to the west, an alternation bed of slate and sandstone exists, and the bed shows a developed schistosity. This sandstone is replaced by a small scale fluorspar deposit.

Deposit: The main deposit is a fissure filling vein in muscovite granite, and the veins consist of two

systems, one the EW system and the other the N 60° E system. The two systems are united into one at the extended point in the direction of east-north-east. The veins occurred in echelon with units each 100 m - 150 m long, totalling 1 km of their confirmed extention.

(a) Feature of the N 60°E system of vein: The dip of the vein goes down 80° on an average either to SE or to NW, but there is observed a comparatively stabilized rich ore in the deposit dipping SE. The width of the vein is observed to be 3 m in maximum, or about 1 m on an average. As to the formation of the deposit, a silicification action came about at the sheared zone in granite at first, and then a small scale shearing came about within or along silicificated rock. Afterward, fluorspar deposited into the above second stage shear zone. At present, the fluorspar at the mining place shows a black, deep green compact ore, and that of the extended part in the north-north east contains more quartz, and there fluorspar is colored blue, pale green and purple, and finally shows white grey. On the face of the joint of black fluorspar is observed pyrite in a thin shell shape.

After the formation of this vein, about 1 cm of comb-shaped quartz is distributed, in the network form, cutting the ore, up to the country rocks.

(b) Feature of the E-W system vein:

The prospecting of the E-W system vein is not yet progressing. The observation, however, about the condition at the point of digging about 3 m deep, in the western part, reveals that the early silicificating action is prevailed at the footwall of the vein, where fluorspar is deposited in a large quantity. Moreover, there observed a bonanza at the bending point of the zig-zag vein. It is 0.80 - 1.00 m in maximum with and 30 m long.

Ore and its quality:

The ore mineral is fluorspar, and the gangue minerals are quartz, calcedony, calcite, and others. Fluorspar is tinted black purple, light blue green, or light grey, either translucent or transparent. According to the analysis at the mine, it contains as high as 97% of concentrated CaF_2.

The analysis of samples taken from this mine shows the following results:

Assay Sample	CaF_2	SiO_2	$CaCO_3$	Remarks
S-52	63.45	32.58	1.65	
S-53	3.13	88.18	1.26	Silicification part.
S-54	49.14	49.74	1.15	
S-55	24.60	69.28	1.37	

Ore Reserves: The mine owner expects 300,000 tons of ore reserves of 90% CaF_2.

No.8 WEST BAN DOITAO Fig. 8, (1), (2) Fluorspar

Location: T. BAN DOITAO, A. HOT, CHIENG MAI

The mine is located on a hill 6 km to the west of the DAITAO mine. Jeep can be driven to the mine.

Geology and Deposit:

The geology is of biotite granite. The vein is formed by fissure filling fluorspar and quartz vein as in the case of DAITAO mine. There is only one vein there, which is being prospected from the surface by means of trench excavating. The vein is 15 m long and branches into two veins. Generally speaking, the strike is N 60° - 70°E with a dip of 70°NW, and is 60 - 70 cm wide in its richest part. There are repeated expanding and shrinking. The quartz is distributed in a network form and is not uniform. There is found a silicification zone of the first stage in the foot-wall of the vein. Quartz fills the cracks existing in the hanging wall. The paragenesis with the quartz is quite the same as in the case of the DOITAO mine, except that the mineralization of fluorspar is not so conspicuous and has plenty of silica. It is a fluorspar vein of short length.

Ore and its quality:

Almost all the fluorspar is tinted light grey and transparent, and the gangue minerals are quartz,

calcedony and calcite in network.

The analysis of the samples taken from the rich ore are as follows:

Assay

Sample	CaF_2	CaC_3	SiO_2
S-70	78.77	1.43	17.48

No.9 THA KUN NGEN Fig. 9, (1) Fluorspar

Location: THA KUN NGEN, A. MAE THA, LAMPHOON

21 km to the east of Lamphoon City is a village called MAE THA, and 7 km further is the deposit.

History: The deposit was discovered around 1960, and once was prospected by means of pittings.

Geology and Deposit:

The well-eroded hill of this district is covered with boulders and no outcrop is observed. In regard to the relation between the boulder zone and the topography, we have observed boulders of sandstones composed of red brown quartz grain and silicified sandstone at a level not higher than 10 m from the foot of hill, while those of conglomerate at the weight of more than 10 m. The conglomerate contains pebbles of horn stone and sandstone. Judging from the fact that there are some boulders which indicate the relation between sandstone and conglomerate, it is presumed that this area was formed by an alternation bed. This bed is underlain by sandstone bed with clino-uncomformity. According to the observation at

the pit, the deposit consists of the boulder bed of the fluorspar ore overlying the red-brown sandstone. From the fact that there is no boulder bed found in a ravine nearby, we can judge it the residual deposit distributed only in the two places, 20 square meters each, around the pittings. The fluorspar ore consists of fluorite bearing quartz vein-lets and network which fill up both the cracks or the druses in the quartz sandstone. The sandstone was undergone silicification.

In the saccharoidal fluorspar sometimes stibnite of elongated crystals is observed. It is probable that the above condition shows that the fluorspar has been formed in a low temperature.

At 500 m to the south-east of the deposit there is the other fluorspar deposit of exactly same occurrence (THA KAT District). But it is only of a poor one.

3-4 Antimony Deposit No.10

No.10 BAN MAE LAUN, Fig. 10, (1), (2) Antimony

Location: T. BANMAE LAUN, A. SANKANPHAENG, CHIENG MAI

A 15 km drive along a highway from CHIENG MAI brings one to SANKANPHAENG, and another 20 km drive to the north-north-east along a local road to BAN MAE. By about 11 km on foot from the village one can reach the ore deposit.

History and Present Condition:

Blocks of stibnite were found in the up-stream of NAM MAE ON in 1955. In 1960, prospecting has

been started and a trench of 40 m long is underway at present.

Geology and Deposit:

The deposit is located on the west side slope of mountain ranges running north to south along the boundary between LAMPHANG and CHIENG MAI. Although the area around the deposit is composed of biotite granite with rather large feldspar crystals, the area adjacent to the deposit is composed of granite of segmatitic appearance containing plenty of muscovite. The deposit is of quartz vein containing stibnite which runs through the above mentioned granite, its strike being N50° - 60°E. This quartz vein with stibnite runs through silicified zone, with a maximum width of 40 cm or so, and has a repeated expansion and contraction. Further, stibnite exists in a irregular mass or linear form in the vein, and, sometimes, there exist stibnite thin veins.

The granite in the hanging wall side of the vein is kaolinized.

Breccia of high grade stibnite and quartz are involved in the crushed zone of a fault which runs along the hanging wall of the vein. The vein is 15 m long, and the tip of the vein in the north-eastern direction thins out, but there exist two outcrops on the extention of the vein strike, one at 100 m apart in the north-east, and the other at 50 m far in the south-west direction.

There we observed another outcrop of the reverse dip, too.

All these indicate that there is a continuous mineralized zone in the direction of strike, at any rate, but it is likely that the vein is of unstable lens-shaped occurred in this mineralized zone.

Ore: The ore is stibnite and easy for hand picking.

This deposit has a repeated expansions and contractions and its mineral condition is unstable. However, as the mineralized zone seems to have a considerable length, we consider that the first step of prospecting is to clarify the character of the deposit, by means of surveying the occurrence of the muscovite granite, and, at the same time, to prospect the area in the extension of the mineralized zone.

3-5 Tin Deposit No.11, No.12

No.11 BAN BO KAEO Fig. 11, (1), (2) Tin Deposit

Location: T. BAN BO KAEO, A MAE SAMOENG, CHIENG MAI

At 14 km to the north from CHIENG MAI City along a highway there is BAN MAERIM. BAN BO KAEO is situated at 33 km along a mining road from BAN MAERIM.

History: The tin deposits were first discovered in the northern Thailand in 1956 and since then this deposit has been worked.

The tin mining here has been carried out at three

places, of which the mine worked by the Mining Organization has produced 120 tons of tin concentrates in these seven years, and others under individual enterprises produce about 5 ton of tin ore per month, the quality of concentrated ore containing about 70% of Sn.

Geology and Deposit:

The main deposits are of the cassiterite placers, existing in a small alluvial basin at the junction of the main stream and many ravines.

The bed-rock of this district is composed of biotite granite with large crystals of feldspar.

The alluvial beds lie horizontally and are composed of mainly granite gravel, quartz gravel and granite sand layers. In the upper most there is a brownish grey sand layer of 2 m thick, and next under it, the layer of the black-grey coarse sand mixed with quartz and granite gravels lies. The latter is interbedded by brown clayey beds, and its average thickness is 3.5 m. Beneath it lies the bed-rock, the granite. The bed-rock surface lies on the same level of the bottom of the river.

The tin sands are mixed in this coarse grain-sands and specially concentrated in the gravel layer of the lower part which covers directly the bed-rock. We have observed a cassiterite crystal of about

2 cm in a light pink colored vein quartz pebble taken from this gravel layer. In the granite nearby, we found out the quartz vein accompanying tourmaline, but we could see no cassiterite. These quartz veins strike N 44°E and dip 72°SE and are accompanied by the secondary quartz veins. The country rocks of this quartz vein is muscovite granite and are extensively affected by argillic alteration and weathing. The area outside of the ore deposits is composed of biotite granite.

No.12 HUEY KHA Mine Fig. 12, (1), Tin deposit

Location: T. HUAY KHA MEAN, A. MAE CHEAM, CHIENG MAI

There is the BAN HUEY KHA MEAN tin deposit on a east tributor of the main river which flows into BAN BO KAEO. Accessible on foot from Ban Bo Kaeo.

Present Condition:

There is an abandoned mine which had been worked by the Mining Organization, and still now some native people are panning tin ores from the sand gravel bed at the bottom of the stream.

Geology and Deposit:

According to the observation on the old working place by the stream, the deposit is formed with a sand bed, about 3 m thick, which consists of a sand gravel layer at the bottom, containing granite gravels and vein quartz gravels. This sand-bed is covered by reddish brown sandy clay of 2.5 m thick. Although the native people are now working on the sand gravel layer at the river bottom, in

place, among sand and gravel. Moreover, just near the outcrop of barite quartz veins are running through the small cracks of limestone which is interbedded in slate. In the quartz vein, there are scattered such sulfides ores as chalcopyrite, bornite and pyrite.

3-7 Iron Deposit No.14

No.14 PHRAN KATAI

Location: A. PHRAN KATAI, KAMPHAENG PHET

At 24 km to the north-east of KAMPHAENG PHET City there is A. PRAN KATAI and further 4.2 km to the east we can reach this iron deposit.

Geology and Deposit:

This district is flat and wide, part of which turns to a swamp in the rainy season. Two three pittings were dug in this ore deposit area.
In the lower part there is reddish clay which covered by an iron ore bed of 30 - 90 cm thick, lying horizontally in an area of 500 m in diameter. A part of it is exposed in a ravine. On the upper part of the ore bed there exists a wide extention of the sand and gravel bed containing a small quantity of boulders of limonite. As to the iron ore bed, round gravels of limonite of about 0.50 cm in diameter exist in the residual soils. The grade is about of Fe30% or so in appearance. A few boulders are of magnetite and hematite.
This mineral deposit is less than 1 m thick and

the distribution of ore is not uniform, and besides, its quantity very poor. Therefore, we believe it will be unworthy of further prospecting.

4. Lampang and Chieng Rai district

4-1 Summary

Investigation of this area covered the two prefectures, Lampang and Chieng Rai.

Sedimentary Rocks

The sedimentary rocks in this region are arranged roughly from the top to bottom:

1. Clay and gravel beds
2. Strata interbedded with tuff (Bentonite clay layer, Andesite tuff layer)
3. Sandstones, mudstones and congromerates interbedded with limestones.
4. Sandstones, slate beds and limestones, some part of which have metamonphosed into phyllites.
5. Schistose rock bed — Black and green schistosed bed, sometimes interbedded with quartzites.

The southern part of this area is mainly composed of sandstone and slate formation striking south-north, or north-east-north. The slate, at times, is altered into phyllite, and occasionally intercalated with limestone (Mae Tha, Kokha, Thoen and Mae Phrik). Those formations may probably be of the same series as Kanchanaburi in Chieng Mai - Lamphoon district.

The sandstones, mudstone and conglomerate beds, probably composing the upper part of these formations, are often interbedded with limestones (Wang Nua, Chae Hom) and run roughly south to north forming the monoclinic structure to the east. These sandstones and conglomerates are sometimes reddish. The relation between the above mentioned two formations is not clear.

The schistose rock beds, considered to be of the lower most bed, develop near the boundary (A. Wang Nua) of granite on the west and also in the eastern part of A. Soprap. They strike generally south to north dipping to the east. Of the same kind of beds, those in Wang Nua interbed with quartzites (some sandstone-like). It is not clear whether these formations have been altered from the slate in the lower most beds or from the shaly parts of the reddish sandstone and congromerate bed.

Some parts of the tuff bed have been altered into bentonite, which is found in the vicinity of Lampang. The bentonite bed exists nearly horizontally and in comformity with the lower sandstone and mudstone beds. The andesite-tuff bed, outcropping between Thoen and Mae Salaen, consists of light-colored fine grains and strikes south to north and steeply dips to the east. The bed is covered by the andesite lava.

Tuff of the same quality is also found in the west of Phayao, in the north-eastern part of this district. It strikes south to north steeply dipping to the west.

Igneous rocks

Igneous rocks found in this area are, from the young to the older ones, as follows:

Basalt,

Andesite,

Rhyolite,

Granite, Granodiorite, Quartz porphyry

Metamorphic igneous rock, granitic gneiss

Gabbro

Basalts of dark color are found at a small hill, to the east of the Lampang Basin and others, covering the various kinds of rock and rock formations. Occasionally, they clearly present pillow joint.

Andesites are found at and near the summit of Doi Kaeo, to the north of Ban Nong, 8 km to the south-east of A. Mae Tha. They are accompanied by agglomerates and have a strong magnetism.

Rhyolites are distributed in a district, about 1 km to the west of the highway between Lampang and Chae Hom, and in another area to the west of Tongyong in A. Kokha. They are of fine grains and are lithoidite-like.

Granites run along the prefectural boundary between Lampang and Chieng Mai from south to north, or, from north-east-east to south-west-west with a width of a few kilometers. They are mainly biotite granites, but in their margin where cassiterite deposits are found, they are a kind of pegmatitic and aplitic. Sometimes, feldspar phenocryst of 1 - 2 cm are found.

Grandodiorites are found around the highway approximately 24 km north of Chieng Rai city, and contain plenty of mafic minerals.

Quartz porphyries are distributed in the area east of and along the highway between Thoen and Tak, 12 km in width, intruding through the surrounding sedimentary rocks. They have generally changed in quality, especially in the eastern part where most of them have altered into cholorite or epidote bearing rocks. They quartz phenocryst is 3 - 5 m/m in diameter, and is found mostly in the west of the district. The dyke which outcrops on the highway between A. Ngao and A. Song is approximately 100 m. wide, and is fresh containing only a few phenocrysts.

The granitic gneiss outcrops over the areas to the west and north-east of Wang Nua and along the highways from the south-west of A. Mae Tha to the north of A. Soprap. Their surrounding sendimentary rocks have altered into phyllitic or schist-like rocks and has schistosity running in a direction. The rock runs parallel to the schistosity of the surrounding sedimentary rock. Some of them show the porphyry-and rhyotite-flow-like structure. They might be called the injection-gneiss.

The gabbro is distributed in the west area of A. Mae Cham (Chieng Rai) and A. Phayao. The rock has schistosity in a definite direction under the influence of metamorphism. In some part, dioritic and diabasic apperances can be found.

The main ore deposits in this area are cassiterite deposits associated with granite, their placer deposits, stibnite bearing veins in granitic gneiss or near granite body, and lead-zinc deposits in porphyry.

Besides, there are lots of non-metal ore deposits in this area. For instance, around the Lampang Basin are found

the bentonite and diatomite deposits and kaolin altered from rhyolite by weathering, etc.

4-2 Antimony Deposits No.15 - No.18

No.15 MAE THA LUNG Fig. 14 Antimony

Location: T. MAE THA LUNG A. CHAEHOM, LAMPANG

One can reach A. CHAEHOM by a 53 km drive to the north from Lampang city. From A. CHAEOM an ox-cart road for about 10 km leads to Mae Tha Lung, from where, after a 8 km walk to the east, one can reach the foot of the mine. Jeep can be used up to Mae Tha Lung in the dry season.

History and Present Condition:

At present, the deposits are being mined.

Geology and Deposits:

The geology in this area consists of the alternation of sandstone, shale and limestone. The area between the mine and Mae Tha Lung forms a monoclinic structure (strike N 10° - 40°E, dip 30° - 50°E). No limestone is found. On the other hand near the mine repeated foldings are predominant and interbedded with limestone layers. Judging from boulders, it is inferred that there are older effusive rocks on the mountain to the east of the mine.

The deposits consist of the impregnation-like, or net-work antimony-calcite-quartz vein occurred in the limestone. In the vicinity of the deposits, a remarkable silicification is observed.

The ores are in two kinds. One is lying on the foot wall side of the limestone and near the boundary with the shale and the other is developed in the joints running diagonal to the former. The former strikes N 10°E with a dip of 30°W, and the latter N 80°W with a vertical dip. Each ore body makes a lens shape of about 10 m long with a maximum width of 50 - 100 cm (width of the mineralized body). The area congregated with antimony ore is supposed to be 10 - 20% of the total. At present, they are being mined at four places but with a poor production.

There is an outcrop of the alternation of sandstone and shale accompanied by limestone in the Huay Rong river bed 100 m to the south, and at its anticline part the impregnation of stibnite and pyrite is found mainly in the limestone. Their content grade is low.

In short, the ore deposits are of an epithermal stibnite deposit type occurred in limestone. Generally mineralization and alteration are weak. Therefore, there is hardly expected finding large ore deposits. Also there would not be so much minable ore left under the present system of mining. The first step to be taken for the future prospecting is to trace the contact line between the limestone and the shale bed.

Assay Sample	Sb
F.13	13.98%
F.14	18.42%

No.16 BAN SERM SAI HUAI LA Fig. 15 Antimony

Location: T. BAN TON YANG A. KOKHA LAMPANG

KOKHA is at about 13 km to the south-west of Lampang city along the highway. From there a 40 km jeep drive (in the dry season only) will take one to Ban Ton Yang. From Ban Ton Yang, a 12 km drive along a lumber road and a walk along the river bed for about 8 km will take one to the mine.

Geology and Deposits:

Sandstones and slates are widely distributed, generally striking N20° - 30°E and dipping 60° - 70°W. These rocks show a light blue color under the influence of weak metamorphism. The conglomerate bed at the mountain top (800 m above sea level) near the ore deposits is considered to cover the sandstone and shale beds. Pebbles of this conglomerate are 3 - 5 cm in diameter, and consist of somewhat angular quartzie, sandstone or slate, and their matrix is silicic and very hard. There are old pittings on both sides (north and south) of the mountain top, which have been filled with waste, but some pieces of ore are seen here and there outside. In the northern slope, the ore body is found under the surface as deep as 4 m. It is said

that the pittings were dug along the extension of the ore bodies. If so, six or seven mineral vein groups are presumed and their strike would be in N 20°E. Pits are found only in alternation of sandstones and shales, and never be found in the conglomerate bed of the upper layers.

Judging from the boulder outside of the pit, the ore contains mainly stibnite accompanied by a little of chalcopyrite, and its gangue mineral consists of quartz. These boulders are of high Sb contents.

In brief, the ore deposits are stibnite-quartz veins which are supposedly composed of a vein group running to the north-east. Besides, the grade is comparably high. We suppose that it is promising in the lower part of the veins. Therefore, it is necessary to cut trenches in order to confirm the ore bodies. Geologically, the ore bodies are to be expected, and in addition to it, terrain is suitable for underground drifting.

No.17 DOI PHA KOK Fig. 16 (1) (2) Antimony

Location: T. BAN WANG PONG, A. WANG NUA, LAMPANG

After a drive of about 51 km from Chieng Rai city along a highway to the west and a further drive of about 40 km. along a local road one can get to A. Wiang Pa Pao. Driving along an ox-cart road by jeep from Wiang Pa Pao across the boundary between Chieng Rai and Lampang prefectures one can reach A. Wang Nua (Lampang). However, in the wet

season, traffic is entirely interrupted. Driving the ox-cart road from Wang Nua Village to T. Ban Wang Pong, and walking for 9 km, one can arrive at the deposits.

Geology and Ore Deposits:

The vicinity of the deposits consists of gneiss, and in its east side, the schist-like bed, of which strike generallyruns from south to the north, are folded repeatedly. In addition, in its eastward there is a conglomerate bed of which gravels are mostly schist-like and somewhat angular (about 10 cm in diameter). The matrix is reddish. Judging from the occurrence, this conglomerate is considered to be a basal conglomerate.

The upper part of this formation consists of the conglomerate and red-colored sand stones forming a monoclinic structure striking NS - N30°E with a dip of 50° - 80°E. There is assumed a north-south fault cutting these beds in the disturbed bed zone.

This deposit is a mineral vein striking N 60°W with a dip of 45° - 50°E, and its country rock is gneiss. The mineralized zone is 0.5 - 1.5 m in width and its mineralization condition is rather steady. Its extension along the strike is confirmed for 60 m by pittings. The boundary in the hanging wall is clear, but the lower part is in the state of impregnation and merged into the country rock. The argiltic alteration of the

country rock is remarkable. The vein is a stibnite-bearing quartz vein and stibnite minerals are partly concentrated.

The branch vein group at the foot wall has also a concentration of stibnite. As there are many horse stones in the vein, the ratio of ore recovery by hand-picking is supposed to be about 30%.

As mentioned above, both the ore vein condition and its quality are comparatively good, but further mining would be interrupted if they carry on the open-cut system presently employed. The transportation of concentrates will also be obstructed.

In future, this deposit should be developed by 30 m of a cross-cut from the lower part of outcrop. However, topographically, the vertical difference of the proposed cross-cut and the surface working is only 9 m. Even so, however, the amount of the ore reserves that can be developed will reach as much as 2,000 tons. On the other hand, up to present, only one vein has been discovered but undiscovered parallel veins are also expected. These explorations should also be carried out as soon as possible.

Assay

Sample	Sb
F.15	4.16%

No.18 BAN KAEN Antimony

Location: BAN KAEN, A. SOPRAP, LAMPANG

After a 59 km drive along a highway from Lampang city one can get to Sorpap, from where another 16 km drive along an unpaved road across the Mae Nam Wang to the west will take one to the mine. Jeep can not be run during the rainy season.

Geology and Ore Deposits:

There is no outcrop of rock in the vicinity of the deposit. But, judging from the pittings, there may be the alternation of sandstone and shale. The strike indicates N 40° - 60°W, dip, 45°N. These beds are somewhat under metamorphism.

This deposit is said to have been mined in a large scale in about 1950, but all the old pits are now collapsed or filled with water. The old stopes extend in the N 70°E direction, and a sheared zone is seen running in it in the same direction. The deposit may be a stibnite-bearing quartz vein in this sheared zone. The vein is said to be of 50 cm in width and to have had a high antimony content. The deposit seems unworthy of mining under the present condition, but is said to have a continuation of ore of a high antimony content at its lower part. As this deposit can be mined only by shafts, it is necessary to make a complete prospectings by borings, etc. before going in to rehabilitate this deposit.

4-3 Cassiterite Deposits No.19 - No.22 Fig. 22

No.19 BAN WAENG Cassiterite deposits

Location: T. CHAESON, A. CHAEHOM, LAMPANG

After a 53 km drive to the north from Lampang city, one can get to A. Chaehom, from where a further 10 km or so of ox-cart drive will take one to Chaeson. The deposits lie 1 km to the south-west of Chaeson. Jeep can be driven from Chaeson to the deposit in the dry season.

Geology and Ore Deposits: Under the 50 - 100 cm overburden, there is a bed of gravels, mostly pebbles (5 - 10 cm in diameter) of quartzite and sandstone. The bed rock is considered to be of schist or sandstone. The ore deposit is a placer deposit contained in this gravel bed, and its area covers over 200 acres. Cassierite deposits have been confirmed by panning.

No.20 BAN SAMSALI

Location: T. BAN SAMSALI, A. WIANG PA PAO, CHIENG RAI TIN

After a 51 km drive along a highway from Chieng Rai and further 40 km or so of drive along a local road one can get to Wiang Pa Pao. Jeep can be driven to the foot of the hill. It is said, however, no vehicle can be driven even in the neighborhood of Wiang Pa Pao in the rainy season.

Geology and Ore Deposit:

The geology in this area consists of biotite granite, in which tourmaline quartz veins and

pegmalite veins run. The former contains cassiterite. The biotite granite is under greisen alteration where these veins are running. The ore deposits consist of the placer deposits lying on the rocks mentioned above and the weathered part of the granite rocks containing many quartz veins and also the sand bed just above the weathered granite rocks. And, from these, cassiterite is being mined.

At present, two mines are under operation. The mine of Mr. Chai Sit Tam Weai (3 km to the west of Sansali) produces nearly 360 kg of concentrates per month.. The mine of the Tin Hien Co. Ltd. (about 2 km to the west of Sansali) is producing 1,800 kg of concentrates per month.

No.21 BAN PONG Tin

Location: BAN PONG, A. WIANG PA PAO, CHIENG RAI

5 km to the south of A. WIANG Pa Pao, and further 4 km to the west, one can get to the deposit in the paddy field.

Geology and Deposits:

The base rock observed at old pit consists of granite weathered to white clay accompanied by lots of quartz veins.

The sand bed on the top is said to have been mined and to contain a little amount of gold together with cassiterite.

Eight years ago, about 10 acre area was mined, but at present, the mining corporation is prospecting this area by systematic boring.

No.22 BA MAE CHEDI Tin

Location: T. BAN PONG NAM RON, A. WIANG, PA PAO, CHIENG RAI

Geology and Ore Deposits:

The bed rock consists of quartzite, sandstone, shale and conglomerate. The over burden is thick and consists of granitic, and sedimentary rock soil. Some of them have turned into laterite. Though pitting is being in operation, no ore has been found yet. Also, from the viewpoint of geology, it may be difficult to find any deposit. There is a hot spring, 1 km upstream from the village.

4-4 Lead and Zinc Deposits No.23 - No.26

No.23 BAN MAE CHANG RAI BON Lead deposit

Location: BAN MAE CHANG RAI BON, A. MAE PHRIK, LAMPANG

The deposit is situated in the flat land 500 m to the east of km stone, 63 km to Tak, which is 125 km from the city of LAMPANG along a highway. It is at about 1 km to the south-east of the BAN MAE CHANG RAI BON village.

Geology and Ore Deposit:

A few years ago, this deposit was prospected by pittings. But, today all of the pits are buried under the ground. Under the overburden (accompanied by quartz porphyry gravels) of

50 cm - 2 m thick, there is the bed rock composed of quartz porphyry in the north-eastern part and alternation of sandstone and slate in the south-western part, the latter striking N 40°E and dipping 40° - 60°E. The hill lying 5 km to the south-west-south of the old pitting is composed of basalt flows.

Though the ore deposit body could not be ascertained, rock blocks containing galena and quartz in the network were found in the gravels near the bed rock. Yet, there is a possibility of finding new deposits in this area by a systematic prospecting. Especially the prospecting development on the deposit in BAN MAE TANG will provide a valuable data for the development of the deposit. However, there may be a possible fear of flood in the rainy season in the ore deposit area.

No.24 BAN MAE TANG Lead and zinc

Location: BAN MAE TANG, A. MAE PHRIK, LAMPANG

After coming down for 119 km along a highway from LAMPANG one can get to BANMAE TANG, and after further proceeding for 1 km to the east from BANMAE TANG, one can reach the ore deposit. Jeep can be driven to the deposit in the dry season.

Geology and Ore Deposit:

Hills in the neighborhood and mountains to the east of the ore deposit are all composed of quartz

porphyry. The ore deposit is a galena and zinc-blend bearing quartz vein in the fissure of quartz porphyry. It strikes N 70° - 74°W and dips vertically. In the northern side, there are several small quartz veins running parallel and in the southern side there is a branch vein striking N 70°E and dipping vertically. The veins are 85 cm in width, and in the 10 cm zone in its northern part small lenses are concentrated by galena and zincblende. These lenses are scattered irregularly and repeatedly expanded and contracted in each 2 - 3 m.

The ore deposit makes a hill ridge along the vein as it is hard due to silicification. Such a topography is also seen in several hills in the neighborhood.

In the ravines around the deposit, white precipilation of zinc hydroxide is found.

The outcrop of the deposit is not workable, but there is a sufficient possibility of the downward development of the deposit and finding some other parallel veins.

The electrical prospecting method seems to be the best way for this area.

Assay

Sample	Pb %	Zn %
F.10	0.17	0.16
F.11	0.14	0.10

No.25. BAN BAE SALAEN Lead, zinc

Location: T. BAN MAE SALAEN, A. THOEN LAMPANG

From LAMPANG, it is 92 km to THOEN, from where it is about 40 km further along an unpaved road to MAE SALAEN. The ore deposit is at about 2 km on foot to the north-west of MAE SALAN. The deposit is situated at about 15 km to the east of BAN CHIANG RAI BON.

Geology and Ore Deposit:

The area around the ore deposit is composed of the quartz porphyry which is considered to be the same rock body as the one in BAN CHIANG RAI BON. But it has changed its nature and the mafic mineral is completely altered to chlorite or epidote. Also the texture of rocks is little different, too. The deposit is a quartz vein filled in the fissure of the quartz porphyry and contains galena, zincblende, chalcopyrite and pyrite. Small lens ore bodies, 3 - 5 cm in diameter, are lying within a 1 m wide zone. These lenses are of high quality, but the ore deposits has only a few ore bodies as a whole and does not show enough quality worth working on. Though the old pit site is 10 m long, 2 m wide and 1 m deep, only a part of it, 2 m in length, makes a small lens body accompanying galena and zincblende and other parts show only a weak impregnation of galena and zinc blende. Judging from the alteration of these country rocks, there may be found

ore deposits in other places, too.

Assay

Sample	Pb %	Zn %
F.12	12.40	1.67

No.26 HUAI IMIN Lead, zinc

Location: T. BAN UM LONG, A. SOPRAP, LAMPANG

It is 50 km along a highway from LAMPANG to A. SOPRAP, from where it is 8 km along an unpaved road to BAN UM LONG. The deposit is located 4 km from BAN UM LONG, for half of the way jeep can be used anyhow.

Geology and Ore Deposit

There exists, to the east of BAN UM LONG, a fault scrap running NE-SE and dividing the Soprap basin in its west and the mountain area in its east. The deposit is located in the mountain area, about 1.5 km to the east of the cliff of the fault. The geology of this district is composed of schist (green or black), a part of which is turned into phyllite. The schist strike is N 20°E, and dip 70° - 80°W, with a monocline structure. The deposit is composed of a galena, zincblende bearing quartz veins and pyrite, filling the cracks along the schistosty of schist, and is 5 - 8 cm wide. The quartz is translucent and the galena and zincblende contents are poor, making mining almost hopeless. Moreover, the

development in the direction of its strike and dip be hardly expected, too.

No.26' DOI KAEO Lead and zinc

Location: BAN HONG, A. MAE THA

It is a little over 10 km along a highway from LAMPANG to MAE THA, from where there is an unpaved road to BAN NONG. From BAN MONG it is a 5 km walk to the south on the mountain top of DOI KAEO.

Geology and Ore Deposit:

The mountain-range of DOI KAEO is formed with schist and meta-quartz-porphyry. The latter is 1 km wide and striking N 20° - 30°E with a dip of 70° - 80°E. In the southern part exists the calcareous sandstone. This bed has become skarn and bears ore deposits. The skarn is rich in garnet, epidite, etc. and is accompanied by zincblende. The bed is 30 cm - 1 m thick. The outcrops are observed just near the mountain top and also boulders are scattered around there. As the calcareous sandstone bed is considerably thin, we can not expect any large deposit.

Also the quality of outcrop is very poor. Despite this fact, there is a possibility, on the other hand, the same kind of deposits be found in the same sort of geology. Such areas are to be pointed out around the area between 40 km and 38 km from Toen on No.5 highway, where we observed old intrusive rocks and calcareous sandstones.

4-5 Manganese Deposit, Gold Deposit and Iron Deposit No.27, No.28, No.29

No.27 SERM SAI HUAI KAMIN Manganese

Location: BAN LAI LONG, A. KOKHA, LAMPANG

There is an ox-cart road from BAN LAI LONG to KOKHA, from where it is a 1.5 km walk to the deposit.

Geology and Ore Deposit:

The outcrops of the rock in the whole neighborhood of this area is very poor, but the geology is supposed to be sandstone and chert, judging from the past prospecting pits and boulders there.

The ore deposit is composed of manganese dioxide in the form of kidney filling the cracks of sandstone and chert, or the space among the large round gravels, with a maximum width of 5 cm and in an irregular distribution in general. Although its quality is comparatively high grade, there is no possibility of finding a sufficient ore reserve.

No.28 WANG NUA Gold

Location: MAE NAM WANG and its tributaries, HUAI TONG, A. WANG NUA and LAMPANG

There is an ox-cart road from A. WANG NUA to the deposit. Especially, gold placer is observed for 10 km to the north of Wang Nua and on the tributary, HUAI TONG, 13 km further to the north of the deposit.

Geology and Ore Deposit:

There are observed lots of gravels of chert, old intrusive rocks and gangue quartz in the river bed and alluvial gravel bed. Gold grains of 0.1 - 1 m/m size are found rather widely in this gravel bed.

The deposit is said to exist exclusively in the main stream of MAE NAM WANG and its tributaries on the east side. It seems that some part of the deposit are worth developing as an enterprise. The source of the gold is considered to have been in the upper stream of HUAI THON. Therefore, it is advisable to make an survey of gold vein, the source of this gold placer, and, at the same time, to make a systematic prospecting about the distribution and amount of gold in the gold placer deposit.

No.29 HUAI MAE KIT Iron

Location: The deposit is situated at HUAI MAE KIT, 15 km to the north of A. WANG NUA, on the upper stream of MAE NAM WANG river.

Geology and Ore Deposit:

There are observed around HUAI MAE KIT, an alternation bed of sandstone, conglomerate and limestone, in which the limestone has at least three beds. The strike of the beds is N 55°W with a dip of 70°E.

These beds are considered to be the upper layers lying in comformity with sandstone, limestone and conglomerate which are observed on the way to the antimony mine of DOI PHA KOK to the south-west of WANG NUA. On the other hand the schist rock, sandstone and phyllitic slate in the eastern part seem to belong to a different formation which interbeds with limestone. At around a fall at about 2 km up-streams of HUAI MAE KIT, the geology is changed in to granite, and a part of it is of gneissose meta-intrusive rock. About 60 m down-streams of the fall mentioned above there are observed a lot of boulders of magnetite, gathered in a place, but the outcrop is unknown. The boulders are round gravels 10 - 30 cm in diameter, and they will weigh several tons, so far as we can see. Also there observed boulders of hematite and magnetite at the outcrop of meta-intrusive rock, in the upper stream of HUAI TONG river located to the south of HUAI MAE KIT. Although we could not find out the source of the boulders of magnetite, it may be situated somewhere to the south-east of the fall.

Assay

Sample	Total Fe	Mn	S	SiO_2	P
	48.65	0.73	0.073	26.86	0.083

4-6 Bentonite and Gypsum Deposit

No.30 - No.34 Fig. 19

No.30 BAN HANG HUNG, Fig. 17 Bentonite

Location: T. BAN HANG HUNG, A. MAE THA, LAMPANG

At 4 km from the MAE MO railway station along the road to MAE MO Lignite Power Station there is BAN HANG HUNG village. The deposit is situated at a further 1.5 km walk to the east.

Geology and Ore Deposit:

The upper part of the bentonite bed is covered by the alluvial gravel but we could not observe the lower part.

The bentonite bed is tinted in red or reddish brown and is of poor value commercially. Within this bentonite bed gypsum in vein and network exists. The gypsum is observed with an appearance of aggregates of fibrous crystal, 1-2 cm in diameter, white and translucent.

The veins strike NS-N 10°E, in general. The veins are about 15 cm wide for a large one, but there are observed remarkable expansion and thining-outs.

No.31 Environs of MAE MO Railway Station Bentonite

Location: The deposit is located on a terrace like height, about 2.5 km to the east of MAE MO Station, where pitting for bentonite and gypsum prospecting are cut.

Geology and Ore Deposit:

The surface of the terrace is covered by the soil 1 m thick, and below the bed there is the bentonite deposit. No other rock is exposed there. The bentonite is white or blue grey and rather in a massive form. The gypsum is developed in the shape of network, below the ground surface of 2.5 m - 3 m, and the biggest of the vein is about 3 cm. Most of them is of anhydrite. The bentonite has a rather good grade, but the gypsum are quite hopeless.

No.32 BAN MAE THA Fig. 18 Bentonite

Location: BAN MAE THA, A. MAE THA

The deposit is situated 2 km from BAN MAE THA, along an unpaved road.

Geology and Ore Deposit:

The terrace around the deposit is covered by basalt flow. Judging from the result of the pitting survey, the bentonite has a strike of N 20°E with a dip of 15°E. Its upper part, about 50 - 100 cm thick, has been altered into white acid earth. The bentonite is comparatively of massive form, and its grade is good. It is about 3 m thick. We believe that it is worthy to operate, if there is demand in the market.

No.33 BAN PONG KA Bentonite

Location: T. PONG KA, A. SOPRAP, LAMPANG

There remains a group of pits worked 20 years ago, 260 m to the east of the KM post 45 km (to LAMPANG) on No.5 highway.

Geology and Ore Deposit:

The gravel bed of about 10 cm covers the surface of the terrace.

It seems that the bentonite bed is widely distributed. The bed is considered to be similar to that of BAN HANG HUNG, but there is almost no possibility of gypsum. Bentonite is red or reddish brown and its grade is not good.

Ref.: Geol, Recon. of Mineral Dep. of Thailand P.152

No.34 BAN SERM SAI Fig. 18 Bentonite

Location: T. BAN TON YANG, A. KOKHA, LAMPANG

There is a 40 km long-ox-cart road from A. KOKHA to BAN TON YANG. Jeep is available in the dry season. The deposit is located on the terrace, 15 km to the north west of BAN TON YANG.

Geology and Deposit:

The upper part of the deposit is composed of bentonite-like shale and tufaceous shale, of which the bedding plane is apparent. The bentonite and sedimentary rock have gradually changed horizontally and vertically and it partly contains plant fossils. The lower part forms a massive bentonite bed, in which an anhydrite network vein

exists. The bed strike is 20°W - 20°E, and is under slow foldings. On the surface, the gravel bed is distributed for about 10 cm in thickness. The gypsum is of anhydrite of transparent fibrous crystal. A vein is 1.5 cm in the maximum thickness, and in a irregular network vein. The lower part of bentonite contains much iron. We believe that the bentonite is distributed in the area of 2 km around this terrace. Although the gypsum has only a poor value, the bentonite deposit is worthy of further investigation.

4-7 Diatomite Deposit No.35, No.36

No.35 LAMPANG Fig. 20 Diatomite

Location: This deposit is located 6 km to the north-east of Lampang, but in fact just at the outskirt of the city. The outcrop is seen at the highway cutting.

Geology and Ore Deposit:

Although the bed rock is invisible, the diatomite crops out on the surface. The deposit is divided into the upper and lower beds, and there is a parallel uncomformity accompanied by fossils between them.

The diatomite is 6 m in the total thickness, and lies almost horizontally.

The diatomite consists of thin whitish-yellowish-brown beds. The outcrop is seen along the cutting of the highway for about 120 m consisting of diatomite beds of almost the same grade.

No.36 BAN HONG THOI Fig. 20 Diatomite

Location: T. BAN NONG THOI, A. MAE THA, LAMPANG

The outcrop is located about 700 m to the south-south-east of BAN HONG THOI, on the right bank of a tributary of MAE CHI CHIANG.

There is an unpaved road up to MAE THA, and from there it is 3 km to BAN HONG THOI by jeep except in the rainy season. One must walk from BAN HONG THOI to the deposit.

Geology and Ore Deposit:

The deposit consists of an alternation of the aggregate bed of diatomite and mudy sandstone beds. The outcrop appears for 30 m, in length and the bed strikes in N 60° - 70°W and dips 5° - 10°N. The surface consists of gravel bed having a thickness of 50 - 100 cm.

The upper part of the deposit, 1.5 m - 4 m thick, is white and of high grade containing a little of mudy sandstone. This deposit is worth working.

4-8 Kaolin and Building Stones No.37, No.38

No.37 CHAE HOM KAOLIN

Location: CHAE HOM KAOLIN

The deposit is located at 1 km west of the highway at a point between km 26 km and 27 km from LAMPANG city and to CHAEHOM.

Geology and Ore Deposit:

The original rocks are lipalite, which seems to be a lava flow covering the sandstone and shale. Kaolinization is conspicuous near the bed rock.

Although the upper part is altered mostly by silicification, kaolinization is not so conspicuous in this part. The relict of original rocks is observed in this part. This deposit is now being worked on for the raw material for the china factory in LAMPANG. The seconddworking place situated at the lower part has a large reserves of high grade kaoline. There are some promising areas near around the place. The same rocks are also observed in the west of T. BAN TON YANG and A. KOKHA. Therefore, there may be found other workable kaoline deposit around LAMPANG.

No.38 BAN MAE TUNG Building Stones

There is a wide deposit of laterite in the surface of a table land to the west of A. MAE THA, and it is being mined in the west of T. BAN MAE PUNG as building material.

This laterite consists of the gravel bed being solidified with iron materials. These gravels covering the surface of the table land are mostly round gravels, 1 - 3 cm in diameter, of chert and shale.

Lateritization seems to have reached several meters below the surface. But, mining is made only on the layer down to 1 meter below the surface.

5. Petchaboon, Uttaradit, Phrae and Nan Districts

5-1 Summary

This investigation Team visited Petchaboon, Uttaradit, Phrae and Nan prefectures, too, where exist a number of copper deposits and such a special mineral bed as asbestos. The main mineralized area in this region can be divided roughly into three districts, the district to the west of Petehaboon city, the district along the River Nan to the east of Uttaradit city and the A. Long district in Phrae prefecture.

The western district of Petchaboon city is a hilly region of 900 - 1,200 m above sea level, and the geology consists of, at its base, the alternated bed of sandstone and shale striking in the west-north-west direction. This shale bed has plant fossils, and is, very often, intruded by porphyrite dikes or sheets. Cutting or covering this formation are andesite and its agglomerate, which contain many copper veins. Gold deposits (No.39) are found related to porphyrite. The relation between this porphyrite and andesite groups is not known yet. But, any way, this area forms a distinctive copper deposit province. However, these copper deposits are small in scale. There is seen a small outcrop of diorite along the highway passing over the pass between Petchaboon and Tepanhin to the south of the hill. Therefore, it is necessary to clarify the occurrences of these igneous rocks to prospect more for copper deposits.

Along the River Nan to the east of the city of Uttaradit there are asbestos and talc deposits, contained within serpentine turned from ultra basic rocks, which seem to have a wide distribution. Therefore, it is preferable,

firstly, to survey the ultra basic rocks for their size and distribution.

Many antimony, lead, zinc and copper deposits are located scattered to the south and north of Ban Pin railway station in A. Long in Phrae prefecture. The geology there is considered to be of the Paleozoic formation consisting of the alternation beds of black shale and sandstone and generally striking north-east to south-west with a dip toward west. Igneous rocks contained in these deposits are porphyrite dyke, porphyry and biotite granite. The deposits consist mostly of thin veins accompanied by quartzs, calcites, etc. related to porphyrite dyke for mineralization. Though there have been found no sizable deposits except for antimony, this area is a significant province having various ore deposits. So survey and research of igneous rocks in this area is quite necessary for prospecting the deposits.

Copper deposits are also found at Phak Tha in the deep mountain region to the east of Uttaradit and A. Sa in Nan prefecture both near the boundary with Laos. They are copper deposits which seem to have deposited there in connection with porphyrite or andesite intrusion into the reddish-brown sandstone or shale beds.

5-2 Gold Deposit No.39

No.39 Klong Huaipao Fig. 29 Gold

Location: T. BAN NAM KO YAI, A. LOMSAK, PETCHABOON

BAN NAM KO YAI is about 5 km straight to the west-south-west from the town of Lomsak, and from there the deposit is 4 km to the west on foot.

Geology and Ore Deposit:

The geology in this area consists of calcareous sandstone and shale beds, and porphyry intruding into them. The sedimentary rock beds strike N-S with a dip of 40°E and the porphyry appears as a dyke rock striking N 30°E. The sedimentary beds, very often, contains small quartz and calcite veins accompanied by a small quantity of pyrite. The ore deposit is a quartz-calcite vein bearing pyrhotite and a small quantity of pyrite filling the fissure at the boundary of sandstone shale bed and porphyry.

The vein strikes NS with a dip of 60°E and expands and contracts with an average width of 0.4 m. The length of outcrop of the ore deposit is ascertainable for about 10 m in length. Existence of gold grain is recognized by panning. The appearance of the outcrop makes us surmise that the vein strength is not steady. Therefore, this vein should be checked firstly of its gold distribution in the whole outcrop and, then, by trench-excavating to detect extension of the vein as well as to examine existence of gold in the soil in the vicinity.

5-3 Copper Deposits No.40 - No.52

No.40 KHAO THONG Fig. 30 Copper

Location: T. BAN PHLAM, A. MUANG, PETCHABOON

Accessible by jeep to as far as Ban Phalm, 9 km to the south-west of the city of Petchaboon in

the dry season. The copper deposit can be reached by walking for 5 km further to the west, and is located in a hilly area.

History: 4 years ago, Mr. P. Carrel, a French engineer, prospected by the pitting method.

Geology and Ore Deposit:

The geology in the vicinity consists of a sandstone shale bed, andesite and andestic agglomerates. Though the sandstone shale bed, in general, strikes N 30°W with a dip of 50°SW, it sometimes is disturbed and the shales partly take an appearance of phyllites, at the same time, showing drag foldings. The relation between the sedimentary rocks and andesite is unknown. There are reddish-brown sandstone boulders around the copper deposit. The copper deposit is filling the sheared zone of greyish-purple andesite in a network form and is composed of copper ores such as marachite and azurite together with quartz and a small quantity of clay. The main direction of the network vein is N 70°E and N 30°W. The deposit is supposed, from the appearance, to be small scale and irregular in shape.

Assay

Sample	Cu %
D.16.2	1.54
D.16.3	2.36

No.41 KOKE NA KAE Fig. 31 Copper

and

No.42 NONE THONG Fig. 32 Copper

Location: T. PHA DAENG, A. MUANG, PETCHABOON

Accessible by jeep to as far as Ban Pha Daeng, 15 km to the west of the city of Petchaboon in the dry season. From there it is a 2 km walk to the Koke Na Kae deposit and a 6 km walk to the None Thong deposit.

History: 4 years ago, Mr. P. Carrel, a French Engineer, prospected by the pitting method.

Geology and Ore Deposit:

The geology in this area consists of an alternation bed of sandstone and shale, andesite and its agglomerate. The sedimentary rock strikes NS - N 40°W with a dip of 30° - 60°NE, but is partly disturbed. The Koke Na Kae deposit lies in the sheared zone of greyish-purple andesite in a network shape. Ore minerals found here are azurite, pyrite, gangue quartz, calcite and some clay. The network vein strikes mostly, NS and N 30°W with a width of 0.1 - 0.3 cm. Also, ore minerals are scattered in spots around amygdaloidal cavity in the host rock. Generally speaking, the ore deposit lacks continuity.

The deposit at None Thong is a thin quartz vein running parallel to the joint (N 70°W - 60°SW) of dark-green or dark-purple andesite with a width of 15 m. It was prospected by pitting.

A small quantity of malachite is found in the ore. (No.41 Deposit Cu 5.00%)

No.43 KHAO NOM SAO Fig. 33 Fig. 34 Copper

Location: T. SAM NAK MAN, A. MUANG, PETCHABOON

There is a small village called Sam Nak Man 8 km to the north of Petchaboon, which is accessible by jeep. The deposit is 10 km from there and is accessible by jeep in the dry season only.

History: There are two pits in Khao Nom Sao excavated many years ago.

Geology and Deposit:

Only weathered andesite is found while sedimentary rock could not be observed. In the vicinity are found many boulders of sandstone similar to sandstone on the Korat series.

The deposits are network veins in the andesite, and strikes mainly N 25°W, and has a width of 2.3 m including the width of the two outcrops, but its length of extension could not be ascertained. Ore minerals are azurite and malachite, and gangue minerals are quartz, calcite and a small quantity of clay. The other pit is located 0.8 km to the south and is under test excavation by the trench and pitting methods. (Fig. 34)

The deposit are network veins in the andesite, with a composition the same as the former.

Assay Sample	Cu
D.18.1	3.13
D.18.2	2.28

BAN TOKE, A. MUANG, PETCHABOON Iron

Location: The village is located 10 km to the south-west of PETCHABOON, and the deposit is 10 km further to the west by jeep in the dry season. There are two pits in this neighborhood, 3 km from KOK PHA DAENG LAN and 0.3 km from KLONG LONG RUA.

Geology and Deposit:

The geology in this area is composed of sandstone and shale, striking generally N 30°W and dipping 50°SW.

No.44 LOK PHA DAENG LAN Fig. 35 Copper

Although it has prospected by trench at two points into the andesite and its agglomerate, they are buried and could not be seen. Azurite and malachite are found among the waste stones left outside the trench.

No.45 KLONG LONG RUA Fig. 36 Copper

A pit has been dug in the andesite, but it is buried in the ground and could not see.

No.46 HUAI KHAI KHAET Fig. 37 Copper

Location: A. FAK THA, Uttaradit

After proceeding for 140 km to the east from UTTARADIT, one can get to FAK THA (jeep can be used in dry season any how). A further 2 km jeep drive (in dry season only) and 1 km walking along a mountain trail will take one to the deposit.

Geology and Ore Deposit:

The geology in this district consists of sandstone, shale and phyllite and porphyry intruding into these sedimentaries. The sedimentary bed strikes NS - N 80° with a dip of 20° - 80° NW. Sandstones take browish purple color and exist apparently in the upper part. In the shale and phyllite there is observed a quartz vein of the network accompanied by a little amount of phyrite. The porphyry dyke is about 2 m wide, strikes N 80°W and dips 50°N.

The deposit makes an outcrop on the cliff on the right bank of HUAI KHAI KHAET and the phyllite is slightly folded. The deposit is located in the sheared zone running parallel to this folding. The deposit is 10 - 70 cm wide. Small particles of malachite is irregularly existing in the 5 cm belt in the hanging wall of this sheared zone and quartz also accompany partly.

The deposit thins out to the western direction.

The ore found in the outcrop, 15 m long, is very poor in the copper grade.

Sample	Cu %
J. 22.1	0.10
J. 22.2	0.30

No.47 HUAI THURB Copper

Location: The deposit is located at about 500 m to the north-east of No.46 HUAI KHAI KHAET.

A. FAK THA, UTTARADIT

Geology and Ore Deposit:

The sandstone and phyllite strike N 55°E and dip 40°NW. Clay of 0.5 cm is lying in the sheared zone running along the bedding plane of the sedimentary rocks mentioned above. Also in the vicinity there is running a barren quartz vein striking WS, dipping 50°E and with a maximum width of 5 cm. However, there is no ore observed in them.

No.48 BO HAM Fig. 38 Copper

Location: T. TAPPHA MOK, A. LONG, PHRAE

BAN NAM RIN (MUH BAN) can be reached from BAN PIN railway station on the northern line of the State Railways of Thailand along a timber hauling road and an ox-cart road. The deposit is located 16 km by jeep and 2 km on foot to the east from BAN NAM RIN (MUH BAN).

History: The deposit is said to have been found about 100 years ago. A few years ago, a pitting of about 10 m deep was prospected.

Geology and Ore Deposit:

The geology consists of phyllitic shale having sandstone within, which strikes N 40° - 50°E and dips 50°SE. In the valley, where the deposit is located, there are scattered big blocks of saccharaidal limestone, and near the deposit, shale bed is very much disturbed.

The deposit is composed of a lens-shaped irregular malachite impregnation lying in the sheared zone in the phyllitic shale, and quartz veins are also found partially. The sheared zone strikes N 5° - 15°E, dips 65°W and has a width of 70 cm. The lens of the deposit is 1 - 5 cm wide. The sheared zone is generally stained with limonite.

In the waste rock the shale impregnated with azurite and chalcopyrite are found.

Assay

Sample	An %	Ag %	Cu %
J.25.1	0.8	173	10.42
J.25.2	-	-	5.85

No.49 HUAI SAN POO Fig. 39 Copper

Location: T. TA THA MOK, A. LONG, PHRAE

A 13 km jeep drive and 1 km walk from BAN NAM PIN will take one to the deposit.

Geology and Ore Deposit:

The geology in this district consists of phyllitic black shale, calcareous shale and porphyry. The phyllitic shale strikes and dips N 25°E, 50°W; N 50°E, 40°W and N 30°E, 60°W. The calcareous shale lies between the rocks mentioned above in a lens shape with a thickness of 3 - 4 m. The porphyry has phenocryst of biotite and feldspar, and is a dyke rock intruding in N 50°E but dipping in the reverse direction to the dipping of the shale bed. It has a width of 2 - 4 m and partly rhyolite-like. The deposit consists of a group of calcite veinlets running in the right angle one another in the phyllitic black shale and black shale, impregnated with chalopyrite. The amount of ore contents is very little. Also, on the hanging wall side (for 0.70 m) of the porphyry dyke there is a little amount of impregnation with malachite which is accompanied by a barren quartz vein.

No.50 HUAI YA ANT or CHAM NAWG ANT Fig. 40 Copper

No.51 HUAI THOOP SOK Fig. 41 Copper

Location: Both deposits are located at 11 km from T. PHA MOK, A. LUNG, PHRAE BAN NAM PIN. One can reach the place by jeep.

Geology and Ore Deposit:

The geology consists of phyllitic shale, a thin bed of limestone, and porphry with phenocryst of biotite and feldspar. The HUAI YA ANI deposit is located at the contact of a porphyry dyke and shale beds and occurred as quartz veinlets in the shale. Although there are three pits, no ore is found there.

The HUAI THOOP SOK deposit, too, is a network calcite quartz vein in the shale, where porphry and shale contact each other, and is impregnated with pyrite and chalcopyrite. The deposit is prospected by trenching.

No.52 LAI NAN Fig. 42 Copper

Location: T. LAI NAN, A. SA, NAN

25 km from NAN city to A. SA, and further 5 km to the deposit.

History: This deposit was prospected by pittings (4 pits) by Mr. P. Carrel, a French engineer.

Geology and Ore Deposit:

The geology in this area is composed of red phyllitic shale, andesite and basalt. The red phyllite is distributed widely in this area, and of the same series of the red phyllite outcropping along the road between RAPARAE and NAN. They strike and dip N 70°W, 60°S in their southern part and become gradually N 30° - 50°W, 80°W toward the north. But they strike N 60° - 75°W

and dip 80°S around the deposit, the same as in the southern part. There are partings of dark brown massive sandstone between A. SA and the deposit. The black grey and fine grained andesite are the country rocks of the deposit and have intruded into the red phyllite, and the mafic minerals are altered. There are green rocks in the boundary between this andesite and red phyllite. These green rocks have been developed with schistosity. There are hornblende crystals with a maximum diameter of 4 - 5 m/m spotted along the schistosity. The strike of schistosity is the same as that of the phyllite bedding plane. The basalt which is considered to be a very new one is located in the south-eastern part of the deposit, colored dark grey and has amigdaloidal cavities.

The deposit consists of malachite, azurite and chalcocite filling in the joint of andesite.

		Cu %	Pb %	Zn %
Sample 1	Powder ore	6.70		
2	Massive malachite	9.60		
	Azurite			
3	Medium size ore	2.57	0.20	0.24

5-4 Lead and Zinc Deposits Nos 53 - 57

No.53 KLONG HUAI RAD Fig. 43 Lead and zinc

Location: T. PHA DAENG, A. MUANG, PETCHABOON

BAN PHA DAENG is located 15 km from PETCHABOON City. The deposit is reached by further 10 km ride of jeep in the dry season only and 3 km on foot from BAN PHA DAENG.

Geology and Ore Deposit:

The deposit area consists of the alternation beds of sandstone and shale together with porphyrite and andesite. The sandstone and shale generally strike NS - N 30°W with a dip of 30 - 50°SW.

The porphyrite shows a conspicuous columnar joint.

The ore deposits are veins filled the faults and sheared fissures in porphyrite and contains zinc-blende, galena and a little chalcopyrite and pyrite as the ore minerals and quartz and a little calcite as gangue mineral. There are two outcrops, which are prospected by drifting and cross-cutting of 10 m long.

An outcrop of probably the main vein has been prospected for about 13 m. They strike N 25°W, dip 70°SW, and have a maximum width of 1.0 m. And judging from their appearance the grade may be Pb 5 - 10%, Zn 25 - 30%, Cn 0.1 - 0.3% and the vein length confirmed is 2 m. The vein turns to a fault clay of 30 cm wide, at the northern part of the outcrop.

The other outcrop running diagonally with this outcrop strikes N 35°E with a dip of 80°N. The maximum width of vein is 0.2 m. and the confirmed vein length is 5 m. But the vein appears very much changeable and the grade is not so good. This outcrop is now being prospected by local people. In addition to above, 2 - 3 barren quartz veins are observed in the porphyrite. They strike the same direction as the main vein.

No.54 WANG NANG Fig. 44 Lead and zinc

Location: T. THA PHA MOK, A. LONG, PHRAE

From BAN PING railway station one can get to BAN NAM, and from there a further 15 km jeep drive will take one to the deposit.

Geology and Ore Deposit:

The deposit area is composed of blackish grey shale and fine sandstone. On the river-bed there is an outcrop of limestone.

The deposit consists of quartz veinlets occurred in the silicified shale and along its layer striking N 35°E with a dip of 55 NW and another thin vein running across the former. The latter contains a small quantity of galena.

Occasionally, chalcopyrite is found.

There is an old prospecting, but caved in.

No.55 BO SAM KLEOW Fig. 45 Lead and zinc

Location: T. TA PHA MOK, A. LONG, PHRAE

A 17 km jeep drive from BAN NAM RIN will take one to the deposit which is located in a wide paddy field area.

Geology and Ore Deposit:

This area is supposed to consist of phyllitic shale.

The deposit is a massive body, 5 m long and 1.8 m wide, appearing on the flat land. It is not clear whether it is a boulder or outcrop. The west side of the body looks like hematite or limonite gossan and porous, soily and unglased-porcelain like.

The east side part consists of barite and quartzs as the gangue mineral, and in the quartz there is a little galena crystals. Some of the quartz picked from the waste of the trench contain galena too.

No.56 HUAI THAM KWAI Fig. 46 Lead and zinc

Location: T. BAN PIN, A. LONG, PHRAE

Going about 10 km to the north of BAN PIN railway station along the railway line, and then proceeding further 1.2 km to the east, one can get to the deposit.

Geology and Ore Deposit:

The geology of the deposit area consists of phyllitic black shale, sandstone and biotite granite.

The strike and dip of the shale is generally N 40°E, 30 NW or N 15°E, 45°W. The sandstone is a thin bed parting in the shale, exposing a 3 m thick outcrop in the ravine, and fine grained and compact. The granite has large crystals of biotite. The contact line between granite and black shale runs N 10°E and dips 70°W. The deposit is a galena-quartz-baryte vein occurred in the granite at near the contact above mentioned. This deposit was found 2 years ago and, stripping the overburden are underway at present. There are three ore veins, showing a strike of N 20° - 35°W with a dip of 65°W. and are 0.05 m, 0.2 m and 0.6 m wide respectively from the north to the south. But, the ore grade suddenly decreases in the lower part. Their estimated grade is Pb 10% or so for the vein of 0.6 m wide. The veins make repeated expansions and thin outs and seem to be very unstable.

No.57 HUAI BONG and HUAI THAM Fig. 47 Lead and zinc

Location: T. BAN PIN, A. LONG, PHRAE

A 1 km jeep drive to the north of BAN PIN railway station will take one to BAN BOH, and a further 2 km walk will take one to the deposit. The area is divided into two by a mountain ridge. It is said to have been found 100 years ago.

Geology and Ore Deposit:

The overburden is so deep that the geology is not yet clear. But it is generally composed of black shales and sandstones. There are two outcrops of black shale at the down-stream direction of the pitting at Huai Bong. But they both show strong phyllitic appearances. It strikes N 10° - 20°E and dips 60°W, while N 50° - 60°E and 75 W at Huai Tham.

There is a tunnel of 10 m long running S 35°W at Huai Tham. The tunnel seems to have been drifted along the shear zone which runs along the bed of black shale. The bed strikes N 40°E and dips 65°E. In the tunnel there is no clear ore vein. There are two pits at the mountain top 60 - 70 m above the tunnel. At Huai Bong there is a pit in the valley 150 m below the mountain top, but it does not reach the rock. Judging from the blocks coming out of the pit, the deposit seems to be a quartz vein containing galena, zincblende and chalocopyrite. High grade zincblende is also found.

The deposit seems to be located between the mountain ridge and the pits. It shall be prospected, first by checking the boulders of ore and, then, by trenching. In this case, it is necessary to take into consideration the fact that many deposits in this region strike NE - SW.

5-5 Antimony Deposit No.58 - No.60

No.58 HUAI MAE SON, KHAO PHA HING

Fig. 48 Antimony

Location: T. BAN PIN, PHRAE A. LONG

The deposit is located at about 1 km along the railway track to the north of PHA KHO station. This deposit was found 2 - 3 years ago, and pitting prospecting was made on the river bed in 1962.

Geology and Ore Deposit:

The geology in this area consists of grey shale and reddish-purple andesite. Their relation is not clear. Shale located around the pit strikes N 5°W - N 5°E with a dip of 85 W, while in the south, it strikes N 25°E with a dip of 35° - 40°W, and in the north area, it is a little disturbed.

Judging from the waste around the pit, the ore is stringers (0.1 - 2 cm wide) of stibnite occurred in the quartz containing breccia of shales or in the shale. This pit is located in the river bed composed of andesite and seems to have been dug into the boulders which were brought down from the upstreams.

	Pb %	Sb %
Sample	5.89	1.52

No.59 DOI PHA KHAM Fig. 49-1, 2, 3, 4 Antimony

Location: T. BAN PIN, A. LONG, PHRAE

The deposit is located at 2.5 km to the south-east of PHA KHAN railway station and is about 110 m higher than the station level.

History: Found in 1939 as the first antimony deposit in this region, it has been worked on intermittently since then. Present operation started in 1961.

Present situation: Monthly production - 600 kg; hand picking ore of about Sb 44%. There are 40 workers. Mining by open pit. Total production since 1961 are 44,350 kg.

Geology and Ore Deposit:

The geology in this district is composed of blackish-grey shale, limestone and calcareous shale. The shales have been changed into phyllitic rocks. The deposit generally strikes in the NE, but partly disturbed. Sandstones are intercalated in the shales. The limestone rocks are located on the top of the mountain in thin layers or lenses. In the southern part of this deposit a granite stock intruded and, further to the south there is the lead deposit described in the separate heading. The deposit is located at the top of the mountain and the mineralized zone, covered by boulders of silicious shale, extends for 200 m. There are more than 10 pits and trenches which were worked in the part or

are working at present.

The deposit is composed of stibnite, calcite and quartz occurred in the crashed breccia zone which lies approximately in conformity to the black shales and limestones. The ore body is 1.5 m thick or more at the pit (b). The hanging wall of the ore body contacts on a thick clay zone by a fault striking and dipping N 50°E, 48°N - N 25°E, NW, while the lower part of the ore body is divided into the calcite and quartz part and the bonanza part comprising calcite, quartz and stibnite. The latter part is of about Sb 20% judging from the wall on the pits. In the pit (c), the breccia body is 2.3 m in thickness and its hanging wall is composed of limestone and black shale while the foot wall composed of grey sandstones. Both strike N 30°E with a dip of 50°W. The higher grade part, 30 cm wide, is a lens, 1 m long along the dip. The ore is stibnite and its acicular crystals are scattered in a radial form in the calcite and quartz. The diameter of the radial form is 10 - 20 cm. There are two trenches, 1 m deep, at 25 m and 35 m to the south-south-west of pit (B), and in the latter there are found the acicular crystals of stibnite. The ore deposits lie within a distance of 200 m. Its both ends are confirmed, but the ore body in the intermediate part is not yet made clear. Therefore,

it is necessary to make the occurrences of the ore bodies clearer by prospecting by a systematic trenching.

No.60 KHAO THAM NGOEM, HUAI MAE YOK Fig. 50 Antimony

Location: T. BAN PIHN A. LONG, PHRAE

The deposit is located 5 km along the railway to the north of BAN PIN railway station.

The deposit is on the ridge of a hill rising in the northern side of a small flat land, about 200 m above the station level.

Geology and Ore Deposit:

In this district there are scattered in a wide area siliceous shale affected by mineralizing actions, striking and dipping N 50°E, 25°S or N 80°E, 45°S. There are outcrops of granite along the railway track. They are course grained and rich in phenocryst of biotite.

The ore deposits are lying in the mineralized zone on the mountain ridge extending NS from the top, where siliceous shale caused by mineralization are scattered. Stibnite is found at two points, one of which is prospected by pitting. Stibnite is arranged in radial shape of 2 - 3 cm in diameter or in acicular form and scattered in the siliceous shales. Bordering it runs a small quartz vein. Also, a small quantity of quartz vein having breccia of black shale are observed. This is probably a stibnite - quartz ore deposit filling

the sheared zone of shale similar to No.59 deposit.

This deposit has a total length of 150 m of silicification zone, but the deposit is not well developed. It should be prospected by pitting.

5-6 Asbestos Deposit and Talc Deposit No.61 - No.66

No.61 MON PHA YOM, WANG DANG Fig. 51 (1), (2) Asbestos

Location: T. HARD NGUI, A. MUANG, UTTARADIT

A 38 km jeep drive (in the dry season only) from UTTARADIT will take one to WANG DANG, from where one can get to the deposit by walking for 1 km to the north-west.

Geology and Ore Deposit:

Plenty of boulders of sandstones, shale and gabbro together with quartz blocks are found along the road from WANG DONG to the deposit. There are 6 pits along a mountain trail of 80 m distance. In pit (1) there is found a fine vein of asbestos, 0.5 - 2 cm wide, running through the serpentine. The asbestos consists of mainly the cross fibre traversing the vein. Among the wastes outside the pit the fibres of 10 cm wide are found. In pit (2), an asbestos vein, about 0.1 cm wide, is found in joints which strike N 60°W to N 75°E.

No.62 HON HIN SOM LEE Fig. 52 Asbestos

Location: A 53 km jeep drive (in dry season) from UTTARADIT city will take one to PHA LUED, from where the pit is 6 km far on foot.

Geology and Ore Deposit:

The area from PHA LUED to the deposit consists of sandstone and shale together with phyllite, porphyrite, pyroxenite, gabbro, and serpentine. The phyllite includes irregular-form of quartz. The sedimentary bed generally strikes N 30°E and dips 55°W and the porphyrite dyke runs N 70°W dipping 80°NE. The pyroxenite, gabbro and serpentine are altogether 60 m wide and strike NE near the deposit. The pyroxenite and gabbro have partly altered to serpentine. There are more than 10 old workings in the 150 m distance of the NE direction of the ore deposits and asbestos are filled irregularly in the country rock which has altered by serpentine alteration.

No.63 MON CHANG NOW, HUAI YANG Fig. 53 Asbestos

Location: T. CHARIM, A. THA PLA, UTTARADIT

A 70 km jeep drive (dry season only) and a further 12 km walk from UTTARADIT city will take one to HUAI YANG. There is another deposit 1 km further to the north-west.

Geology and Ore Deposit:

There are two pits. An outcrop of amphybolite exposes 300 m to the east of the pits. This amplybolite strikes N 60°E and dips 55°SE. At A pit a small quantity of thin asbestos vein, 0.5 m/m wide is seen. Actinolite is observed at the upper part of the pit. A thin asbestos vein

of about 0.5 m/m is observed in the serpentine at the foot wall of the sheared zone at B pit.

No.64 DEN SUA KLAUAK, PHA TAO Fig. 54 Asbestos

Location: T. PHA LUED, A. THPPLA, UTTARADIT

A 45 km jeep drive (dry season only) from UTTARADIT city will take one to BAN PHATAO. The deposit is located 2 km to the south of BAN PHATAO across MAE NAM NAN.

Geology and Ore Deposit:

There are outcrops of sandstones shales and phyllite (N 10° - 20°E, 30° - 50° NW) on the bank of MAE NAM MAN.

There are 4 pits within an area of 50 m^2.

A 0.5 m/m wide stringer is observed in the serpentine among the wastes. We have picked up magnetite ore of the size of a fist, together with choromite among the wastes. Among the wastes of the pits asbestos of fine grains are found.

No.65 MON KAI CHAE, WANG DANG Fig. 55 (1),(2) and (3)

Asbestos

Location: T. HARD NGUI, A. MUANG, UTTARADIT

A 35 km jeep drive (dry season only) from UTTARADIT city and a further 1.5 km walk will take one to the deposit.

Geology and Ore Deposit:

We were told that, during World War II, about 60 m.t. of asbestos were mined from shallow pits and trenches in this area. But almost no mining has been done since 1944.

We were also told that there are more than 100 test pits in this area. The ore deposit is located on the flat hill, where many boulders of quartz and slate are scattered. There are asbestos filled in the joints and fissures of serpentine, 1 m/m - 10 m/m in width, and in the form of cross or slip. The cross-shaped ones are generally amber-colored with silken lustre and the slip-shaped ones are as long as 20 cm in length and light-grey colored.

In pit A an asbestos vein with a width of 7 cm - 1 m/m and striking N 30°E - N 20°E exists. But its asbestos contents is 1 - 2%. In pit B a vein having 0.5 - 1% of asbestos contents is found and it strikes N 20°W and N 70°E. There seems to be a shear zone of 50 cm wide in the hanging wall of asbestos vein in Pit B. Therefore, it seems the asbestos stringers occur mainly on the foot wall side controlled by this shear zone.

No.66 KAENG KRA TAD Fig. 56 Talc

Location: T. RHA LUED, A. THA PLA UTTARADIT

A 56 jeep drive (dry season only) from UTTARADIT city will take one to PHA LUED, from where the

deposit is reached by 3 km walk to the south.

Geology and Ore Deposit:

The sedimentary bed, striking generally N 30°E with a dip of 50°NW, consists of sandstone, shale and phyllite. The phyllite is interbedded by a quartz vein (accompanied by a small quantity of calcite) of about 30 cm thick. Green basic rocks look like the glassy andesite and crop out for about 80 m at the bank of the MAE NAM NAN.

The talc is occurred in a part of this green basic rock. There is an ore body on the water surface of MAE NAM NAN, which is now worked. The ore is reddish-brown at the outcrop, but it is green or grey in the core, and is accompanied by a little amount of pyrite, partially. Some of them are exfoliatic. We observed, 30 m to the west of the mine, a stringer of asbestos associated with talc.

5-7 Red Soil, Limonite and Coal No.67,No.68,No.69

No.67 WANG RONG Fig. 57 Red soil

Location: T. THA EA BOON, A. LOMSAK, PETCHABCON

The deposit is located at 65 km to the north of PETCHABOON, or at 15 km to the north-east of LOMSAK.

Geology: There are observed 2 sedimentations of red soil over a total length of 20 m on the left bank of MAE NAM NAN. They consist of sandy clay and

coloidal iron and looks, at first glance, to be reddish-brown loose sand.

No.68 KOKE PHA KAI, BAN HUAI KAI Brown iron ore

Location: T. TABOK A. MUANG, PETCHABOON

The deposit is located at 3 km to the east of BAN HUAI KAI, or at 12 km to the south-east of PETCHABOON city.

Geology: The deposit is located in a forest in a flat plain. The ore is 20 m in diameter and contains several limonites of 0.5 m in diameter. Limonites have 10 cm - 100 cm chart breccia as the core.

No.69 SUB TA PAN Coal

Location: T. NA CHALIENG, A. VICHIANBURI

The deposit is located at SUB TA PAN, which is 2 km to the west of NA CHALIENG. The latter is to the south of PETCHABOON city in the distance of 50 km. Jeep can be driven from WANG CHAN POO to NA CHALIENG.

Geology: Coal is lignite. Samples we have picked up look mostly like wooden and coaly shales. Many of them have proved of poor quality for ignition test. Coal outcrops in the river of SUB TA PAN, which we could not observe at the time of our visit. We are told that they are 0.5 - 0.80 m and are accompanied by pyrite. There are outcrops of shale and limestone striking N 20°E with a dip of 70°NW.

Report on Feasibility

of Iron and Steel Project

in Thailand

Contents

I. Summary

We have made a survey tour in Thailand to investigate iron ore deposits, suitable locations for erection of an iron and steel works, etc., to find out whether the construction plan of an iron and steel works to be proposed by the government of Thailand using her domestic iron ore is justifiable and how it should be realized. And, based on the overall knowledge on site conditions, etc. which we have obtained from this investigation, we have made the following plan. We regret to say, however, that, as stated in paragraph VII Conclusion, the proposed iron and steel works cannot be a profitable enterprise.

The well-known iron ore deposits in Thailand are the Uem Kruem deposits located near Kanchanaburi, the Khao Thap Khwai deposits located near Lop Buri and the Chieng Kan deposits in Loey, details of the last-mentioned being unknown. The first- and second-mentioned two deposits have only such small iron ore reserves that they cannot be relied upon as the iron ore sources for an integrated iron and steel works under the conventional blast furnace process. This fact, together with the fact that no coal for coke manufacture is produced in Thailand, leads us to the conclusion that the proposed plant should employ the charcoal blast furnace or electric smelter process.

However, after comparing the expected supply and price of electric power and charcoal, we have decided to adopt the electric smelter process. As for the steel melting system, we have adopted the electric arc furnace for the Bangkok project and the open-hearth furnace for the

Phitsanulocke project, and only one set of merchant bar mill of medium and small sizes is adopted in each case to reduce the capital cost and to increase feasibility of the plant.

The outline of the recommended plan is as shown in Table 1.

Table 1

Item	Bangkok Project	Phitsanulocke Project
Supply source of ore	Uem Kruem	Chien Kan
Fe content of ore to be supplied	41%	57%
Ore reserves of mine	4,800,000 t	10,000,000 t
Estimated life of mine	45 years	78 years
Pig iron mfg. facilities	50 t electric pig smelter x 2 sets	70 t electric pig smelter x 3 sets
Annual production of pig iron	36,000 t	72,000 t
Steel mfg. facilities	30 t electric arc furnace x 2 sets	55 t open-hearth furnace x 3 sets
Annual production of steel ingot	72,000 t	130,000 t
Rolling facilities	Merchant bar mill x 1 set	Merchant bar mill x 1 set
Annual production of finished steel	54,000 t	100,000 t
Construction cost	562,000,000 Bahts	858,000,000 Bahts

Item	Bangkok Project	Phitsanulocke Project
Production cost per ton		
Pig iron	1,739 Bahts	1,656 Bahts
Steel ingot	2,189 "	2,124 "
Finished steel	3,091 "	2,911 "

Note: (1) The construction costs shown above do not include expenses for the development of the mines and construction of new roads and railways required for the project.

They are expected to amount to about 125,000,000 Bahts for the Bangkok project, but no estimate is presentable for the Phitsanulocke project as no data is available for the situation there.

(2) Even if the amount of iron ore reserves at Khao Thap Khwai iron mine is confirmed to be 600,000 t by future prospectings, the existing facility of the Siam Cement Company will be sufficient to handle it.

II. Supply of raw materials and demand for iron and steel products

(1) Iron ore and other materials

a. Iron ore

Several of the well-known iron ore deposits are outlined as follows:

(i) Uem Kruem (Kanchanaburi)

This deposit is situated in a hilly district located 55 km to the northwest of Kanchanaburi city which is 130 km to the west of Bangkok. The ores are hematite and limonite qualities. Detailed prospection conducted by Krupp of West Germany has led to confirmation that the average Fe content of the ore is 41% and the amount of ore reserve 4,800,000 t. A 55-km new railway line will have to be constructed to take out the ore.

(ii) Khao Thap Khwai (Lop Buri)

This deposit is located at a point 70 km to the northeast of the charcoal blast furnace of the Siam Cement Company. It is situated along the highway. The ore type is hematite and limonite. Fe content is 48 - 66% and the amount of reserve is 50,000 - 60,000 t. The estimate of ore reserves is expected to increase with further prospectings.

(iii) Chieng Kan (Loey)

This deposit is located at a point 320 km to the northeast of Phitsanulocke City, east of Skothai, noted for its old ruins. A new 100 km road will have to be built to carry out the ore. Though no complete investigation has been made yet, the deposit is credited by several authoritative sources as embracing a comparatively large reserve with high Fe content. Its Fe content grade is optimistically estimated to be 45% and the total reserve 10,000,000 t. The report by the Krupp predicts that the ore may contain more or less of pyrite.

b. Manganese ore

Though some manganese ore is required for pig smelting, it can be sufficiently supplied from Sattahip situated to the south of Bangkok. Ferromanganese required for steel refining will have to be imported.

c. Limestone

As limestone is produced at many places in Thailand as in Japan, there is no problem in its acquisition from the domestic market.

d. Fluorspar

It is easy to obtain fluorspar as it is produced at a place to the south of Lamphoon and a large part of it is now being exported to Japan. About 2 kgs of fluorspar is necessary for each ton of steel.

e. Reducing agent

The choice of carbon source to be used as the reducing agent of iron ore is the most important problem in iron and steel production. However, as no caking coal is produced in Thailand, it is not recommendable to build a large blast furnace. Charcoal has been the only household fuel in all parts of Thailand including the vast city of Bangkok. However, there is no possibility of a continuous bulk supply of charcoal for the charcoal blast furnace unless the household fuel is changed from charcoal to lignite. Taking this situation into consideration, too, we have decided to employ the electric pig smelting method that consumes only half the amount of charcoal required by the blast furnace.

f. Electric power

The two 70,000 kw generators at the Yanhee Hydro Power Station are expected to start operation shortly. When all generators (8 sets) at that station start operation, the unit price of power is expected to become about 40 Satang. Since, the electric pig smelting method cannot be employed unless this price is reduced to less than 20 Satang, the cost calculation has been made on the assumption that the power charge will be reduced to 20 Satang.

g. Cooling water

A sufficient amount of cooling water can be obtained, as the project site has been chosen taking into consideration the convenience of river transportation as well as supply of cooling water.

h. Labor

Native laborers are expected to be almost the same as Japanese workers in character and physical constitution. It is expected that there will be an ample supply of laborers.

(2) Demand for iron and steel products

Thailand is importing about 240,000 tons of iron and steel products each year, and about the same amount of iron and steel manufactured products are estimated imported each year. Therefore, consumption of iron and steel products seems to be about 10 kg per capita per year.

The demand for iron and steel is estimated by experts to increase to 450,000 tons in 1970 and 600,000 tons in 1980, which we think are very appropriate.

240,000 tons of steel now being imported consists of

bars and flats in the same amount.

Steel sheet manufacturing facilities are becoming larger in scale in recent years all over the world. They are now especially powerful and their products are so cheap that small-scale facilities cannot compete with them. Therefore, it is necessary to limit the product of the proposed iron and steel mill in Thailand only to merchant bars and to limit their sizes so as to cut down their cost of production.

III. Selection of project site for integrated iron works

The most important consideration to be made in planning an iron and steel mill is the cost of transportation of raw materials. Also, the site chozen must have a sufficient supply of electric power and water. The mill should most preferably be situated near the sources of raw materials to obtain their easy transportation by dependable existing transportation facilities. If the works is to be built in an inland area, it is most preferable that the plant is located in a river port area in view of possibility of using river transportation, but it is the best that the site may be in the sea port area if there were big necessity of importation of supplies from abroad.

The amount of transportation necessary for the operation of the projected works should be calculated with the bulk capacities of the raw materials and products instead of their weight. From this point of view, conditions of transportation of charcoal become the most important factor in deciding the site of the works.

Taking into consideration the above conditions, we have chosen the following three sites for final selection:

1. Bangkok project

It is provided with harbor, river and railway transportation facilities in addition to being located in a major consuming area of steel products. Though it has a sufficient supply of electric power and cooling water, too, the disadvantage is the weakness of the ground of the river banks at the lower stream of the Chao Phraya river.

2. Phitsanulocke project

Its location on a railway line and on the bank of the Nan river, one of the largest tributary of the Maenam, plus the Friendship Highway running on the east side makes this site a very favorable one for an inland iron and steel works.

Although it is far from the Chieng Kan deposit from where iron ore will be supplied, it will have an easy supply of charcoal.

Bangkok is about 400 km from here by rail.

3. Thaluang project

No new roads and railway will have to be built.

The iron ore deposit is only 70 km from here by a highway. However, it is situated a little too far from the supply area of charcoal. Bangkok is about 150 km by rail or highway.

Even if the reserve of the Khao Thap Khawai deposit is confirmed to be 600,000 tons by future investigations, building of an iron smelting facility of a daily production capacity of more than 50 tons or a steel refining facility of a daily production capacity of more than 100 tons

is not recommendable.

IV. Bangkok Project

1. Outline of facilities

As this works depends on the Uem Kruem deposits with an iron ore reserve of 4.8 million tons of 41% Fe content, if we take the life of the deposit as 50 years, the daily production capacity of pig iron cannot set but 100 tons.

a. Pig smelting facilities

50-ton electric pig smelter x 2 sets

Charcoal will be used as the reducing agent

Amount of production 100 tons per day

or 36,000 tons per year

b. Steel refining facilities

The charging ratio of pig iron and scrap iron will be 50 : 50

30-ton electric arc furnace x 2 sets

Amount of steel ingot production

200 tons per day

or 72,000 tons per year

c. Rolling mill facilities

Rolling mill for medium- and small-sized bars will be built.

Medium and small size merchant bar mill x 1 set

Amount of production 150 tons per day

or 54,000 tons per year

d. Accessorial facilities such as for power receiving and distribution, water supply, drainage, testing and storage.

2. Estimated capital cost

The capital cost is expected to be 560,000,000 Bahts including the expenses required for the ore dressing and sintering facilities but not including the expenses for development of the mine and expenses for transportation facilities up to the rail-head.

3. Estimated cost of production

a.	Pig iron	1,739 Bahts per ton
b.	Steel ingot	2,189 " "
c.	Finished steel	3,091 " "

V. Phitsanulocke project

1. Facilities and capacity

This mill is based on the Chien Kan deposit. And, assuming that its Fe content is 45%, ore reserve 10 million tons and ore supply life about 75 years, pig smelting facilities with a daily production capacity of 200 tons of pig iron can be built.

a. Pig smelting facilities

70-ton electric pig smelter x 3 sets

Charcoal will be used as the reducing agent

Amount of production of pig iron

200 tons per day
or 72,000 tons per year

b. Steel refining facilities

55-ton open-hearth furnace x 3 sets

The charging ratio of scrap iron will be 50%.

Steel ingot production 400 tons per day
or 130,000 tons per year

c. Rolling mill facilities

Medium and small size bar mill x 1 set

Finished steel production 300 tons per day

or 100,000 tons per year

2. Estimated capital cost

The total capital cost is estimated to amount to 858,000,000 Bahts including the expenses for the ore dressing and sintering facilities and for the construction work but not including the expenses for the development of the mine and construction of roads.

3. Estimated cost of production

a.	Pig iron	1,656 Bahts per ton
b.	Steel ingot	2,124 " "
c.	Finished steel	2,911 " "

VI. Other considerations

It will be worth studying the feasibility of a steel mill provided with a set of facilities capable of manufacturing steel ingot depending on imported pig iron and steel scrap and rolling them into 100,000 tons of finished steel bars per year.

It is also worth considering the feasibility of manufacturing steel sheets or bars using imported semi-finished products such as hot coils, billets and wire rods instead of raw materials.

Some examples of such are given below:

1. Bangkok steel project based on imported pig iron and steel scrap

A study on the steel mill capable of producing

100,000 tons of steel ingot per year using imported pig iron and steel scrap is outlined as follows:

a. Outline of facilities

(i) Steel refining facilities

60-ton open-hearth furnace x 2 sets

Steel ingot production 100,000 tons per year

(ii) Rolling mill facilities

Merchant bar mill x 1 set

Finished steel production

75,000 tons per year

b. Estimated capital cost

420,000,000 Bahts

c. Estimated cost of production

2,800 Bahts per ton

Though the cost of production is lower than that of the project using domestic iron ore, more than 80% of the cost requires foreign currency spending.

2. Bangkok sheet mill project of cold rolling

This project depends on imported hot coil, an intermediate product in the case of sheet production by the continuous hot strip mill, and manufactures steel sheets by using one roll stand of 4-high cold reversing sheet mill. The most appropriate capacity of it is considered to be 60,000 - 120,000 tons per year.

The thickness of the hot coil is about 3.2 mm, from which will be obtained steel sheets by repeated rollings under the cold state instead of hot.

a. Outline of facilities

4-high cold reversing mill facilities

Annual production capacity 60,000 tons

b. Estimated investment costs

130,000,000 Bahts

c. Estimated cost of production

The working expenses will be almost the same as those in Japan. There is expected to be a big difference in the cost of packing and transportation of hot coil as well as in the customs duties as compared with galvanized iron sheets. The cost of production will be affected considerably depending on the CIF cost of the hot coil.

(Note) The steel sheets manufactured by this mill will be supplied to the two galvanizing factories already in operation in Bangkok.

VII. Conclusion

1. On iron ore reserves

According to past certain investigation data, the iron ore deposits that can be developed are the following three:

a. Uem Kruem

Fe content 41%, estimated reserve 4,800,000 tons (by Krupp Survey).

As it is a low grade ore, dressing and sintering are required. A new 55-km highway or railway must be constructed. The ore reserve is too small to build an ordinary coke blast furnace.

b. Khao Thap Khwai

This deposit was estimated to have an iron ore reserve of 700,000 tons when it was discovered, and as 100,000 tons has since then been exploited, 600,000 tons is estimated to be remaining for further mining. As its Fe

content is very high and it has a good accesibility, we would like to prospect this deposit as soon as possible to confirm the exact amount of its ore reserve.

c. Chien Kan

This deposit has not been investigated yet on a full scale. But, judging from the external appearance of its outcrop, etc., this deposit seems to be a comparatively valuable ore bed.

The ore reserve is estimated to be 1 million tons or 34 million tons depending on different investigators.

Here, we assumed its ore reserve to be 10 million tons and Fe content 45%. If the reserve is confirmed to be different from these figures by future prospectings, this plan should naturally be revised.

2. On integrated iron and steel project

a. In the Bangkok project, we have adopted the electric pig smelting process using charcoal as the reducing agent. But the low Fe content of the ore makes the electric power consumption per ton so high and further electric power charge per unit so high, too, that the cost of production will become so high that the products cannot compete with their foreign counterparts in price. However, the foreign currency spending will be about 50% of the total cost of production. The scanty ore reserve and poor accesibility to charcoal supply make the iron and steel project of more than 100,000 tons per year unprofitable.

b. We have mapped out the Phitsanulok project assuming that the Chien Kan deposit may be found worthy of developing in the future. The electric pig smelting process

using charcoal as the reducing agent is adopted. The open-hearth method is employed as there will be a large production of steel ingot.

The cost of production will be higher than in the case of (i), but the foreign currency spending is similarly 50% as in the case of (i). The mill site is far from both the mine and the consumer markets, and located off the power transmission network of the Yanhee Hydro Power station, but still it is located close to the charcoal supply source, that is a splendid circumstance.

This project has been mapped out on an optimistic assumption of the deposits. Therefore, this project requires reappraisal after confirmation of accurate ore reserve in the future.

c. When ore from the Khao Thap Kwai deposit is used, facilities with a pig smelting capacity of more than 50 tons per day cannot be built, even when its reserve is confirmed as being 600,000 tons.

3. Overall conclusion

(1) The project shown in (1) is not recommended because profitable operation cannot be expected even when the electric power charge is lowered to half the present level.

(2) The projects shown in (2) and (3) are meaningless under the present situation and cannot be executed unless the ore reserve is confirmed accurately.

Annexed Figures

Fig. 1 (1) (2) (3) (4) (5) (5')

Ban Mae Tuen Manganese Mine, A. Li, Lamphoon

Fig. 2 (1) (2) (3)

Ban Huey Haen Manganese Prospect, A. Li, Lamphoon

Fig. 3 (1) (2) (3) (4) (4') (4")

Ban Pa Phai Manganese Prospect, A. Li, Lamphoon

Fig. 4 Ban Ma Kok Manganese Prospect, A. Pa Pasang, Lamphoon

Fig. 5 (1)

Ban Wanz Roan Manganese Prospect, A. Ban Hong, Lamphoon

Fig. 6 (1) (2)

Ban Pha Phlu Fluorite Mine, A Ban Hong, Lamphoon

Fig. 7 (1) (2)

Ban Doi Tao Fluorite Mine, A. Hot, Chieng Mai

Fig. 8 (1) (2)

West Ban Doi Tao Fluorite Prospect, A. Hot, Chieng Mai

Fig. 9 (1)

Tha Kun Ngen Fluorite Deposit, A. Mae Tha, Lamphoon

Fig. 10 (1) (2)

Ban Mae Laun Antimony Prospect, A. Sankanphaeng, Chieng Mai

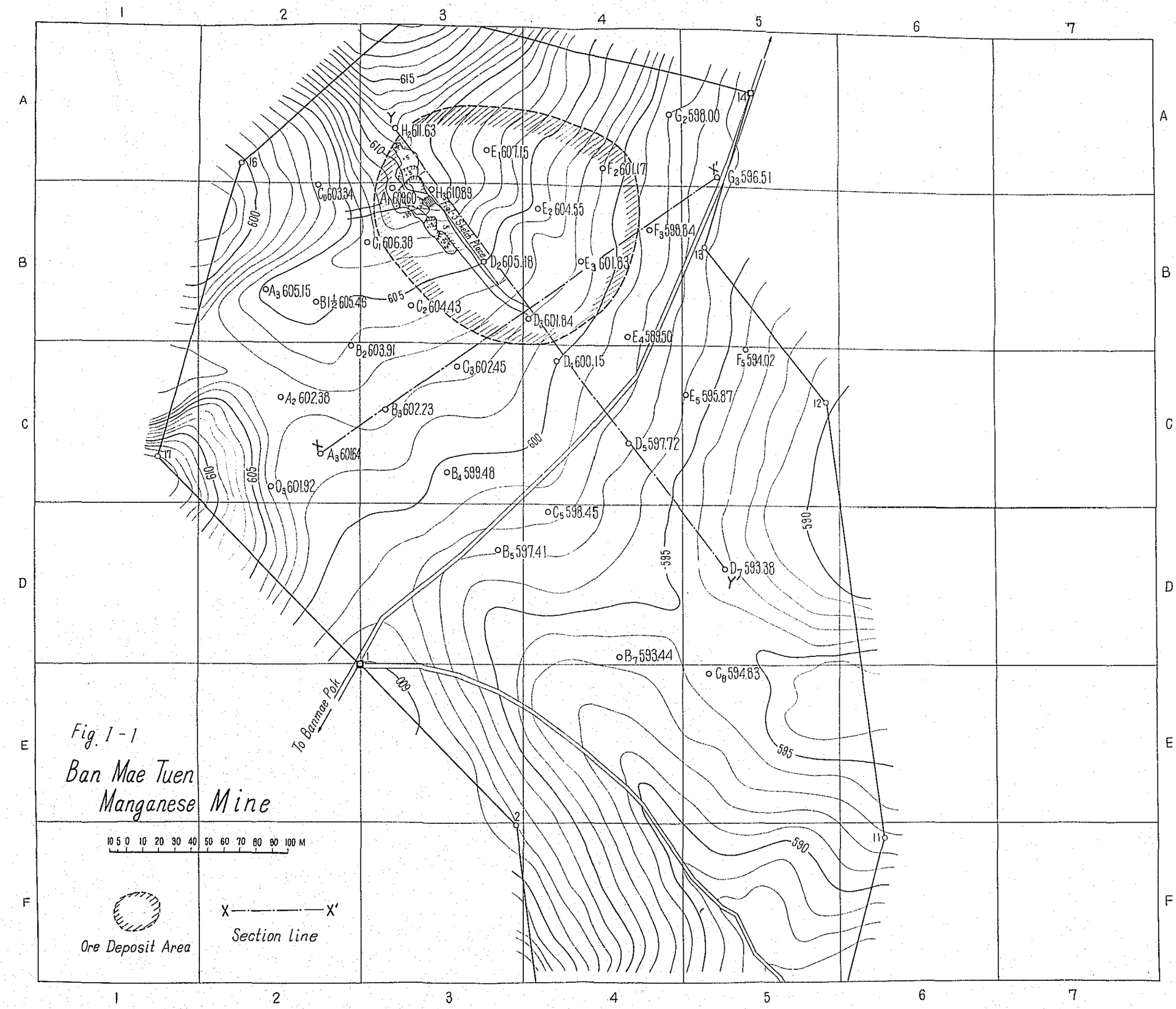

1
2
3
4
5
6
7
A
B
C
D
E
F
615
610
605
600
595
590
H2 611.63
E1 607.15
F2 601.17
G2 598.00
G3 596.51
C0 603.34
A1 604.60
H3 610.89
E2 604.55
F3 598.84
C1 606.38
D2 605.18
E3 601.83
A3 605.15
B1½ 605.46
C2 604.43
D3 601.84
E4 599.50
B2 603.91
C3 602.45
D4 600.15
F5 594.02
A2 602.38
B3 602.23
E5 595.87
A3 604.64
D5 597.72
O3 601.92
B4 599.48
C5 598.45
B5 597.41
D7 593.38
B7 593.44
C8 594.83
Ref. 3 Skeet Place
To Banmae Pok
Fig. 1-1
Ban Mae Tuen
Manganese Mine
10 5 0 10 20 30 40 50 60 70 80 90 100 M
Ore Deposit Area
X——·——·——X'
Section line

Fig. I - 2

Ban Mae Tuen Mn Deposit, Section Map

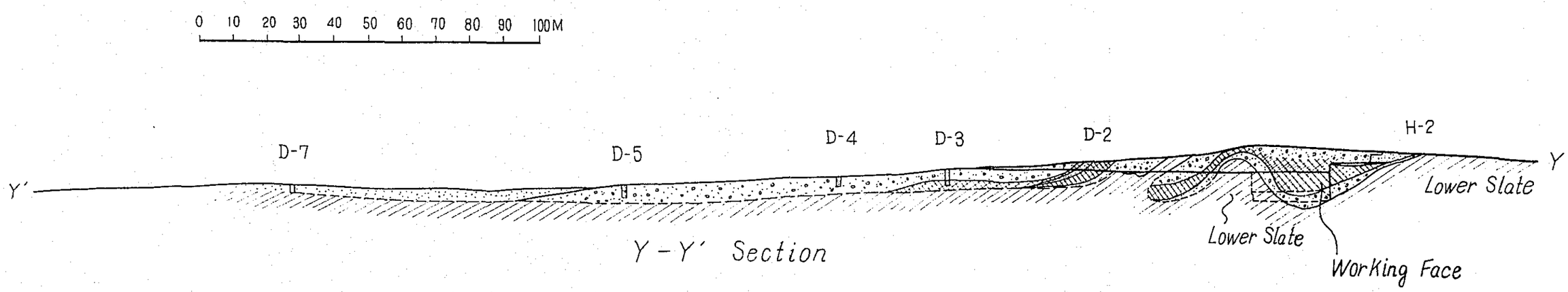


Fig.1-3 Sketch of Working Face

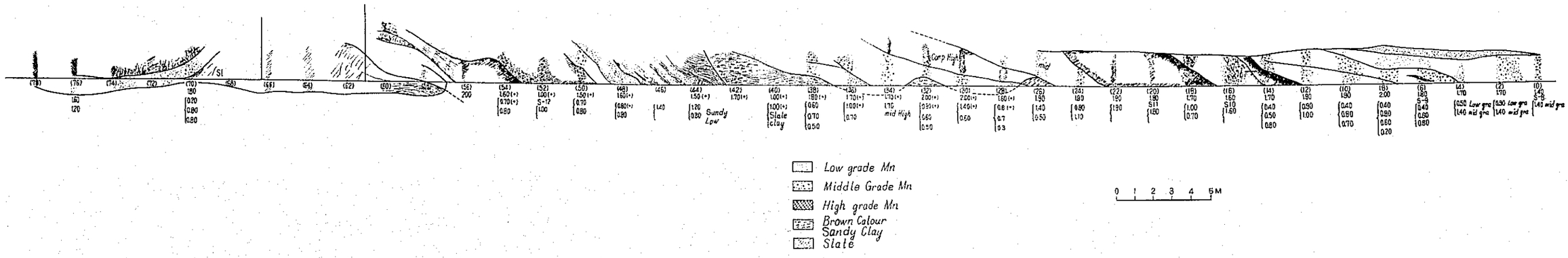
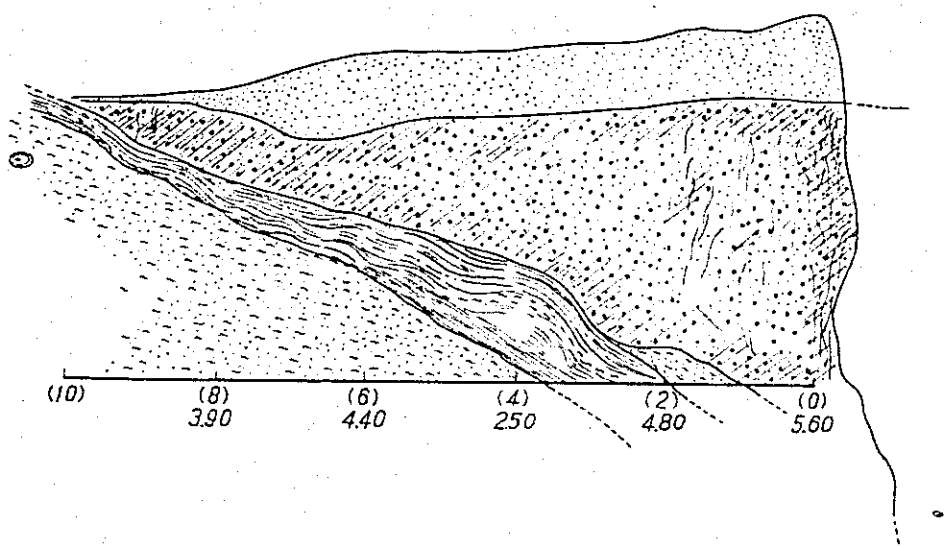


Fig.1~4 Sketch of Facing

Scale 1/100



Low grade

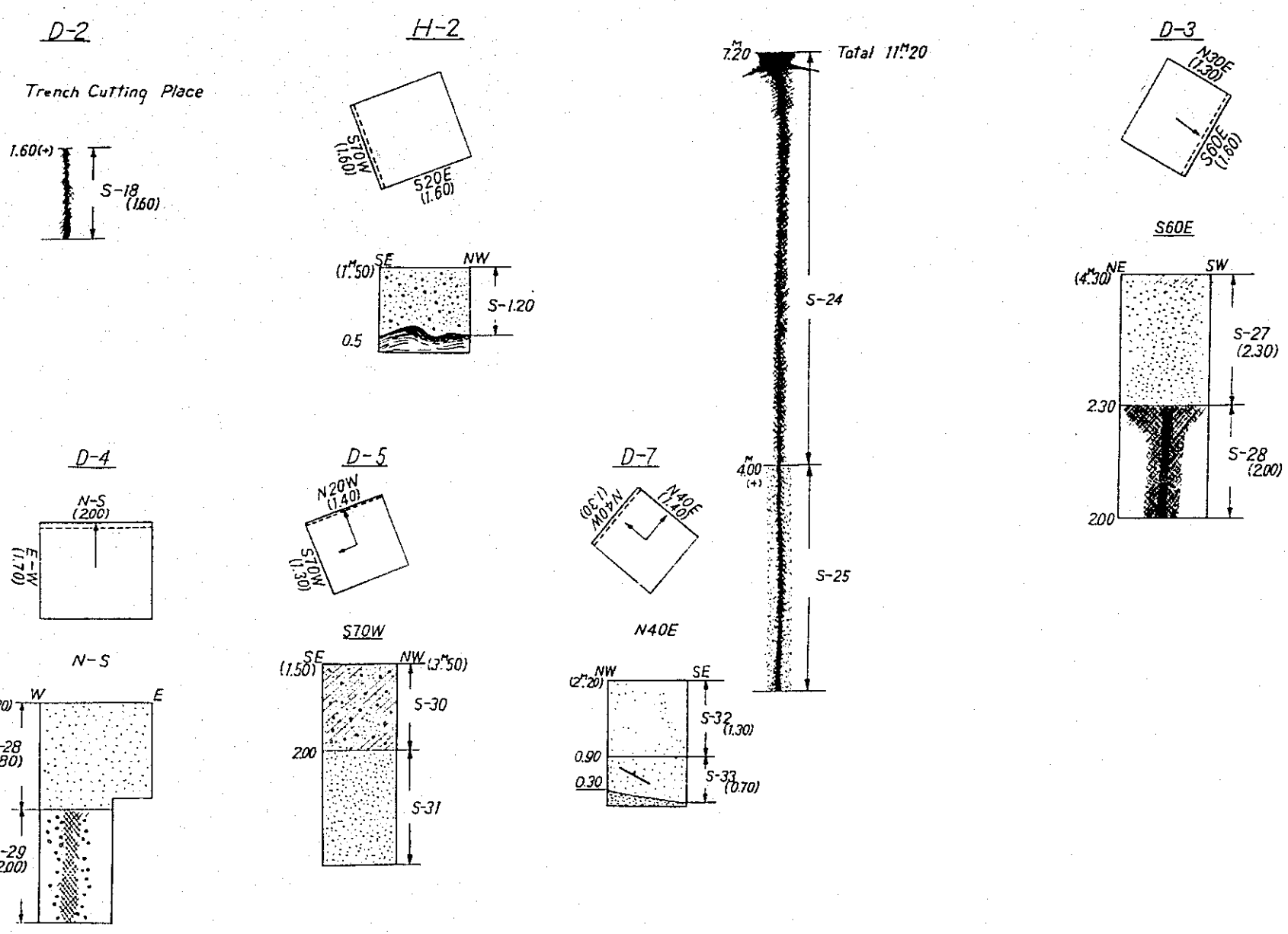
Middle grade

Pale yellowish clay

Alternated slate

Reddish clay

Fig.1~5' Ban Moe Tuen Deposits (Pit)



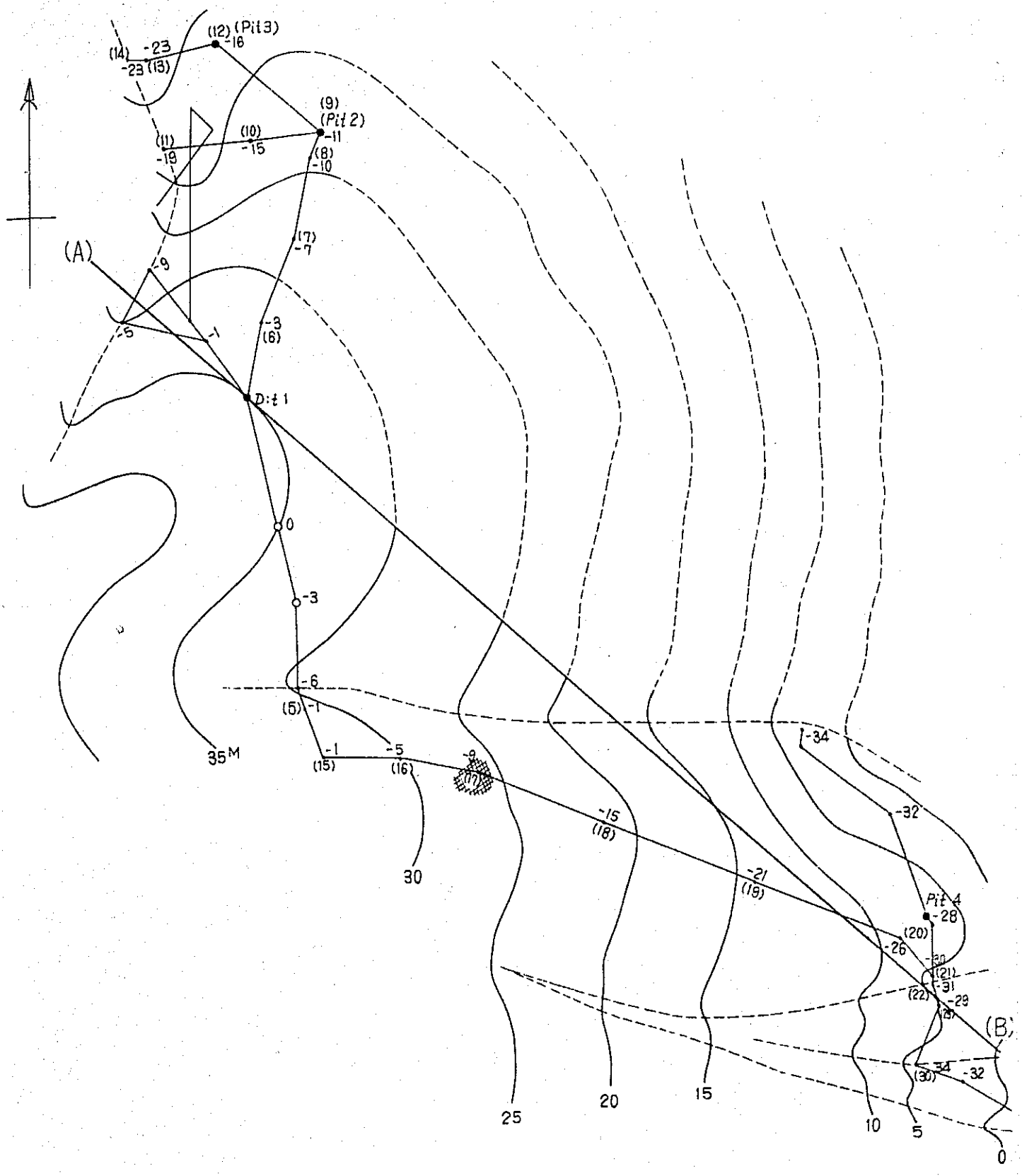


Fig 2-1 Ban Huai Haen
Manganese deposit

0 50 100M

Fig 2-2 Ban Hney Haen deposit
A-B Section

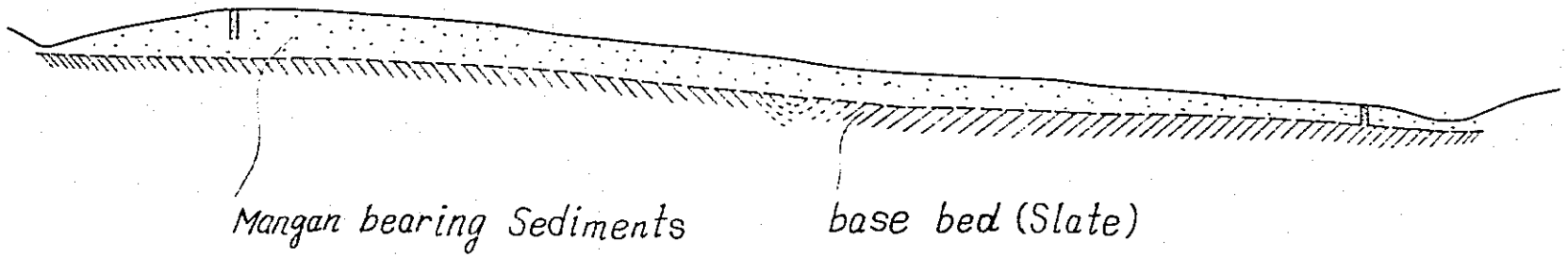
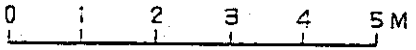
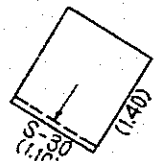


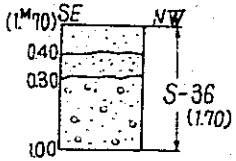
Fig. 2-3 Bam Huey Haen deposit (Mm)

Sketch of Pitting

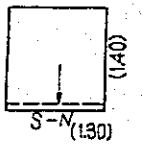




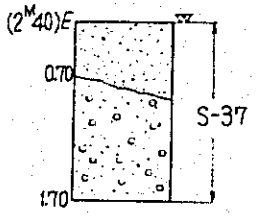
P-1



Sili Qgite



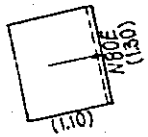
P-2



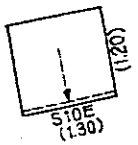
P-2

Sample from Ore Stock

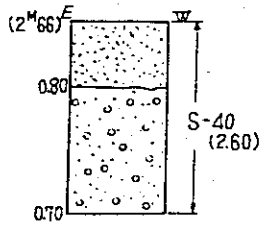
S-41



P-3

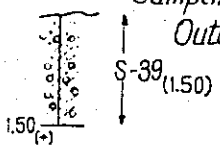


P-4



Survey Mark No.22

Sampling taen from an Outcrop in a ravine



Sandy mix.- Low grade

chert, Slate } Middle Grade

Fig. 3-1 Ban Pa Phai Mangan Deposit
Topograrhy and Ore Deposit

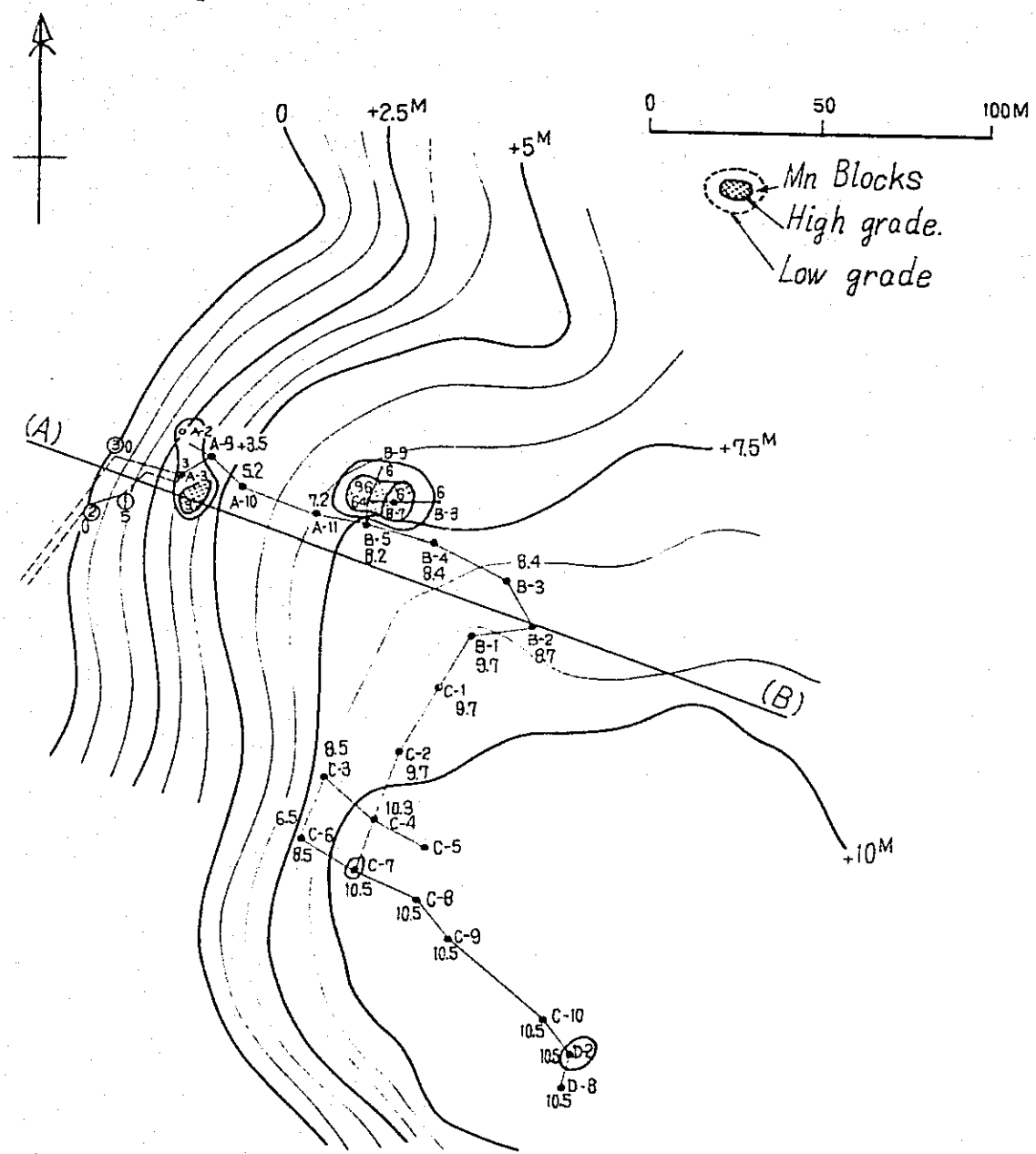
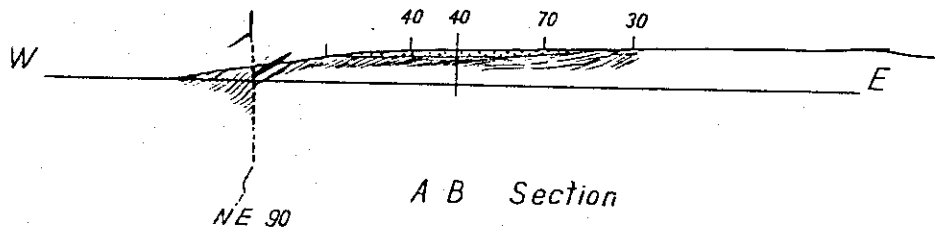


Fig.3~2 Ban Pa Phai Deposit 1/2000



A B Section

Sand. gravel bed

Slate

Manganese deposits

Fig.3-3 Ban Pa Phai Manganese Deposit

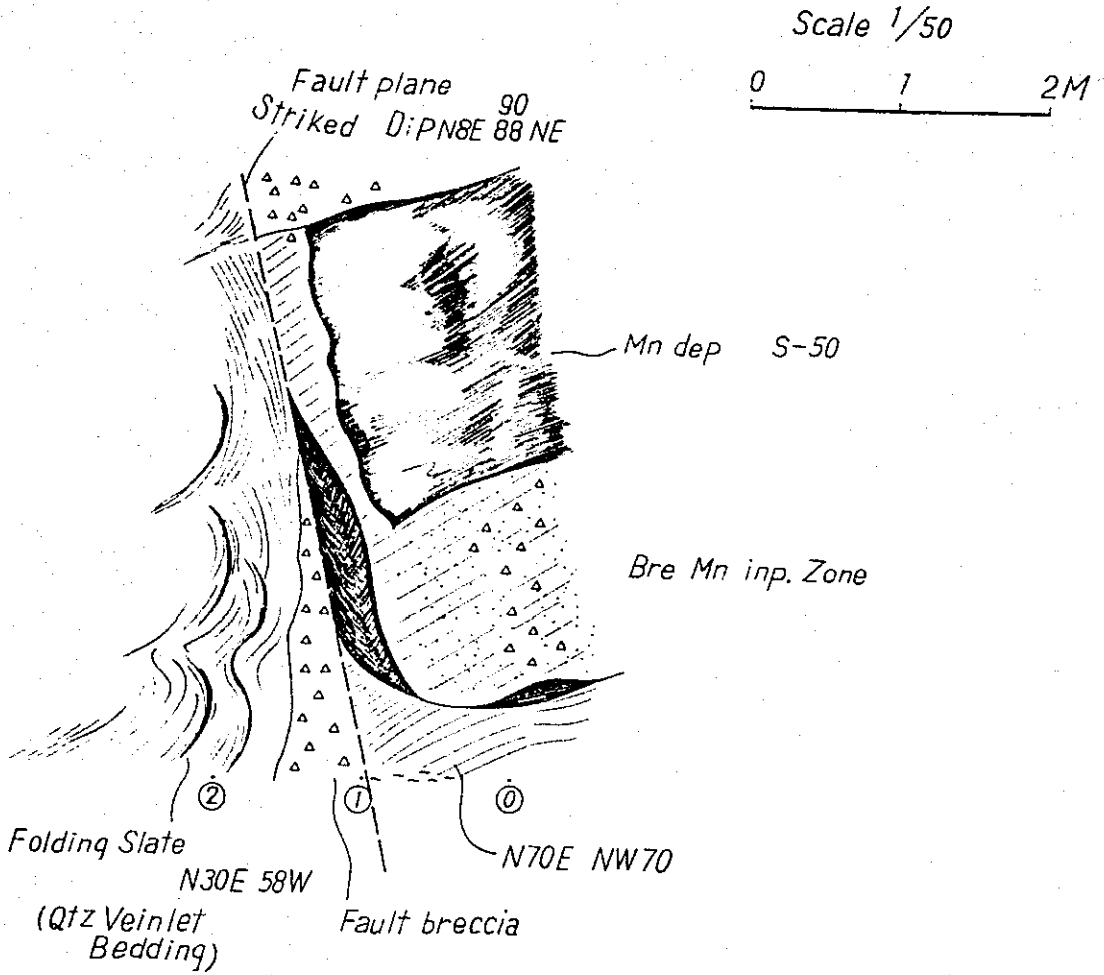


Fig.3-4 Ban - Pa - Phai (Mn) Deposit 1/100

Pit Sketch

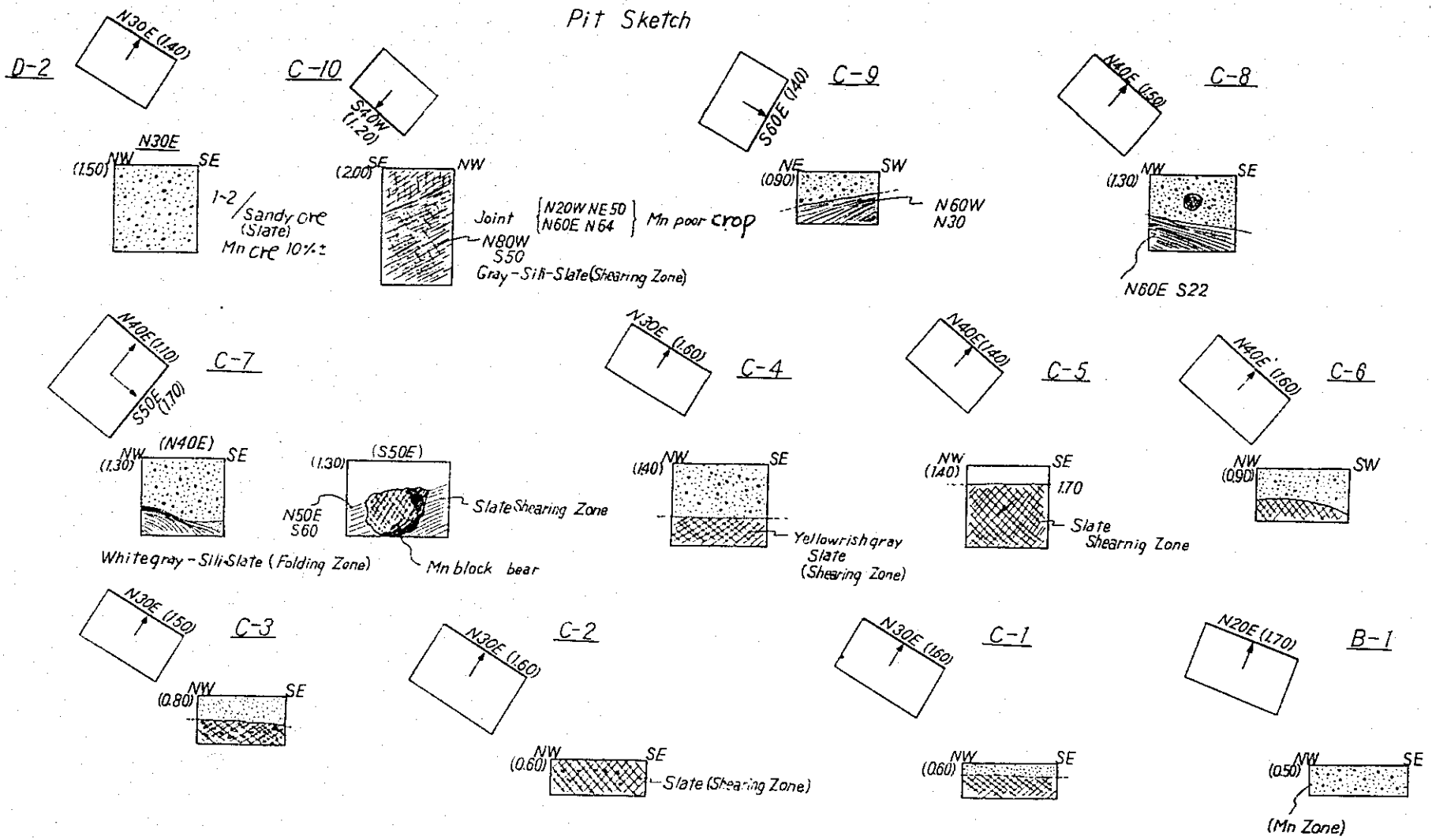


Fig.3-4' Ban Pa Phai Deposit

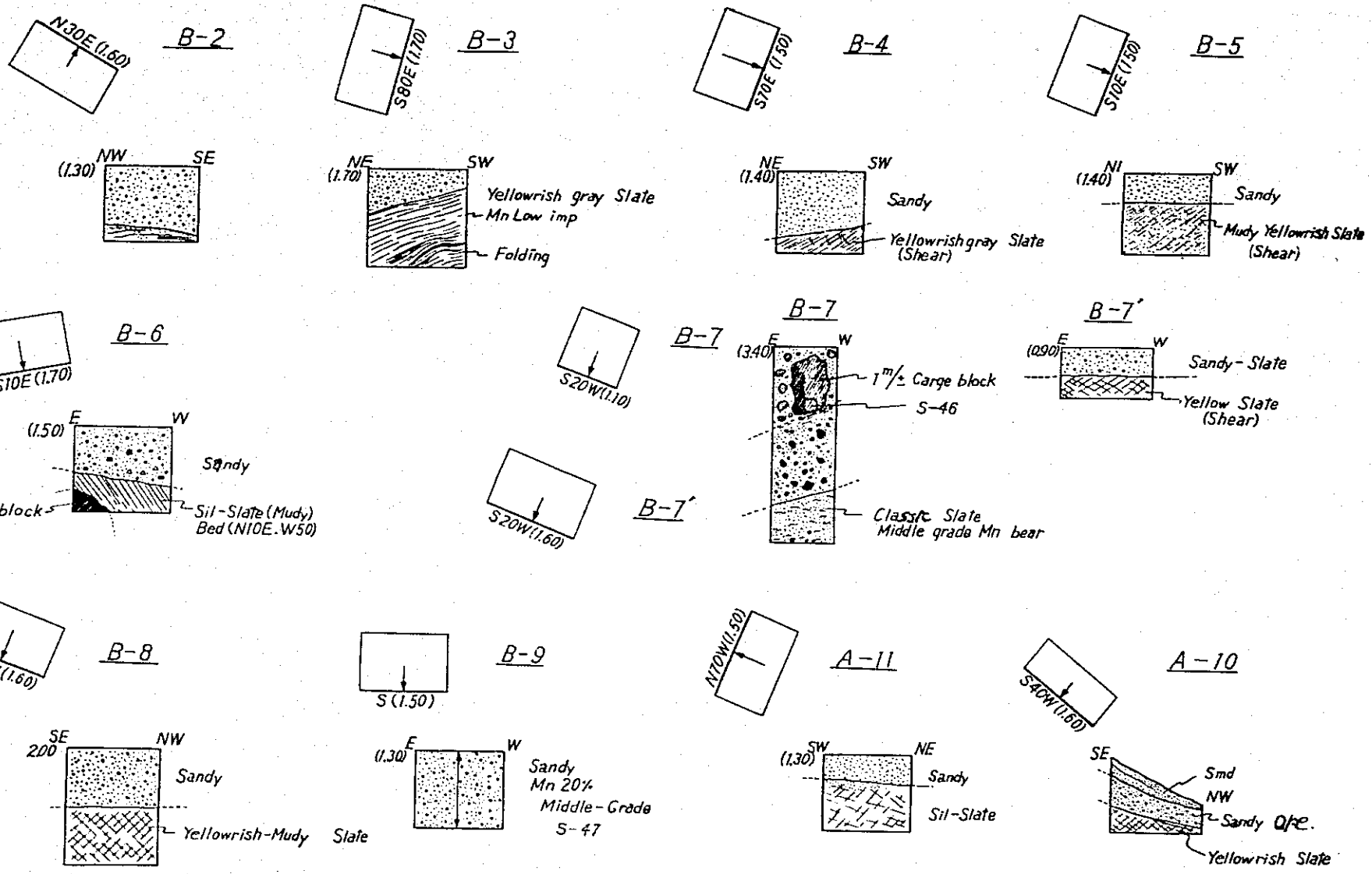


Fig. 3-4" Ban-Pa-Phai Mn Dep.

Pit Sketch

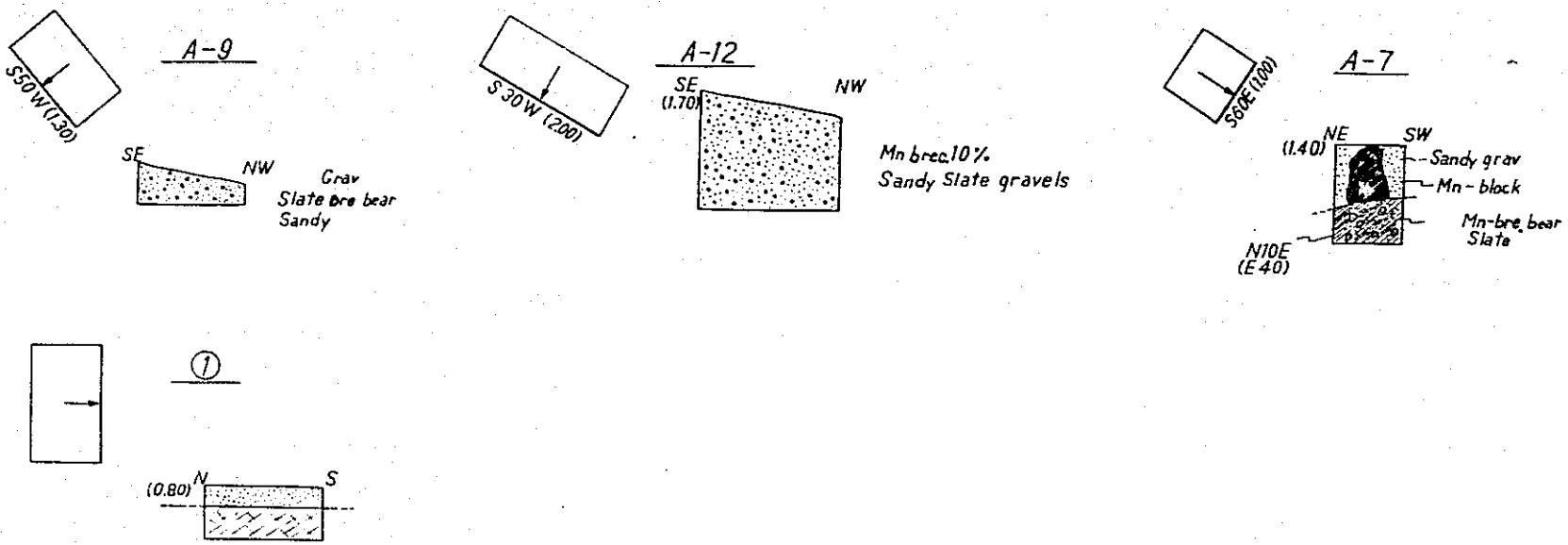


Fig.4 Ban Mokok Manganese Deposit (Trench Sketch)

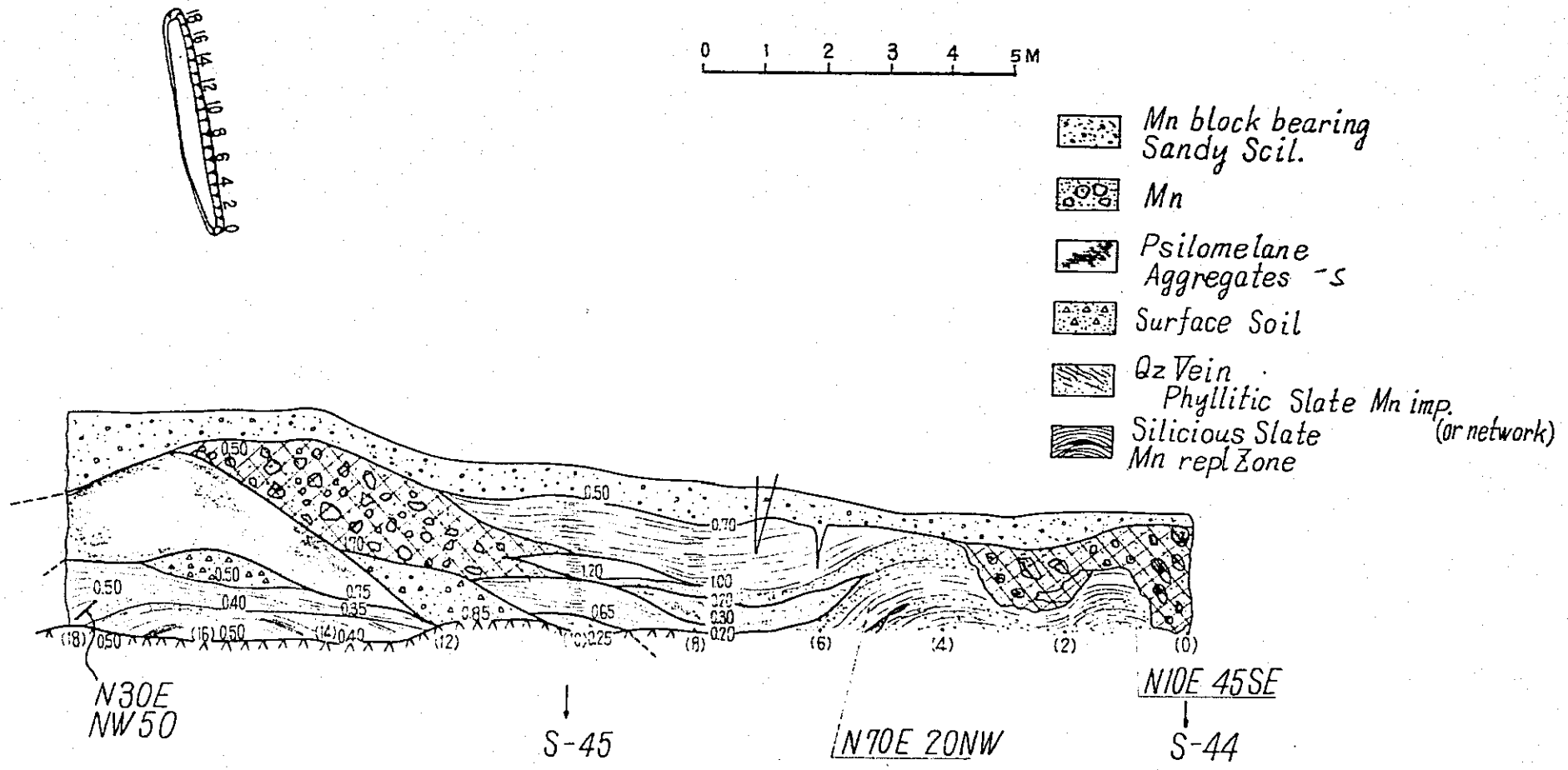
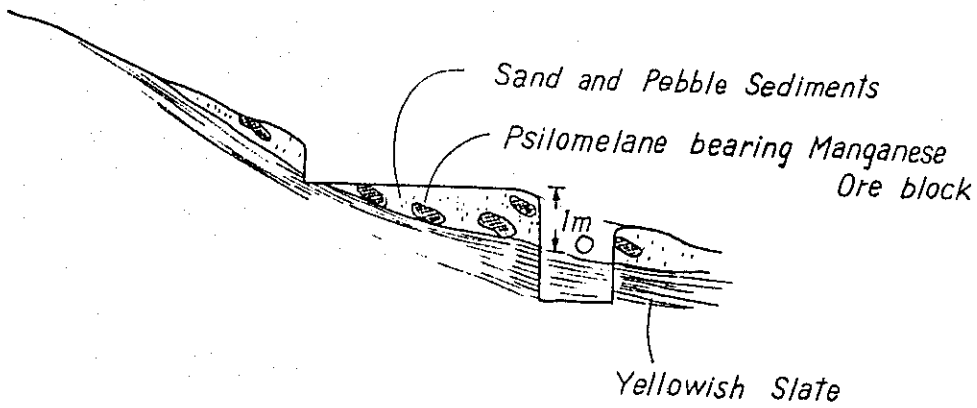


Fig.5-1 Ban Wang Roan Mn Deposit

Modified Section



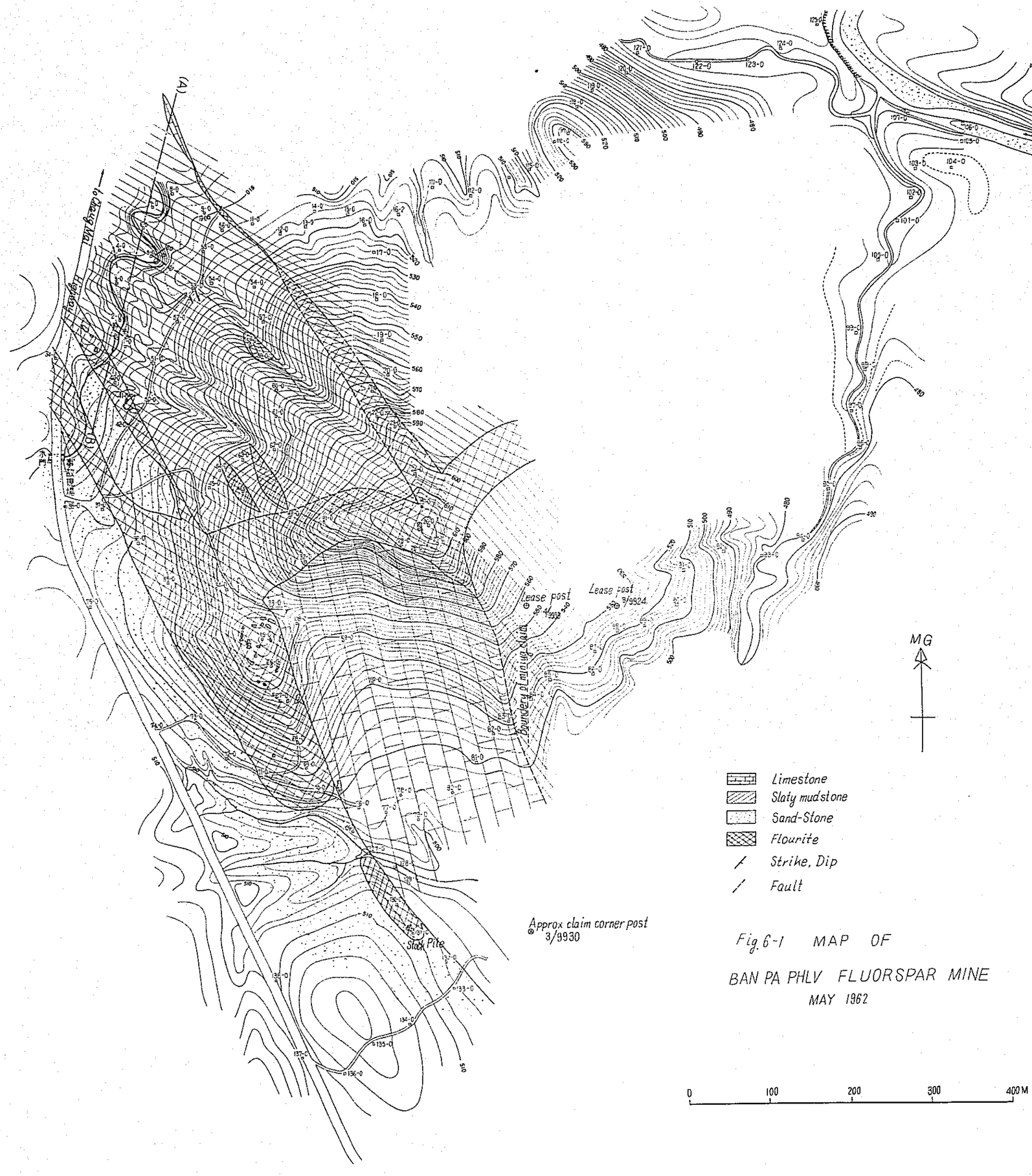
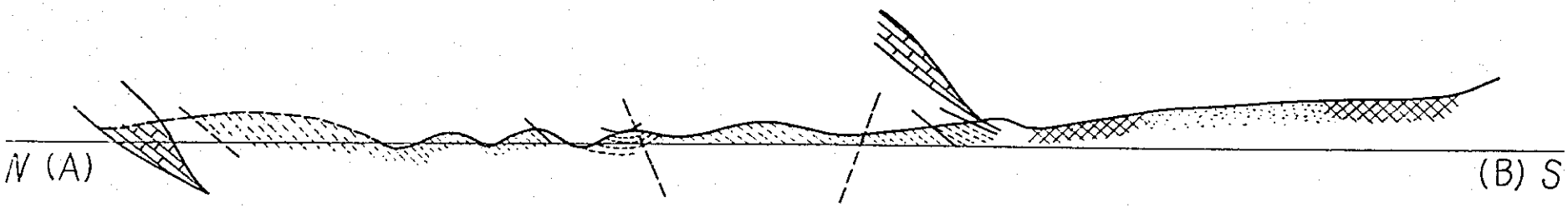


Fig. 6-1 MAP OF

BAN PA PHLV FLUORSPAR MINE

MAY 1962

Fig.6-2 Ban Pa Phlu Fluorsper deposits
N-S geological Profile Section



Lime Stone
Mudy Slate
SandStone
Fluorite

0 50 100 150 200M

Fig. 7-1 MAP OF THE DOITAO MINE

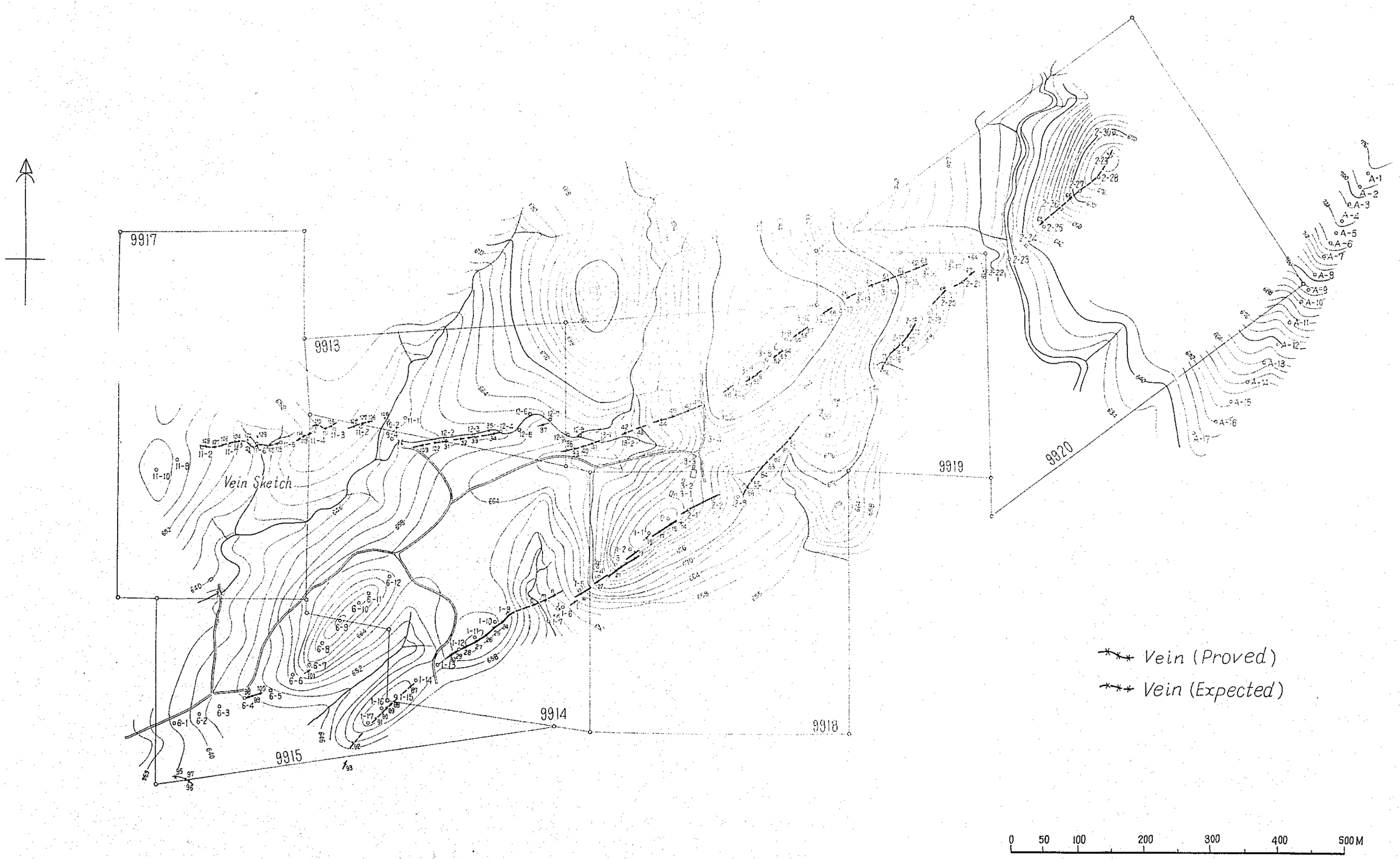


Fig. 7-2 Doi Tao Fluorite Mine
Vein Sketch Map

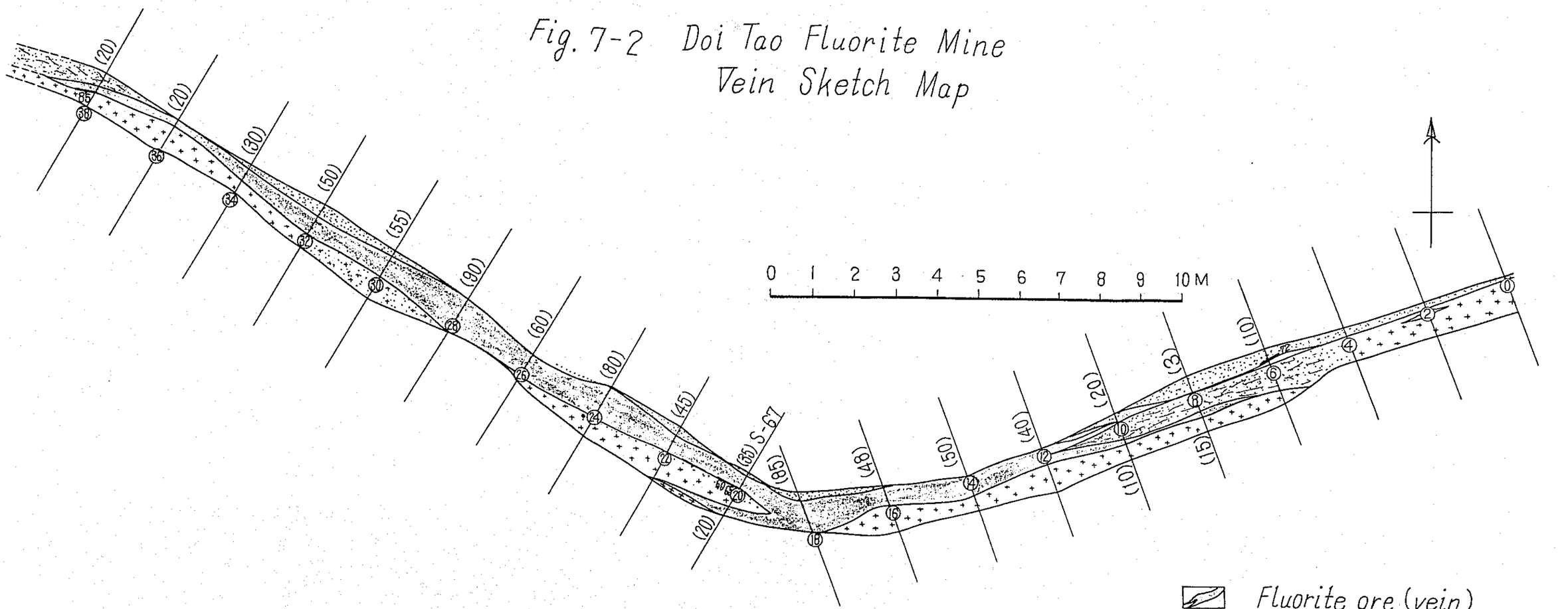


Fig.8-1

West Ban Doitao Fluorite Deposit

Topographic Map and Vein Map

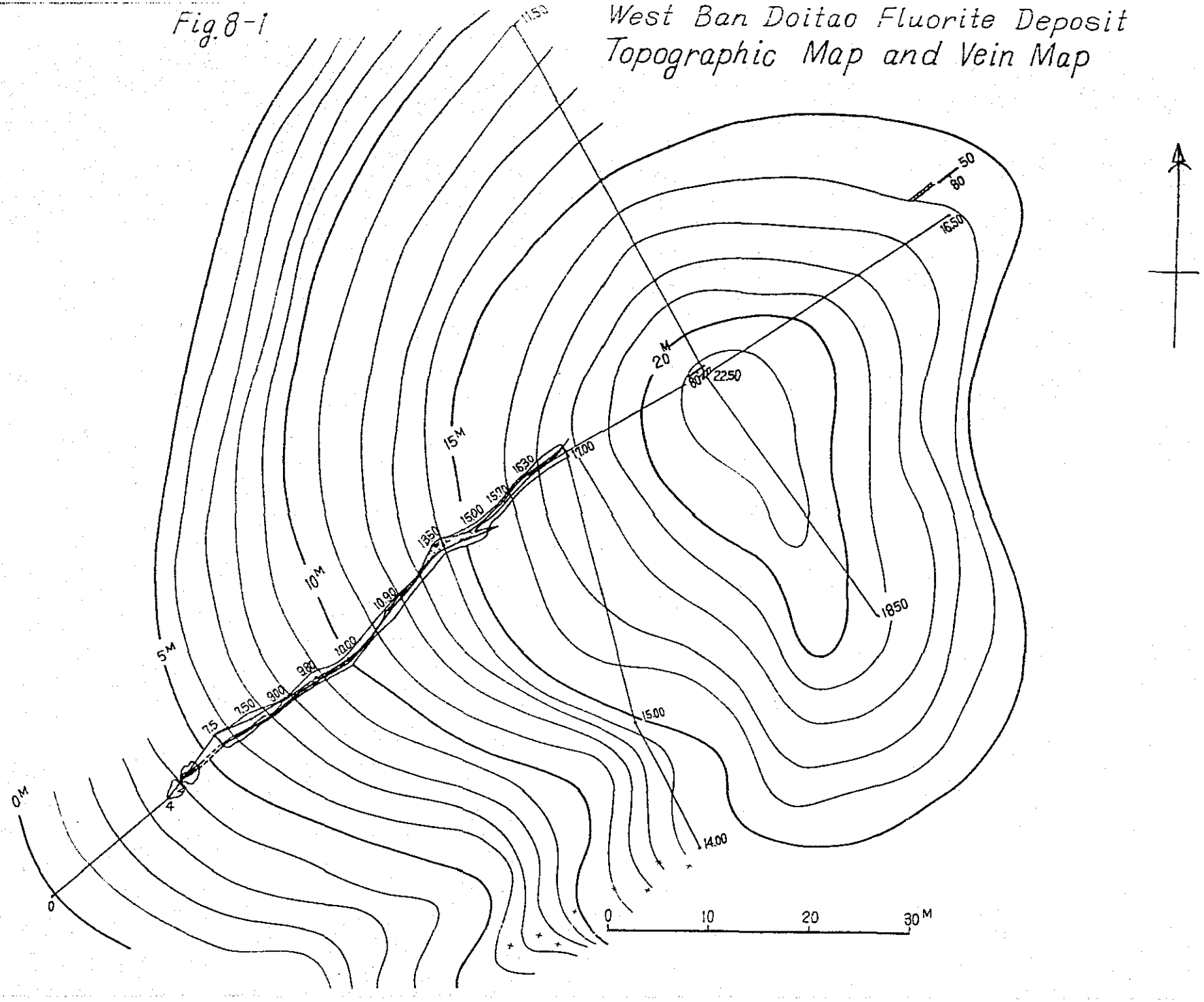


Fig. 8-2 West Ban Doi Tao Fluorite Deposit

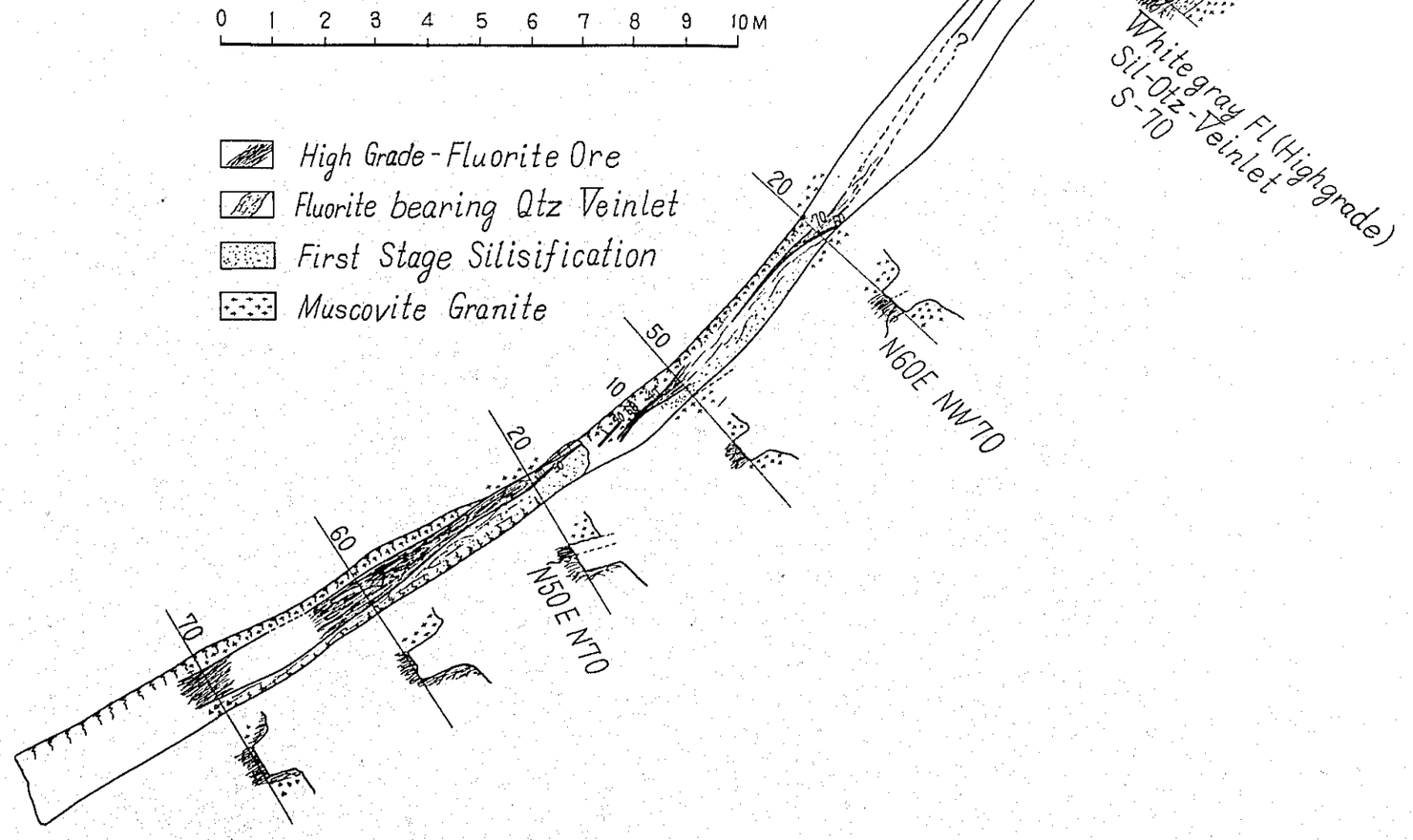


Fig.9-1 Mea Tha Tha Kun Ngoen Fluorite Deposit

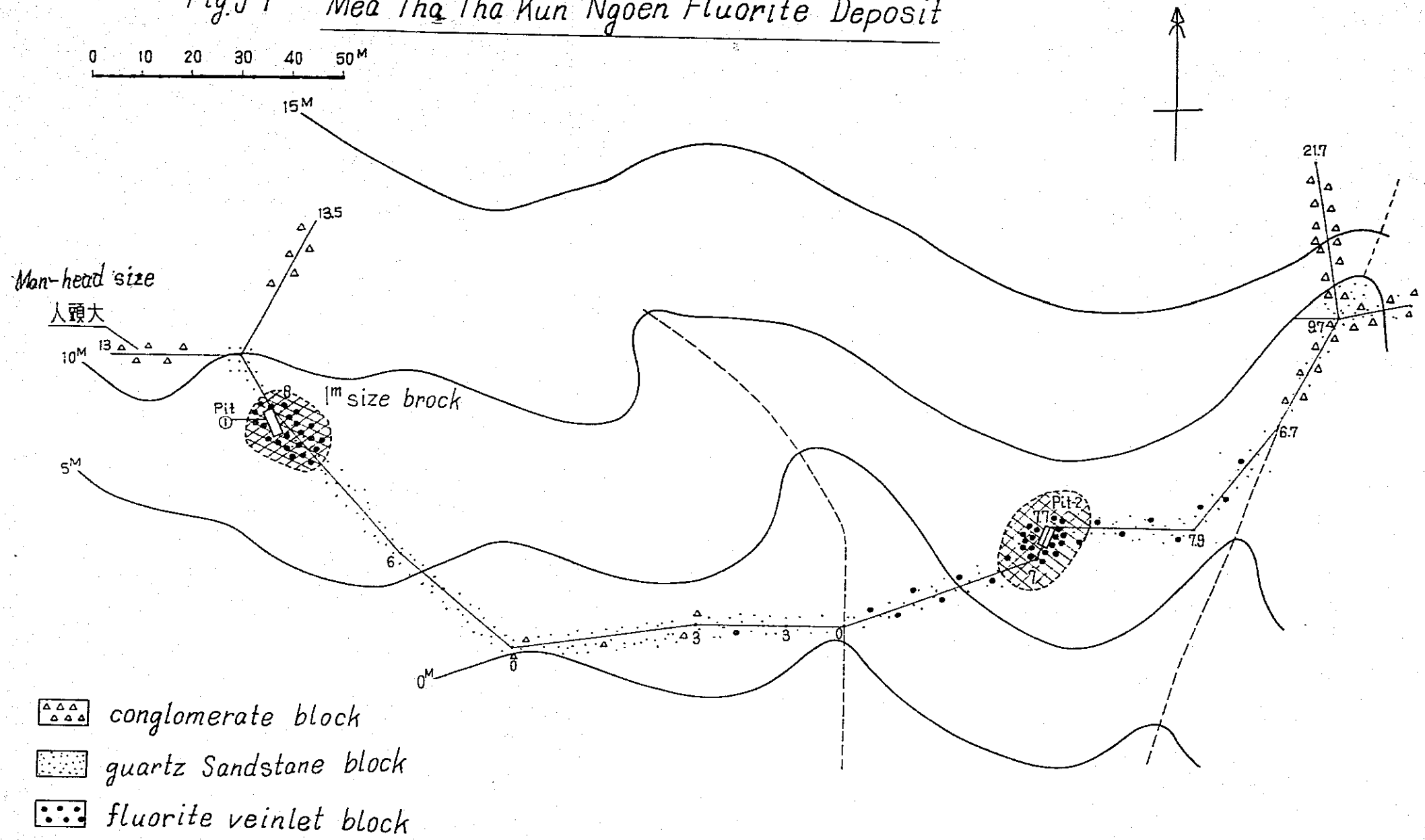


Fig. 10-1 Ban Mae Laum Stibnite Deposit

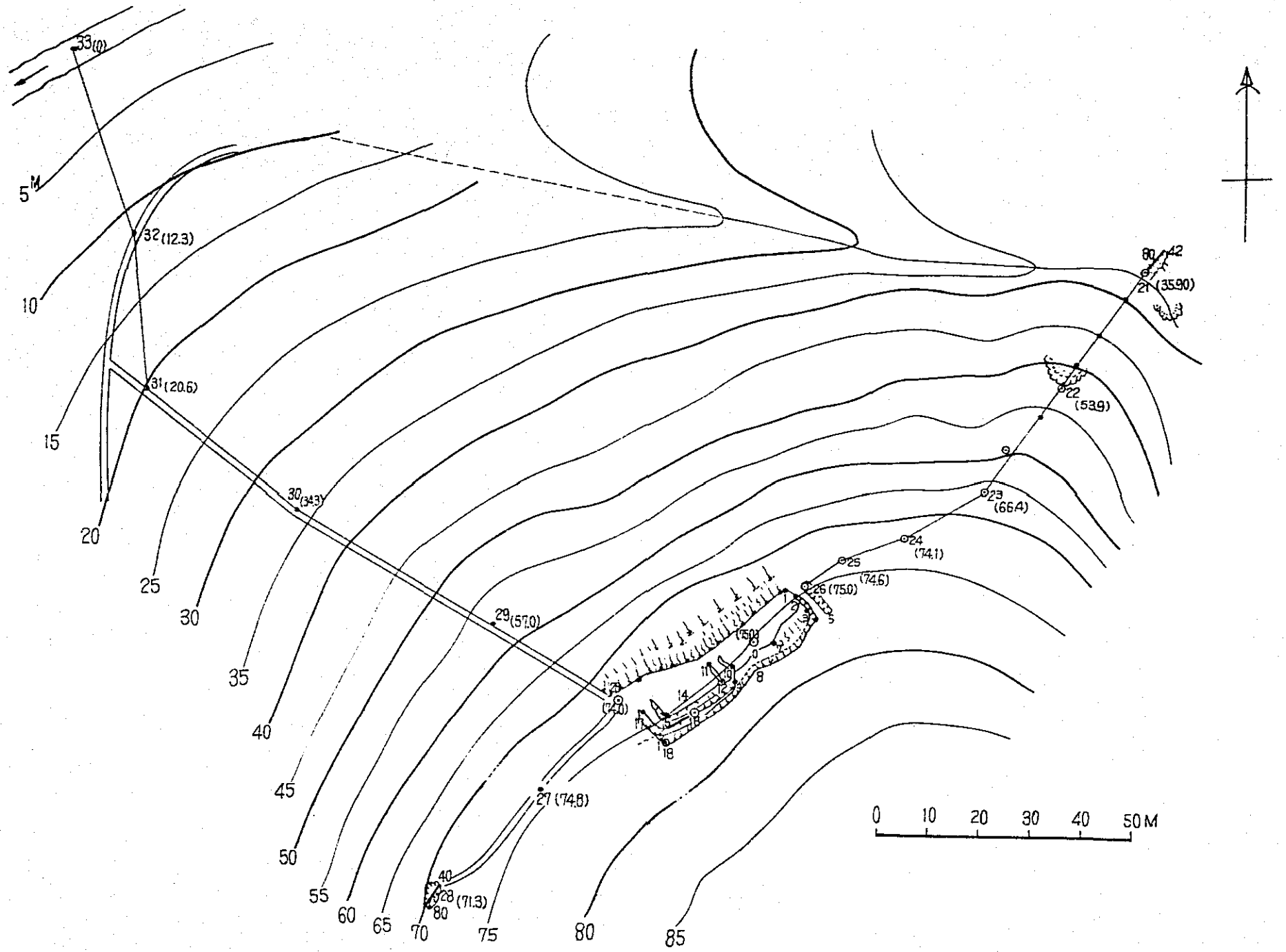


Fig. 10-2 Ban Mae Laum Stibnite deposit
Vein Sketch

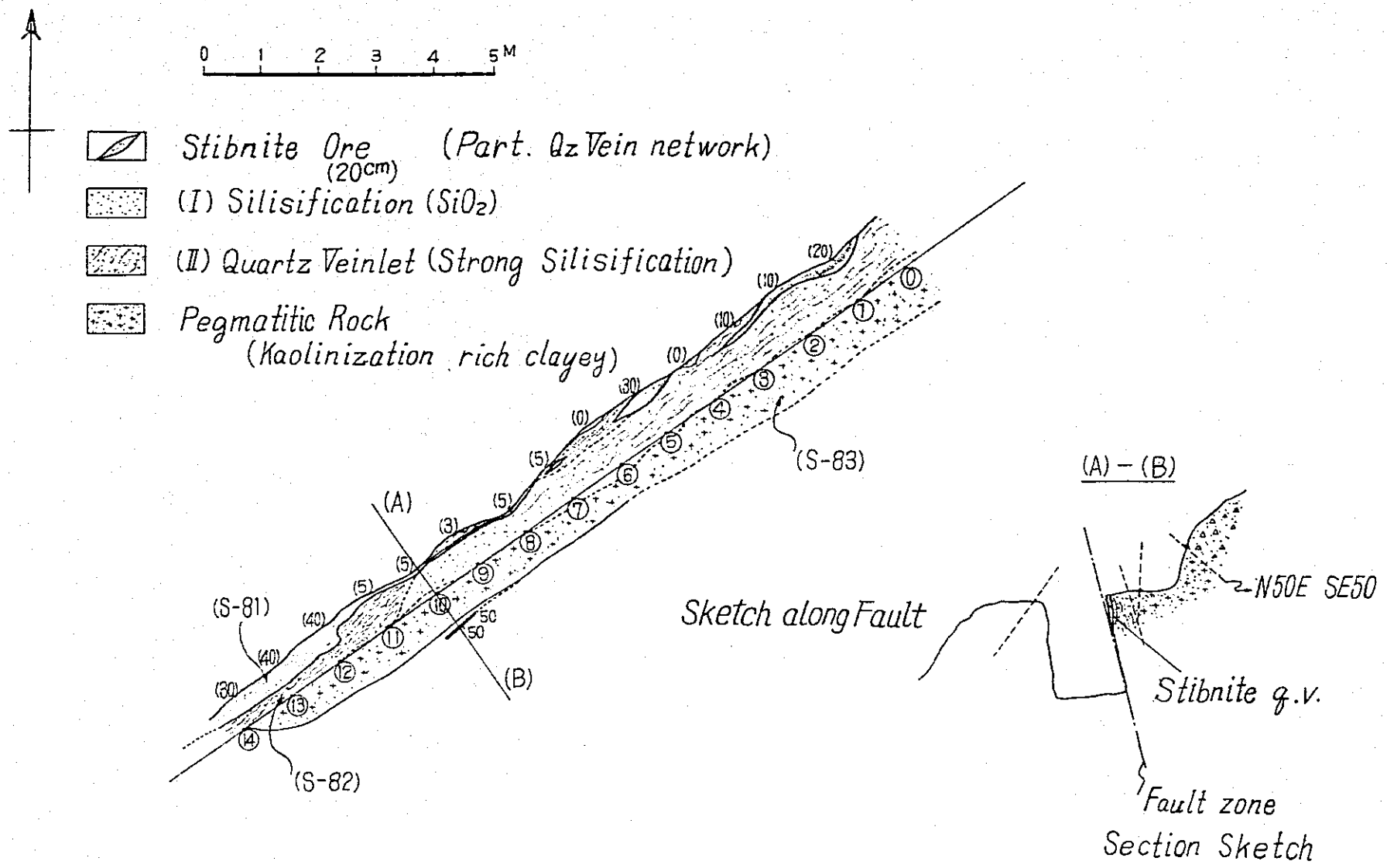


Fig.II-1 Ban Bo Kaeo Tin Mine
Bo Kaeo Sn

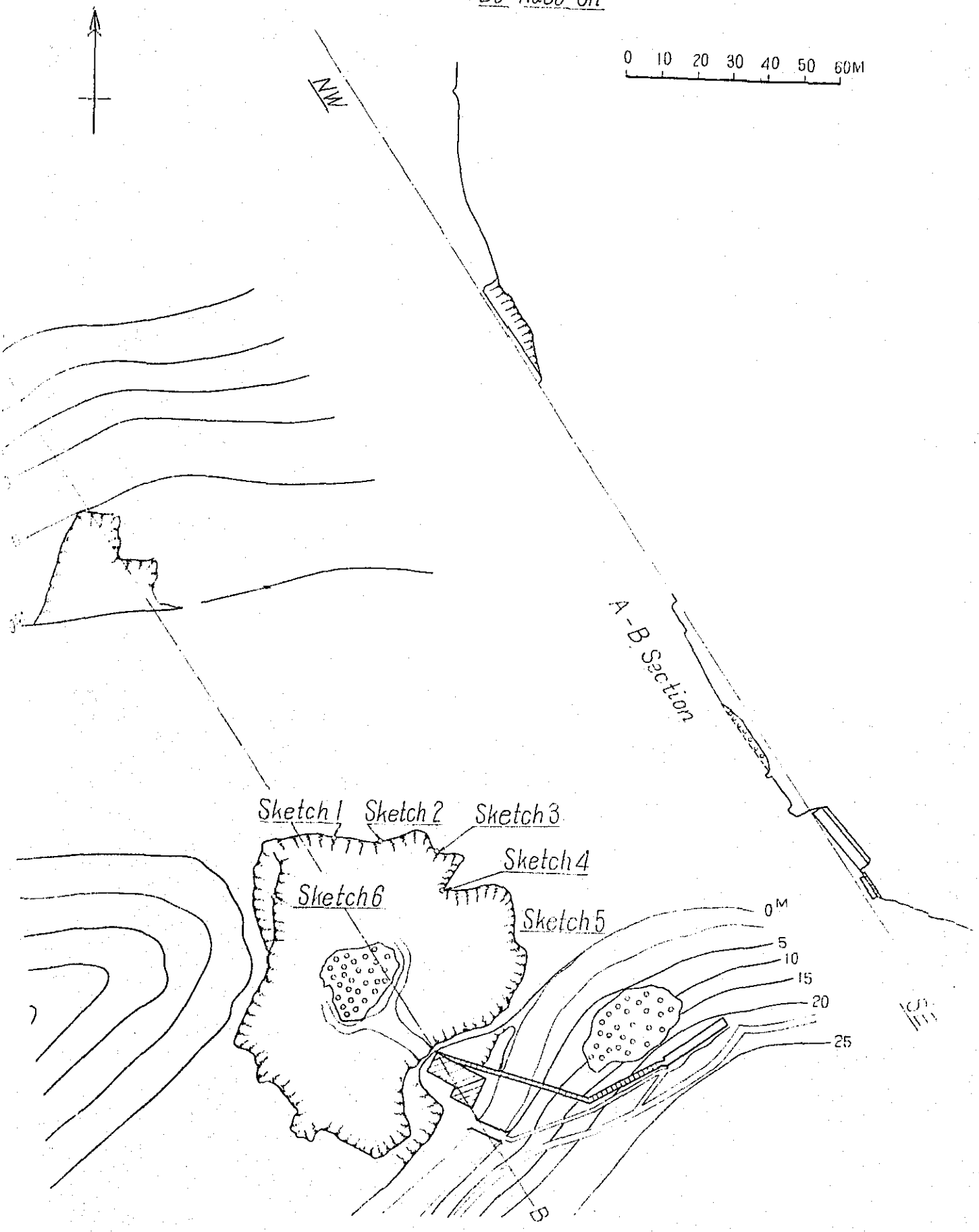
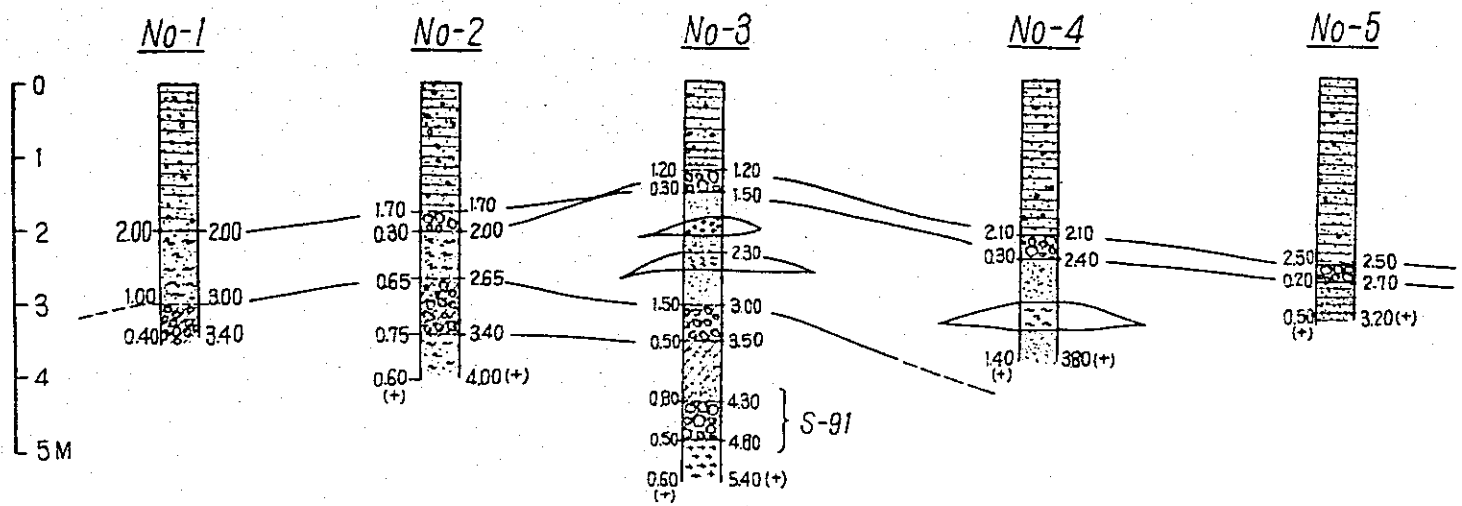
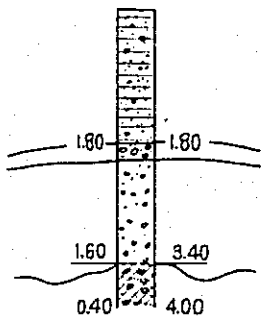


Fig. 11-2 Ban Bo Kaeo Tin deposite





Columnar Sections

- gray-brown banded Porous Sandy bed
- Black gray coarse-Sandy
- brown gray clay Zone
- Cassiterite bearing Qtz Vein block and Biotite granite gravel bed
- Biotite granite

Fig.12-1 Huay Kha Min Tin Deposite

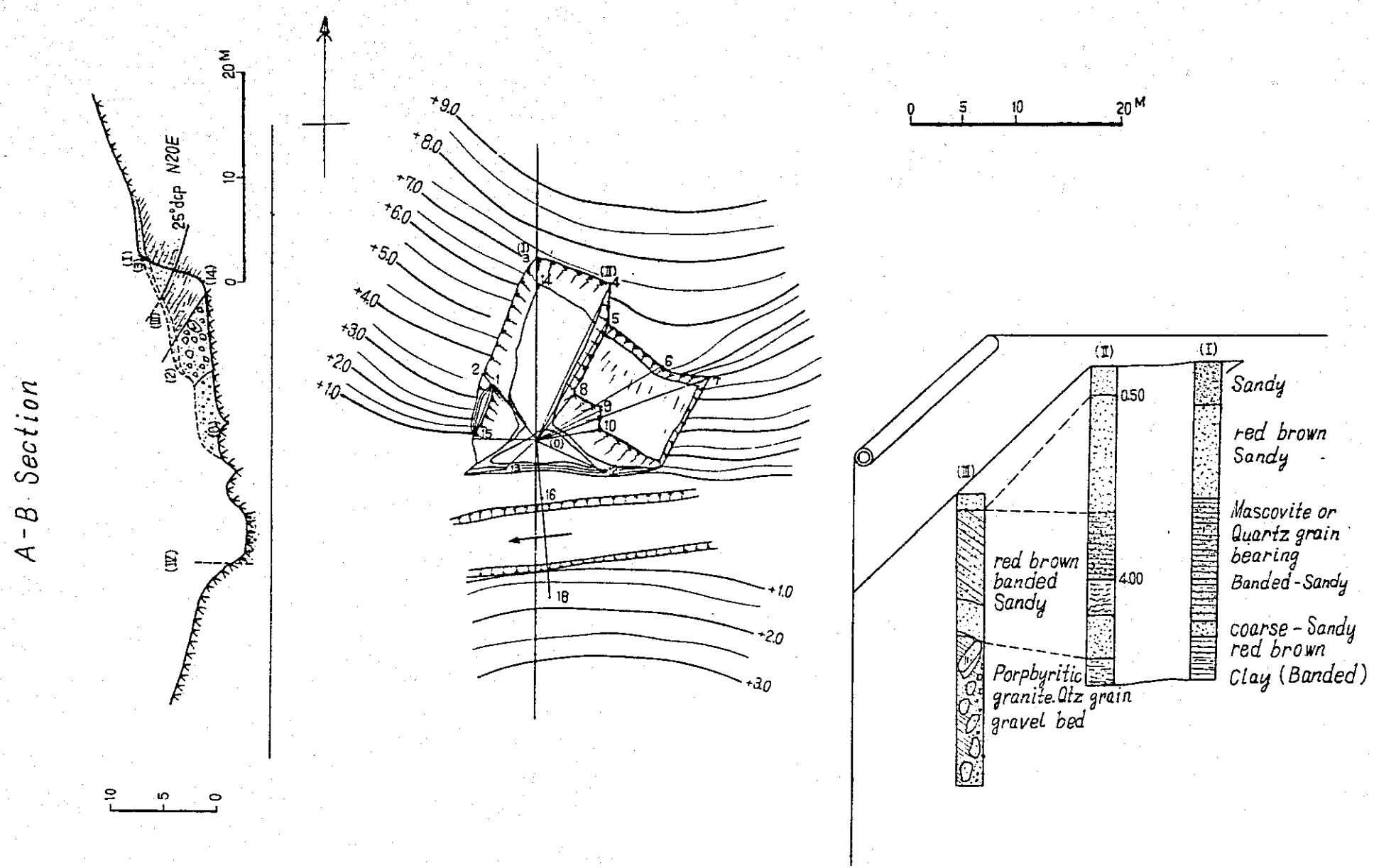


Fig. 43-1 Adai Poo Moe Barite Deposit

Topographic Map and Ore Out Crop

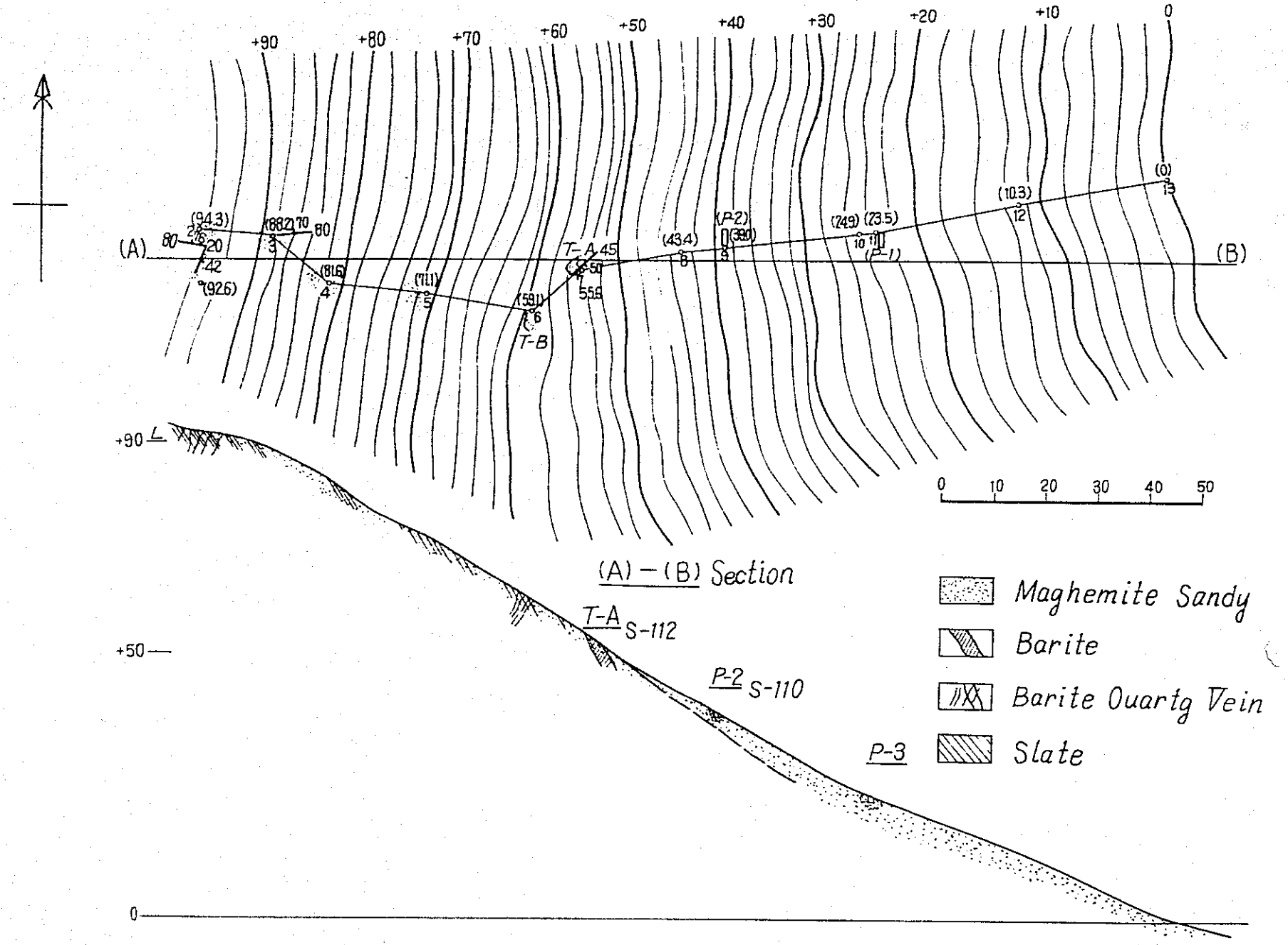


Fig.13-2 Huai Poo Mai Barite Deposits (NO.2)
Outcrop

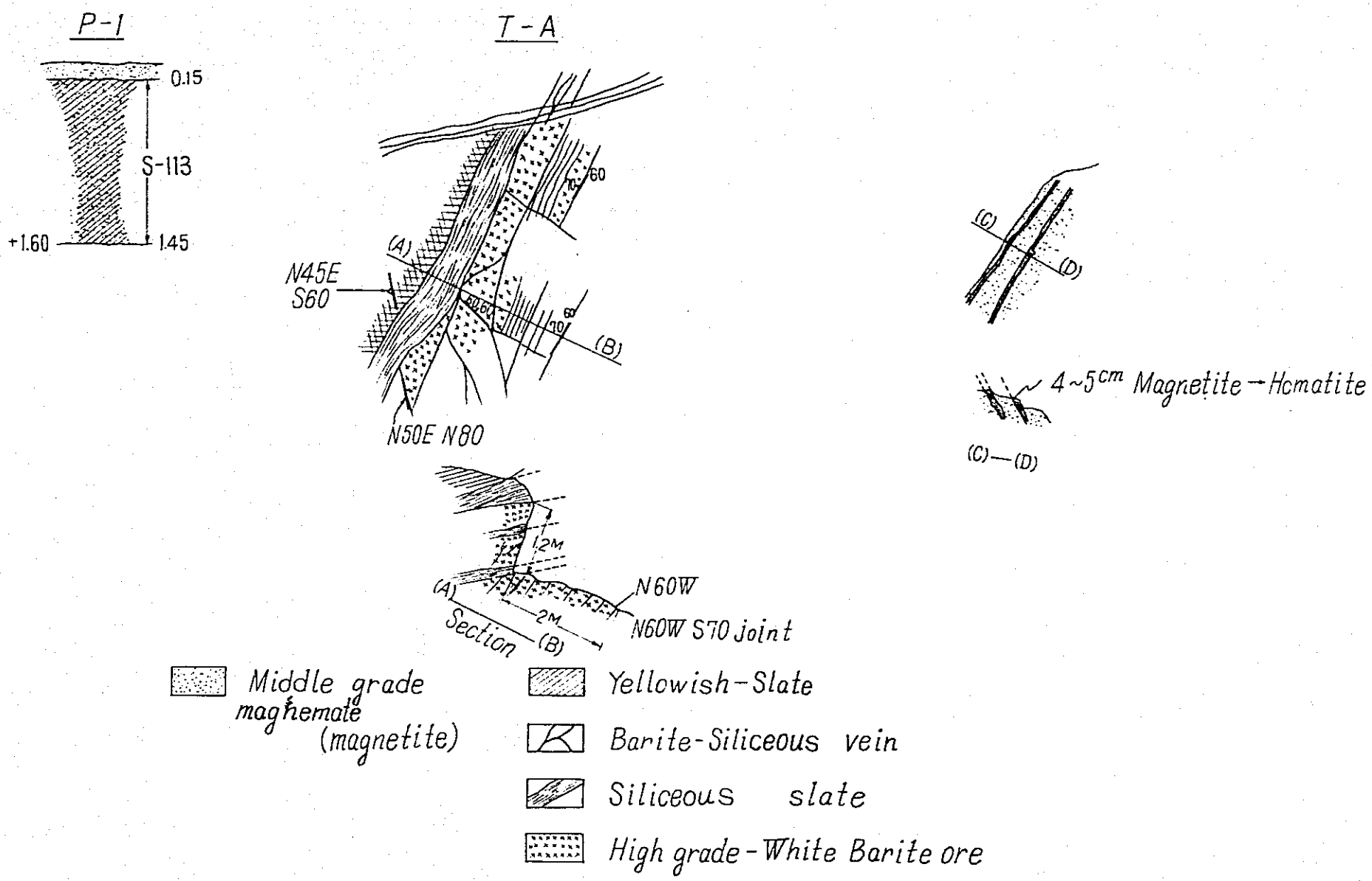
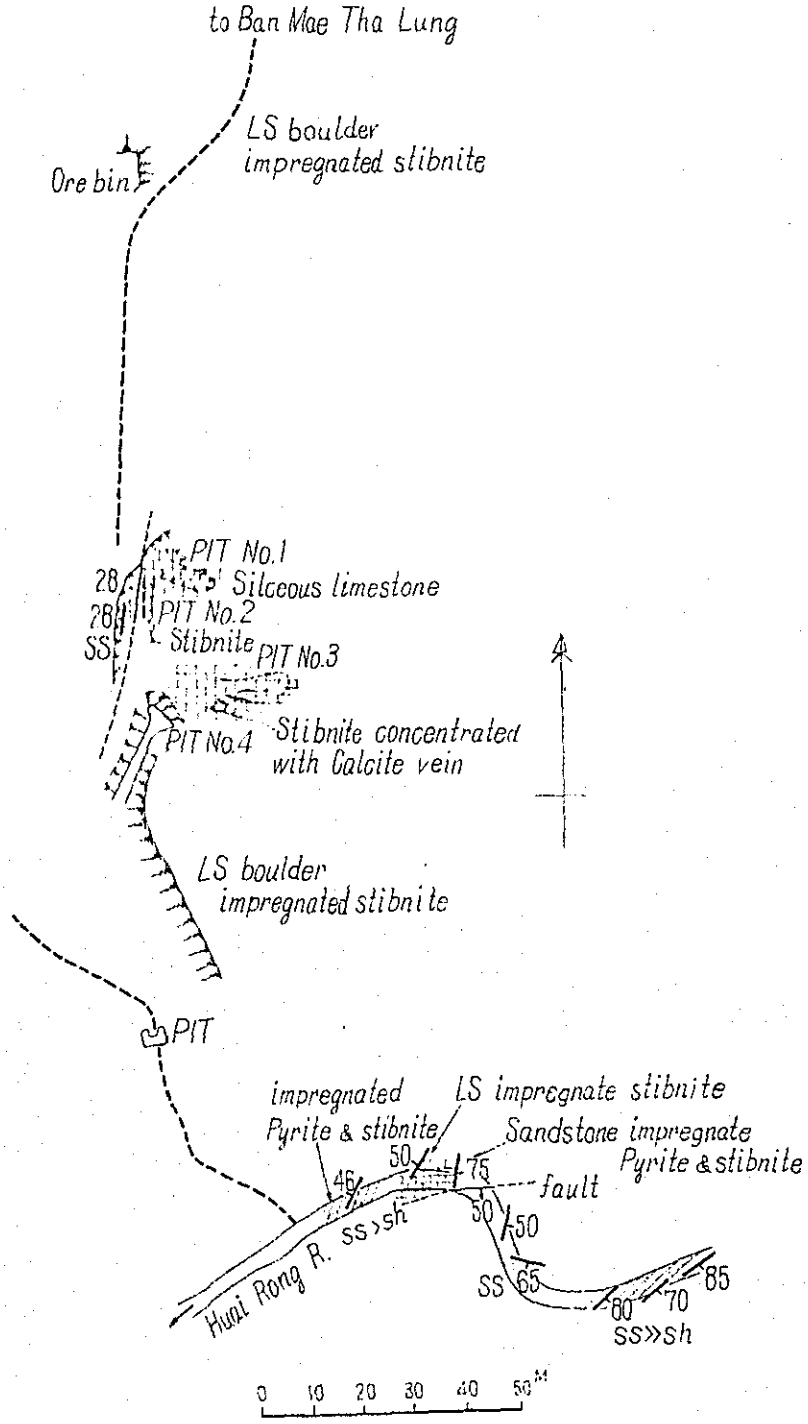


Fig. 14 A. Chaehom Mae Tha Lung Sb PIT Route Map



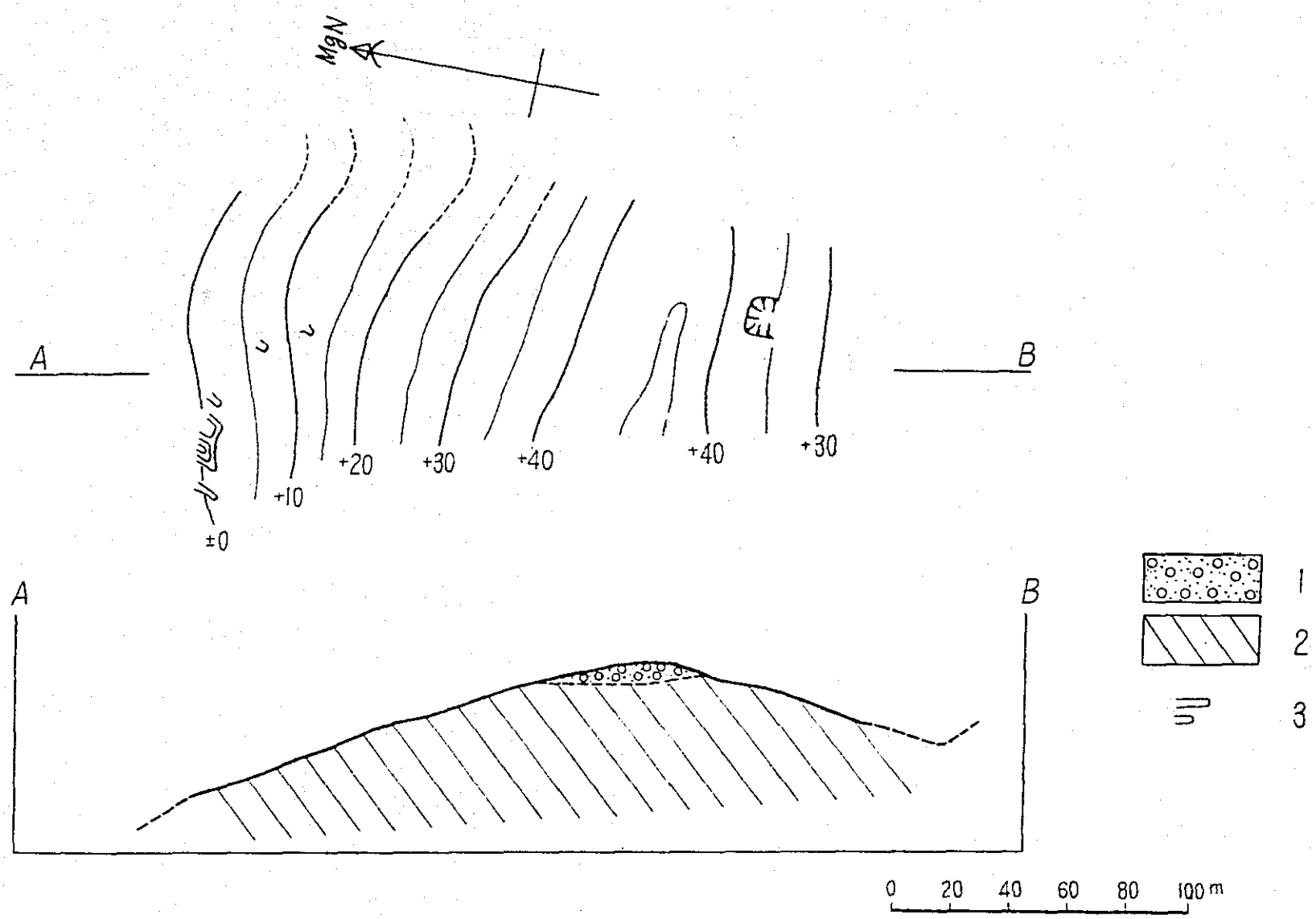


Fig. 15 A. Ko Kha T. Ban Serm Sai Huai La Sb

1. Sandstone and slate 2. Silicious Congromerate 3. Old pittings

Fig. 16 (1) A. Wang Nua , Doi Pha Kok Sb

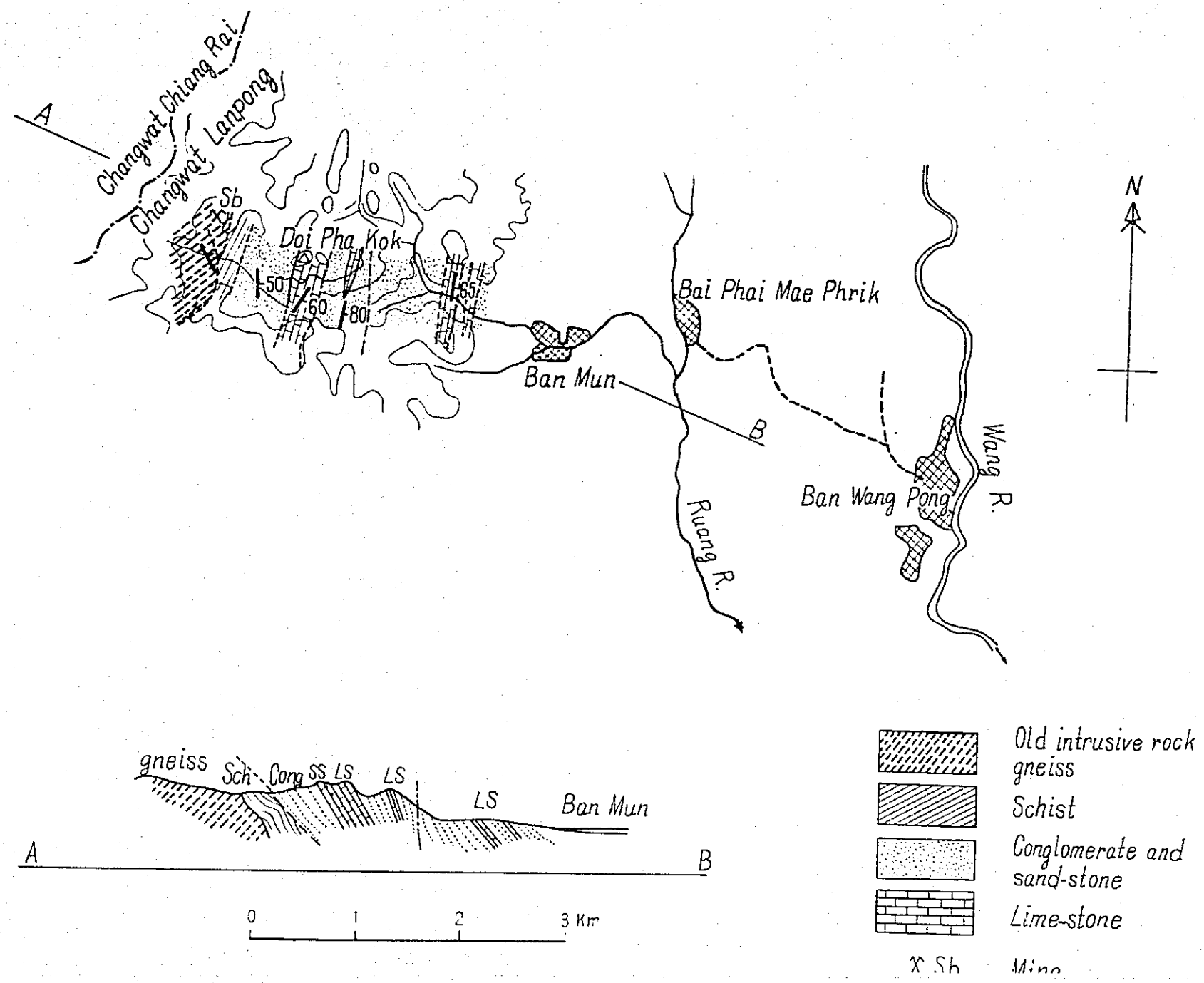
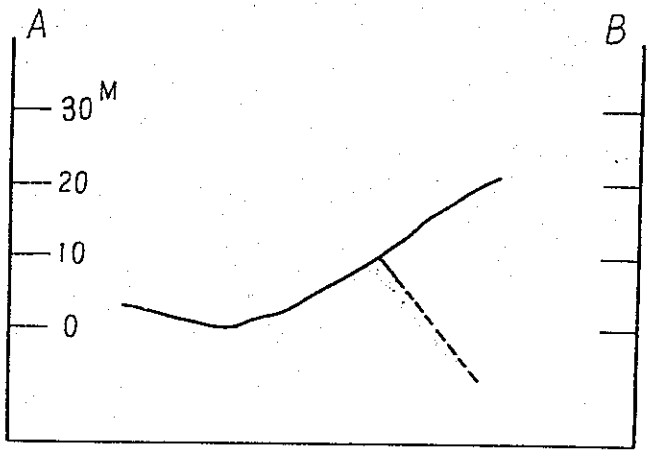
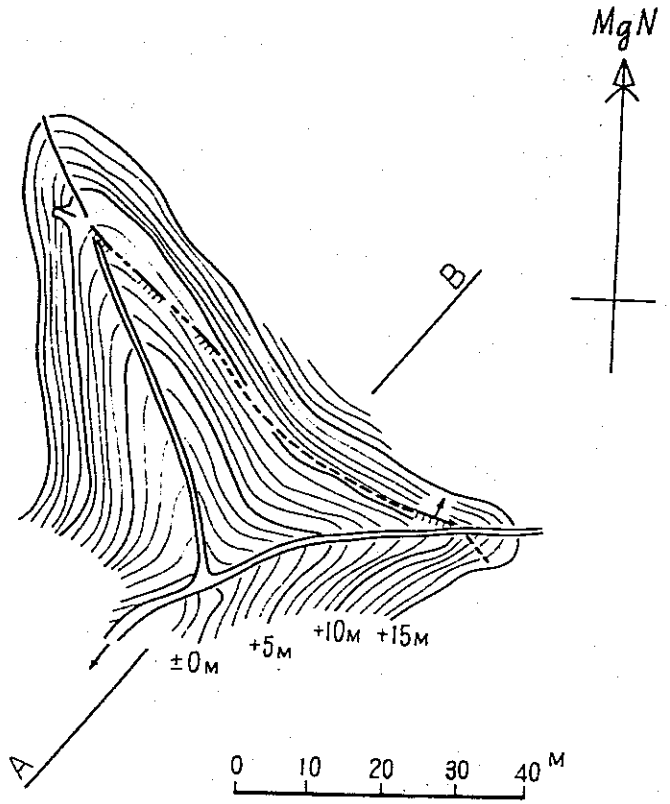


Fig. 16 (2) Doi Pha Kok Sb





1 2 3

1 Gneiss(Old intrusive rock)

2 Vein

3 Altered zone

Fig. 17 A mae Tha T. Ban Hang Hung

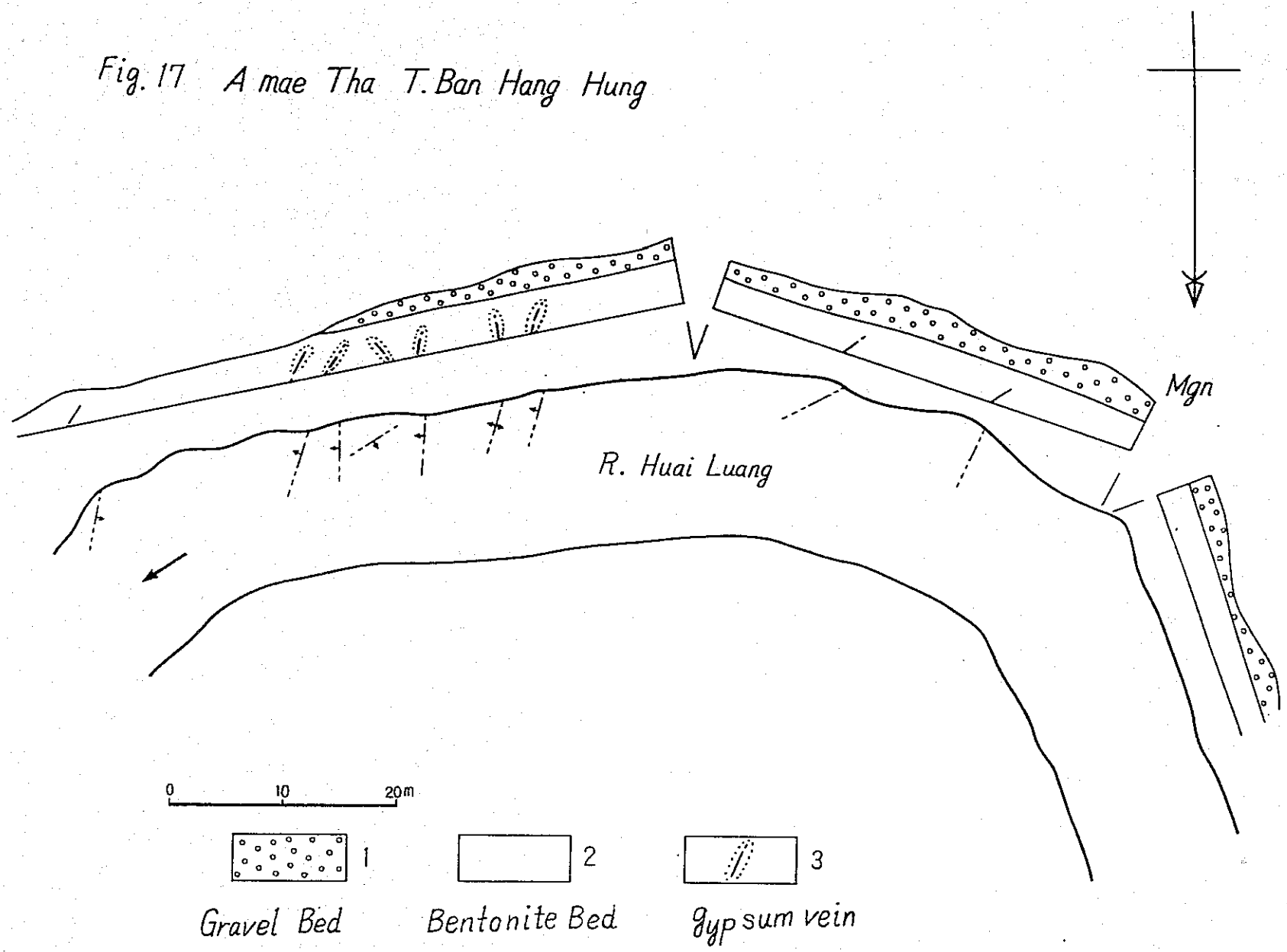
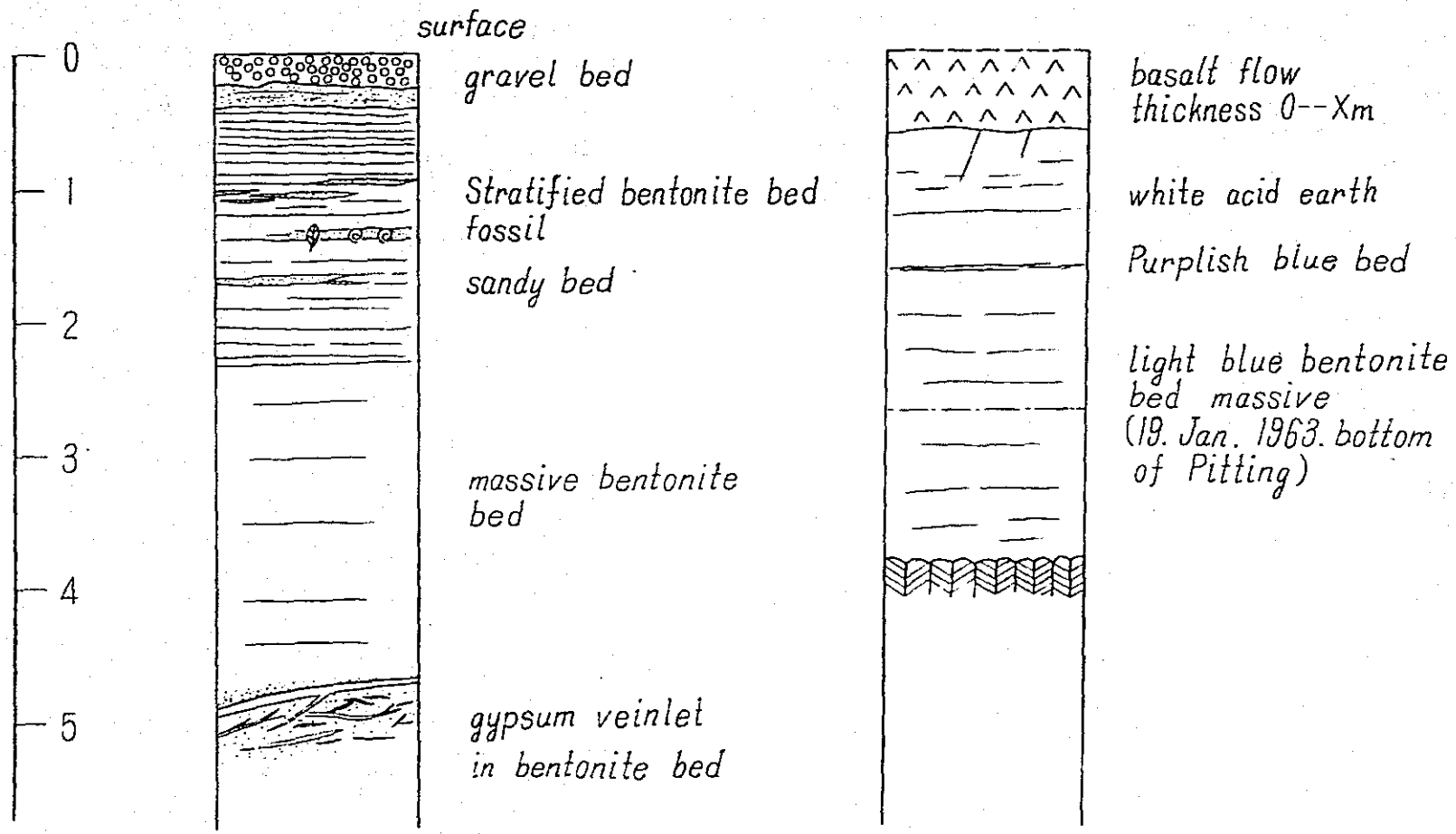


Fig.18 Diagramatic Columnar Section of Bentonite



(1) A. Kokha T. Ban Serm Sai

(2) A. Mae Tha T. Ban Mae Tha

Fig.19 Non-metallic Mineral Deposits around Lampong City

LIST OF NON-METAL MINERAL DEPOSITS NEAR LAMPANG

BENTONITE AND GYPSUM

(1)	T. BAN HANG HUNG	A. MAE THA
(2)	SATANI MAE MO	A. MAE THA
(3)	T. BAN MAE THA	A. MAE THA
(4)	T. BAN PONG KA	A. SOPRAP
(5)	T. BAN SERM SAI	A. KO KHA

DIATOMITE

(6)	LAMPANG	
(7)	T. BAN NONG THOI	A. MAE THA

KAOLINE

(8)	CHAEHOM	A. CHAEHOM

BUILDING STONE

(9)	T. BAN MAE PUNT	A. MAE THA

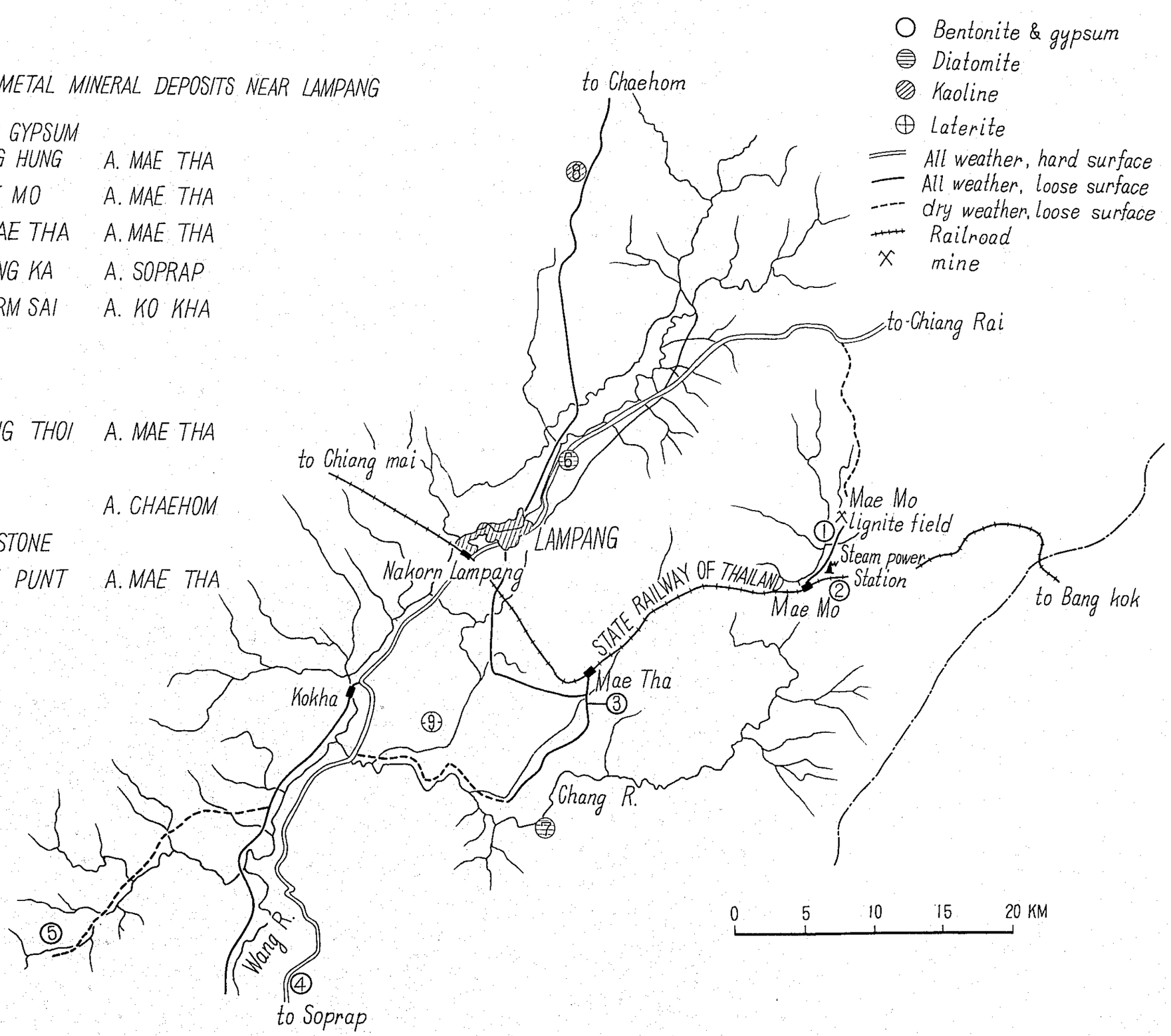
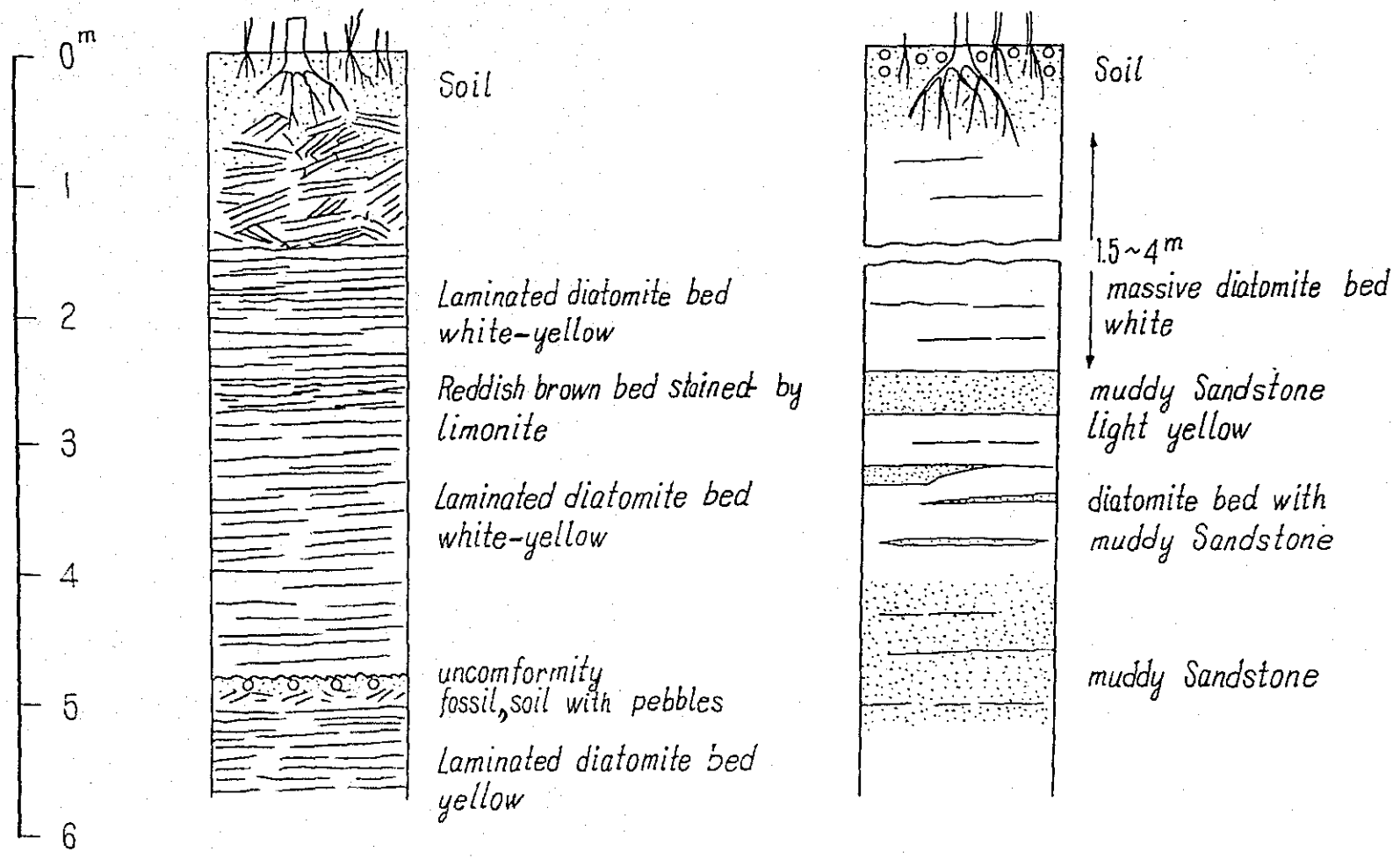


Fig. 20 Diagramatic Columnar Section Diatomite Deposit



(1) North of Lampang

(2) A. Mae Tha T. Ban Nong Thoi

Fig. 21 A. Wiang Pa Pao Tin

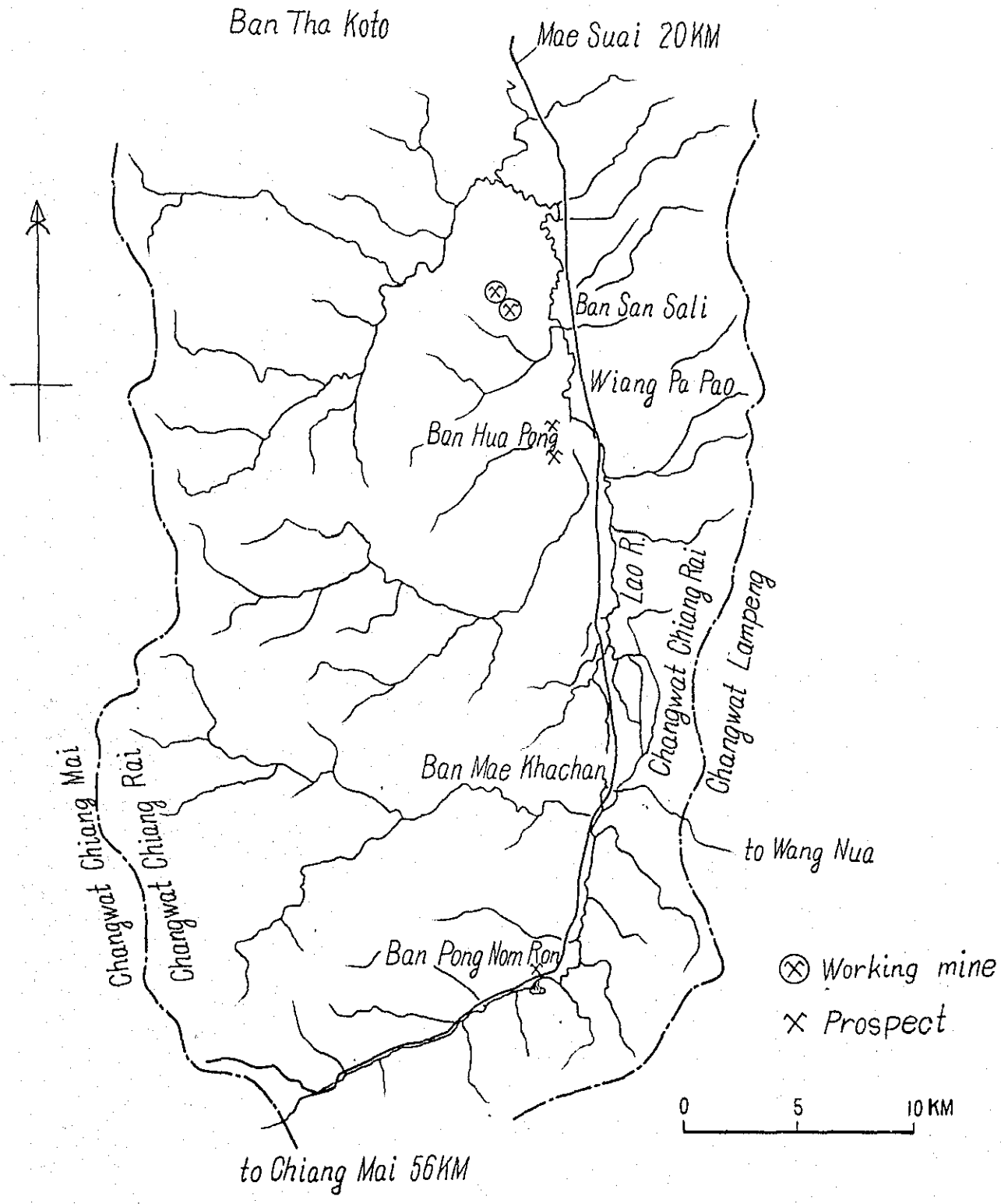


Fig. 23 Legend


Shale or Phyllite


Sandstone

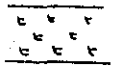

Limestone


Diorite


Basic Rocks


Andesite or Porphyry


Agglomerate


Tuff


Bedding or vein.


Joint


Fault

Fig. 24-1 GEOLOGICAL PLAN

Between Ban Dong Khui Nua And Ban Suan Phrik

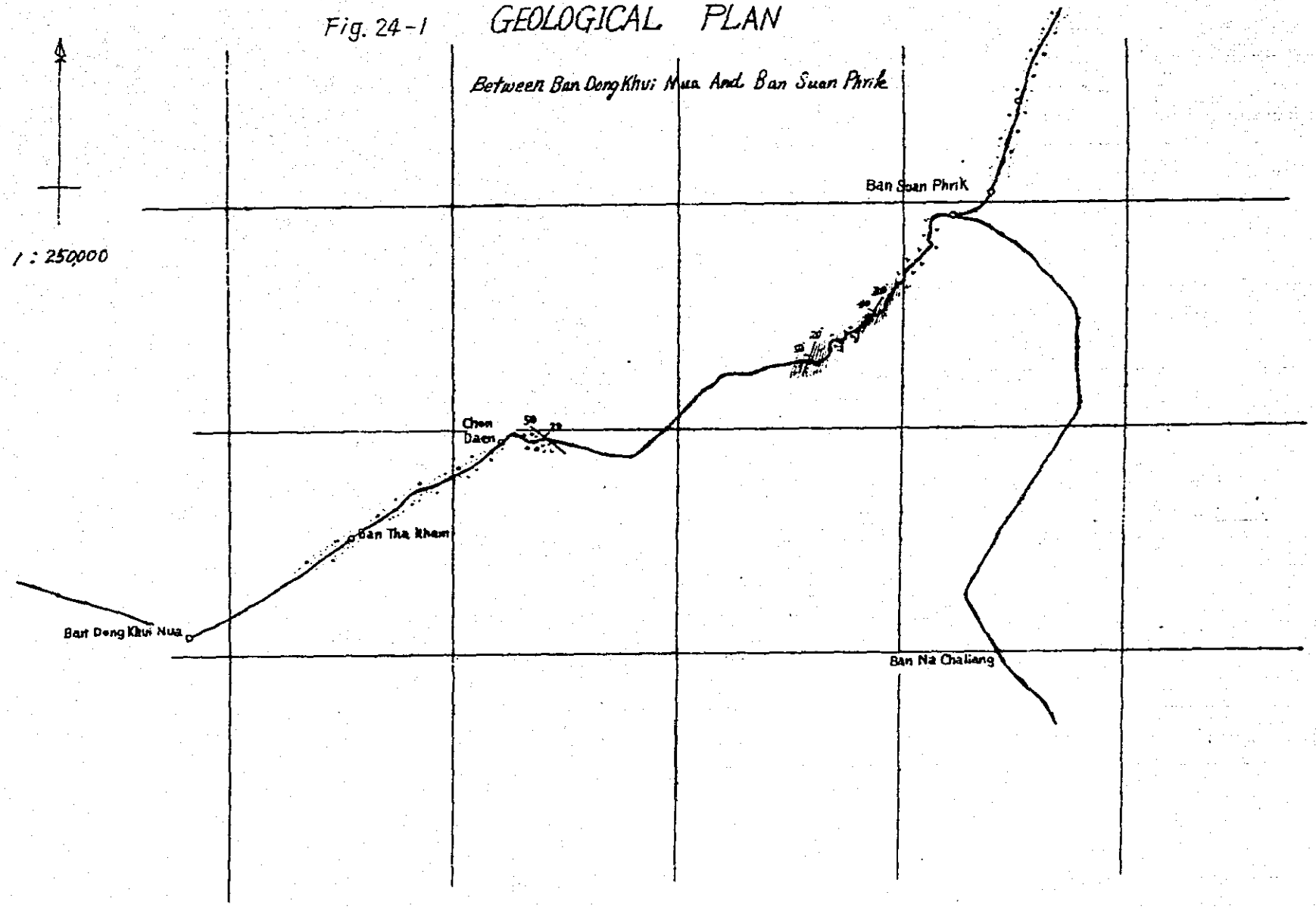
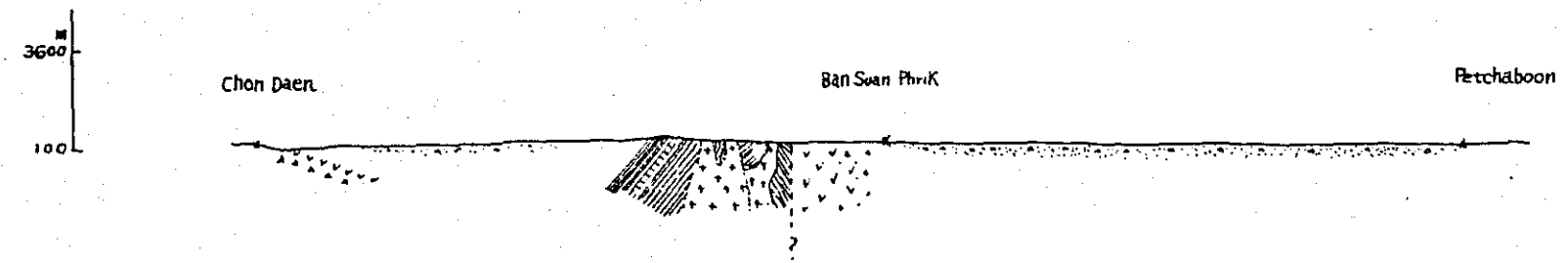


Fig. 24-2 GEOLOGICAL SECTION (NE—SW)

Between Ban Dong Khui Nua And Ban Suan Phrik.



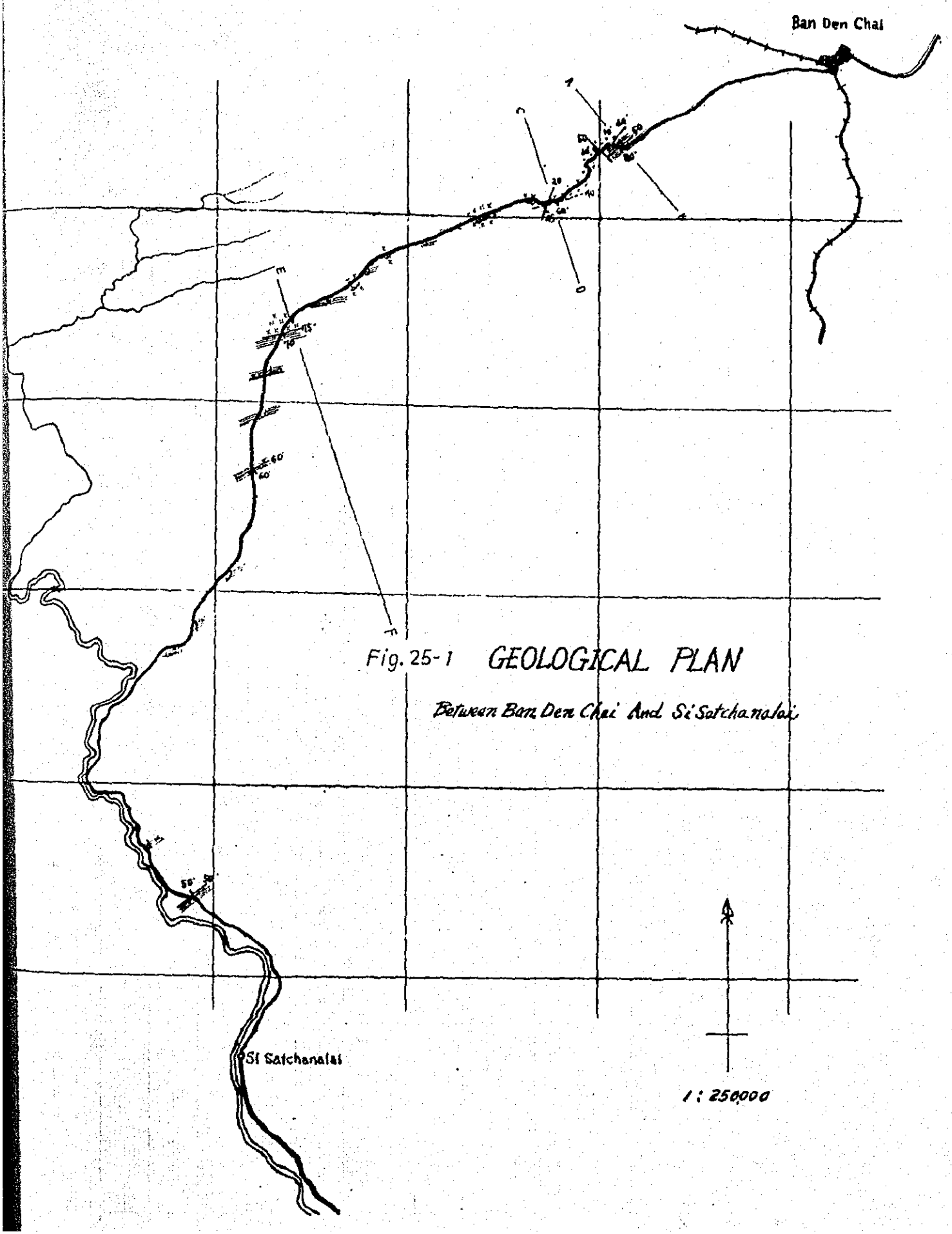


Fig. 25-1 GEOLOGICAL PLAN

Between Ban Den Chai And Si Satchanalai

Fig. 25-2 GEOLOGICAL SECTION (Outline)

Between Ban Den Chai And Si Satchanalai

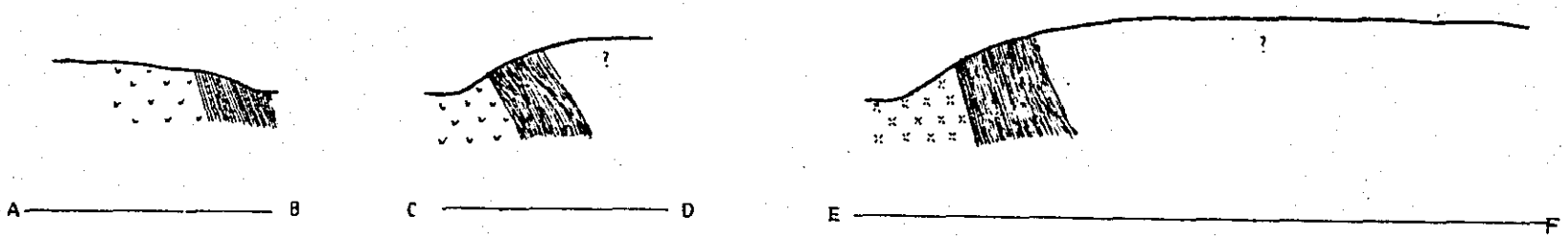


Fig. 26-1 GEOLOGICAL PLAN

Between Amphur Rong Kwang and Amphur Sa

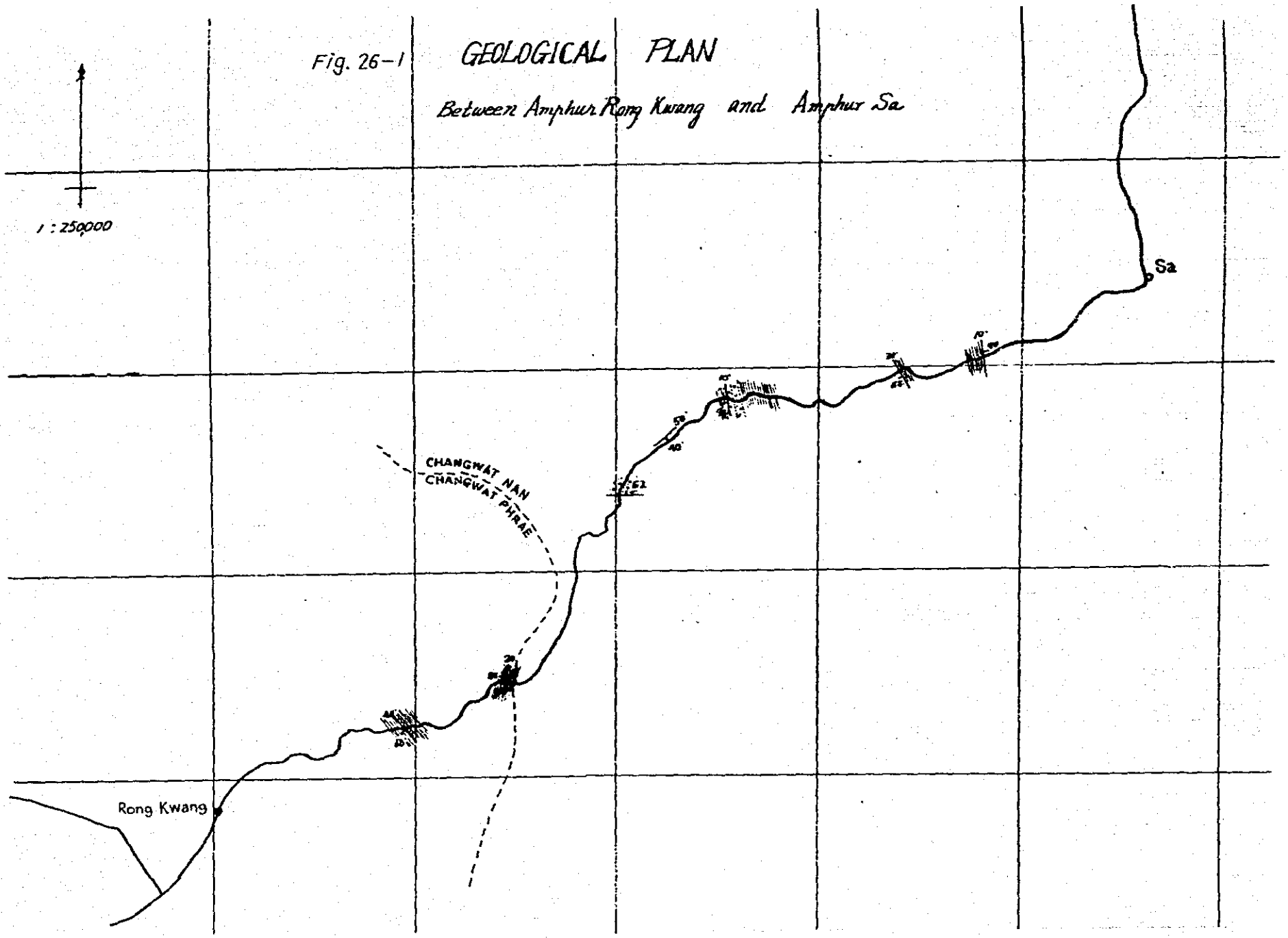


Fig. 26-2 GEOLOGICAL SECTION (NE — SW)

Between Amphur Rong Kwang And Amphur Sa

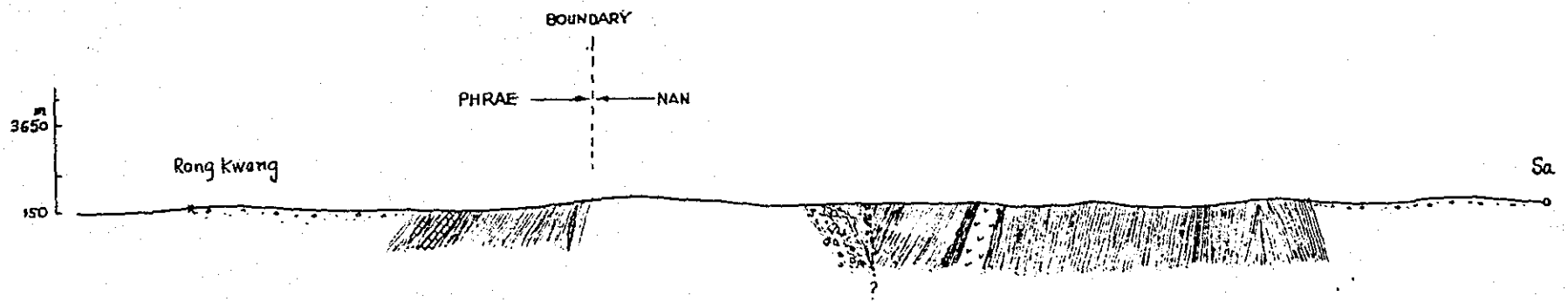
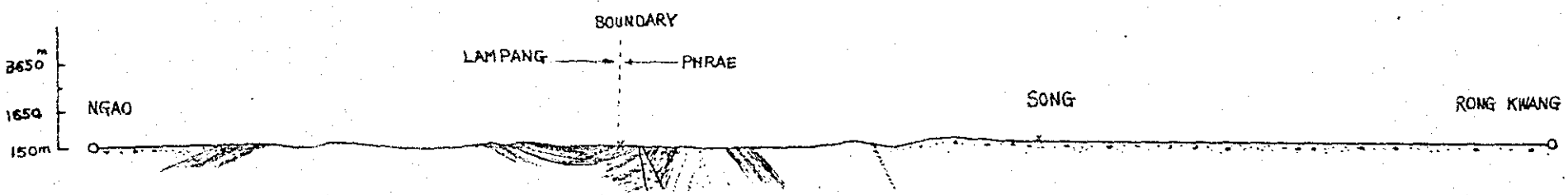


Fig. 27-2 GEOLOGICAL SECTION (NW—SE)

Between Ngao And Rong Kwang



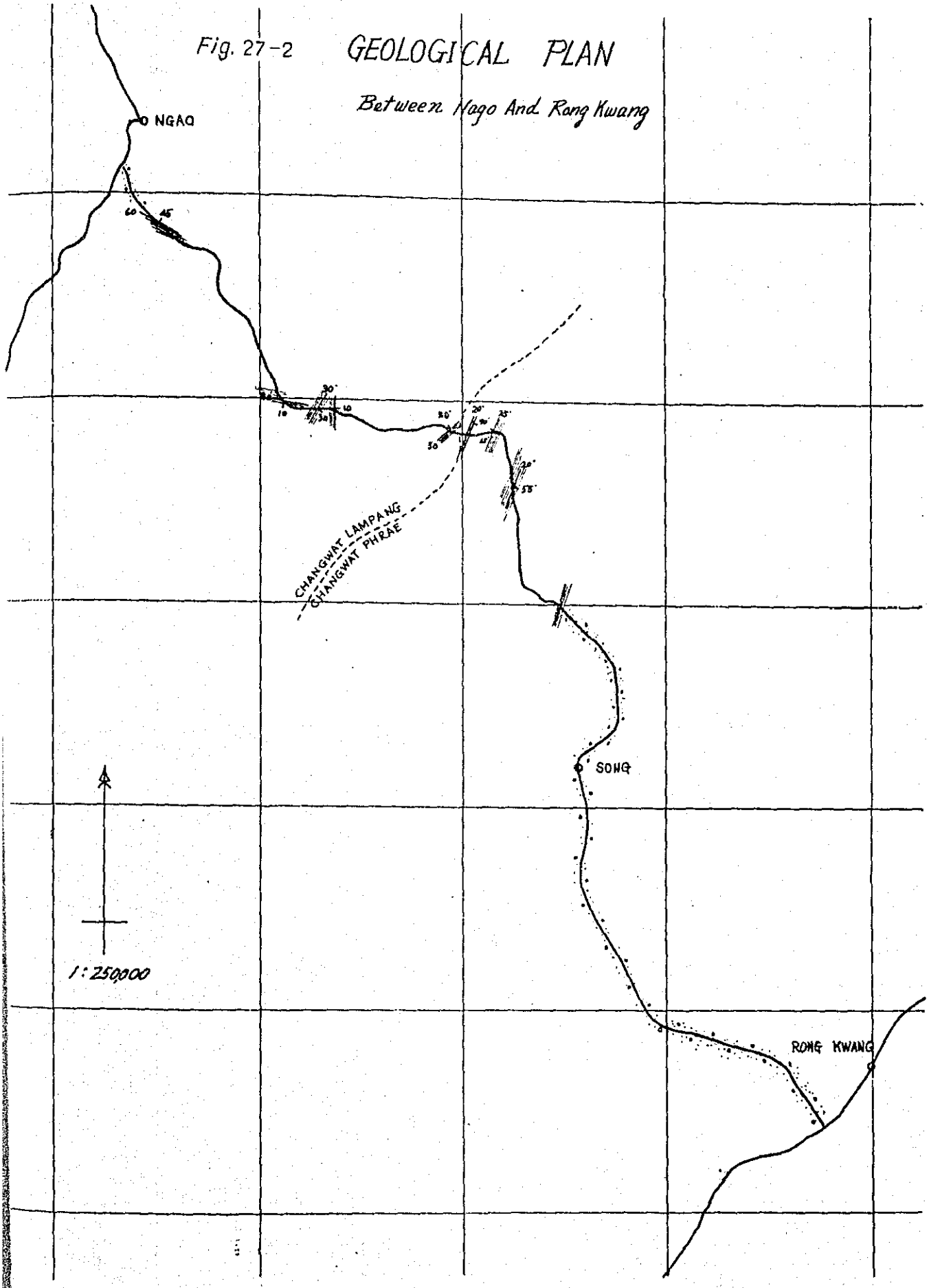


Fig. 27-2 GEOLOGICAL PLAN
Between Nago And Rong Kwang
NGAO
60
45
30
10
50
20
25
55
CHANGWAT LAMPANG
CHANGWAT PHRAE
SONG
1:250,000
RONG KWANG

Fig. 28-1 GEOLOGICAL PLAN

Between Lomsak And Phitsanulok.

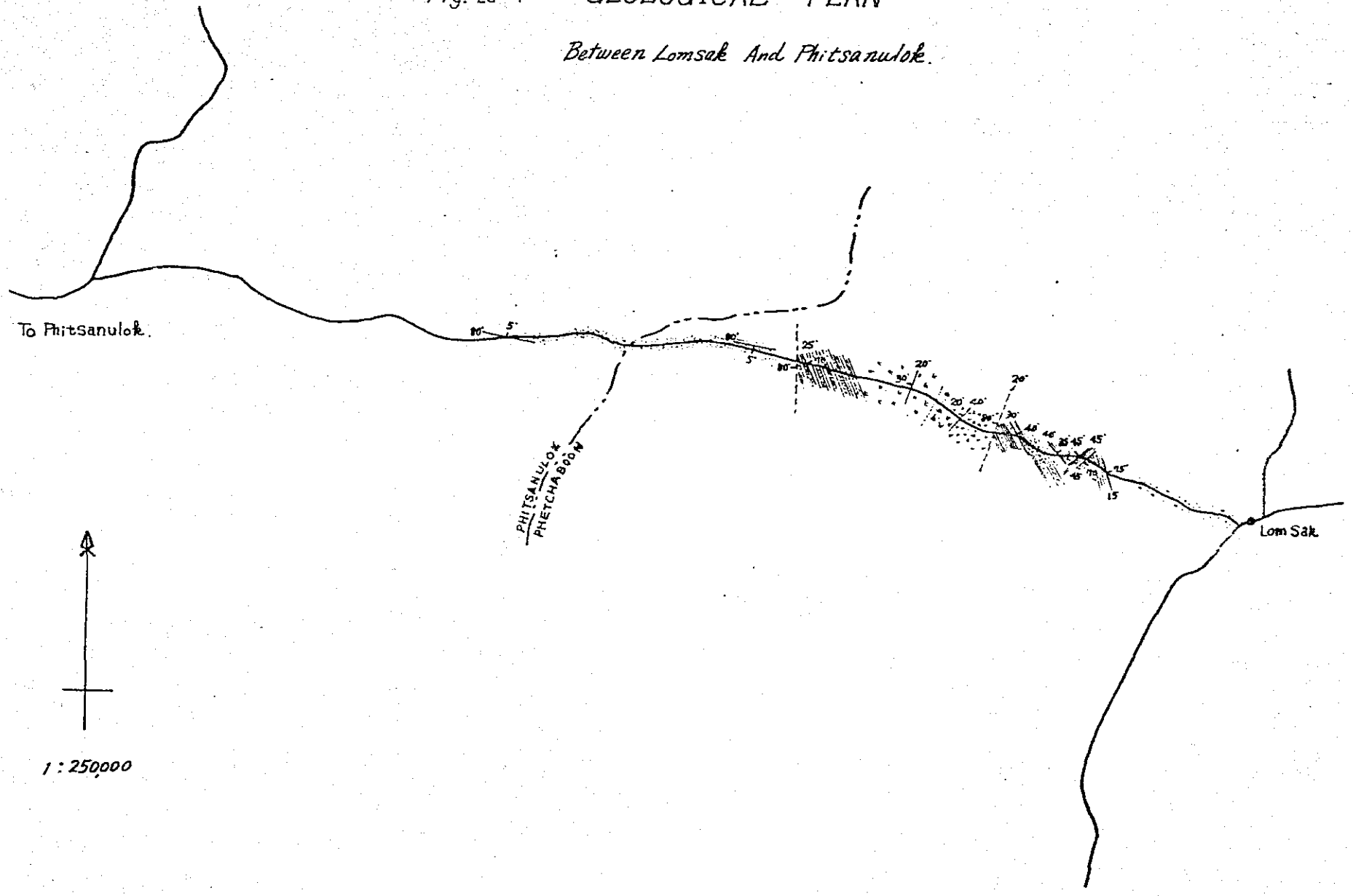


Fig. 28-2 GEOLOGICAL SECTION (E — W)

Between Lom Sak And Phitsanulok.

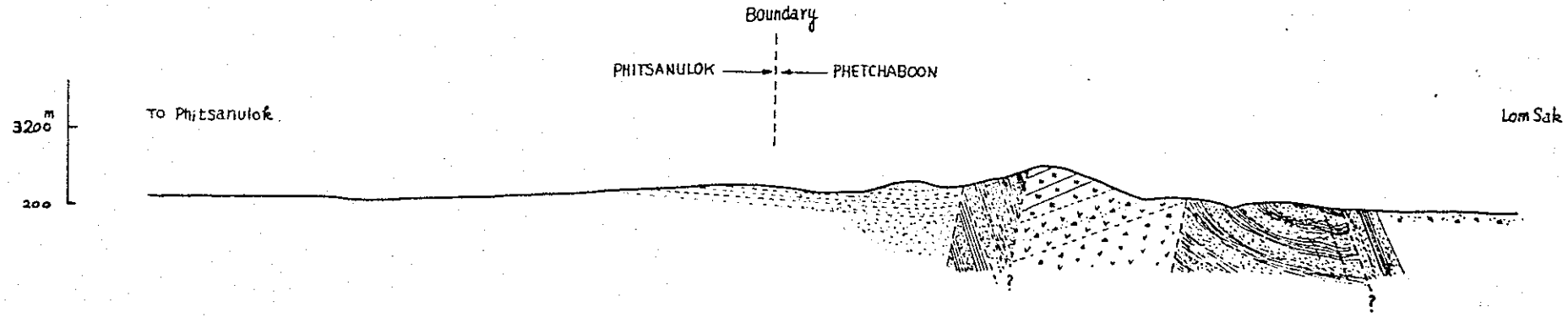
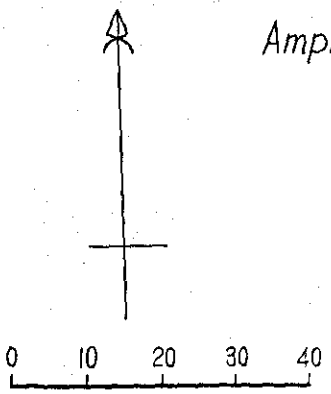
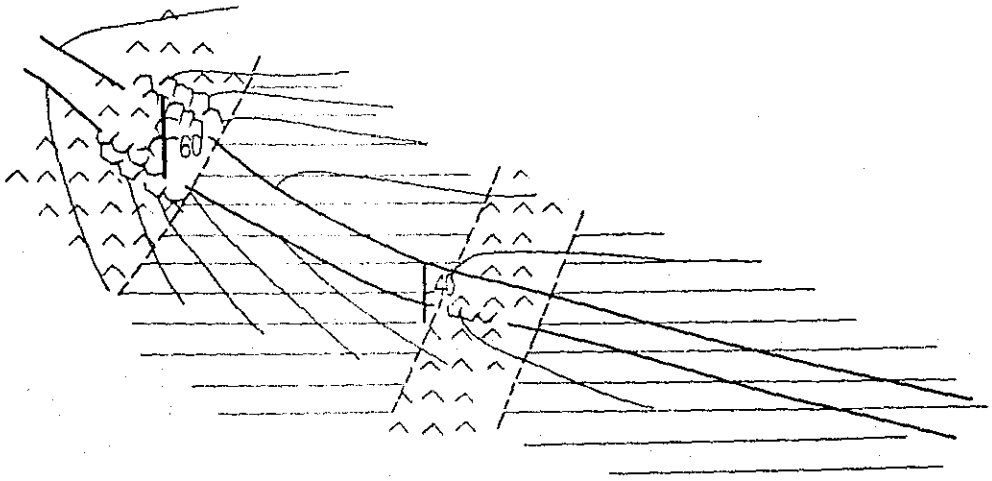


Fig. 29 Sketch Map of Klong Huai Pao Gold Prospect, Ban Nam Ko Yai, Amphor Lomsak, Changwat Petchaboon.





Shale and Sandstone

Porphyrite

Strike and dip of Vein

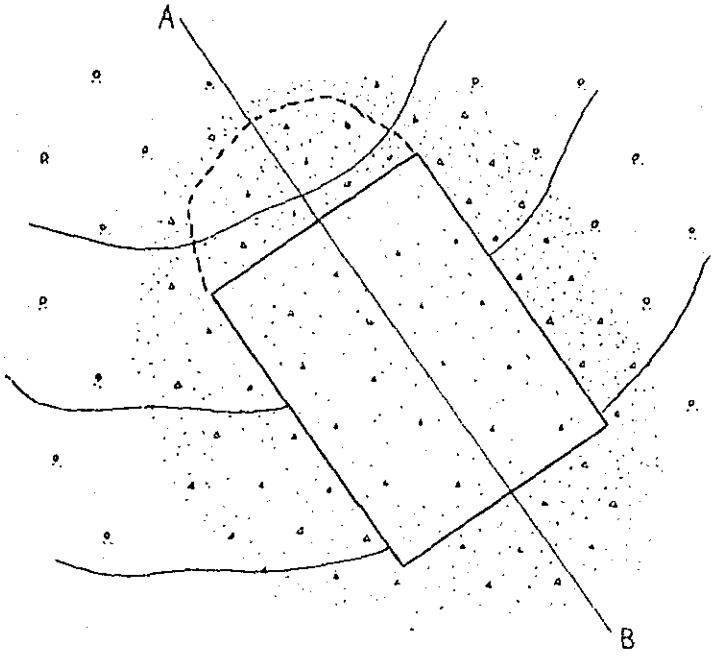
Strike and dip of beds

Fig. 30 Copper Pit At Khao Thong

Bon Phlam Amphur Muang Changwat Petchaboon

1 : 100

PLAN



SECTION

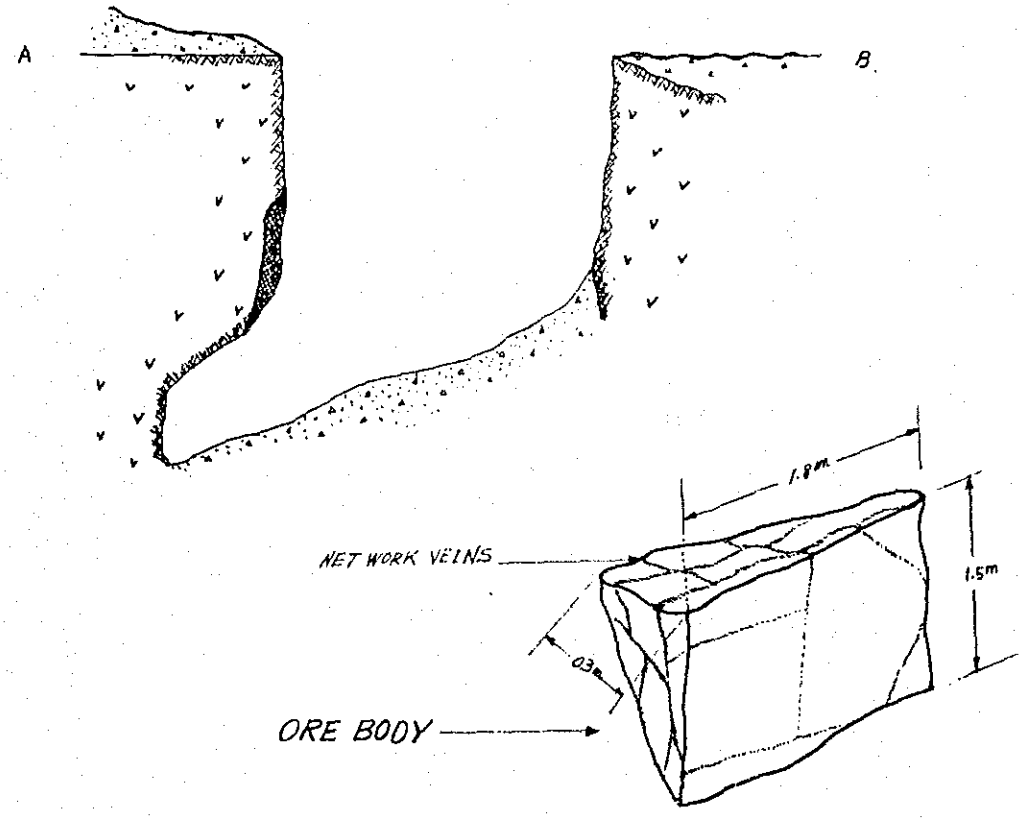
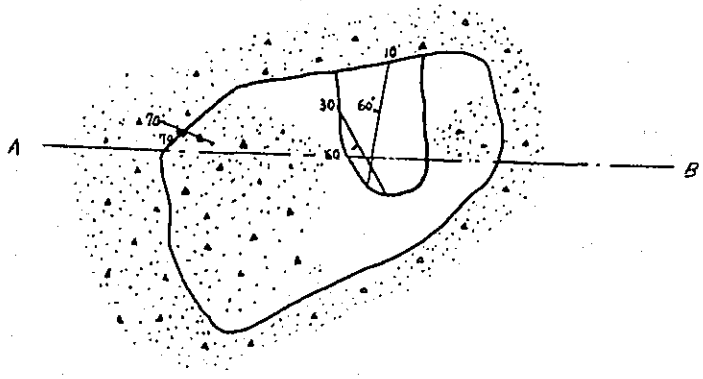


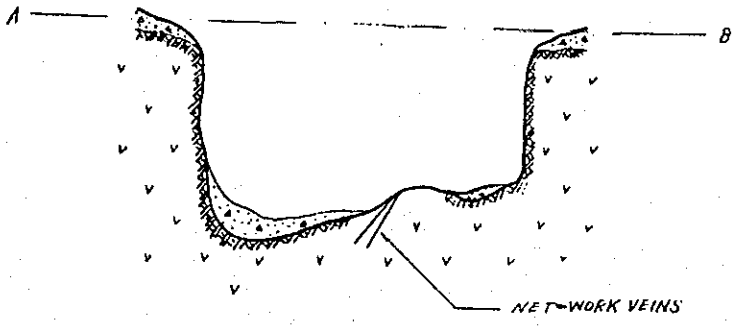
Fig. 31 Copper pit At Koke Na Kae

Tambon Pha Daeng Amphur Muang
Changwat Petchaboon.

1 : 50



PLAN & SECTION



GEOLOGICAL SECTION (OUTLINE)

Between Koke Na Kae And None Thong

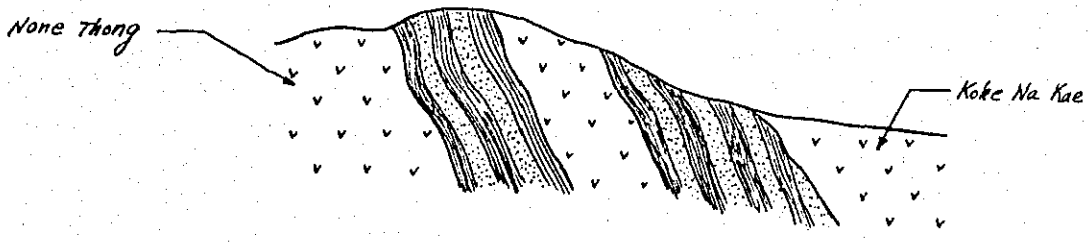
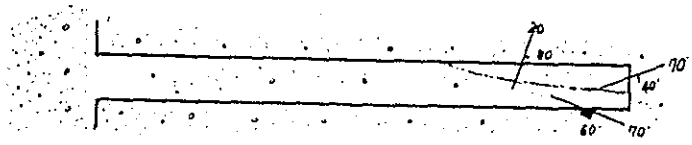


Fig. 32 Copper Pit At None Thong

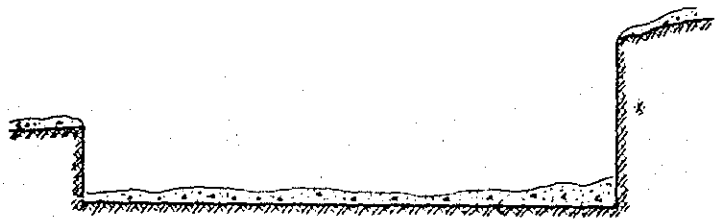
Tambon Pha Daeng Amphur Muang
Changwat Petchaboon.

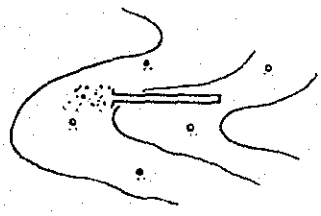
PLAN

1 : 200



SECTION





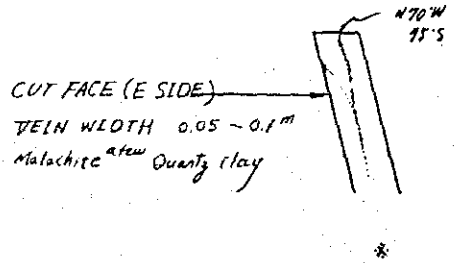
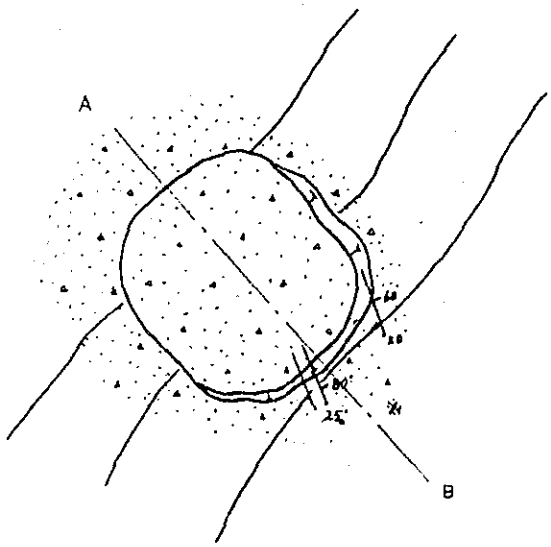


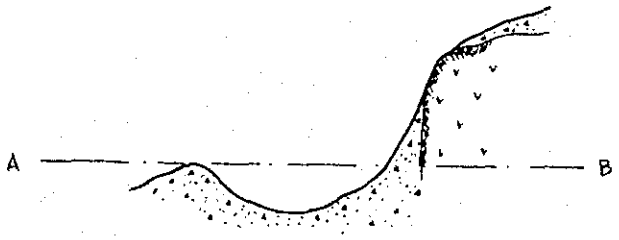
Fig. 33 Copper Pit At Foor Hill of Khao Nom Sao

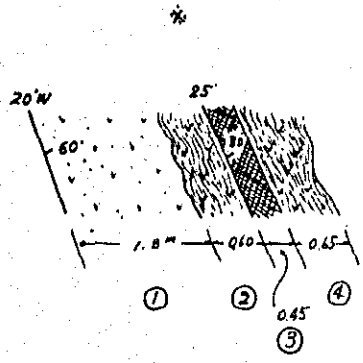
Tambon Sam Nak Mam Amphur Muang
Changwat Petchaboon.

1 : 200



PLAN & SECTION





① Weak Weathering zone.

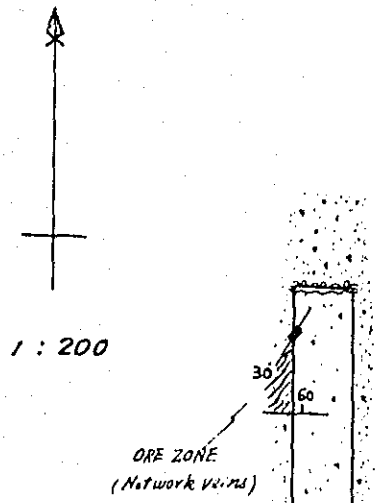
②④ Strong Weathering Zone

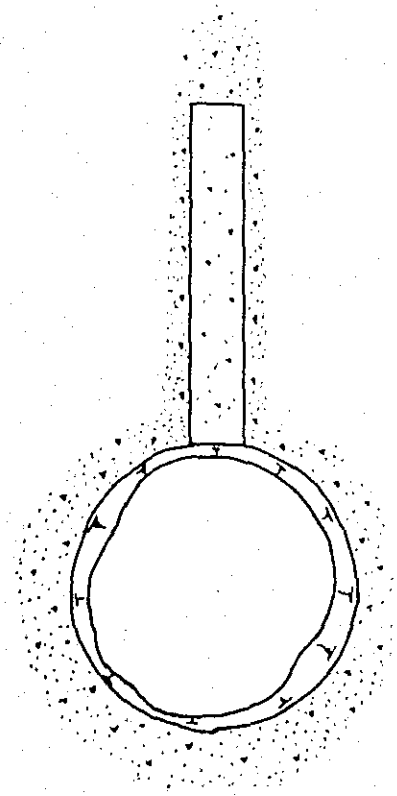
③ Ore Body (Not Work veins)

Fig. 34 Copper Pits At Khao Nom Sao

Tambon Sam Nak Man Amphur Muang
Changwat Petchaboon.

PLAN & SECTION





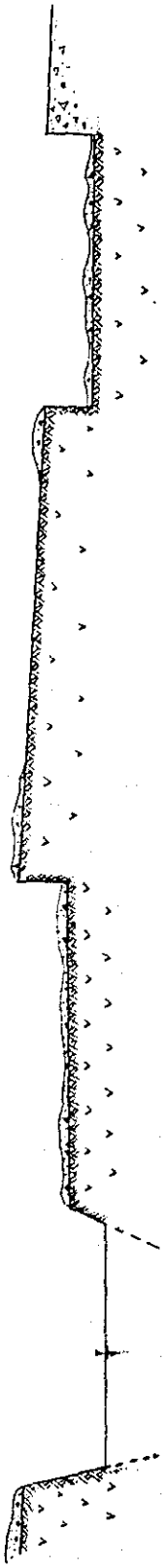
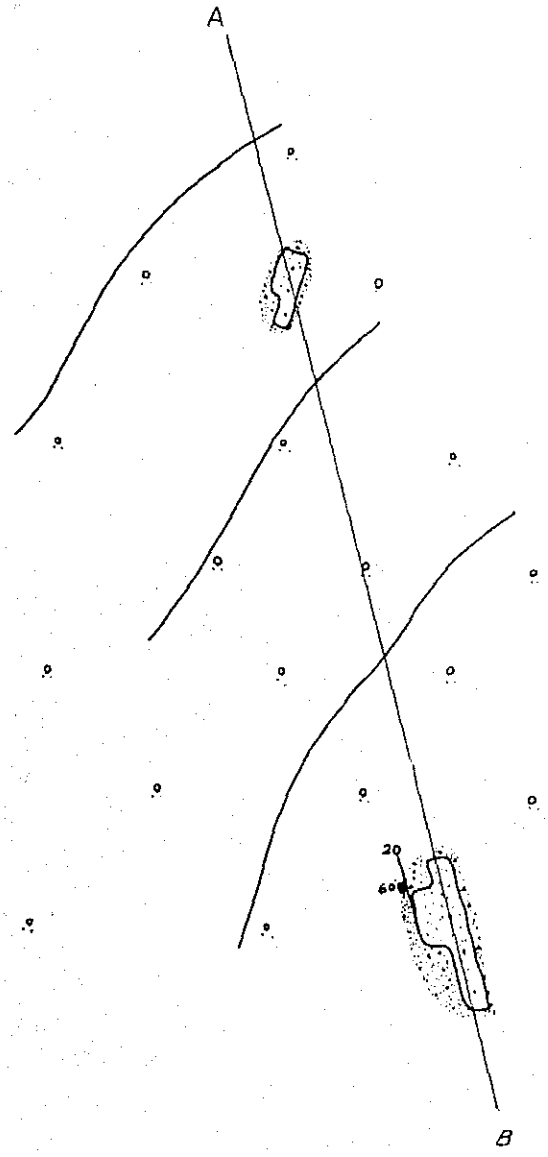


Fig. 35 Copper Pits At Kok Pha Daeng Lan

Ban Toke Amphur Muang Changwat Petchaboon.

PLAN & SECTION

1 : 500



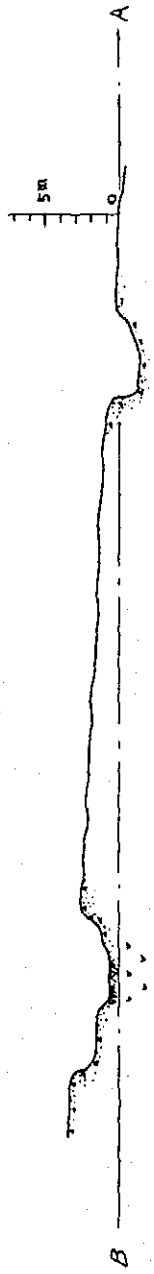
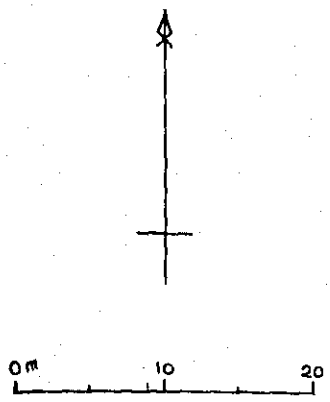


Fig. 36 Copper Pit At Klong Bo Thong Dang

Ban Toke Amphur Muang Changwat Ratchaburi.



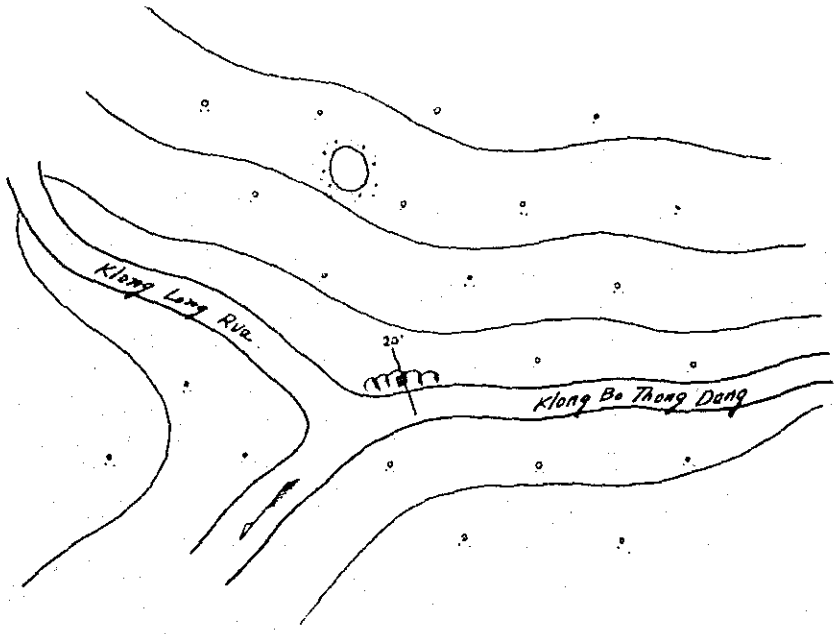
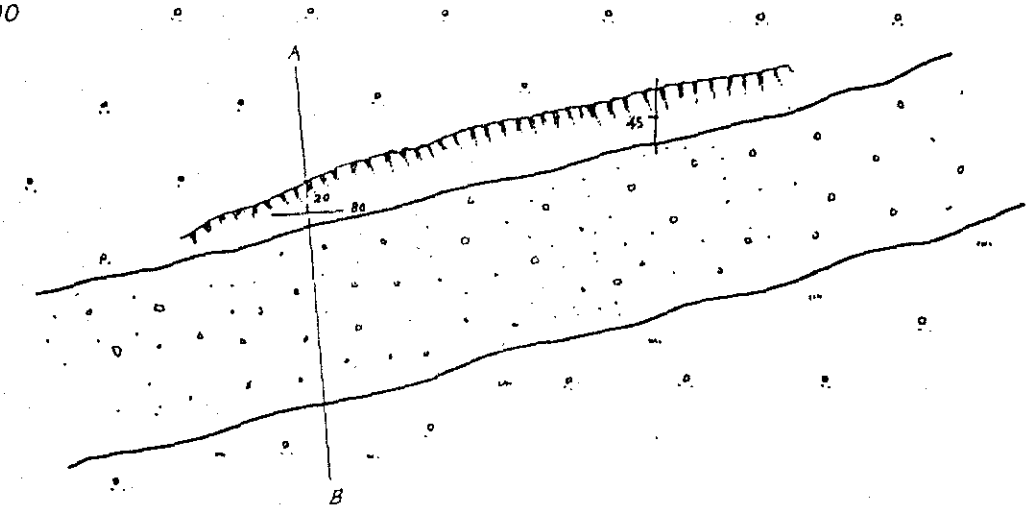


Fig. 37 Copper Out-Crop At Hvai Khai Khaet

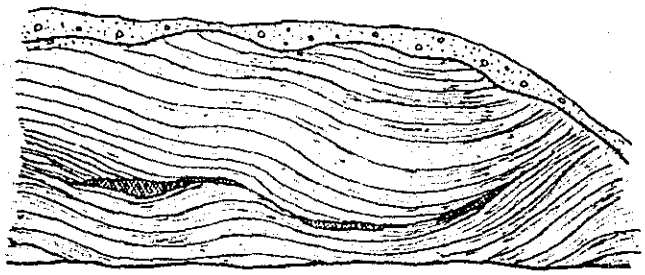
Amphue Fak Tha Chongwat Uttaradit

PLAN

1 : 200



VERTICAL PLANE



SECTION

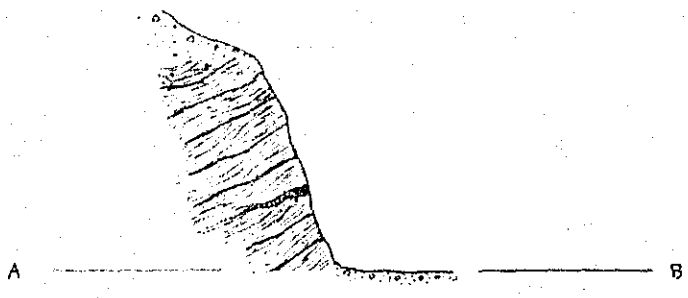
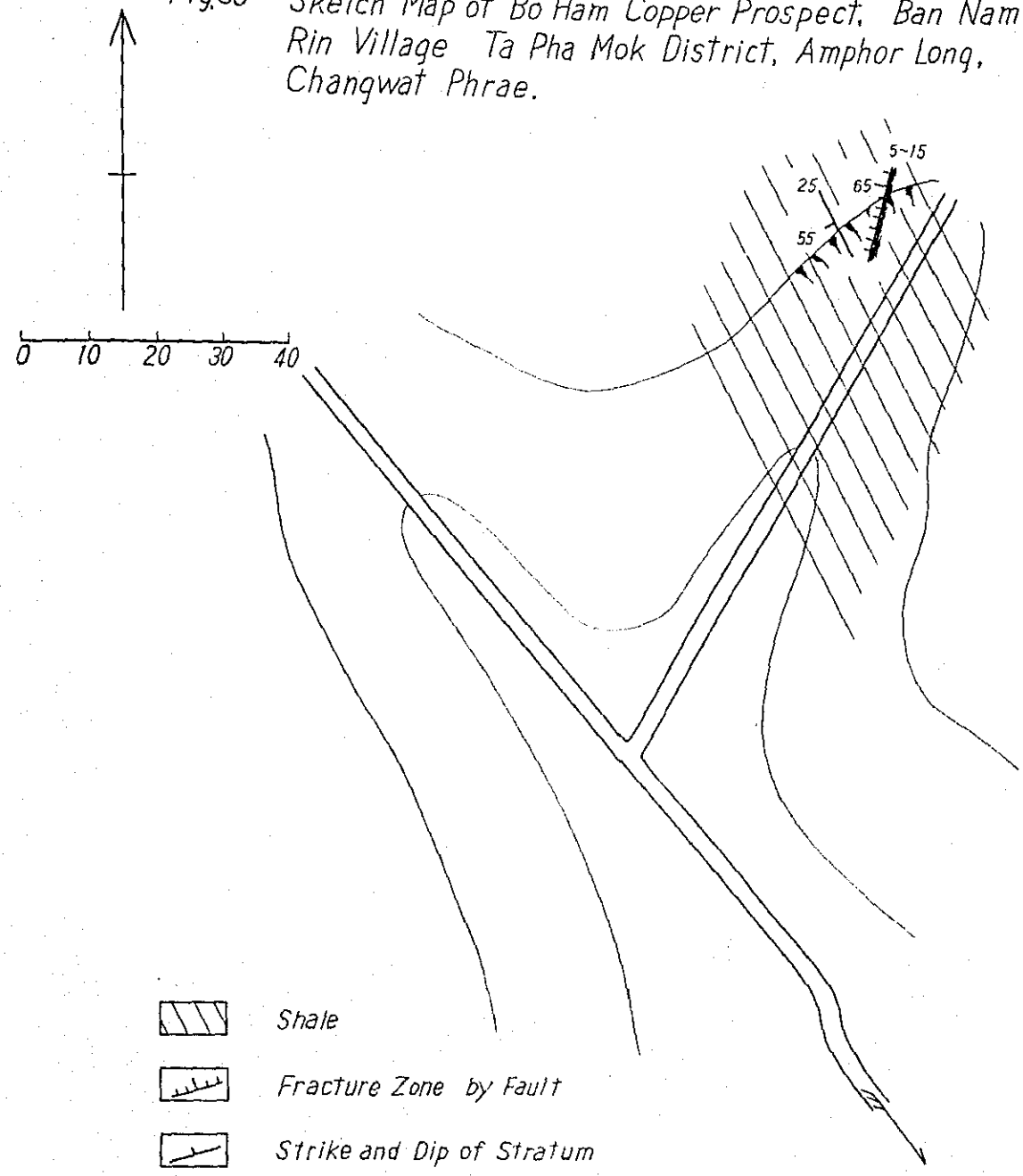


Fig.38 Sketch Map of Bo Ham Copper Prospect, Ban Nam Rin Village Ta Pha Mok District, Amphor Long, Changwat Phrae.



Cross Section of Bo Ham Copper Outcrop Ban Nam Rin Village, Ta Pha Mok District, Amphor Long, Changwat Phrae.

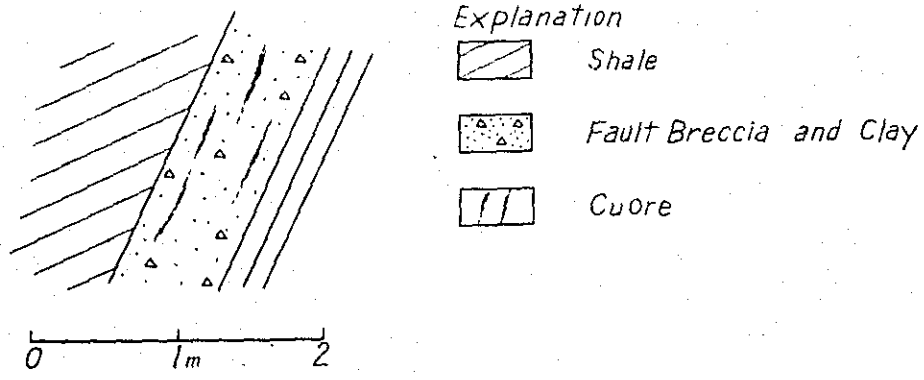
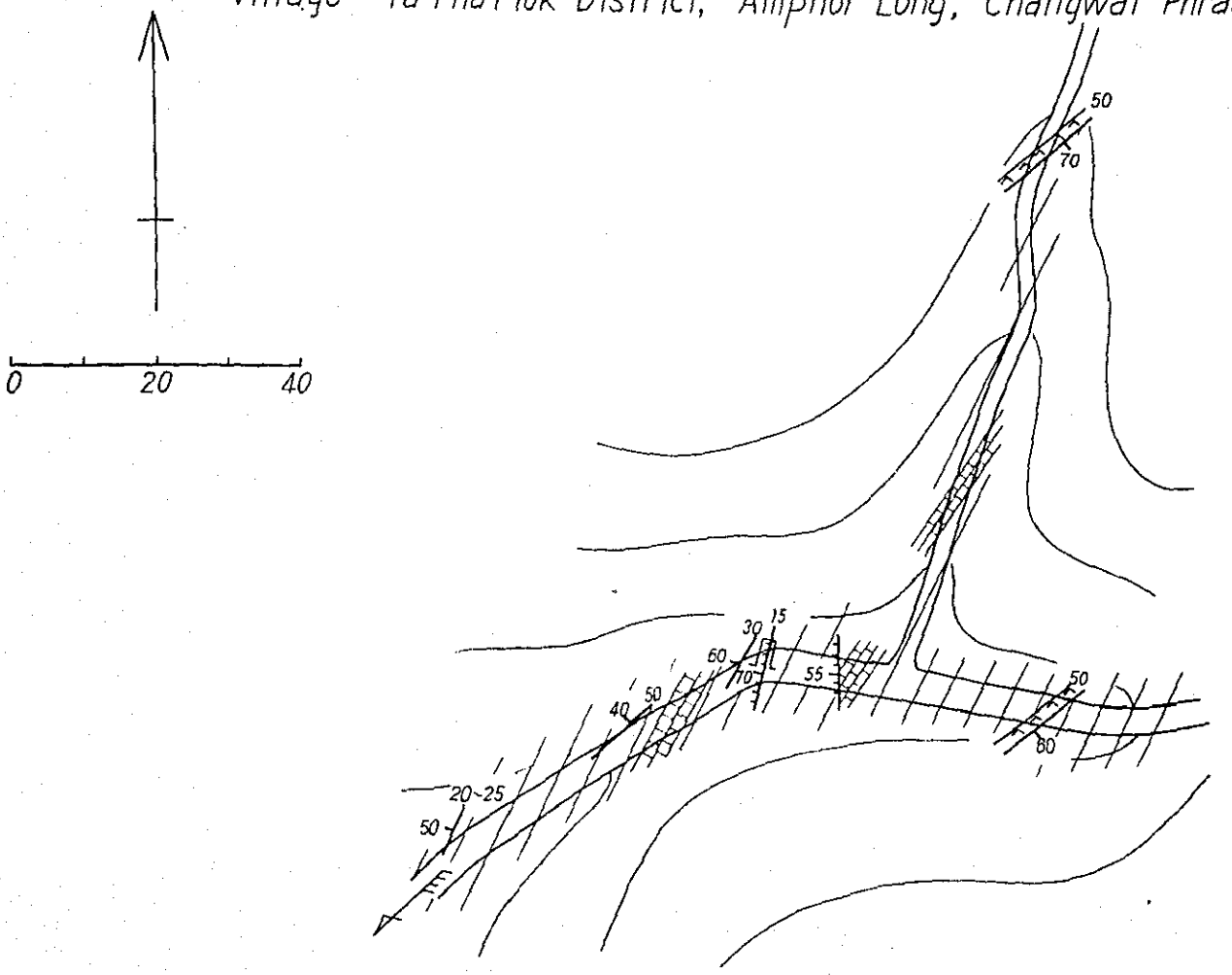


Fig.39 Sketch Map of Huai San Poo Copper Prospect, Ban Nam Rim Village Ta Pha Mok District, Amphor Long, Changwat Phrae.



Phyllitic Black Shale

Calcareous shale

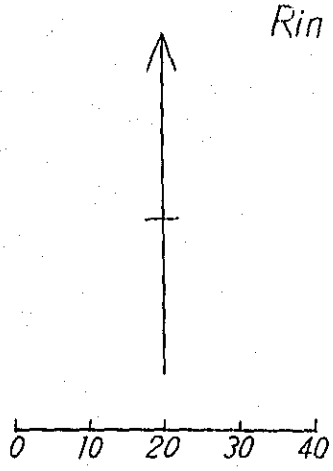
Quartz Porphyry

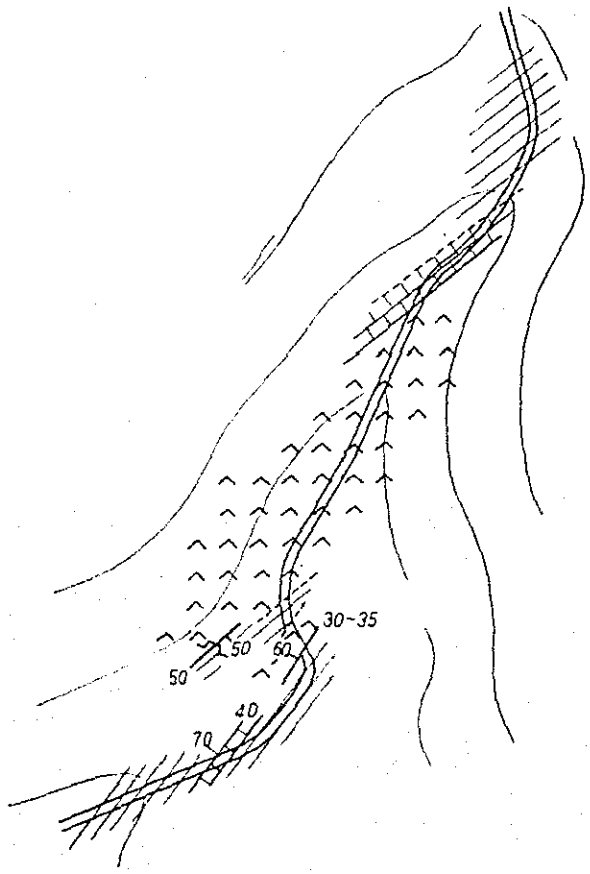
Shear Zone

Strike and Dip of Beds

Trench

Fig.40 Sketch Map of Cham Nang Ant Copper Prospect, Ban Nam Rin Village Ta Pha Mok District, Amphor Long, Changwat Phrae.





Black Shale

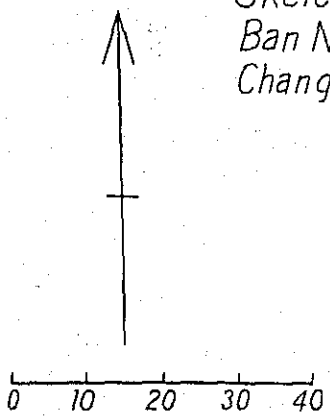
Limestone

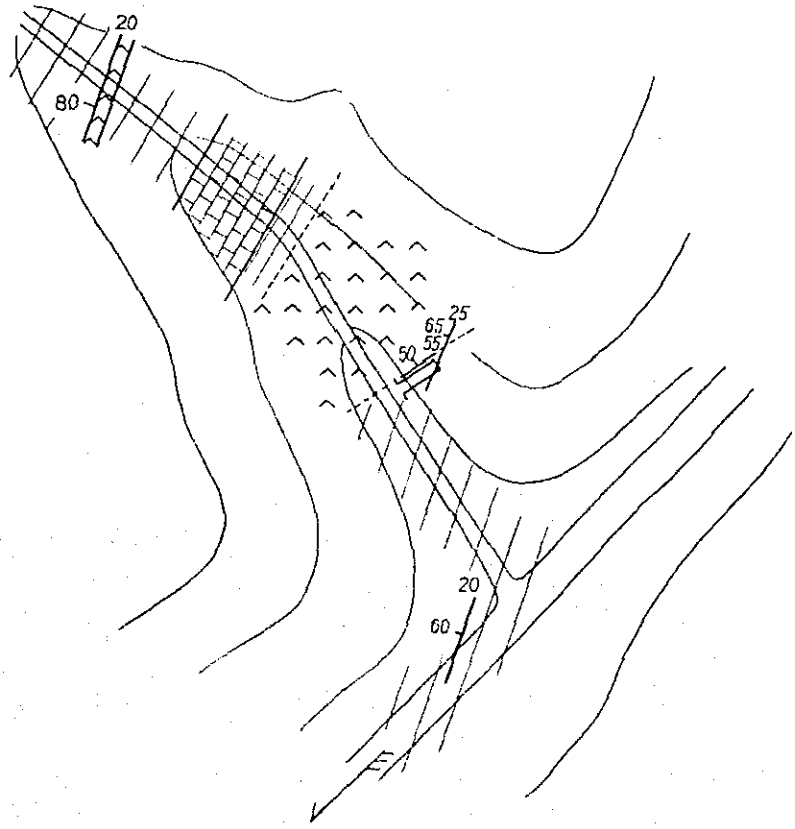
Porphyry

Strike & Dip of Stratum

Pit

Fig.41 Sketch Map of Huai Thoop Sak Copper Prospect, Ban Nam Rin Village, Ta Pha Mok District, Amphor Long, Changwat Phrae.





Shale

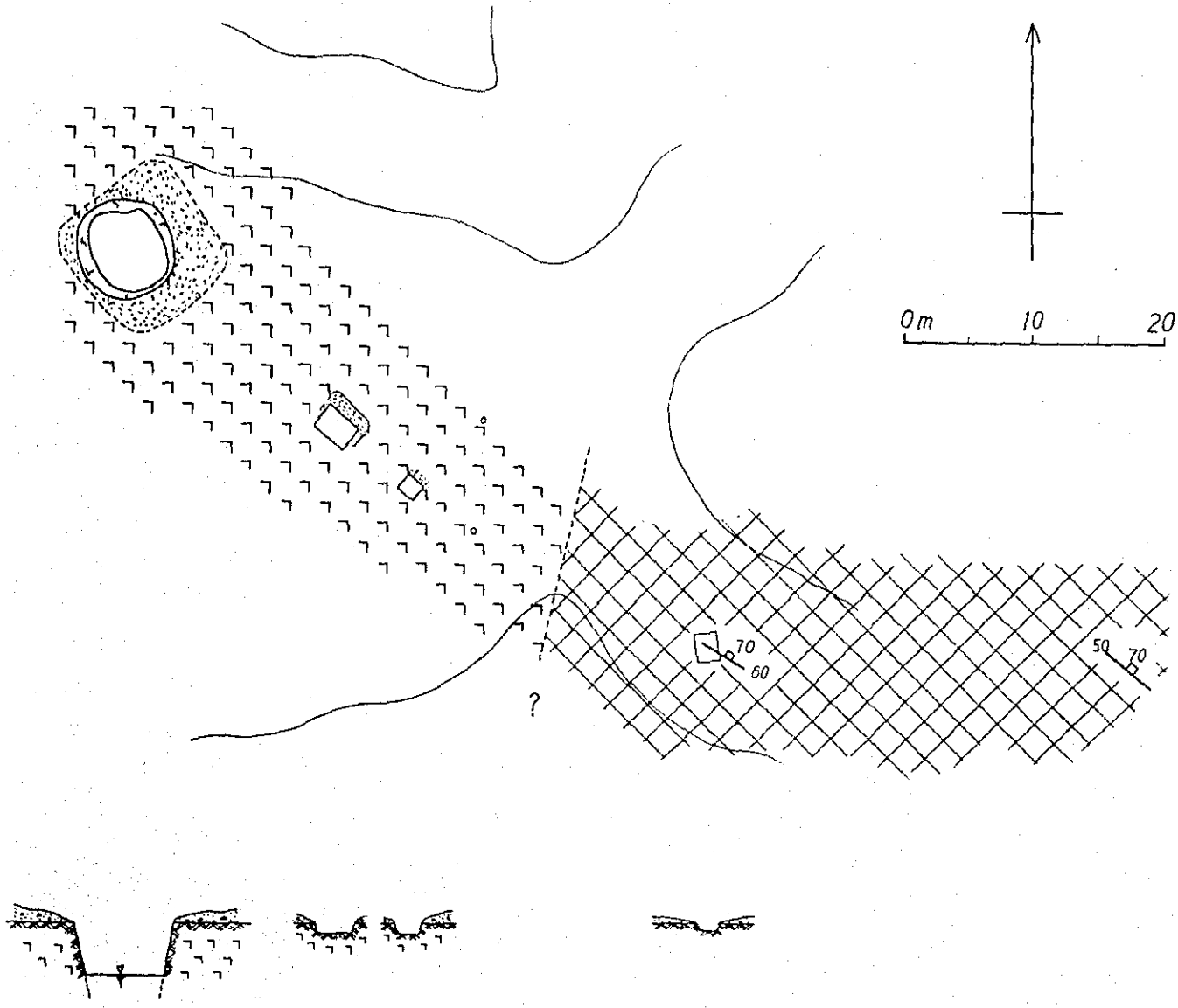
Limestons

Quartz Porhyry

Trench

Strike and Dip of Beds

Fig.42 Sketch Map and Section of Lai Nan Village Copper Prospect, Lai Nan District Amphor Sa, Changwat Nan.



Andesite

Basalt

Joint

Pit

Fig. 43 Zinc & Lead Deposits At Klong Huai Rad.

Tambon Pha Daeng Amphur Muang
Changwat Petchaboon.

PLAN

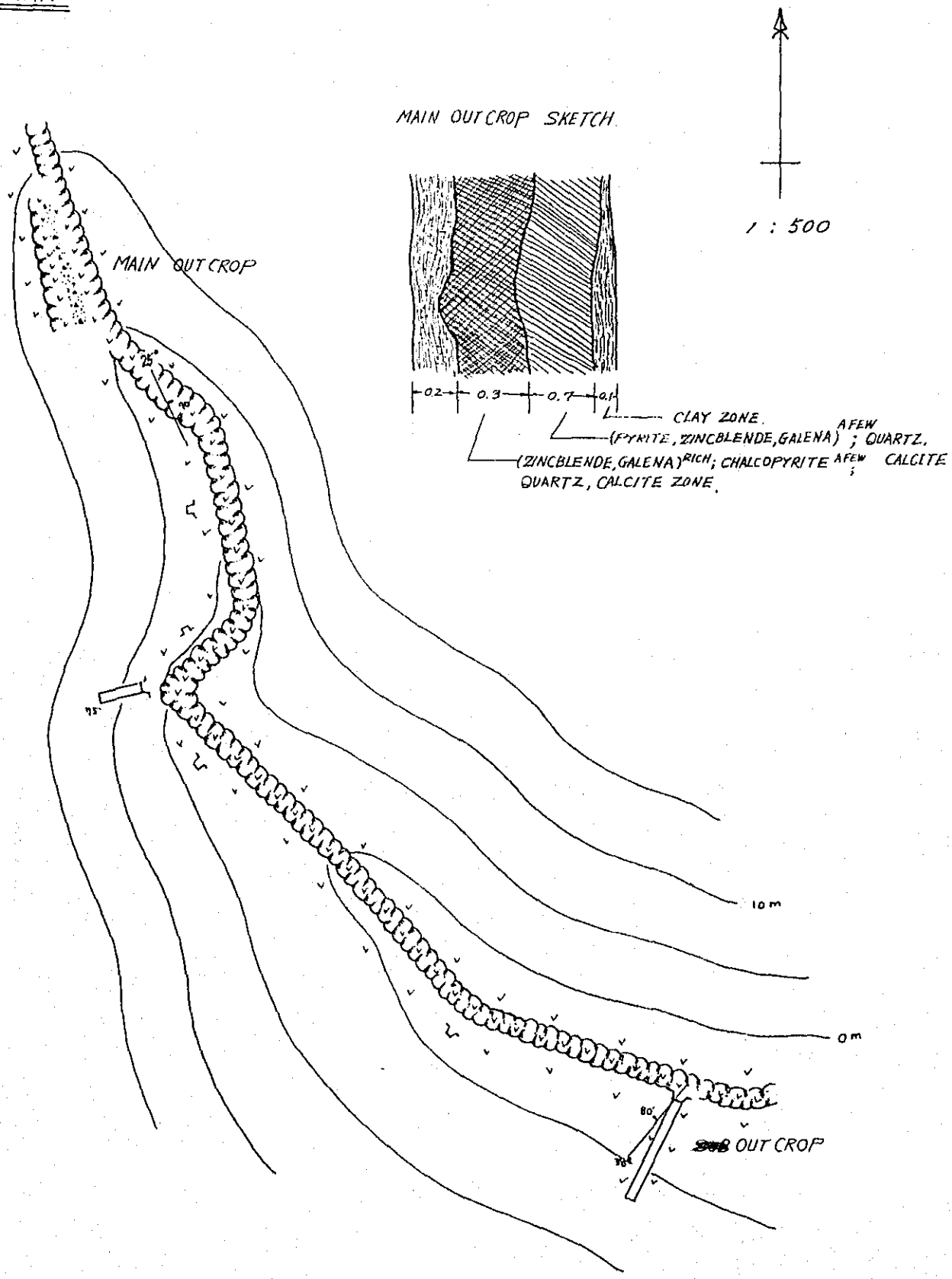
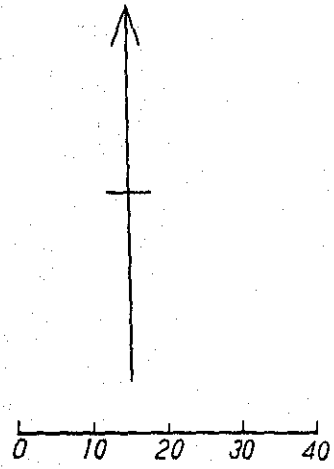
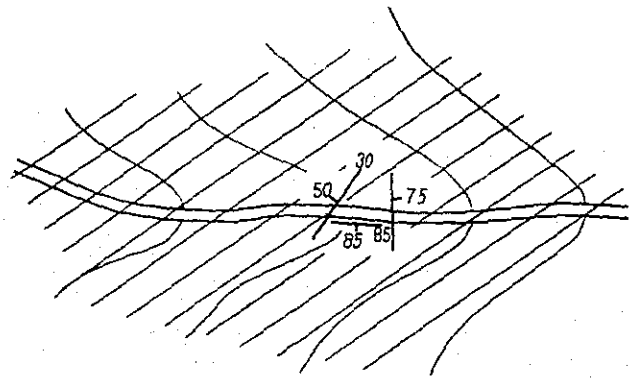


Fig.44 Sketch Map of Wang Nang Lead-Zinc Prospect, Ba Nam Rin Village Ta Pha Mok District, Amphor Long, Changwat Phrae.

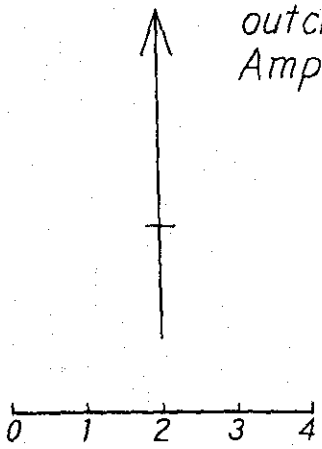




Shale

Strike & Dip of Quartz Veinlets

Fig.45 Sketch Plan and Section of Bo Sam Kleow Lead outcrop, Ban Nam Rin Village, Ta Pha Mok District, Amphor Long, changwat Phrae.



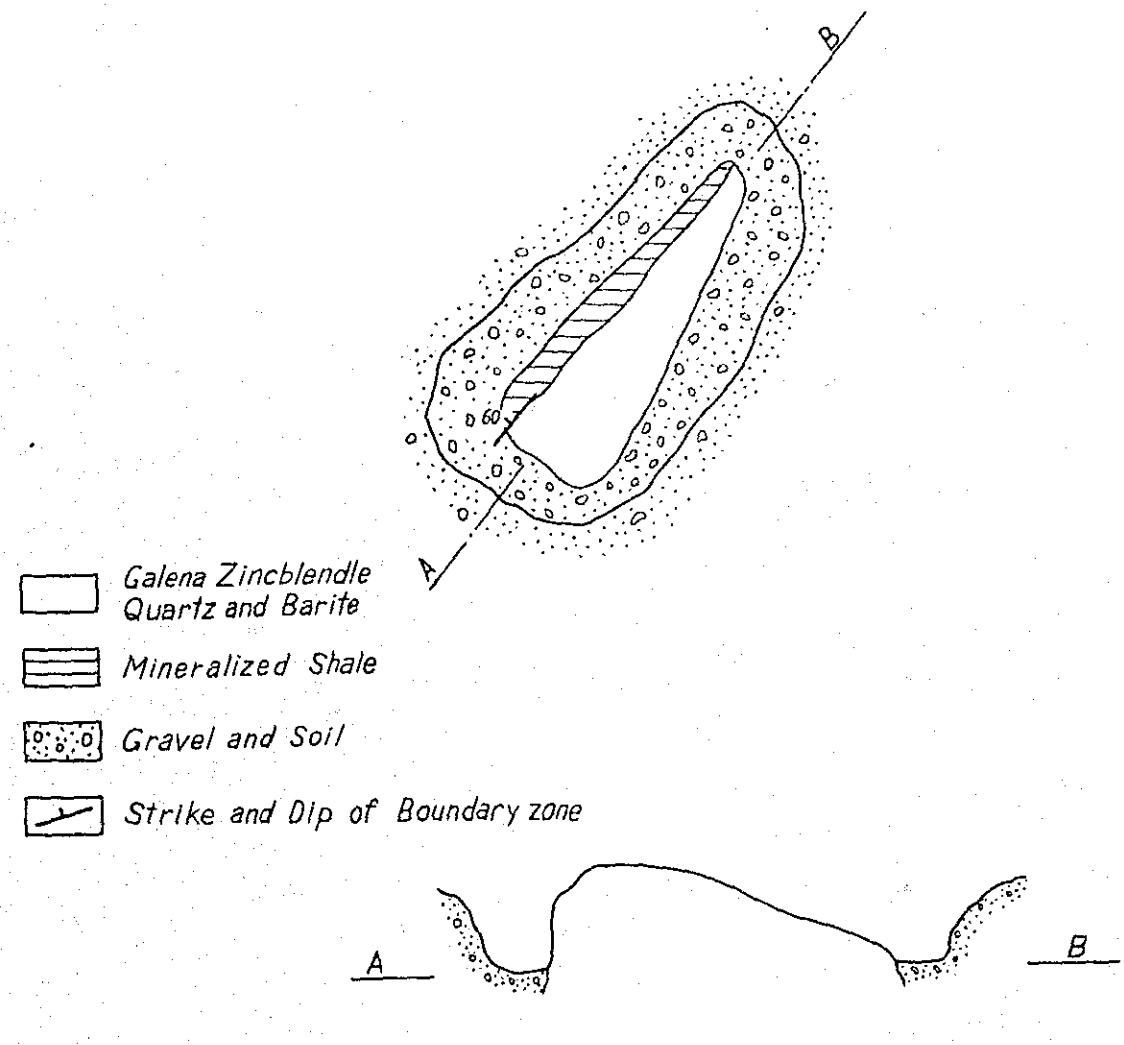
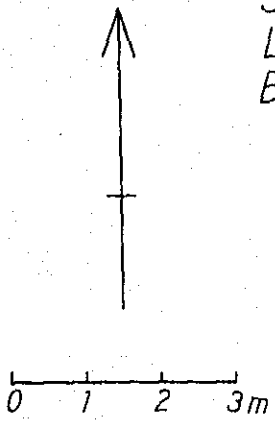
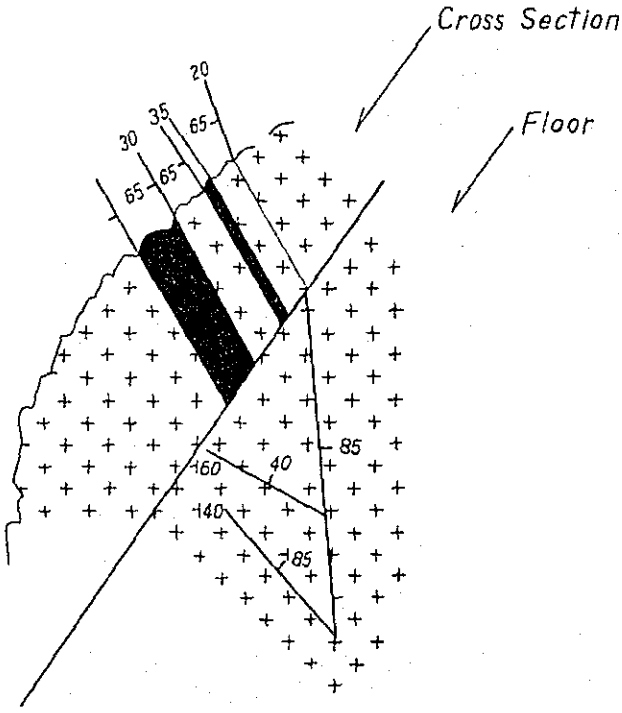


Fig. 46

Sketch Plan and Cross Section of Huai Tham Kwai Lead Outcrop, About 10km North of Ban Rin Station, Ban Rin District, Amphor Long, Changwat Phrae.





Granite

Barite-Quartz-Pb Vein

Strike and Dip of Vein

Fig.47 Sketch Map of the Huai Bong Zinc prospect, Ban Bo Village Ban Pin Ditrict, Amphor Long, Changwat Phrae.

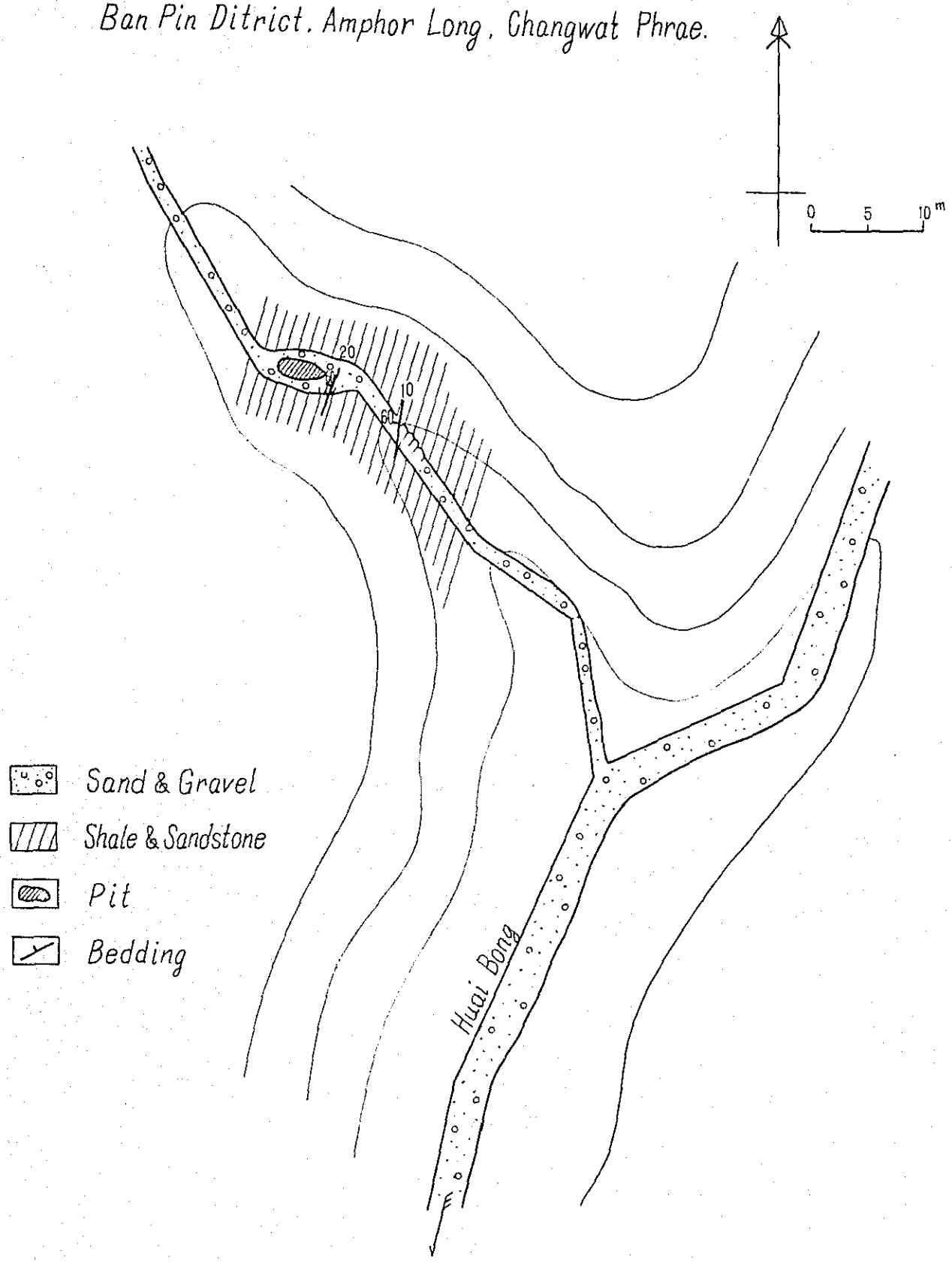


Fig. 48 Sketch Map of Huai Mae Som, Khao Pha Hing Antimony prospect, North of Pha Kho Station, Ban Pin District, Amphor Long, Changwat Phrae

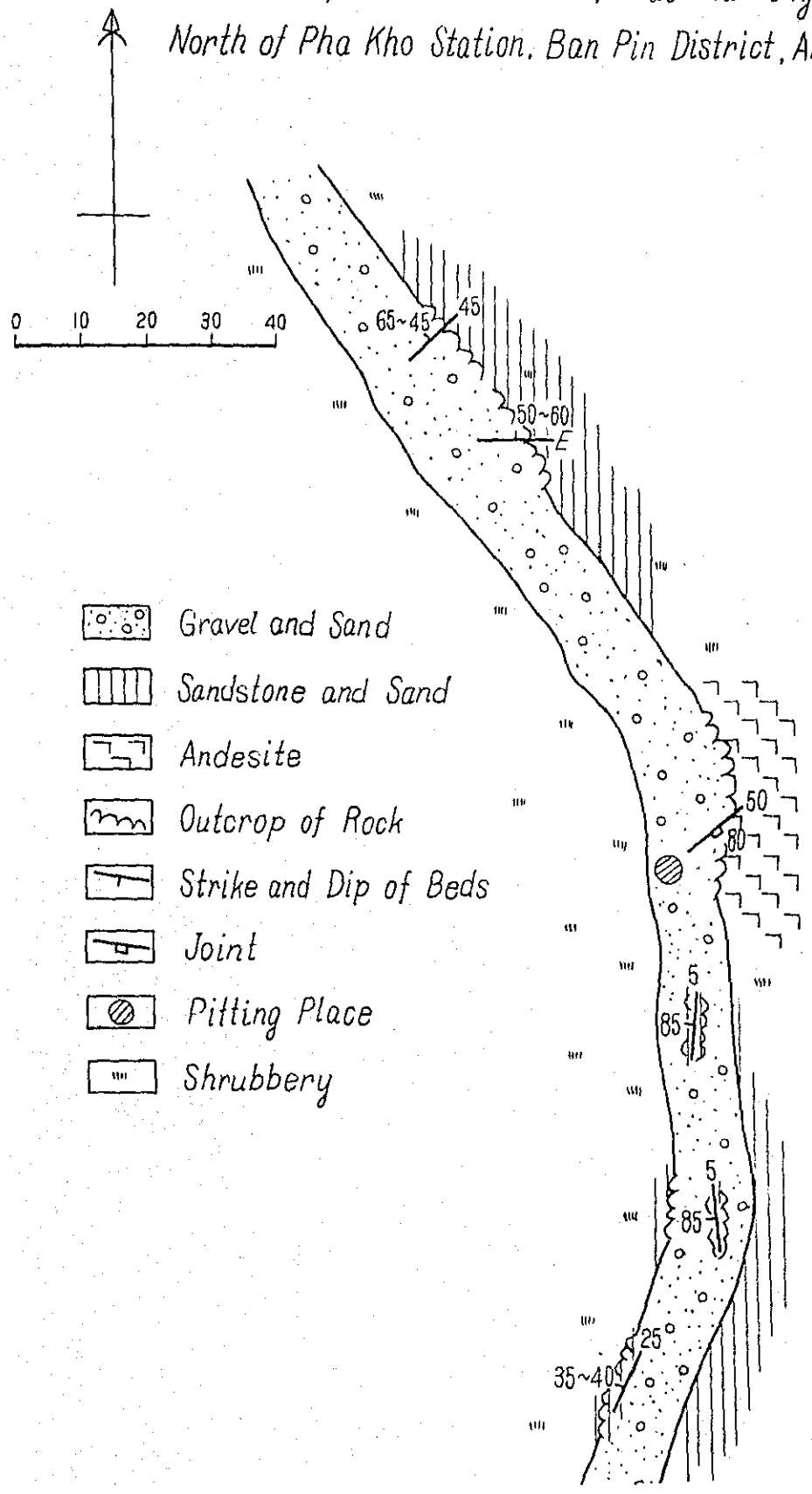


Fig. 49-1

ANTIMONY MINE AT DOI PHA KHAN

Ban Pin District, Amphur Long, Changwat Phrae.

PLAN & SECTION

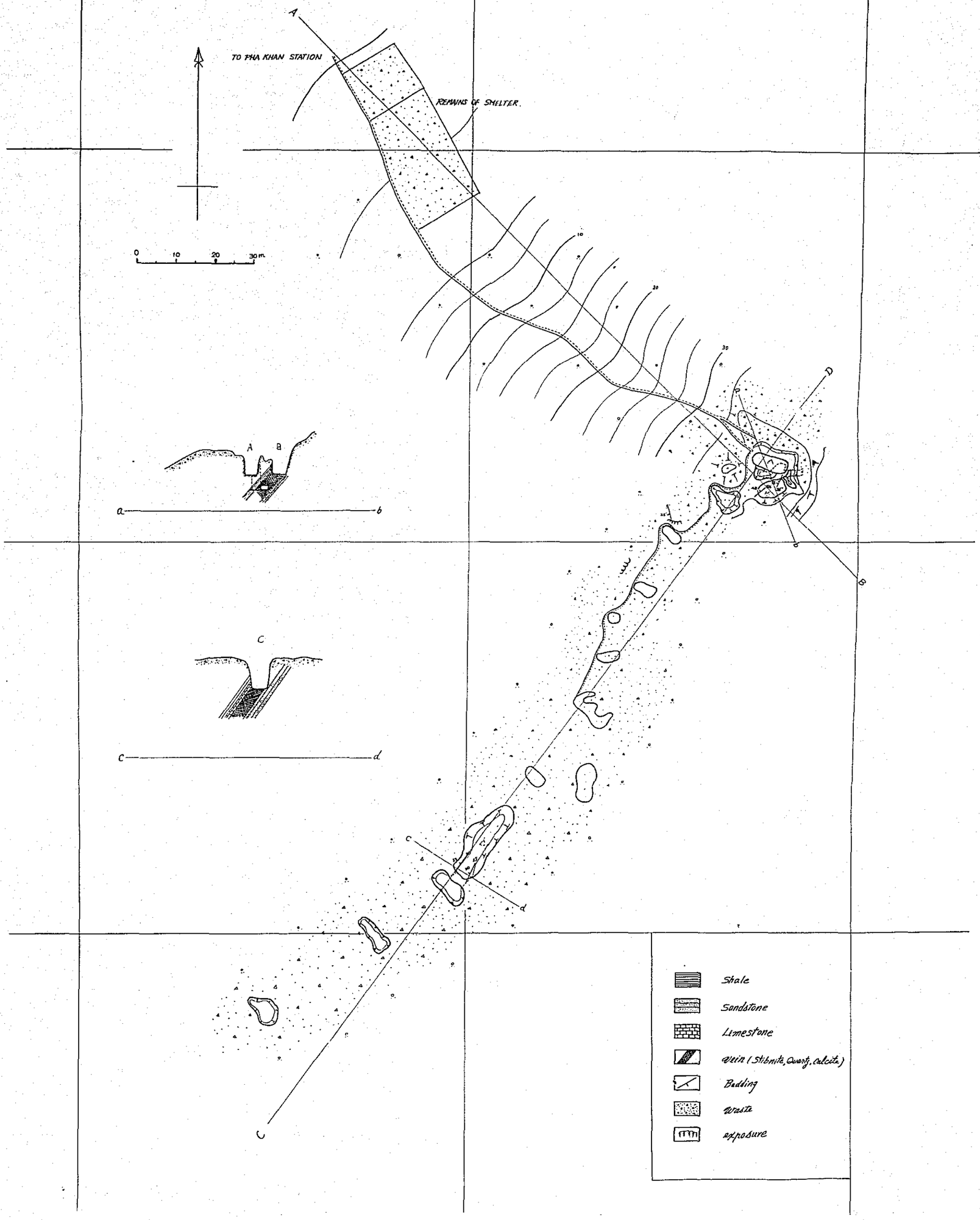


Fig. 49-2 A—B CROSS SECTION

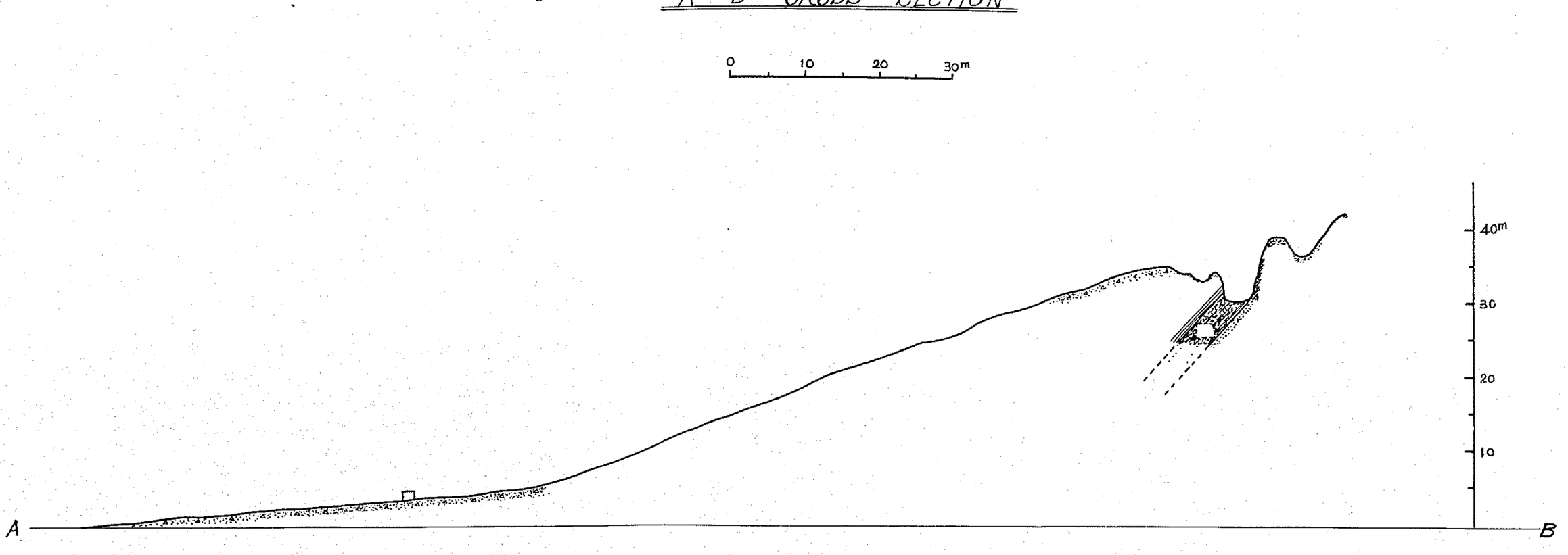
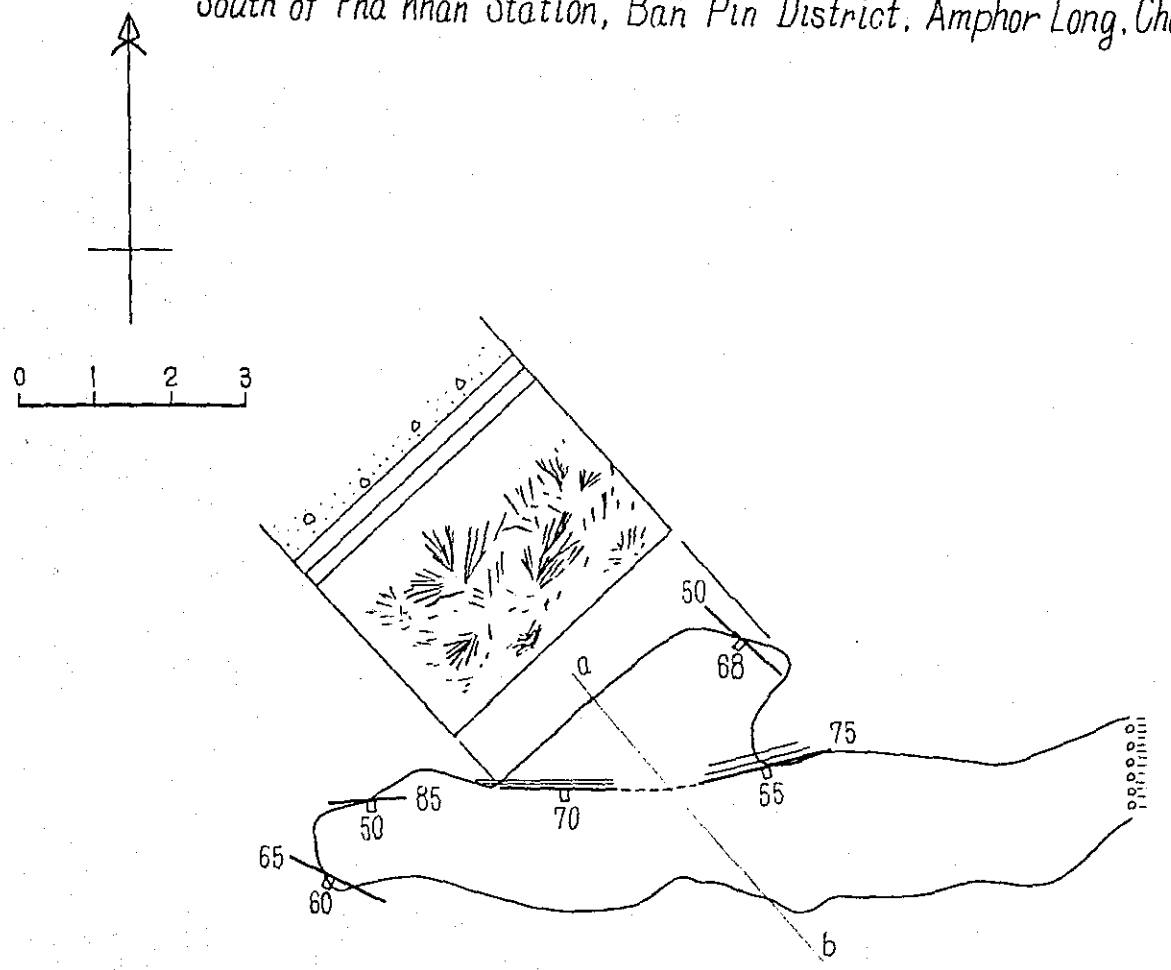
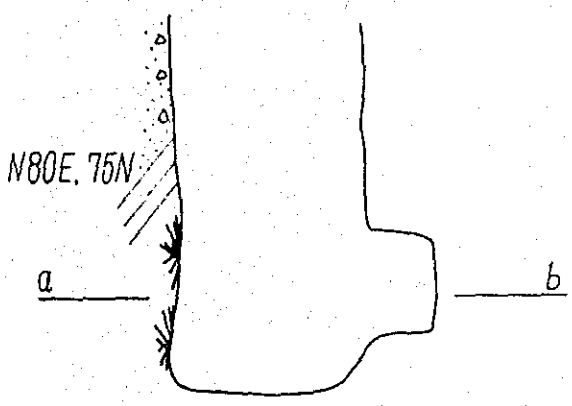


Fig. 49-3 C——D CROSS SECTION

0 10 20 30m

Fig.49-4 Sketch plan and section of adit of Doi Pha Khan Antimony Mine, South of Pha Khan Station, Ban Pin District, Amphor Long, Changwat Phrae.





Calcite and Quartz

Stibnite

Oxide zone

Limy Shale & Limestone

Breccia & Clay

Strike and Dip of crack

Fig. 50 Sketch Map of Khao Tham Ngoem Antimony Prospect Ban Pin District. Amphoy Long Changwat Phvae.

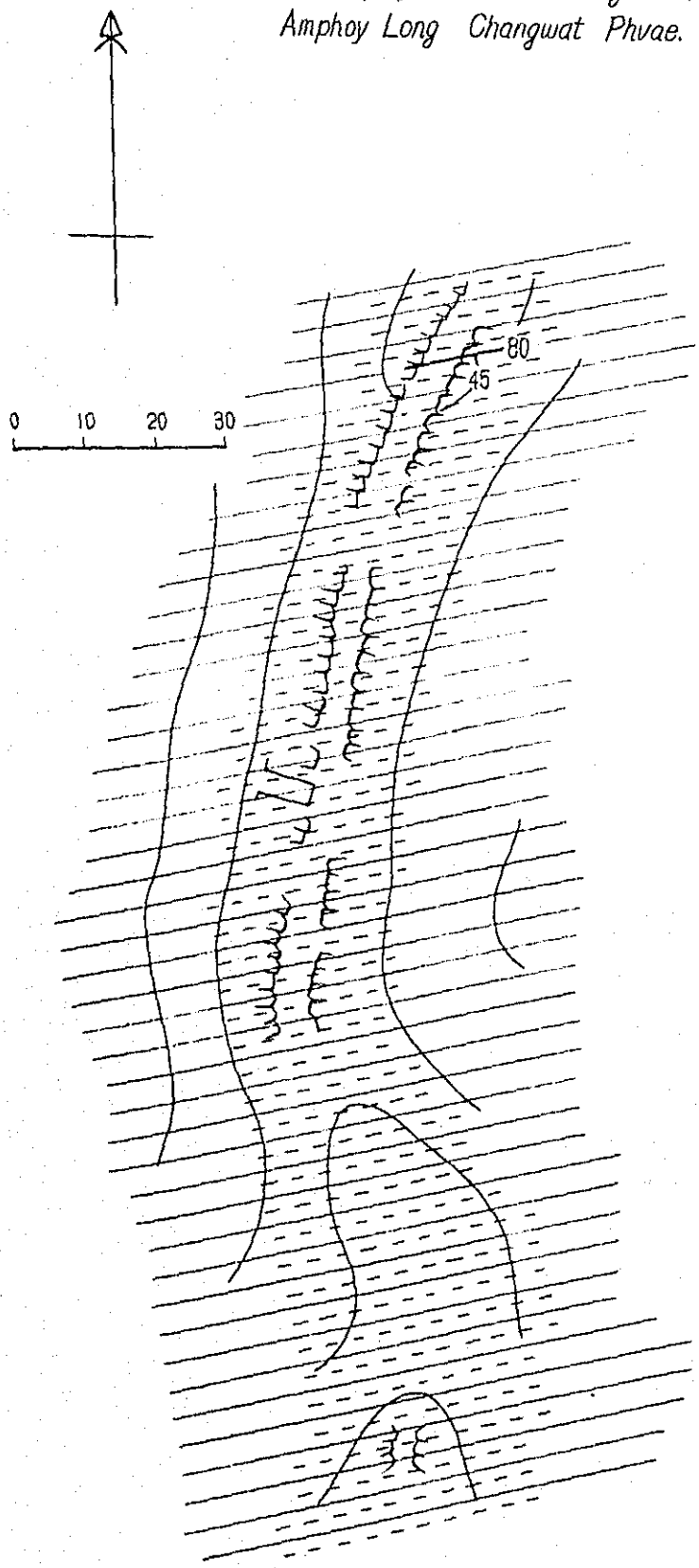


Fig. 51-1 Asbestos Pit At Mon Pha Yom.

Wang Dang Village Hard Ngui District.
Amphur Muang Changwat Uttaradit

PLAN

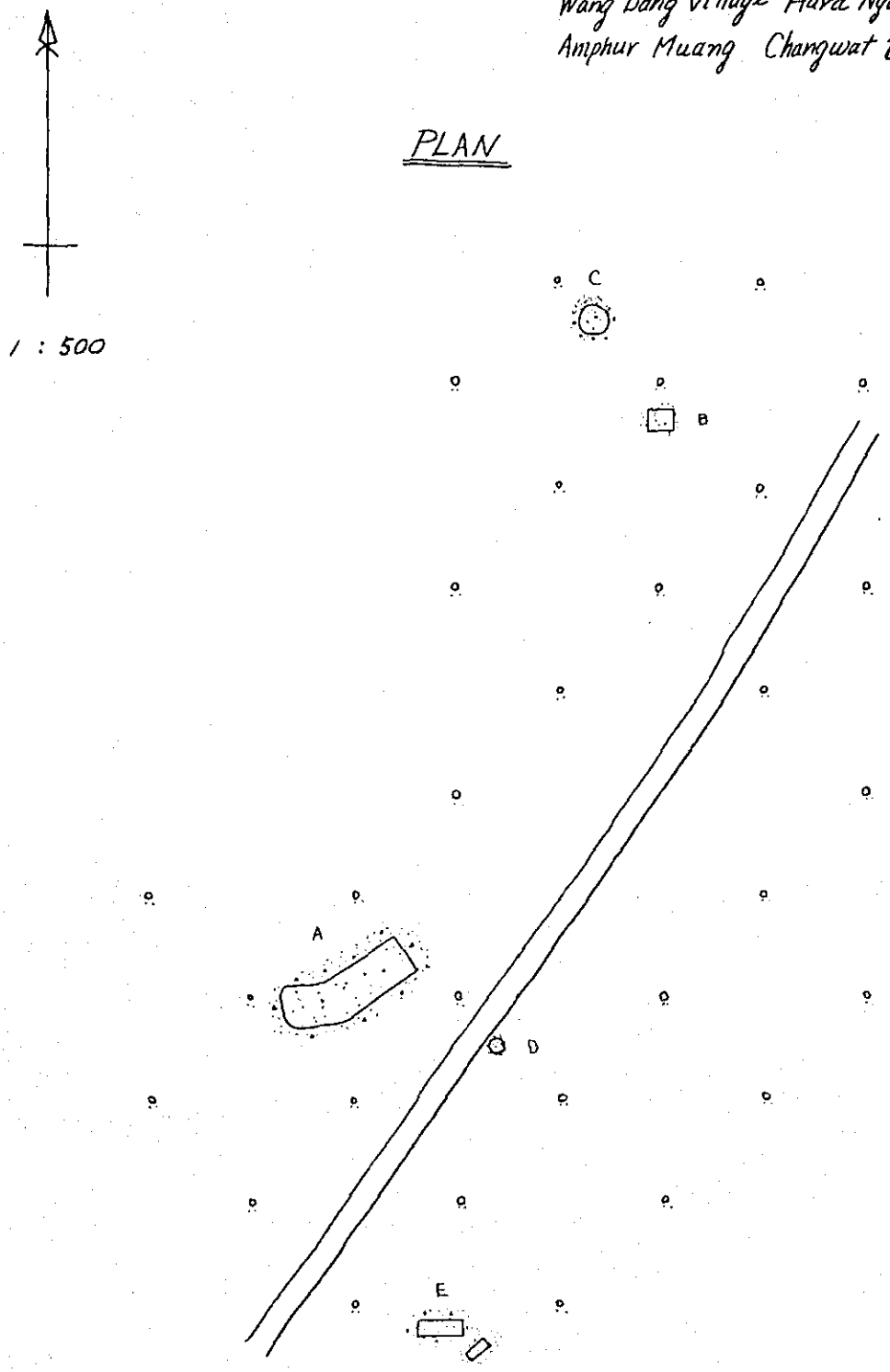


Fig. 51-2 Asbestos Pit At Mon Pha Yom.

Wang Dang village Hard Ngui District Amphur Muang Changwat Uttaradit.

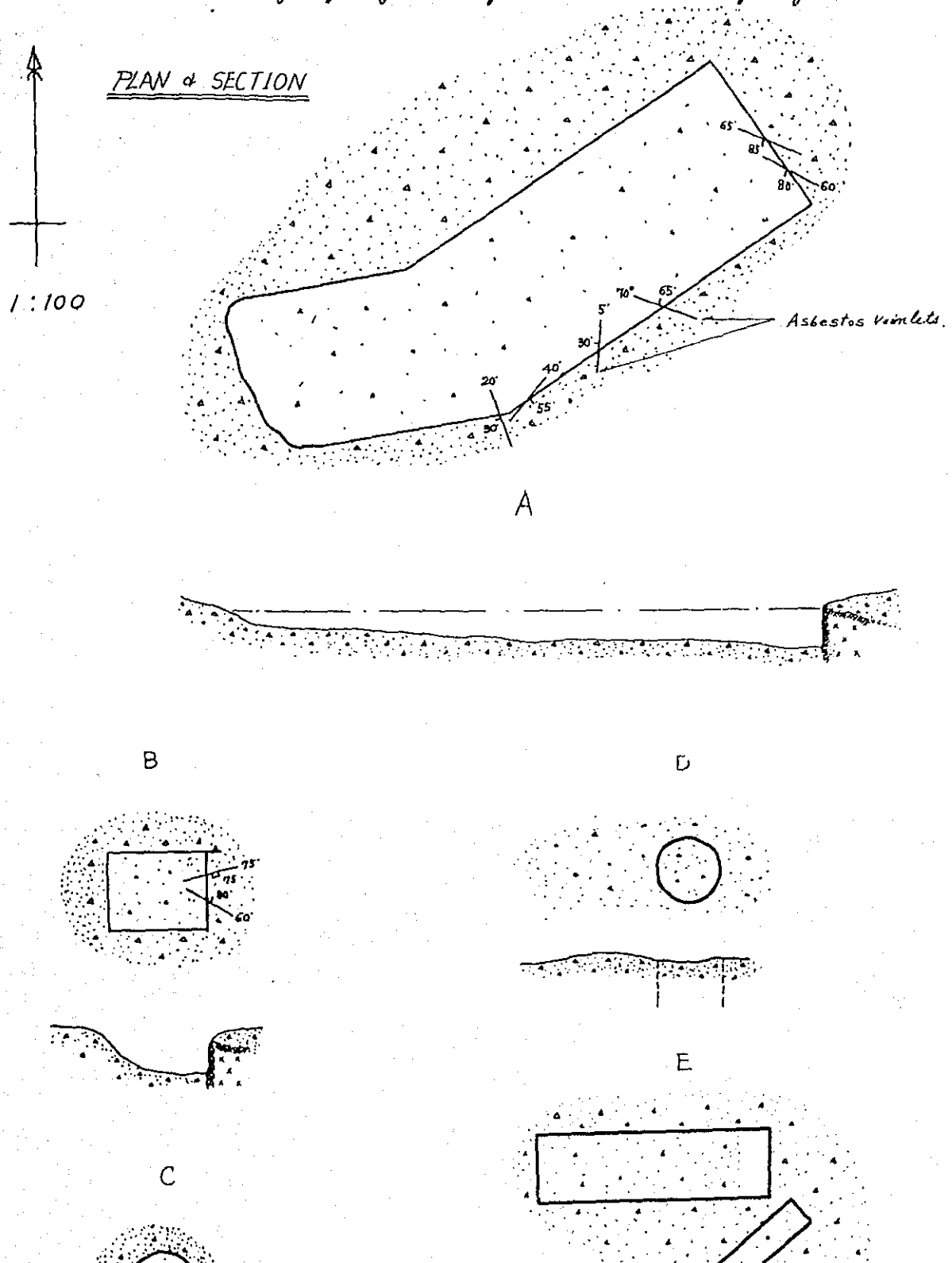


Fig. 52 Asbestos Pit At Mon Hin Sam Lee

Tha Lued Village Tha Lued District
Amphur Tha Pla Changwat Uttaradit.

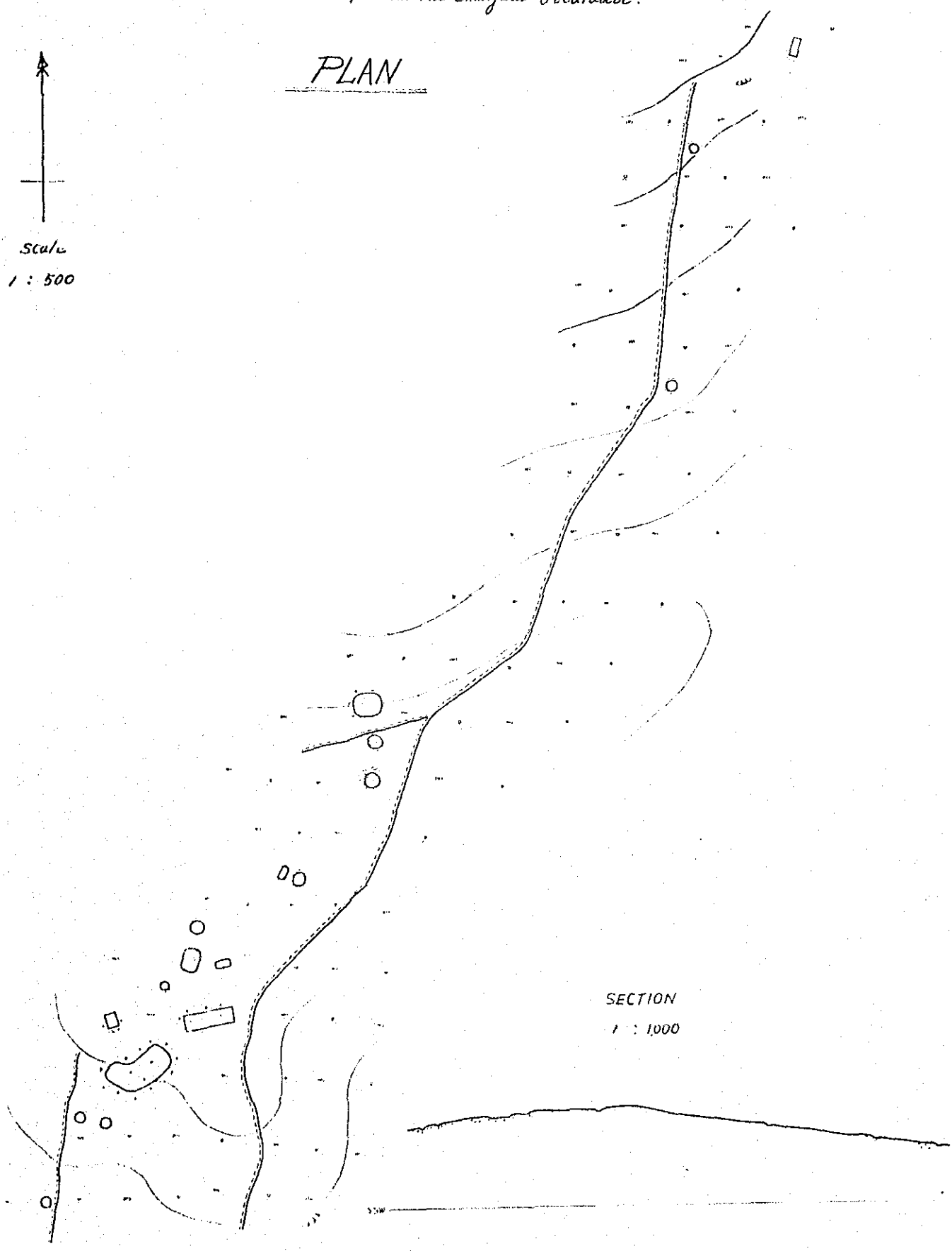
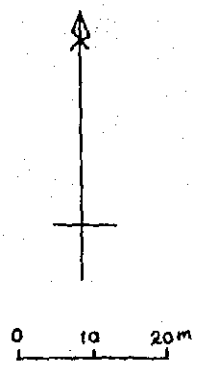
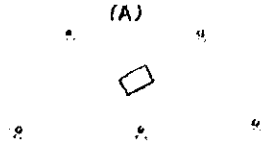


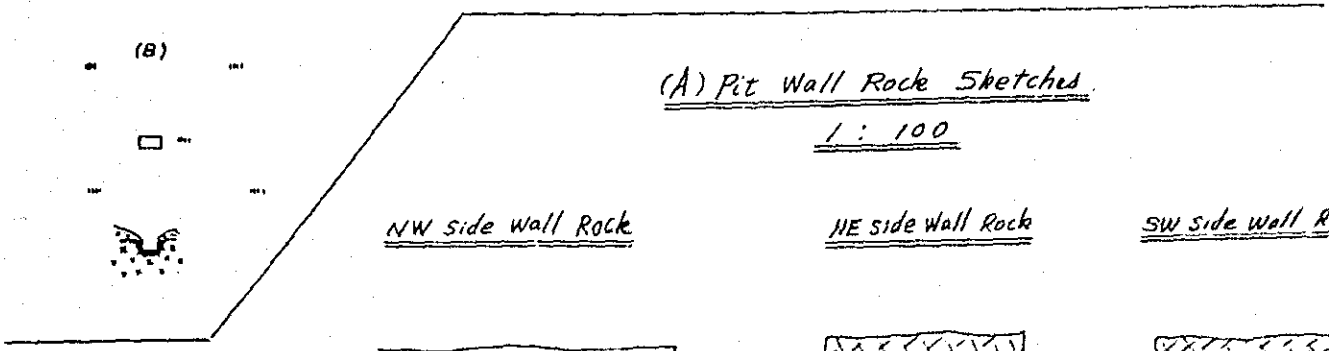
Fig. 53 Asbestos Pits Mon Chang Now

Huai Yang Village Charim District
Amphur Tha Pla Changwat Uttaradit



PLAN & SECTION

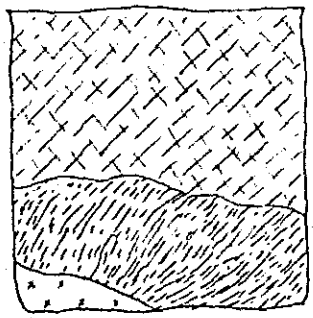




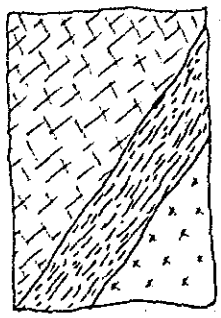
(A) Pit Wall Rock Sketches

1 : 100

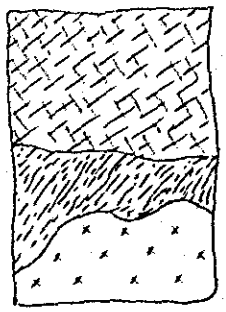
NW side Wall Rock



NE side Wall Rock



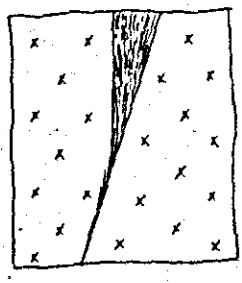
SW side Wall Rock



(B) Pit Wall Rock Sketches

1 : 50

East Side Wall Rock



West side Wall Rock

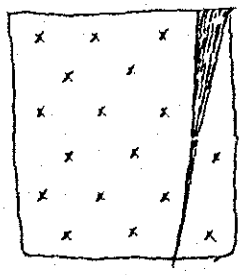


Fig. 54 Asbestos Pit At Den Sua Kluak

Pha Tao Village Pha Lued District
Amphur Tha Pla Changwat Uttaradit

Plan & Section

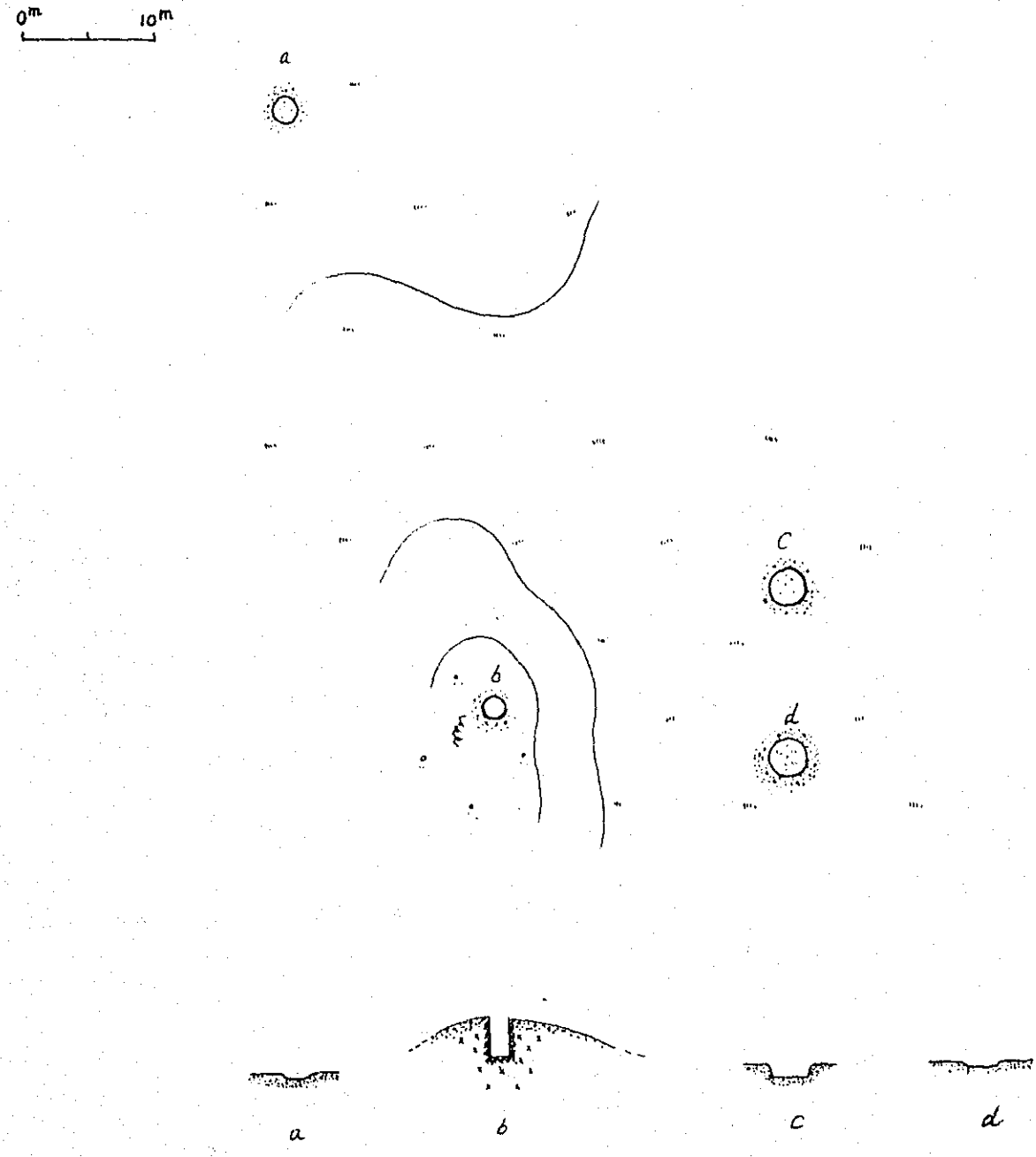
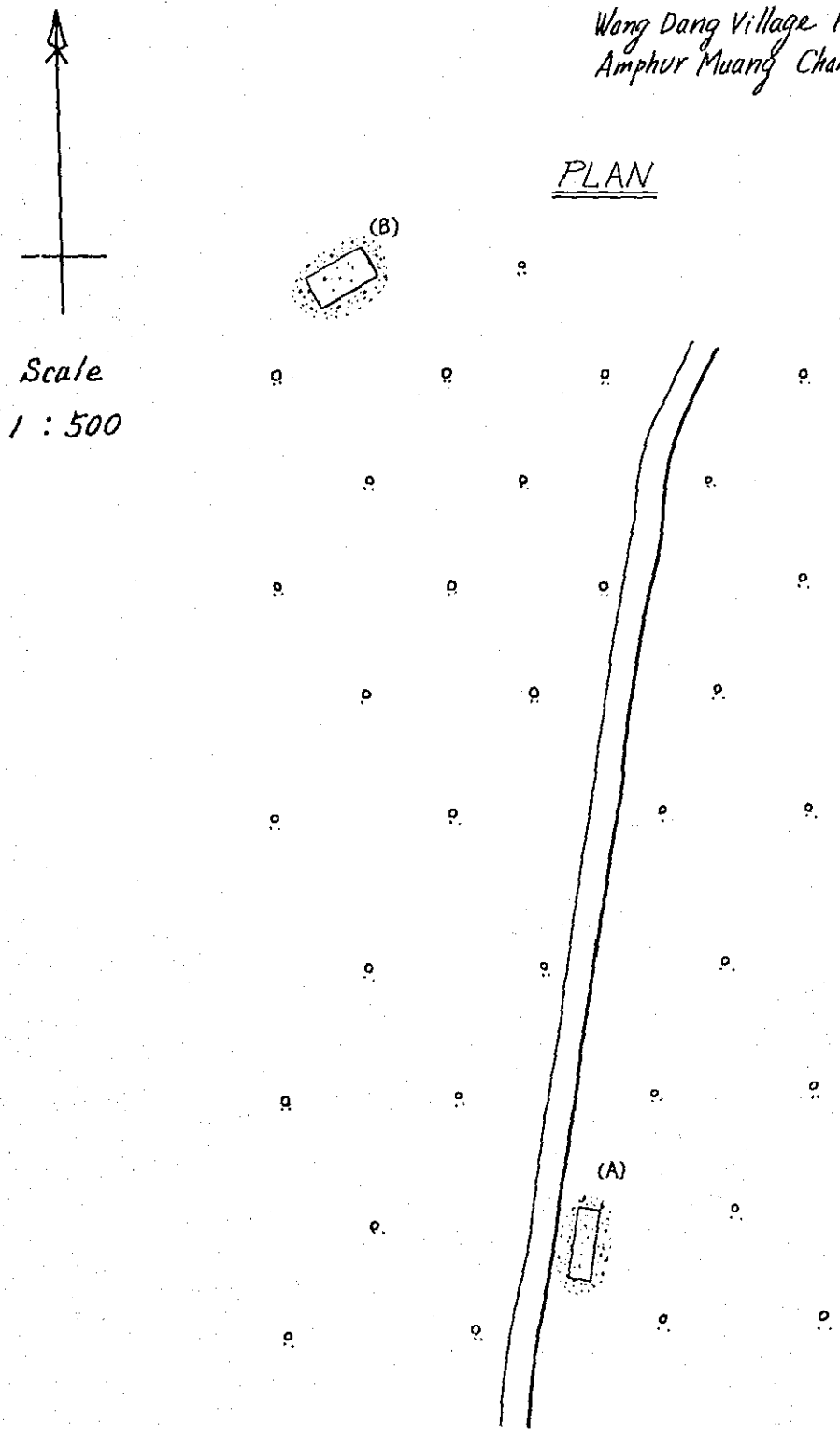


Fig. 55-1 Asbestos Pit At Mon Kai Chae

Wong Dang Village Hard Ngui District
Amphur Muang Changwat Uttaradit.

PLAN



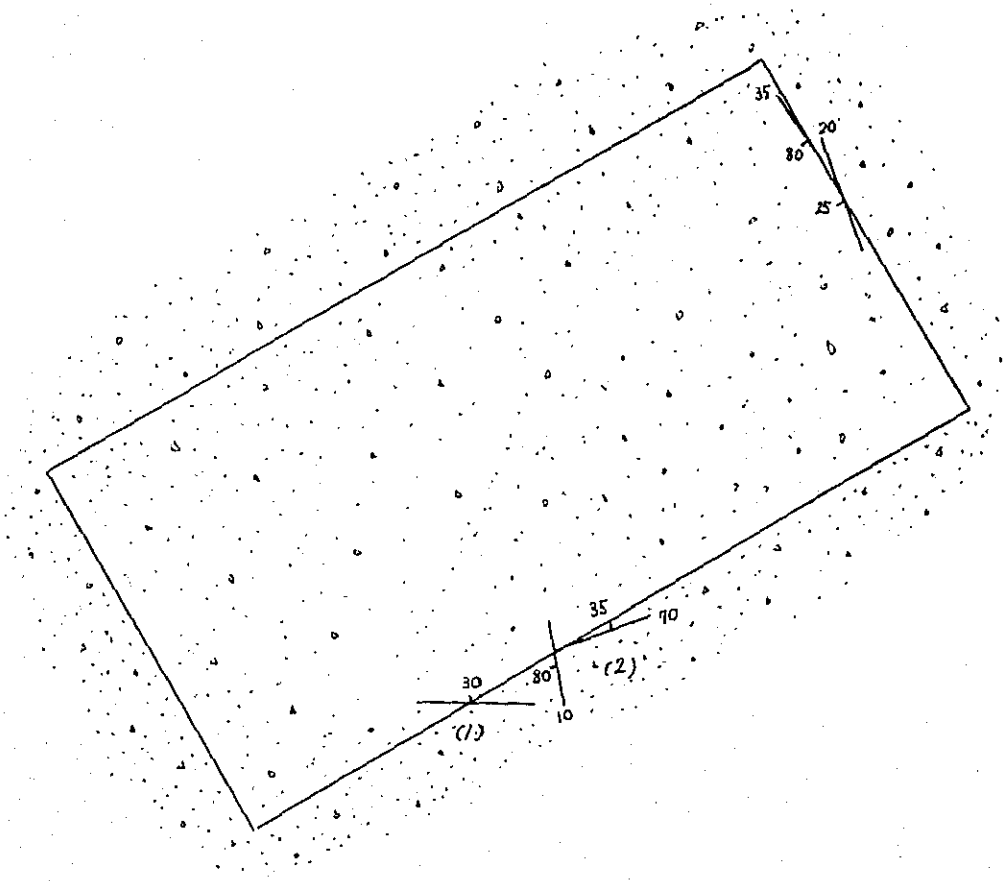
Scale
1 : 500

Fig. 55-2 Asbestos Pit At Mon Kai Chae

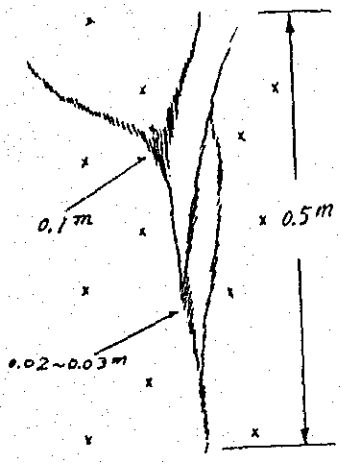
Wang Dang Village Hard Ngui District
Amphur Muang Changwat Uttaradit

(B) PLAN.

1 : 50



(1) ASBESTOS VEINS SKETCH



(2) ASBESTOS VEINS SKETCH

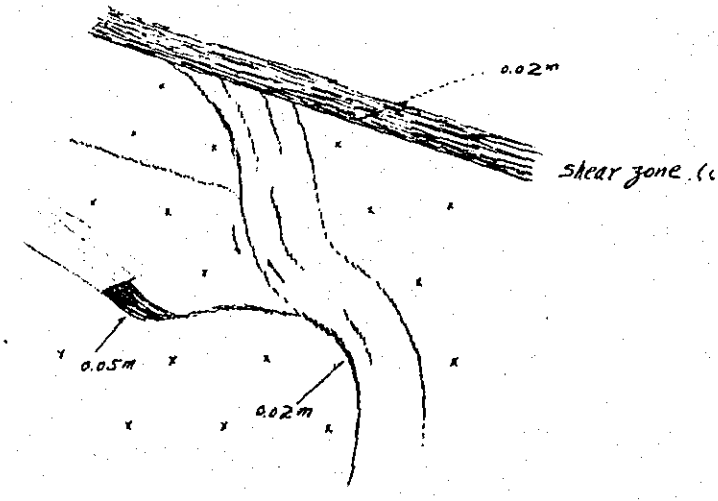
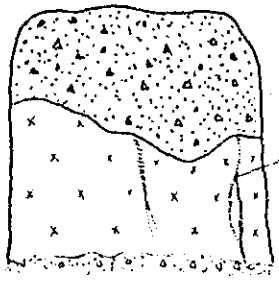


Fig. 55-3 Asbestos Pit At Mon Kai Chae

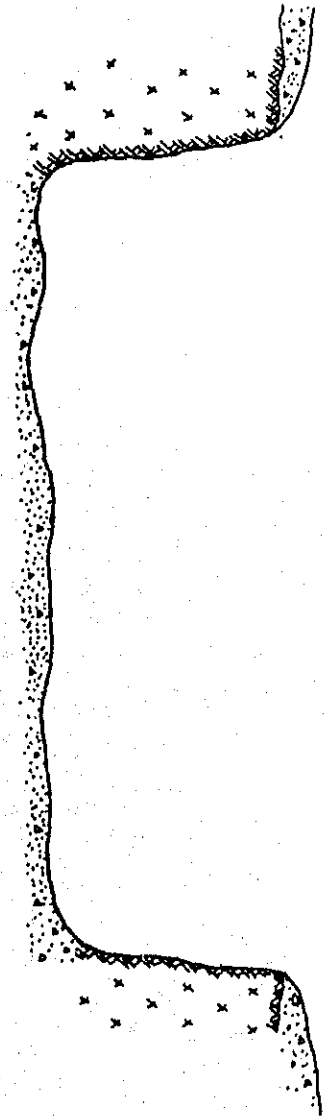
Wang Dong Village Hard Ngui District
Amphur Muang Changwat Uttaradit

1 : 50

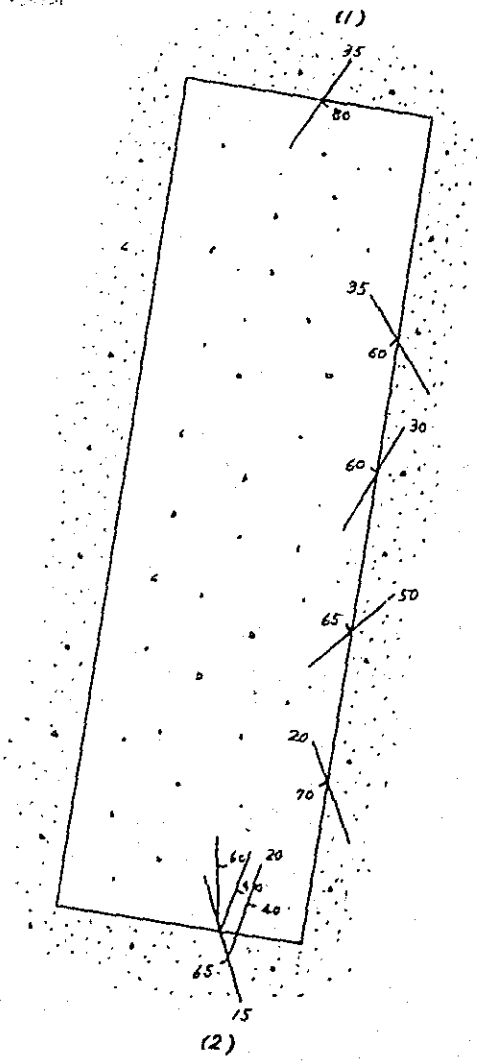
(1) CUT FACE SKETCH



ASBESTOS VEINS Maximum width 0.07m.



PLAN & SECTION



(2) CUT FACE SKETCH.

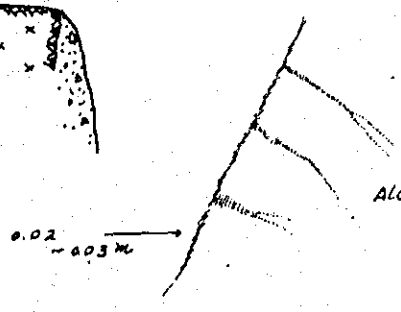
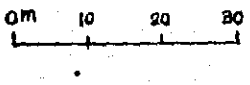


Fig. 56 Talc Pit At Kaeng Kra Jad

Pha Lued District Amphur Tha Pla.
Changwat Uttaradit



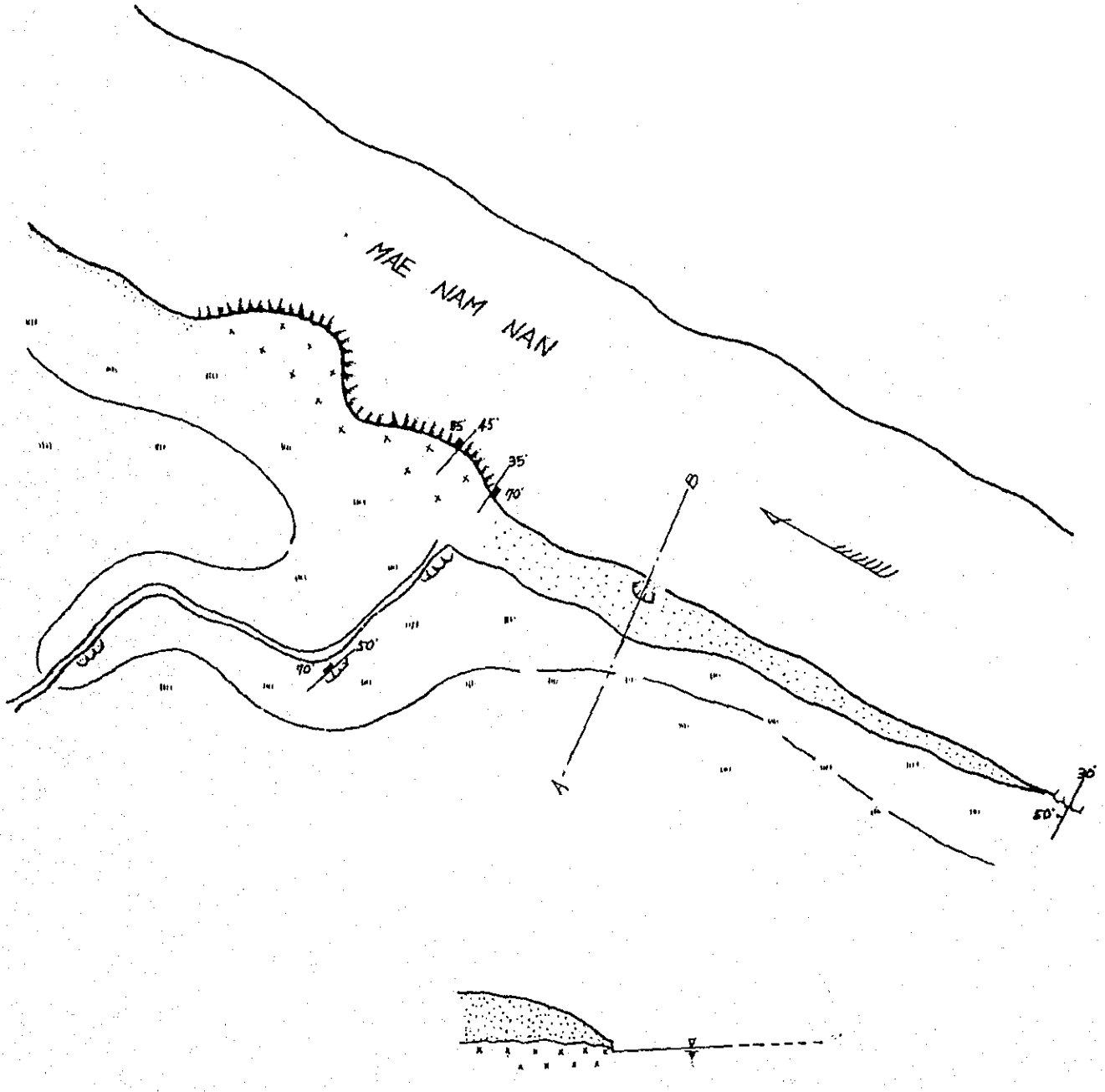
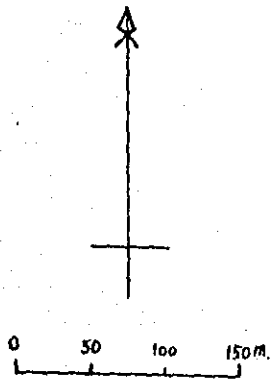
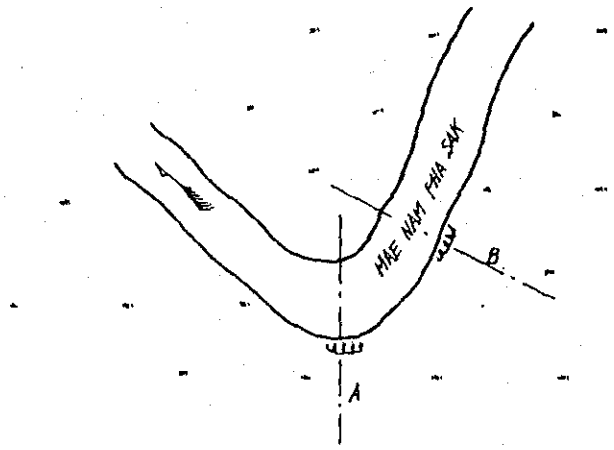


Fig.57 Red Soil At Wang Rong

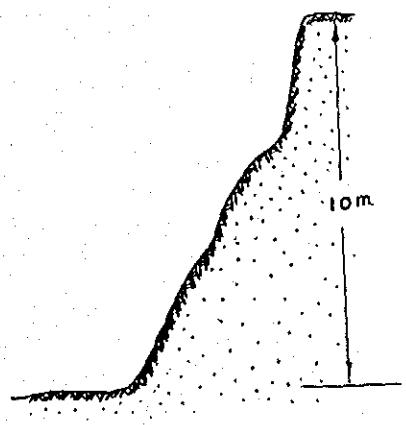
Tambon Tha Ea Boon Amphur Lomsak
Changwat Petchaboon.



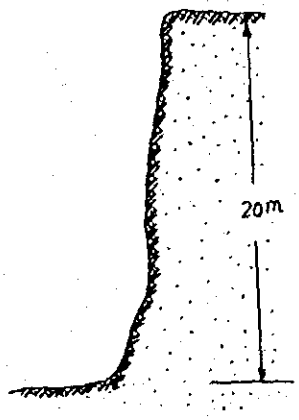
PLAN



SECTION



A



B

Fig 60

Location of Ore Deposits Surveyed by Japanese Mineral Resources Survey Team 1963