THE KINGDOM OF THAILAND

REPORT ON THE COOPERATIVE MINERAL EXPLORATION OF YANG KIANG AREA (THE COLUMBITE-TANTALITE EXPLORATION PROJECT)

PHASE Ⅲ

OCTOBER 1989

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

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PREFACE

In response to the request of the Government of the Kindgom of Thailand, the Japanese Government decided to conduct a Mineral Exploration in the Yang Kiang Area Project and entrusted the survey to the Japan International Cooperation Agency (JICA) and Metal Mining Agency of Japan (MMAJ).

The JICA and MMAJ sent to the Kingdom of Thailand a survey team headed by Mr. Iwao Uchimura from December 4, 1988 to April 12, 1989.

The team exchanged views with the officials concerned of the Government of the Kingdom of Thailand and conducted a field survey in the Yang Kiang area. After the team returned to Japan, further studies were made and the present report has been prepared.

We hope that this report will serve for the development of the project and contribute to the promotion of friendly relations between our two countries.

We wish to express our deep appreciation to the officials concerned of the Government of the Kingdom of Thailand for their close cooperation extended to the team.

June, 1989

Kensuke Yanagiya
President
Japan International Cooperation Agency

Kensuke Yanagiya

Junichiro Sato
President
Metal Mining Agency of Japan

Junichiro Sato

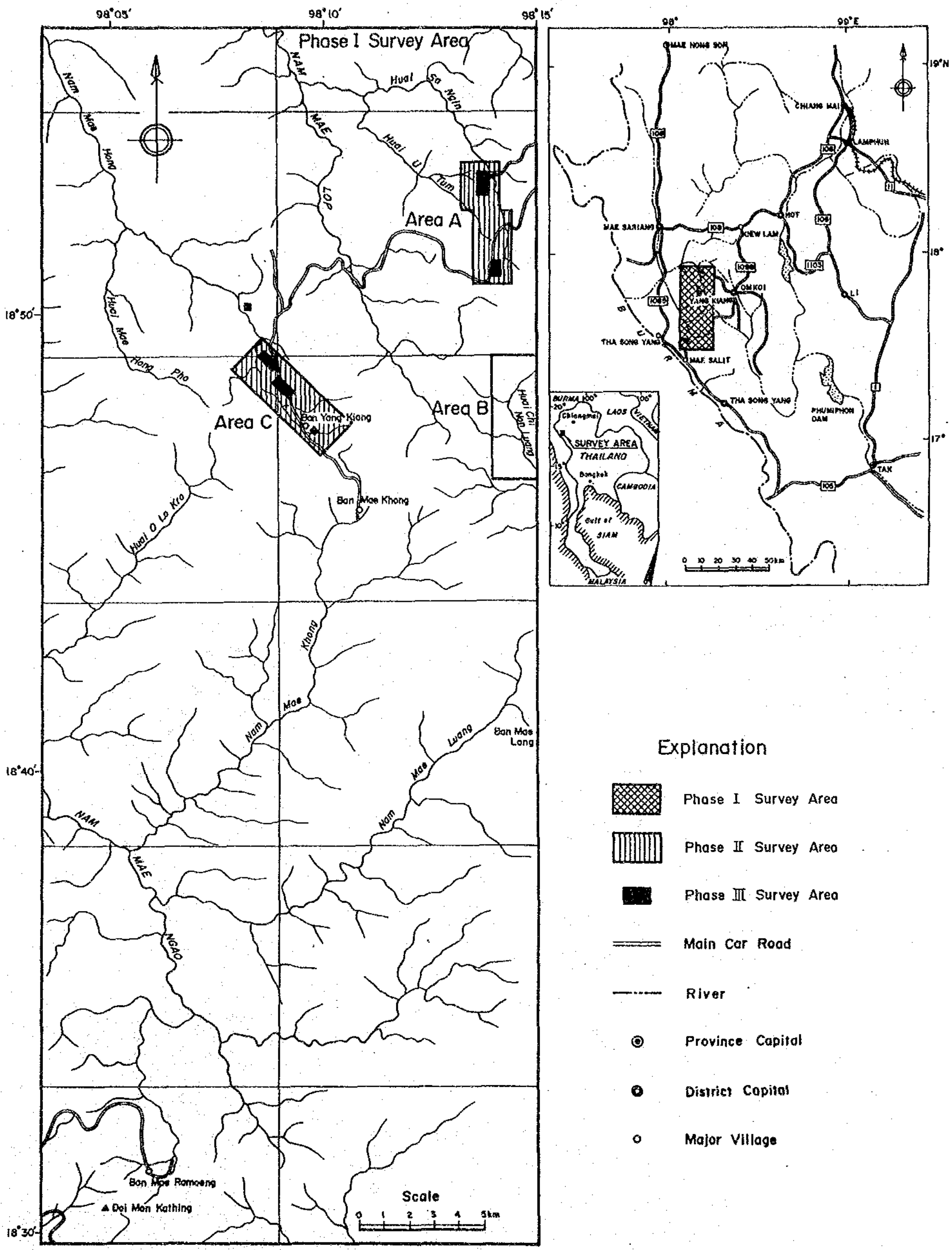

Fig.1 Location map of the survey area

SUMMARY

Trench survey in Area A and drilling survey in Area C were carried out to confirm mineralization of the areas and to evaluate their mineral potential.

Area A is composed of biotite granite of the Triassic, two mica granites of the Cretaceous, and pegmatite, aplite and quartz-vein intruding these granites.

Trench survey was carried out in the geochemical anomalous zones of niobium, tantalum, tin and tungsten.

Dikes composed mainly of pegmatite were found in most of the trenches, and the analytical values of them coincide nearly with geochemical anomalous values. This suggests that geochemical anomalies originate from pegmatites.

While dikes in a few of the trenches contain high values of niobium, tantalum and tin, these are of too low grade to warrant exploitation as a primary ore deposit.

Tin and tungsten minerals were found in panning samples collected from the streams and old workings of placer deposits are scattered along the streams. These reveal that dike rocks such as pegmatites are the source of placer deposits. However most of promising areas for placer deposits have already been mined by local people and the probability of discovering new placer deposits seems low.

Area C is composed of Cambrian to Carboniferous sedimentary rocks, Triassic granite, Cretaceous granite and alluvium.

Geochemically anomalous zones of tin and tungsten show clear zonal distribution trending in a NNW-SSE direction, and many small-scale gossans are also scattered here.

Sedimentary rocks as roof pendant are sporadically scattered on a small scale.

Mineralization was found along the boundary between granite and sedimentary rocks and in the sedimentary rocks. Contact metasomatic deposits have been formed here replacing limestone or calcareous rock.

Orebodies are present in skarn. Ore minerals are sphalerite and chalcopyrite as major minerals, galena, scheelite and argentite as minor minerals. Each orebody is lens-shaped ranging from 20x20m to 70x100m wide and from 5 to 10m thick, and not widely traceable. They are distributed over a zone 200 to 300m wide and more than 3km long. Drilling in a limestone area 1km NNW of Area C also confirmed the presence of a considerable skarn zone and massive sulfide beneath the limestone. This suggests that mineralization is predominant in this direction.

Ore reserve is estimated at 899,000 tons, Cu:0.49%, Zn:1.17%, Ag:27g/t ; these grades are too low to warrant mining in the area.

A promising area exists between the above-mentioned limestone area and Area C, where the distribution of roof pendant limestone and a scattering of gossans suggest the presence of ore deposits. Further study of the area extending NNW of Area C would be expected.

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PART I GENERAL REMARKS

PART I GENERAL REMARKS

Chapter 1 Introduction

1–1 Background and Objective of the Survey

The first series of the cooperative mineral exploration was carried out in the Omkoi area of northern Thailand from 1983 to 1985. The survey in the Omkoi area identified the geology, geological structure, related igneous rocks and characteristics of mineral deposits, and discovered some new indications of a mineral zone of tungsten.

On the basis of these findings, the Thai Government requested the Japanese Government to conduct a second series of cooperative mineral exploration in the Yang Kiang area adjacent in the west to the Omkoi area (Fig. 1).

In response to this request, the Japanese Government began basic survey for resources development in Yang Kiang in 1986, with the anticipation of possible deposits of niobium, tantalum, tin, tungsten, gold, silver copper, lead, zinc, etc. During the first year survey (1986), geological survey (preliminary survey) and geochemical prospecting were performed in a 1,000km^2 area centering on Yang Kiang village. As a result, Huai U Tum ∿ Huai Sa Ngin (Area A), Huai Chi Non Luang (Area B) and the environs of Yang Kiang village (Area C) were identified as areas with high potential for deposits of niobium, tantalum, tin, tungsten, etc.

In the second year survey (1987), further geologic survey and soil geochemical prospecting were performed in the U Tum ∿ Sa Ngin (Area A) and the environs of Yang Kiang village (Area C). As a result, areas of high mineral deposit potential were identified consisting of a geochemical high anomaly zone of tin and tungsten in Area A and geochemical high anomaly zone of tin and tungsten with gossan in Area C.

In this phase, survey was conducted to confirm the mineralization by trench survey in Area A and drilling survey in Area C.

1–2 Conclusion and Recommendation in the Second Phase Survey

1–2–1 Conclusion

<u>Area A</u>

The area is underlain by biotite granite, two mica granite, pegmatite, aplite, and quartz vein, being regarded as the Triassic.

It is inferred from difference of lithology, texture, distribution, and form that after the biotite granite batholith was formed, the two mica granite intruded and the pegmatite, aplite, and quartz veins subsequently intruded into both granites.

It is confirmed by chemical analyses of panning concentrates that the pegmatites contain nibobium, tantalum, tin and tungsten.

Locations of geochemically anomalous zones rich in all analized elements generally coincide. It was concluded that these anomalous zones have potentiality for existence of pegmatites rich in niobium, tantalum, tin and tungsten.

Area C

The area is underlain by Cambrian to Carboniferous sedimentary sequence, Triassic granites and alluvium.

The granites are biotite granite and two mica granite same as Area A. It is inferred from lithology and texture distribution that the latter granite intruded into the former one. Pegmatite is not seen in the area.

Many small gossans are seen in the two mica granite area and is aligned in NNW-SSE direction. They form a gossan zone in approximately 200m wide and 3km long strip.

Some gossans accompany skarn zones and silicified zones and show mineralization of tin, tungsten, copper, zinc and others.

Geochemically anomalous zones rich in tin and tungsten are distributed in a NNW-SSE strip and overlap the gossan zone. An anomalous zone rich in niobium and tantalum is continuous to the aforementioned anomalous zone and overlaps the kaolin alteration zone. These anomalous zones contain many high assay values of tin and tungsten suggesting high potential for economical mineralization zones.

1–2–2 Recommendation

As a result, the following two places are identified as highly potential areas for economical ore deposits:

(1) Around the old workings along a tributary of Huai U Tum, and a geochemically anomalous zones in the middle course of Huai Sa Ngin in Area A.

(2) A geochemically anomalous zone extending NNW-SSE which overlaps the gossan zone and the kaolin zone in Area C.

It was recommend for the third phase survey that trench survey and shallow drilling to 30 to 50m deep should be carried out to confirm existence of mineral indications and extent of mineralized zone at the geochemically anomalous zone in the above places.

1–3 Outline of the Third Phase Survey

1–3–1 Location and Accessibility

The survey area comprises 2 areas in Omkoi district of Chiang Mai province as shown in Fig. 1, namely, 1 upper reaches of Huai Sa Ngin ∿ Huai U Tum (Area A) and 2 environs of Yang Kiang village (Area C).

Omkoi town is accessible from Chiang Mai by national highways 108 and 1099. Bus service follows this route making 1 trip per day. Both highways are paved. The distance can be negotiated by automobile in about 3½ hours.

An unpaved road from Omkoi to Mai Khong village passed through both portions of the survey area. However, 4 wheel drive is necessary to negotiate the steep and winding route. The distance from Omkoi to Area A is about 25km and takes about 1½ hours by automobile. The distance from Omkoi to Area C is about 55km and takes about 3½ hours by automobile.

1–3–2 Objective of Survey

In the Third Phase Survey, survey was conducted to identify conditions of ore deposits. This was achieved by trench survey in Area A and drilling survey in Area C, which confirmed underground geologic and mineralization conditions. In addition, relation with geologic conditions, mineralized zones and geochemical anomalies in the vicinity of the survey area was studied.

1–3–3 Contents of the Third Phase Survey

In the Third Phase Survey, survey focused on the zones of geochemical anomaly and minerallization identified in the second year survey.

25m trenches were excavated at 20 locations (total length: 500m) in Area A in order to clarify the relationship between geologic structure and mineralizing action and details of mineralization. Trenches were sited on measuring lines centered on zones of geochemical anomaly so as to effectively grasp conditions of geology and mineral presence. Trenches were dug a standard 1m wide and 2m deep, and details of geology and mineralization observed. On the basis of findings, a 1:100 scale trench survey map was prepared. In addition to sampling of the weathered pegmatite veins observed in the trenches, panning of heavy minerals was also attempted. Ore deposits and geology in the vicinity of the trenches were also surveyed.

Drilling survey was performed in Area C in order to clarify geochemical characteristics and detailed geologic structure of mineralized zones, thereby identifying mineral zone forming structure and extent of deposits. Drilling sites were set on measuring lines centered on zones of geochemical anomaly.

Drilling commenced in the center of the area where bringing in and erection of drilling equipment was facilitated, and then gradually moved outward towards the periphery. Cores were examined in detail, and a 1:200 scale boring logs were prepared. Sampling was also performed centered on points on mineral indication. Drilling (75m X 2 holes) was also carried out to determine the extent of the northern portion of mineral indication area.

The conventional drilling method was adopted, with both soft and hard rock core tubes used as conditions dictated in order to achieve the highest core recovery rate possible. Two drilling rigs were employed with three shifts.

Analysis of samples and survey findings were performed in Japan. Survey items and quantities are as shown in Table 1.

Table 1 Survey Items and Quantities

Area	Survey Item	Quantity	Laboratory examination	Quantity
Area A	Geologic survey Geochemical prospecting	trench total length: 500m (25m X 20 sites)	thin section microscopic study polished section microscopic study geochemical analysis (Sn, W, Nb, Ta) X-ray diffraction test EPMA analysis	5 pieces 6 pieces 50 pieces (200 components) 6 pieces 6 pieces
Area C	Drilling survey	drill hole no.: 56 total drilling depth: 1,965.55m	thin section microscopic study polished section microscopic study chemical analysis (Sn, W, Nb, Ta, Cu, Pb, Zn, Cd, Au, Ag) X-Ray diffraction test EPMA analysis	20 pieces 13 pieces 209 pieces (1,946 components) 8 pieces 10 pieces

1–3–4 Personnel of the Survey

1. Negotiation and Planning of Survey

Japan		Thailand	
Minoru Fujita	Metal Mining Agency of Japan	Thawat Japakasetr	Department of Mineral Resouces (Director of Economic Geology Division)
Seiichi Ishida	ditto	Phairat Suthakorn	Department of Mineral Resouces (Project Manager)
Hiroshi Shimotori	ditto	Prachon Charoensri	Department of Mineral Resouces

2. Field Survey

Members of Survey Team

Japan		Thailand	
Iwao Uchimura	Geologist	Peerapong Khuenkong	Geologist
Takamasa Horikoshi	ditto	Patchara Jariyawat	ditto
Shohei Kusano	Drilling Engineer	Wason Chanseang	ditto
Hisao Ataka	ditto	Veerachart Jittamasey	Drilling Engineer
Etsuo Hatakeyama	ditto	Sontaya Pungsuk	ditto
Kazuto Tatsuyanagi	ditto	Kwancahi Saingtong	ditto
Hidenobu Fujinuki	ditto	Sukhum Tawachana	ditto
Yuji Shinkubo	ditto	Winai Trumong	ditto
		Sangwarn Kattapong	ditto
		Suwicha Puthanon	ditto

1–3–5 Survey Period

Period: December 4, 1988 to June 30, 1989

(Field Survey: December 4, 1988 to April 12, 1989)

Chapter 2 Geography of the Survey Area

2–1 Topography

Area A is located at the upper reaches of the Huai Sa Ngin and Huai U Tum. The area is mountainous ranging in elevation 1,100∿1,500m. However, weathered granite zone shows little differential in relative height, consisting of gently sloping old topography. Huai Sa Ngin flows from north to south in the eastern portion of the area. Huai U Tum flows from southeast to northwest in the western portion of the area. Hills 150∿200m in elevation run north-south and northwest-southeast in the area between the two rivers. There is long narrow flatland in the catchment of the Huai Sa Ngin which is paddy field. However, no such flatland is found along the Huai U Tum.

Area C is at the upper reaches of the Mae Khong river and comprises a mountainous zone 1,000∿1,600m in elevation. The Mae Khong river flows from southeast to northwest - north-northwest through the area. The river is hemmed on both sides by hills running northwest-southeast. Topography in the southern half of the area is gentle. Paddy fields are found in flatland in the Mae Khong catchment in the vicinity of Yang Kiang village. However, erosion is advanced downstream in the northern half of the area, resulting in mature, steep topography forming several waterfalls along the river route.

2–2 Climate and Vegetation

The Yang Kiang area belongs to the tropical savanna type climate. The period from May to October is the rainy season influenced by the southwest monsoon, while the period from November to February is the dry season under the influence of the northeast monsoon. The months of March and April are the hottest in the year as the northeast wind weakens.

Generally, the monthly average temperature is in the range of 16∿28°C. However, daily temperature ranges widely in the dry season 3∿35°C. In high mountain areas, the lowest temperatures drop to around 0°C, and frost forms at times. Annual precipitation is 800∿900mm. Very little rainfall occurs during the dry season from December to March.

In the north and east of the Yang Kiang area, most of the vegetation consits of primeval thin forests of broadleaf trees mingled with pine and other conifers. However, junglelike thick forests including hemp palm prevail in the southwest.

Chapter 3 Geological Information of the Survey Area

3–1 Previous Works

The survey area is in northwestern Thailand, located in a tin belt which extends from the Thai-Malaya peninsula to the Thai-Burma border.

A German Geological Mission conducted a regional survey in northern Thailand in cooperation with the Department of Mineral Resources from 1965 to 1971, and evaluated its mineral potential based on the stratigraphy and geological structure established by the survey. The report describes tin, tungsten, fluorite and antimony deposits in the Omkoi area. Based on the results of the survey, the Geological Map of Northern Thailand (1:250,000 scale), compiled by E. v. Broun, L. Hajn, and H. D. Maronde, 1981, was prepared.

Hahn and Siebenhüner described fossils in the above mapped area in 1982.

Vichit and Khunkong described tin and tungsten occurrences and characteristics in the Omkoi area in 1983. At the same time, they discussed the relationship between tin deposits and niobium-tantalum minerals found in stream sediment from the area.

JICA & MMAJ (1986) carried out a series of geological survey and geochemical prospecting over the area of 1,000km^2 around Omkoi twon from 1983 to 1985, and selected some favorable zones for Sn-W mineralization.

3–2 Summary of Geology and Ore Deposits

Geology in the Yang Kiang area including the survey area is summarized from 1) the Geological map of Northern Thailand "Sheed 6-Amphoe Li" scale 1:250,000 compiled by Broun, et. al, 1981, ii) the report of the German Geological Mission, 1972, and iii) the results of the first and the second phase survey.

The area is underlain by sedimentary, metamorphic, and granitic rocks as shown in Fig. 2 and Fig. 3. The stratigraphy of the area is classified from the bottom to the top as follows: Pre-Carboniferous metamophic rocks, Cambrian to Ordovician System, Ordovician System, Silurian to Devonian System, Devonian to Carboniferous System, Carboniferous to Permian System, Permian to Triassic System and Quaternary System. The igneous activity took place in Triassic and Cretaceous to Tertiary ages.

The east part of the area is occupied by batholith granite extending north~south, and the west part is distributed with sedimentary rocks of the Paleozoic and Mesozoic. The sedimentary rocks strike NW~SE. Granite stocks intrude in conformity with this structural direction at the middle and southwest end of the area.

It is reported the ore deposits bear close relationship with granite activity after the Mesozoic (GGM, 1972). Ore deposits and mineral indications of tin, tungsten, lead, zinc, antimony, etc. are seen throughout the area.

All ore deposits of tin and tungsten occur in granite or quartz veins originating therefrom, and are found in the cupolas and margins of granite bodies or in sedimentary rocks overlying the same.

Secondary ore deposits of tin and tungsten are found in batholith granite at the eastern portion of the area. Primary and secondary ore deposits are found in granite stock centered on the Mon Kathing mountains at the southwestern extreme of the area.

Tin and tungsten mines located in Omkoi district to the east are Yong Ku, Pha Pun, Pha Pun Dong, Pi Tu Khi, Huai Yap and Huai Sue. In the west in the Mae Sariang district, mines are Mae Rama, Pha Mark, etc.

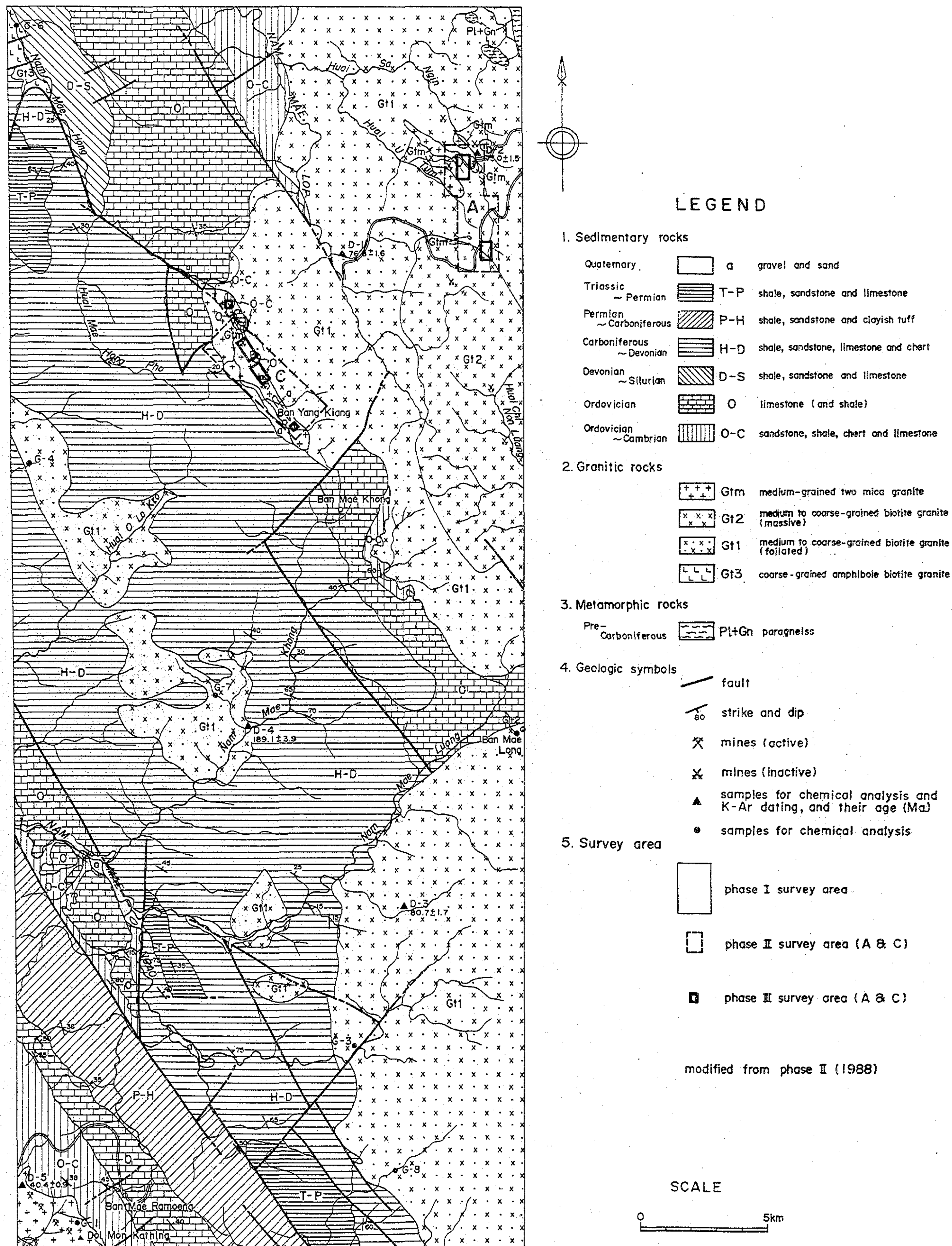


Fig.2 Geologic map of the Yang Kiang area

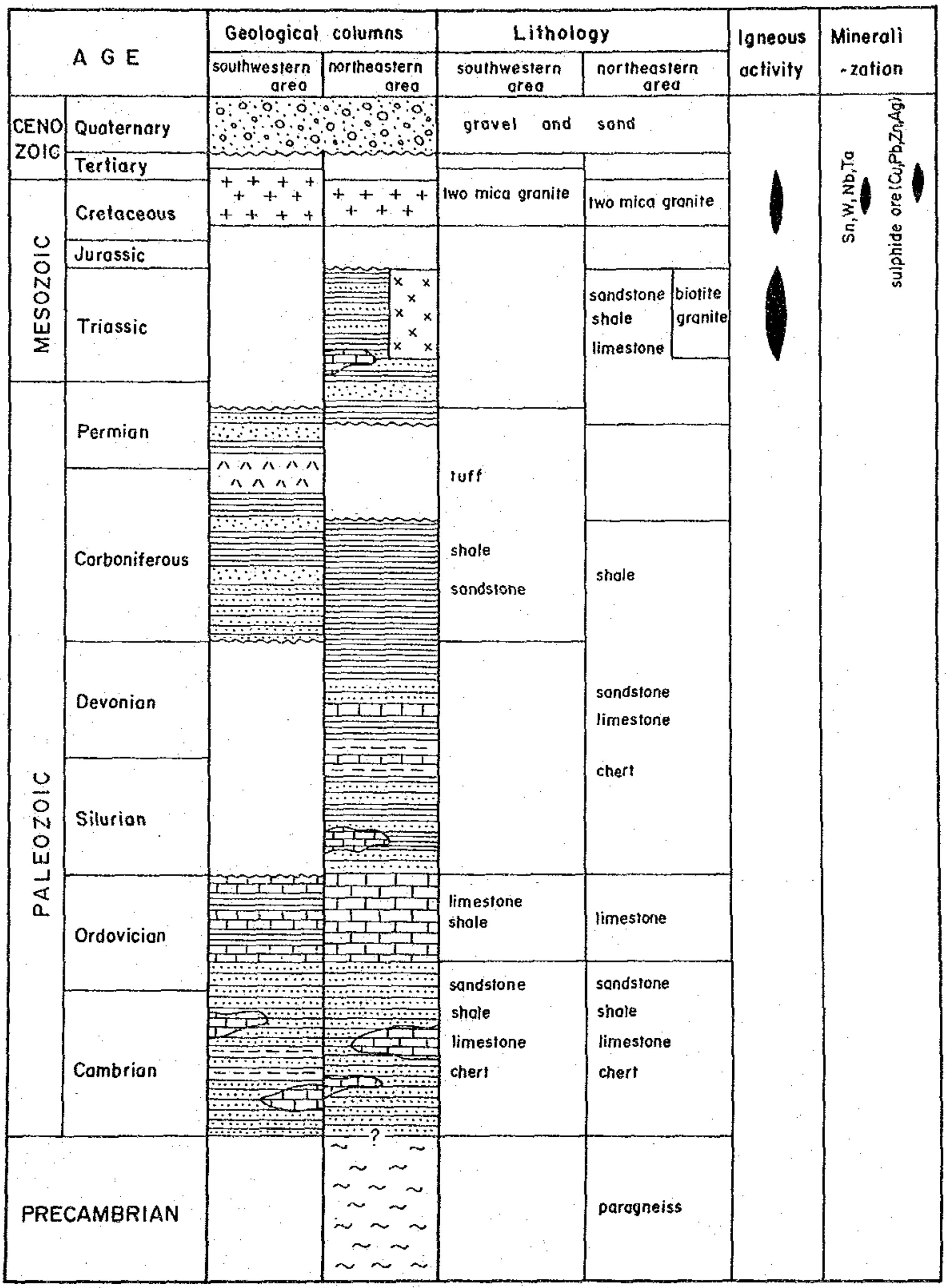


Fig.3 Schematic geological column

Chapter 4 Comprehensive Discussion

Many data regarding geology and mineral occurrences of the area have been collected from this year's survey. The results have integratedly been studied with the results of Phase I and Phase II. Results of the study are as follows.

4–1 Area A (Trench Survey)

4–1–1 Geology

A trench survey was conducted on geochemical anomalous zones of niobium, tantalum, tin and tungsten.

This area is composed mainly of biotite granite of the Triassic and two mica granite of the Cretaceous. These granites are widely decomposed in the area and which consit mainly of pegmatites and a small number of aplites and quartz veins. Dikes intrude into them. These dikes crop out only along the main streams, though a large number of pegmatite fragments are scattered in some places.

Through this trench survey, many dikes were observed in the trenches. Pegmatites are observed in every trenches except T–6, while aplites were only found in three trenches, and quartz veins in five trenches.

The results of the trench observations in each anomalous zone are as follows (Fig. 4, 5):

(a) Anomalous zones of niobium and tantalum (T–1 to T–3)

Pegmatite veins are composed mainly of feldspar, quartz and muscovite. A large number of pegmatites, 10 to 120cm in width, and a small number of quartz veins, 1 to 2cm in width, were seen.

(b) Anomalous zones of niobium and tungsten (T–4, T–5)

Pegmatites, less than 20cm in width, are composed mainly of quartz and feldspar.

(c) Anomalous zones of niobium, tantalum and tungsten (T–6 to T–8)

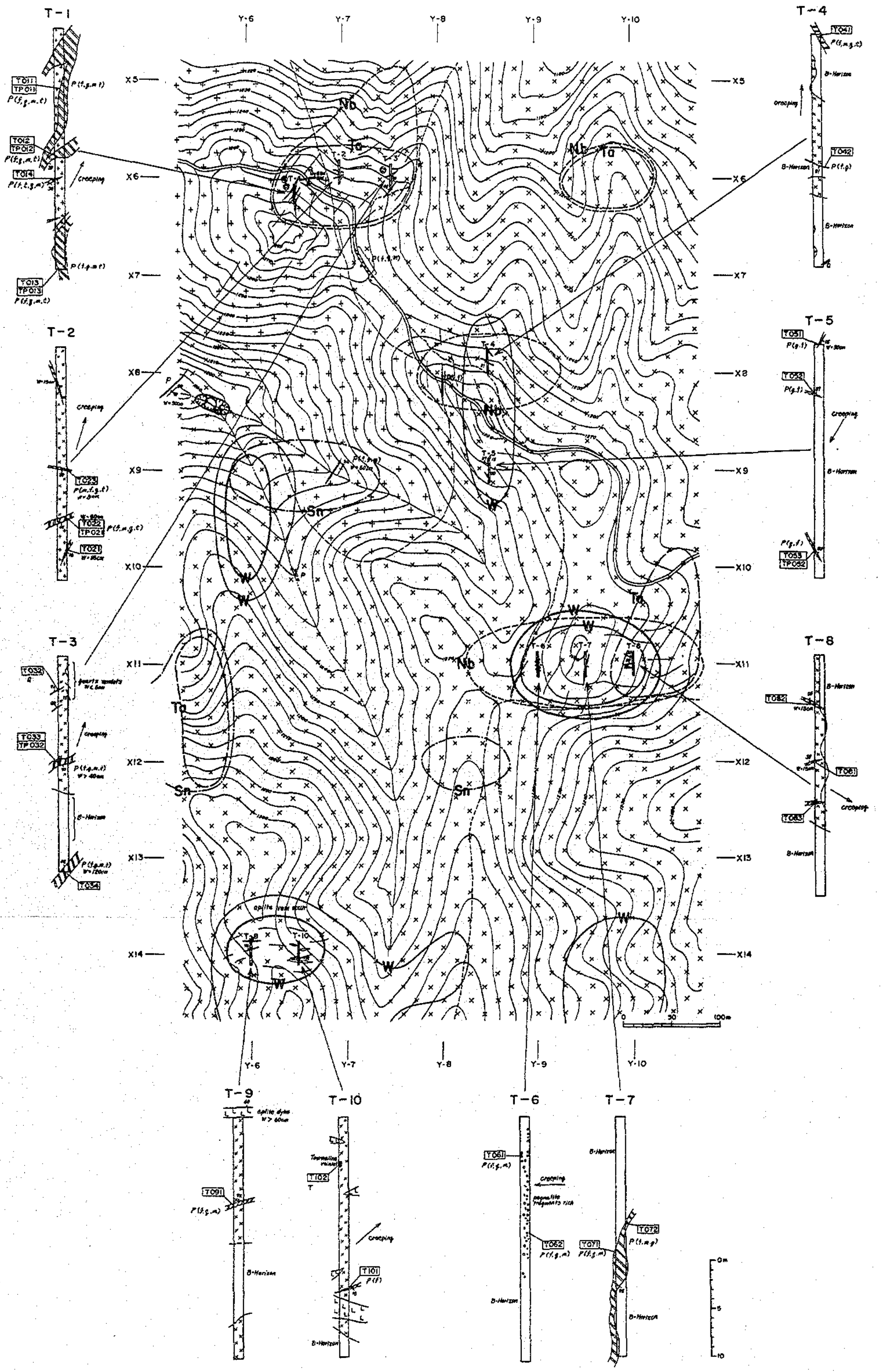
Pegmatites, 10 to 80cm in width, are composed mainly of feldspar, quartz and muscovite and a small amount of tourmaline.

(d) Anomalous zones of tungsten (T–9, T–10)

A few of pegmatites, 10 to 40cm in width, composed mainly of feldspar, and aplite veins, 40 to 200cm in width, were seen.

(e) Anomalous zones of tin, tungsten and niobium (T–11, T–12, T–15)

Few pegmatites were seen. Quartz veins and tourmaline veins, 0.5 to 3cm in width, were observed.



LEGEND

pegmatite vein
quartz vein
aplite vein
biotite granite
two mica granite
trench and number
mine works (inactive)

T-1 trench number
pegmatite vein
quartz vein
aplite vein
biotite granite
two mica granite
rock sample
panning sample

Panning samples (cassiterite)

abundant
common
rare

Geochemical indication

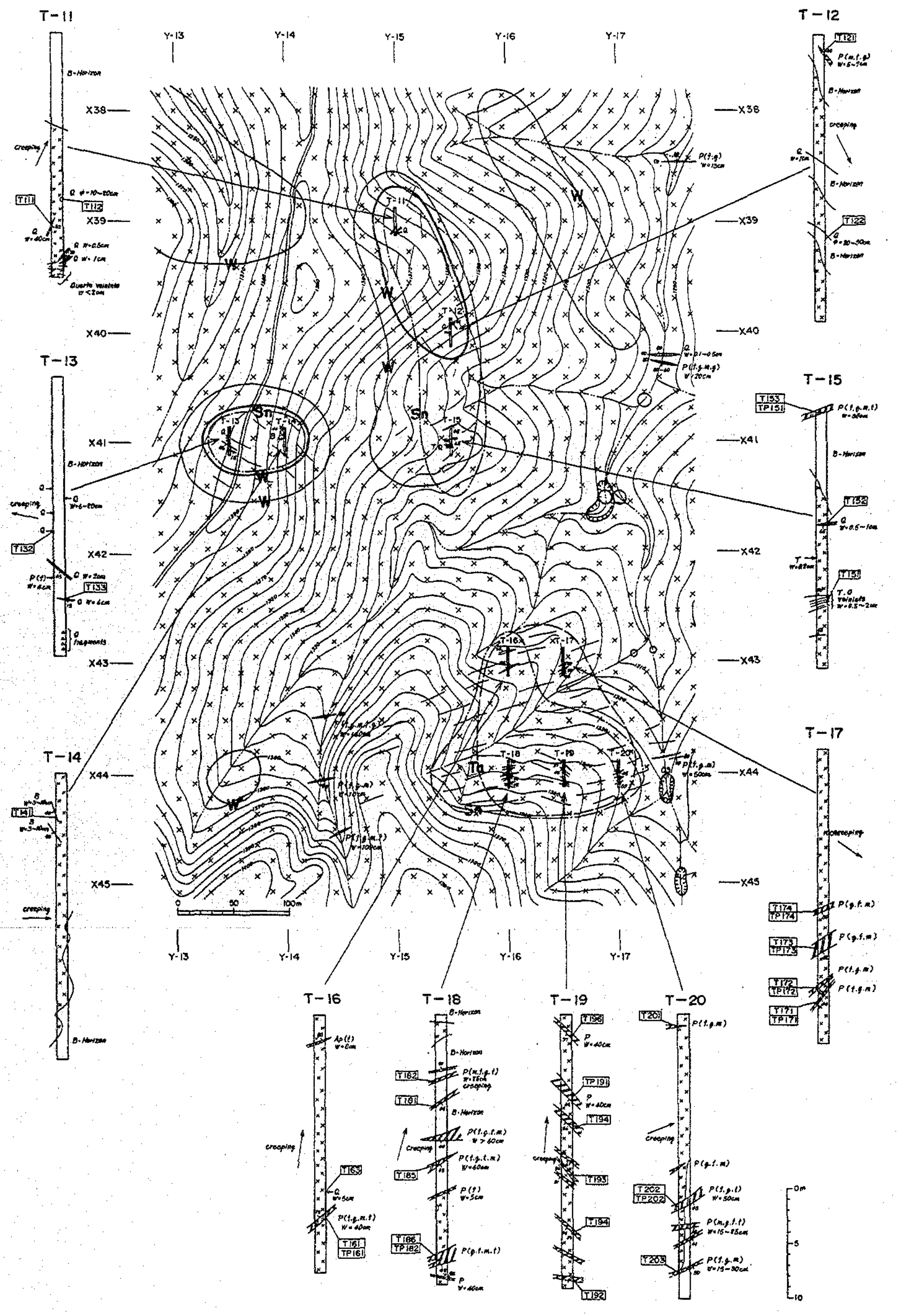
Element	Symbol	Class	Range (ppm)
Nb		high	49 ≦ Nb
		moderate	37 ≦ Nb < 49
Ta		high	27 ≦ Ta
		moderate	16 ≦ Ta < 27
Sn		high	79 ≦ Sn
		moderate	61 ≦ Sn < 79
W		high	77 ≦ W
		moderate	46 ≦ W < 77

Assay

Sample No.	Sn (%)	W (%)	Nb (ppm)	Ta (ppm)	remarks
T 011	0.004	0.001	40	18	P(f,q,m,t)
T 012	0.009	0.000	38	27	P(f,q,m,t)
T 013	0.004	0.001	32	13	P(f,q,m,t)
T 014	0.006	0.000	18	<10	P(f,t,q,m)
T 021	0.004	0.001	18	<10	P(m,f,q,t)
T 022	0.003	0.001	82	48	P(f,m,q,t)
T 023	0.008	0.001	24	42	P(m,f,q,t)
T 032	0.001	0.001	8	<10	Q
T 033	0.011	0.001	60	41	P(f,q,m,t)
T 034	0.007	0.001	74	87	P(f,q,m,t)
T 041	0.004	0.002	96	31	P(f,m,q,t)
T 042	0.001	0.000	11	<10	P(q,f)
T 043	0.001	0.001	15	<10	P(q,f)
T 051	0.002	0.002	42	23	P(q,f)
T 053	0.009	0.002	18	<10	P(q,f)
T 061	0.003	0.002	21	<10	P(f,q,m)
T 062	0.009	0.002	37	80	P(f,q,m)
T 071	0.002	0.001	74	39	P(f,q,m)
T 072	0.002	0.001	21	11	P(f,m,q)
T 081	0.012	0.002	88	34	P(f,q,m)
T 082	0.002	0.001	12	<10	P(f,q,m)
T 083	0.004	0.001	30	18	P(f,q,m)
T 091	0.008	0.030	23	<10	P(f,q,m)
T 101	0.003	0.008	18	<10	P(f)
T 102	0.003	0.002	21	<10	T

P ; pegmatite vein, Q ; quartz vein or quartz block
T ; tourmaline vein
f ; feldspur, q ; quartz, m ; muscovite, t ; tourmaline

Fig.4 Synthetic map of Trench Survey (north subarea in Area A)



LEGEND

- pegmatite vein
- quartz vein
- aplite vein
- biotite granite
- two mica granite
- T-1 trench and number
- mine works (inactive)

T-1 trench number
- pegmatite vein
- quartz vein
- aplite vein
- biotite granite
- two mica granite
- T111 rock sample
- TP174 panning sample

Panning samples (cassiterite)

- abundant
- common
- rare

Geochemical indication

Element	Symbol	Class	Range (ppm)
Nb	Nb	high	49 ≦ Nb
	Nb	moderate	37 ≦ Nb < 49
Ta	Ta	high	27 ≦ Ta
	Ta	moderate	16 ≦ Ta < 27
Sn	Sn	high	79 ≦ Sn
	Sn	moderate	61 ≦ Sn < 79
W	W	high	77 ≦ W
	W	moderate	46 ≦ W < 77

Assay

Sample No.	Sn(%)	W(%)	Nb(ppm)	Ta(ppm)	remarks
T 111	0.001	0.001	4	<10	Q
T 112	0.005	0.004	6	<10	Q
T 121	0.013	0.009	170	160	P(m,f,q)
T 122	0.001	0.001	6	<10	Q
T 132	0.001	0.005	3	<10	Q
T 133	0.002	0.011	7	<10	Q(q,t)
T 141	0.007	0.016	21	<10	granite
T 151	0.009	0.018	8	<10	Q(q,t)
T 152	0.004	0.009	12	<10	Q
T 153	0.011	0.009	45	110	P(f,q,m,t)
T 161	0.008	0.004	56	96	P(f,q,m,t)
T 163	0.000	0.000	<1	<10	Q
T 172	0.010	0.007	170	300	P(f,q,m,t)
T 173	0.011	0.004	69	130	P(q,f,m)
T 174	0.009	0.004	76	110	P(q,f,m)
T 182	0.004	0.004	49	37	P(m,f,q,t)
T 185	0.018	0.006	82	200	P(q,f,m)
T 186	0.011	0.008	130	73	P(f,q,t,m)
T 192	0.009	0.002	66	140	P(m,f,q,t)
T 193	0.004	0.004	72	89	P(m,f,q,t,b)
T 194	0.005	0.002	45	25	P(m,f,q,t)
T 196	0.005	0.004	59	20	P(m,f,q,t)
T 201	0.012	0.002	31	32	P(f,q,m)
T 202	0.009	0.003	72	64	P(q,f,m)
T 203	0.008	0.006	70	47	P(f,q,m,t)

P ; pegmatite vein, Q ; quartz vein or quartz block
T ; tourmaline vein
f ; feldspar, q ; quartz, m ; muscovite, t ; tourmaline

Fig.5 Synthetic map of Trench Survey (south subarea in Area A)

(f) Anomalous zones of tin and tungsten (T–13, T–14)

Pegmatites were not seen. Quartz vein, 5 to 20cm in width, were observed.

(g) Anomalous zones of tin and tantalum (T–16, to T–20)

A large number of pegmatites, 20 to 70cm in width, composed mainly of muscovite, quartz and feldspar, partially accompanied with tourmaline, were seen.

The general features of these dike rocks are as follows:

A large number of pegmatites are distributed in this area. These pegmatites vary markedly in width from 5 to 140cm and branch and wind irregularly. Most of them are composed mainly of quartz, feldspar, muscovite and tourmaline, although some have other accessory minerals. Garnet and zircon were detected by panning from pegmatites in the trench. While a very small amount of cassiterite, tantalite-columbite, rutile, scheelite and wolframite were identified by microscopic observation and EPMA qualitative analyses (Table 2 to 5).

A small number of quartz veins, 1 to 10cm in width, and quartz blocks were seen in five trenches. Some of these quartz veins contain tourmaline.

Several aplites were observed in T–9 and T–10.

In terms of direction the above dikes were extremely irregular. However, they did show a tendency to strike N60°E to E-W and dip to the south.

4–1–2 Chemical Analyses

Nb, Ta, Sn and W contents of the dikes observed in the trenches were analyzed for studying mineralization.

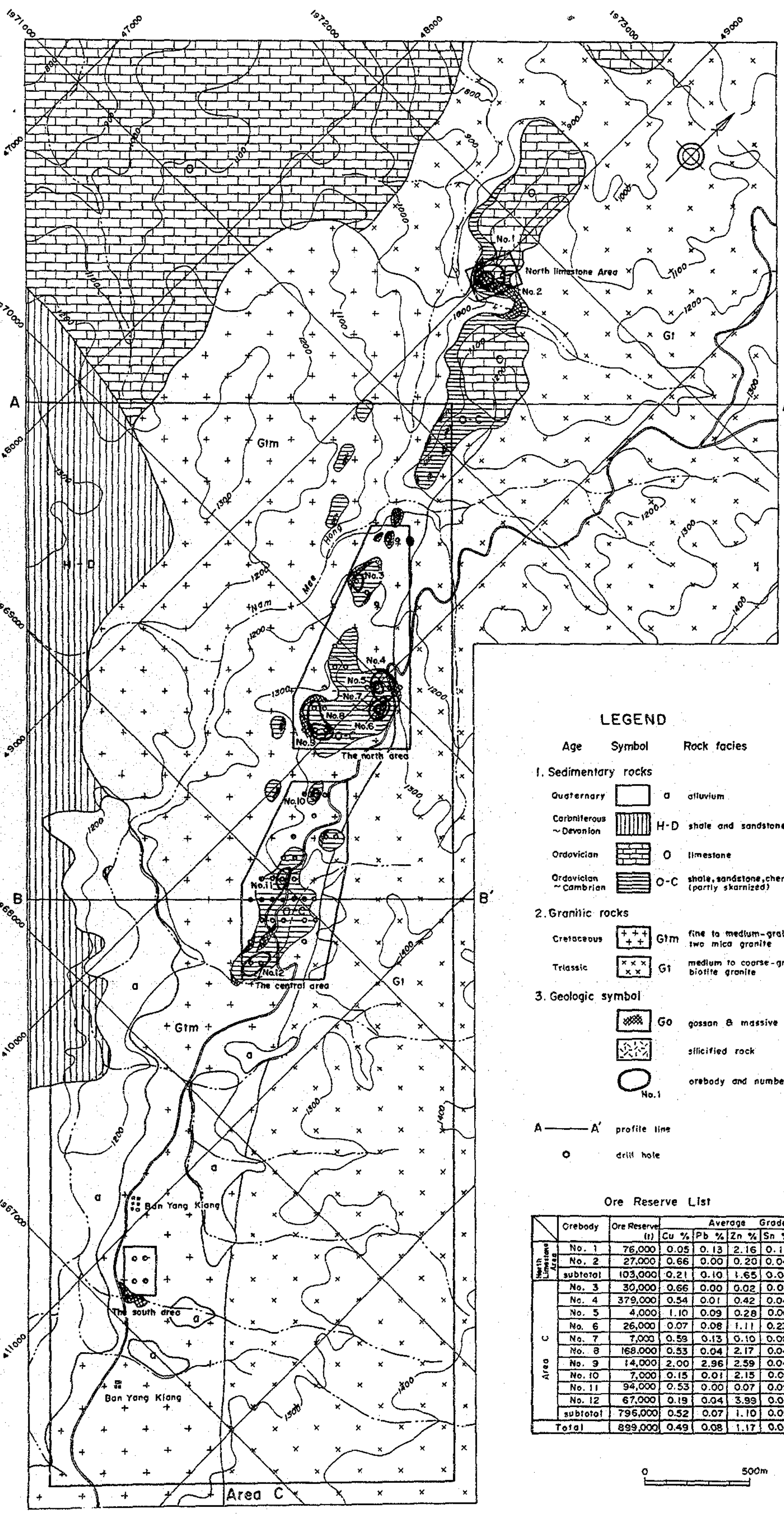
The analytical values of pegmatites is Nb: 11 to 170 ppm, Ta: <10 to 300 ppm, Sn: 10 to 180 ppm, W: 0 to 300 ppm.

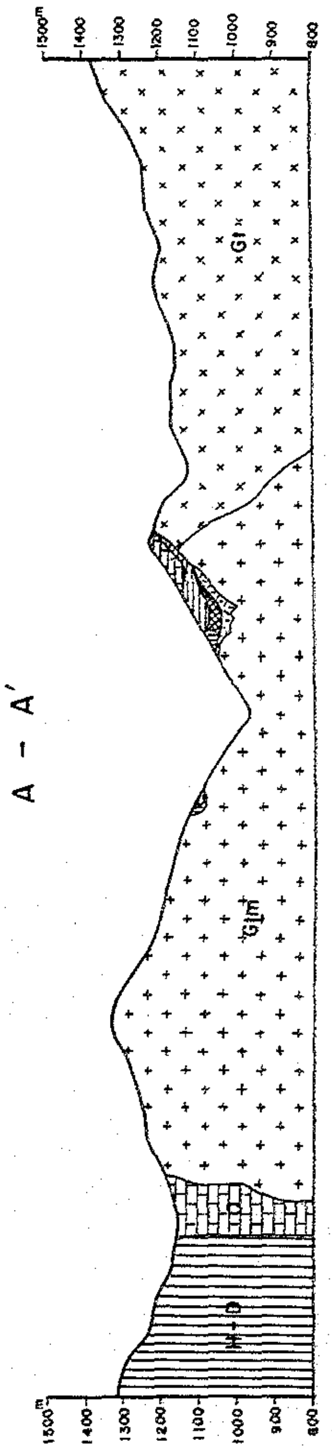
The analytical values of quartz veins is Nb: <1 to 12 ppm, Ta: <10 ppm, Sn: 0 to 80 ppm, W: 0 to 160 ppm.

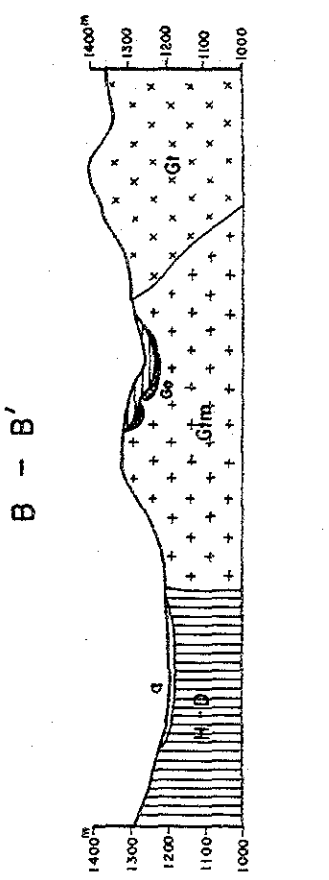
It is generally recognized that the niobium, tantalum and tin contents of pegmatites are higher than those of quartz veins. On the other hand the tungsten content of quartz vein is higher than that of pegmatites. There are some exceptions.

4–1–3 Discussion

Dikes composed mainly of pegmatite were found in most of the trenches. Analyses show that the niobium, tantalum, tin and tungsten content of these dike rocks nearly coincide with geochemical anomalous values, except in the case of tungsten in the above mentioned anomalous zones (b) and (c), and tin in (f). This fact indicated that geochemical anomalies originate from







Ore Reserve List

	Orebody	Ore Reserve (t)	Average Grade Cu %	Pb %	Zn %	Sn %	W %	Ag g/t
North Limestone Area	No. 1	76,000	0.05	0.13	2.16	0.11	0.04	70
	No. 2	27,000	0.66	0.00	0.20	0.04	0.07	19
	subtotal	103,000	0.21	0.10	1.65	0.09	0.05	57
Area C	No. 3	30,000	0.66	0.00	0.02	0.04	0.03	8
	No. 4	379,000	0.54	0.01	0.42	0.04	0.09	26
	No. 5	4,000	1.10	0.09	0.28	0.06	0.02	13
	No. 6	26,000	0.07	0.08	1.11	0.23	0.04	15
	No. 7	7,000	0.59	0.13	0.10	0.08	0.16	53
	No. 8	168,000	0.53	0.04	2.17	0.04	0.05	19
	No. 9	14,000	2.00	2.96	2.59	0.04	0.06	106
	No. 10	7,000	0.15	0.01	2.15	0.05	0.03	11
	No. 11	94,000	0.53	0.00	0.07	0.09	0.02	11
	No. 12	67,000	0.19	0.04	3.99	0.05	0.09	35
	subtotal	796,000	0.52	0.07	1.10	0.05	0.07	24
Total		899,000	0.49	0.08	1.17	0.06	0.07	27

Fig.6 Synthetic map of Drilling Survey (Area C)

pegmatites.

In the trenches T–16 to T–20, many pegmatites were observed. These pegmatites contained twice to five times as much tin, niobium and tantalum as those in other trenches. The maximum value of tungsten content in pegmatite occurred in trench T–9 and was 300 ppm. However, these are not enough to be exploited as a primary ore deposit.

Around trenches T–16 to T–20, 2 to $12g/m^3$ of panning concentrates of stream sediment, containing cassiterite, tantalite-columbite, rutile, monazite, ilmenite etc., were collected. Old workings of placer deposits exploited by local people are scattered along the streams. These facts suggest that the source of these placer deposits is pegmatites, and the most promising areas of placer deposits have already been mined or prospected. Therefore, it is difficult to discover new placer deposits.

4–2 Area C (Drilling Survey)

4–2–1 Geology

Triassic biotite granite and Cretaceous two mica granite are widely exposed in the area, and Cambrian to Carboniferous sedimentary rocks are scattered as small roof pendants on these granite masses (Fig. 6).

Biotite granite covers a wide portion of the eastern part of the area, forming a batholith mass and including characteristic megaphenocryst of K-feldspar 2 to 4 cm in width. Two mica granite is distributed in the central part of the area as stock-like lenticular rock mass extending NNW-SSE, and including characteristic primary muscovite.

The sedimentary rocks are composed mainly of mudstone and shale, and a minor amount of limestone and quartzite. These rocks are strongly weathered, resulting in the original rock texture being illegible. The roof pendants of these sedimentary rocks are 500x500m, 300x600m on a large scale, and 50x50 m to 150x200 m in width on a small scale. The thickness of them is generally 30 to 50 m, or partially more than 50 m.

4–2–2 Ore Deposits

Mineralization was found along the boundary between granite and sedimentary rocks, and in the sedimentary rocks. Contact metasomatic ore deposit has been formed here, replacing limestone or calcareous rocks.

Mineralization is observed in almost all the sedimentary rocks of roof pendants, and is scattered in more than 3km in lengh, and 200 to 300m in width strip extending towards the north-northwest from the center of this area to the northern limestone area.

The drill survey has shown the presence of a considerable skarn zone and massive sulfide beneath the limestone at 1km north of Area C. This suggests that mineralization is of a higher grade in a NNW direction.

There are two kinds of orebodies in skarn ; one is dissemination of sphalerite and chalcopyrite, another massive sulfide composed of abundant pyrrhotite with minor amount of chalcopyrite.

It was clarified in this drilling survey that an individual orebody is lenticular and untraceable, 20 x 20m to 70 x 100m wide and 3 to 27m thick. Three orebodies can be traced in neighbouring drill holes MJTY–14, 20, MJTY–36, 37, MUTY–26, 53.

Ore minerals consist mainly of sphalerite, chalcopyrite, pyrrhotite, magnetite and a minor amount of galena, covelline, arsenopyrite and bismuth minerals. Although tin, together with tungsten, indicated geochemically high anomalous values, and the analytical values of the drill cores also show the same amount of values, tin minerals could not have been detected by microscopic observation and EPMA qualitative analyses.

In the niobium and tantalum geochemical anomalous zone, strong kaolinization more than 30m thick was detected, but the niobium and tantalum contents of the drill cores were equivalent to geochemical anomalous values.

In this survey, ore assay was performed for 209 ore samples collected from drill cores. Assayed components were Cu, Pb, Zn, Sn, W, Nb, Ta, Au, Ag. Cd was also assayed for 65 samples which contained more than 0.5% of Zn. The results of the analysis are shown in Appendix 7.

Cu : The highest assay value of Cu was 5.34% in green skarn. Generally, the Cu content of mineralized rocks was 0.2 to 0.8%.

Pb : The highest assay value of Pb was 11.6% in green skarn. Only a few samples contain more than 1%. Generally, the Pb content of the mineralized rocks was lower than 0.1%.

Zn : The highest assay value of Zn was 13.3% in green skarn. Generally, Zn content of mineralized rocks was 1 to 4%.

Cd : The assay values were 0.01 to 0.2%.

Sn : The highest assay value of Sn was 0.45% in green skarn. Generally, the Sn content of the mineralized rocks was lower than 0.1%.

W : The highest assay value of W was 0.44% in green skarn. Generally, the W content of the mineralized rocks was lower than 0.1%.

Nb, Ta : The assay values of Nb and Ta were 31 to 91 ppm and 14 to 28 ppm respectively in the southern part of Area C where granites are kaolinizated. Other assay values of Nb and Ta were Nb: 3 to 20 ppm and Ta: $<$10 ppm in the central part and the northern part of Area C.

Au : The assay values of Au were 0.1 to 0.5 g/t except for one value of 30.8 g/t in the extent from 29.20 to 30.00 m depth in the drill hole MJTY–29.

Ag : The highest assay value of Ag was 373g/t. Generally the assay values of Ag were higher than 100 g/t in the cores containing relatively high Pb and Zn.

Copper and zinc are relatively concentrated in this area. The ore reserve was approximately calculated with cut-off grades of 1.0% Zn and 0.5% Cu on the basis of geological interpretation and the geological sections which have been obtained from the results of the drilling survey. This calculation was made on 12 orebodies (Fig. 7 to 9).

The equation to be used in the calculation is;

Ore reserve = Area of orebody x half of the maximum orebody thickness in core log x specific gravity (3.3) x safety ratio (0.7).

The result of the calculation is shown in Table 11. Each ore reserve ranges from 4,000 to 379,000 tons. Only 2 orebodies are more than 100,000 tons, and most of the orebodies are 10,000 to 100,000 tons. Copper orebodies vary in grade from 0.53 to 2.00% Cu, and 2 of them are more than 1% Cu. Zinc orebodies contain grades of 1.11 to 3.99 Zn. The total ore reserve is estimated to be 899,000 tons with average grade of 0.49% Cu, 0.08% Pb, 1.17% Zn, 27g/t Ag.

The massive sulfide composed mainly of pyrrhotite is roughly estimated to be 1,000,000 tons with 0.2 to 0.4% Cu in addition to ore reserve.

4–2–3 Discussion

As the result of drilling survey, 12 orebodies were discovered in this area. These are low grade, and each ore bodies relatively small and scattered. Therefor it seems difficult to warrant exploitation in this area.

However, an ore promising area exists between the above-mentioned limestone area and Area C, where the distribution of roof pendant limestone and a scattering of gossans suggests the presence of ore deposits. Further study of the area extending NNW of Area C would be expected.

Chapter 5 Conclusion and Recommendation

5–1 Conclusion

The following conclusions are obtained from the trench survey carried out in Area A and the drill survey in Area C.

5–1–1 Area A

(1) Dike rocks composed mainly of pegmatite were seen in most of the trenches, and analytical values of the niobium, tantalum, tin and tungsten of the dike rocks nearly coincide with geochemical anomalous values. This indicates that geochemical anomalies originate from pegmatite.

(2) Although pegmatites in the trenches T–16 to 20 contain relatively high values of tin, niobium and tantalum, these minerals are not present in quality sufficient to warrant the exploitation for a primary ore deposit.

(3) Tin and tungsten minerals were found in panning samples collected in the streams around geochemical anomalous zones where the above-mentioned trenches are located, and old workings of placer deposits are scattered along the streams. These suggest that the source of placer deposits is pegmatites.

(4) Most promising areas of placer deposits have already been mined by local inhabitants, and the probability of discovering new placer deposits would seem low.

5–1–2 Area C

(1) Sedimentary rocks as roof pendant are scattered on a small scale in the granite distribution.

(2) Contact metasomatic ore deposits were found on the boundary between granites and sedimentary rocks, replacing limestone or calcareous rock. Mineralizations were also confirmed in the limestone area 1km north-northwest of Area C. This suggests that mineralization is of a higher grade towards the northwest.

(3) Ore minerals are composed of sphalerite, chalcopyrite, pyrite, pyrrhotite, magnetite and small amounts of galena, scheelite, corelline, arsenopyrite and bismuth mineral. The major ore minerals are sphalerite and chalcopyrite.

(4) The ore reserve was estimated at 899,000 tons, Cu:0.49%, Pb:0.08%, Zn:1.17%, Ag:27g/t. This is too low a grade to warrant exploitation.

5–2 Recommendation for the Future

The extension of mineralization is expected from Area C toward the northwest where limestone is widely distributed.

We recommend that geophysical survey method such as IP would be carried out in order to detect the distribution and the depth of mineralization. This could be followed by drilling in order to ascertain the presence of orebodies.

PART II SURVEY DESCRIPTION

PART II SURVEY DESCRIPTION

Chapter 1 Area A (Trench Survey)

1–1 Selection of Survey Sites

Trench survey was performed to identify distribution of mineral indications in zones of geochemical anomaly found during the 2nd phase survey, clarify mineralization in the survey area and evaluate the ores present.

For each element (niobium, tantalum, tin, tungsten), numerous small zones of geochemical anomaly are widely scattered throughout the area. However, the zones of high anomaly tend to be found in the north and south. An area of high anomaly was selected for each element, and trenches at 2 to 5 locations were excavated in each area. As shown in Fig.7 , trenches are located at 10 sites in the north (T-1∿T-10) and at 10 sites in the south (T-11∿T-20).

Trench dimensions are 1m width, 2m depth and 25m length. Trench axes are N∿S. Total trench length is 500m.

Trench profiles were prepared by sketching the trench walls at a scale of 1:100. Chemical analysis was performed on samples taken from the main pegmatite and quartz veins. Thin sections from representative rock were prepared for microscopic study. Samples from pegmatite veins and streams near trenches were panned for heavy minerals. Trench profiles are shown in Appendix 8, sample lacalities in Fig. 8 and 9 and overall trench analysis in Table 2∿5 and Appendix 6.

1–2 Geology of Trench

1–2–1 North Subarea

1. Anomaly zones for niobium and tantalium

Three trenches (T-1, T-2, T-3) were excavated at 50m intervals from east to west in the zones of geochemical anomaly for niobium and tantalum.

<u>T-1</u>:

Sequence from the top in this trench is horizon A, horizon B, granite and pegmatite veins intruding the granite.

Horizon A is black organic soil 0∿15cm thick. However, in one portion of the trench, horizon A is not present.

Horizon B is comprised of pinkish to reddish gray granitic soil 70∿120cm in thickness. The lower boundary with weathered granite (horizon C) is irregular, with local intrusions of the weathered granite into horizon B.

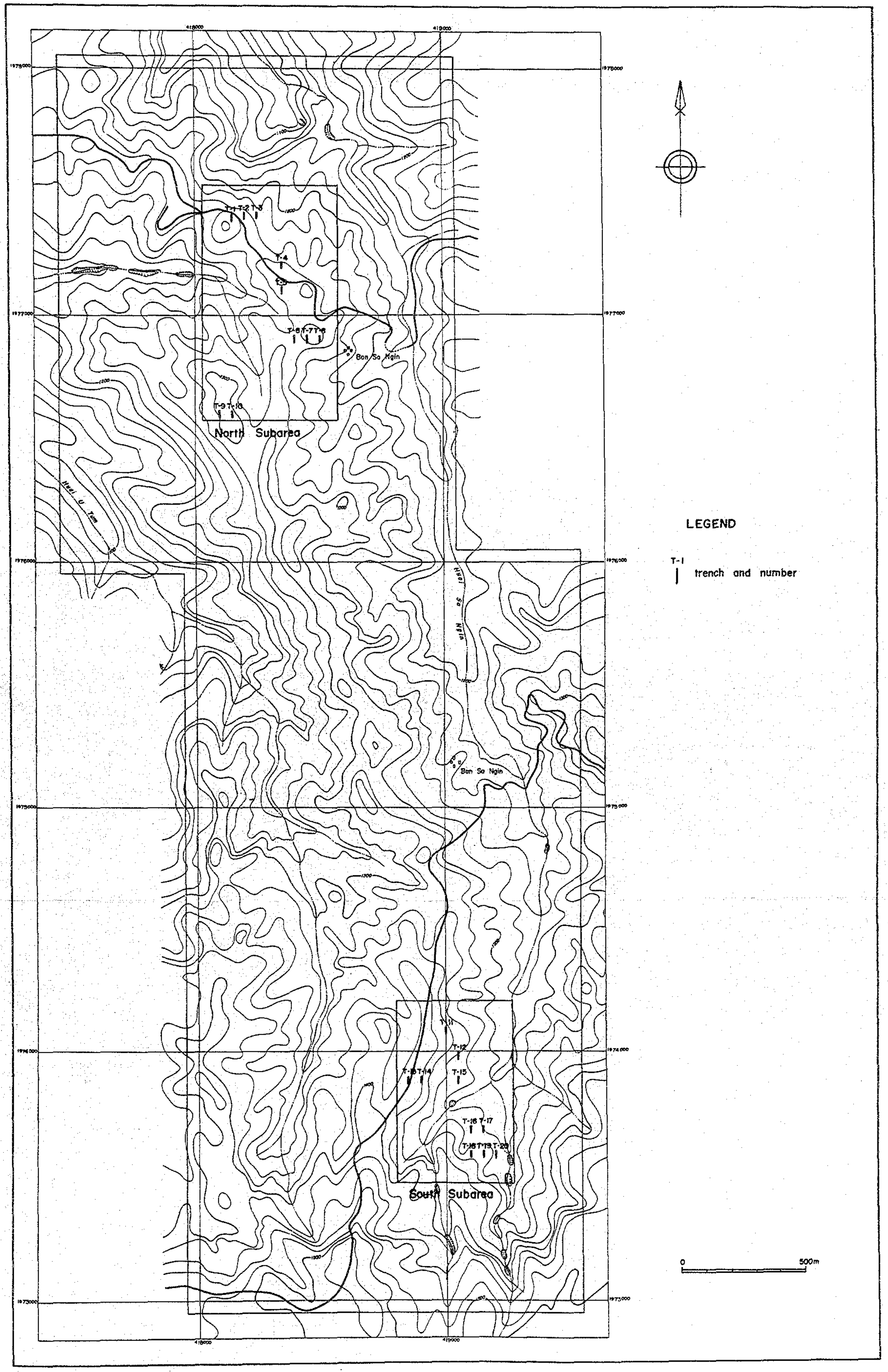


Fig.7 Location map of trenches (Area A)

Granite is highly weathered, grayish to pale reddish gray, medium grained two mica granite.

Five veins of pegmatite, 10∿120cm in width, were seen in the granite. The pegmatite veins are composed of feldspar, quartz, muscovite and tourmaline. Tourmaline content is relatively heavy compared with that of other trenches. The tip of the pegmatite is a large amount of pegmatite mineral fragments in the B horizon, creeping in the direction of the stream side. As strike and dip of pegmatite veins creep, they are unclear. However, on the basis of visual inspection, they show E-W/30°N, N55°E/30°SE, N33°W/50°S. Of these, E-W, S dip is the most common strike and dip. Panning samples taken from 3 pegmatite veins contain garnet and zircon. Microscopic observation of polished section indicated the presence in one sample of cassiterite, scheelite and ilmenite.

A number of thin veins of tourmaline, 0.2∿5mm in width were also seen. Strike and dip of these is N75°E/50°S.

Results of analysis of 4 pegmatite veins are Nb: 15∿40ppm, Ta: 10∿27ppm, Sn: 40∿50ppm and W: 0∿10ppm.

T-2:

Sequence for this trench from the top is horizon A, horizon B, granite and pegmatite veins intruding the granite.

Horizon A is 1∿20cm in thickness, consisting of dark gray organic soil.

Horizon B is 50∿160cm, consisting of grayish to brownish gray granitic soil. Lower boundary with weathered granite (horizon C) is irregular. One portion of horizon B contains granite cobbles 20∿80cm in dia.

Granite is highly weathered whitish gray to pale brown gray, coarse grained biotite granite. As with biotite granite distributed in the area, it shows a characteristic K-feldspar porphyritic structure. Muscovite appears to be of secondary mineral in biotite granite.

Four pegmatite veins 8∿95cm in width are seen in the granite. Vein tips are a large amount of pegmatite mineral fragments of quartz, feldspar, muscovite, etc. extending into the B horizon and creeping in the direction of the stream side. On the basis of visual inspection, strike and dip show E-W/40°N, N65°E/48°SE, N60°E/20°SE, N85°E/42°S, N20°E/18°E, etc. Of these, N65°E∿E-W, S dip is considered to be dominant. The panning sample taken from 1 pegmatite vein contains garnet and zircon. Naked eye observation does not indicate the presence of cassiterate, scheelite, etc.

Results of analysis of 3 pegmatite veins are Nb: 16∿82ppm, Ta: 10∿48ppm, Sn: 30∿80ppm, and W: 0∿15ppm.

T-3:

Sequence for this trench from the top is horizon A, horizon B, granite and pegmatite and quartz veins intruding the granite.

Horizon A is 0∿15cm in thickness, consisting of dark gray to black organic soil. However, horizon A is absent for one portion of the trench.

Horizon B is 50∿200cm in thickness, consisting of granitic soil. The layer is thicker to the south side, and thinner to the north side. Color is partially reddish gray and partially pale yellow. The latter color is dominant close to the weathered granite.

Granite is highly weathered whitish gray to pale brown gray, medium grained biotite granite. It includes large crystals (a maximum 40 X 10mm) of K-feldspar. The rock corresponds to the prophyritic biotite granite widely distributed in the area. The muscovite appears to be of secondary mineral.

Three pegmatite veins 40∿120cm in width were seen from the granite to horizon B. Vein tips in horizon B are a large amount of pegmatite mineral fragments of quartz, feldspar, muscovite tourmaline, etc. These creep in conformity with topography in the direction of the stream side. On the basis of visual inspection, strike and dip show N25°E/45°NW, N50°E/70°S, N60°E/20°SE, N85°E/42°S, N20°E/18°E, etc. EPMA analysis of the panning sample from the pegmatite vein shows garnet, zircon, tantalite-columbite and rutile. Microscopic observation indicates the presence of a small amount of cassiterite.

Two quartz veins, 1∿5cm in thickness, were seen. Strike and dip are N10°E/85°W, N72°E/72°N.

Results of analysis of 2 samples from the pegmatite veins are Nb: 74∿84ppm, Ta: 41∿57ppm, Sn: 70∿110ppm and W: $<$ 10ppm. Results of analysis of 1 sample from the quartz veins are Nb: 5ppm, Ta: $<$ 10ppm, Sn: 10ppm and W: 10ppm.

2. Anomaly zones for niobium and tungsten

As the high anomaly areas for tungsten extend southward, trenches T-4 and T-5 were excavated at a 100m interval with N∿S axis.

T-4:

Sequence for this trench from the top is horizon A, horizon B, granite and pegmatite veins intruding the granite.

Horizon A is 1∿40cm in thickness, consisting of dark gray to black organic soil. Predominant thickness of the layer, however, is 1∿10cm.

Horizon B is 120 to over 200cm in thickness, consisting of granitic soil. Granite cobbles 10∿50cm in dia were seen in the layer. Near the surface, layer color is brown, while close to the granite it is yellowish orange to whitish gray.

Granite is weathered, medium grained prophyritic biotite granite. It is distributed at the bottom of the trench in a thickness of 0-50cm.

Pegmatite veins are of two types, one comprised of feldspar, muscovite, quartz and tourmaline, and one comprised of quartz and feldspar. One vein of the former type is found at the extreme northern end of the trench, with a width of over 30cm. Four small veins of the latter type 3∿10cm in width were seen. Strike and dip are E-W/44°S, E-W/21°S, E-W/72°, showing consistent strike of E-W.

Results of analysis of 1 sample from the pegmatite vein of feldspar, muscovite, quartz and tourmaline are Nb: 98ppm, Ta: 31ppm, Sn: 40ppm, and W: 20ppm. Results of analysis of 2 samples from the pegmatite vein consisting of quartz and feldspar are Nb: 11∿15ppm, Ta: ‹ 10ppm, Sn: 10ppm and W: 0∿10ppm.

T-5:

This trench is sited 100m south of T-4 in a geochemical high anomaly area for tungsten.

The trench sequence from the top is horizon B and pegmatite. Neither horizon A nor weathered granite are exposed.

Horizon B is over 200cm in thickness, and consists of granitic soil. Near the surface the layer is pale gray, and near the bottom of the trench it is yellow gray to brown. Concentrations of mineral fragments of feldspar, quartz, muscovite, etc. were seen. Although not clear in one portion, weathered granite exhibits prophyritic structure.

Three pegmatite veins 15∿20cm thick seen were comprising mainly of quartz and feldspar, and containing small amounts of tourmaline. Visual observation indicates strike and dip of N30°W/30°NE, N85°W/37°N, N20°E/15°SE. However, as with other trenches, strike and dip are assumed to be creeping.

Results of analysis of 2 samples from the 2 pegmatite veins are Nb: 15∿42ppm, Ta: 10∿23ppm, Sn: 20∿30ppm and W: 20ppm.

3. Anomaly zones for niobium and tungsten

T-6, T-7 and T-8 trenches were excavated at 50m intervals east to west in the geochemical high anomaly zone for niobium and tungsten.

T-6:

The trench sequence from the top is horizon A and horizon B. Weathered granite is not exposed.

Horizon A is 1∿15cm thick, and consists of dark gray, organic soil.

Horizon B is over 200cm in thickness, and consists of granitic soil. Color is mainly reddish to reddish gray, with one portion yellowish gray. Concentrations of mineral fragments mainly of feldspar, quartz and some muscovite were seen. No muscovite is seen in the main matrix of the layer. Weathered host rock is assumed to be biotite granite. Prophyritic structure from large

K-feldspar characteristic of biotite granite distributed in area A is not clear in this layer.

Results of analysis of 2 samples from concentrations of pegmatite minerals are Nb: 21∿37ppm, Ta: 10∿20ppm, Sn: 30ppm and W: 20ppm.

T-7:

The trench sequence from the top is horizon A, horizon B and weathered pegmatite. Weathered granite is not exposed.

Horizon A is 1∿20cm thick, and consists of dark, organic soil.

Horizon B is over 200cm in thickness, and consists from the top of yellowish brown, highly weathered and well soilized old talus sediments, yellowish brown to reddish brown granitic soil, and reddish, prophyritic granitic soil. Old talus deposits are dominant at the south side of the trench, and prophyritic granitic soil is common at the north side of the trench. Between these, yellowish brown to reddish brown granitic soil was found.

One vein of weathered pegmatite was seen consisting mainly of feldspar, quartz and muscovite. The pegmatite appears as an irregular, slightly undulating vein in the weathered granitic soil with porphyritic structure. Vein width varies 30∿80cm, and apparent strike and dip are N60°∿80°W/25°S.

Results of analysis of 2 samples from the pegmatic vein are Nb: 21∿74ppm, Ta: 11∿39ppm, Sn: 20ppm and W: 10ppm.

T-8:

The trench sequence from the top is horizon A, horizon B, granite and pegmatite veins intruding the granite.

Horizon A is 1∿10cm thick, and consists of darkish gray to black organic soil.

Horizon B is over 200cm in thickness, and consists of pale gray to brown granitic soil. Mainly pegmatite minerals of feldspar, quartz and muscovite are contained in the layer.

Granite consists of weathered yellowish gray, medium grained, porphyritic biotite granite, and is exposed near the trench bottom.

Three pegmatite veins were seen. They consist of feldspar, quartz, muscovite, etc., and are 13∿50cm in width. Apparent strike and dip are N70°W/24°N, N80°E/30°W, E-W/60°N. As with the other trenches, it is assumed that strike and dip are creeping.

Results of analysis of the 3 pegmatite veins are Nb: 12∿88ppm, Ta: 10∿34ppm, Sn: 20∿40ppm and W: 10ppm.

4. Anomaly zones for niobium and tungsten

Trenches T-9 and T-10 were excavated at a 50m interval east∿west in the area of high geochemical anomaly for tungsten.

T-9:

The trench sequence from the top is horizon A, horizon B, granite and pegmatite and aplite veins intruding the granite.

Horizon A is 5∿10cm thick, and consists of darkish gray to black organic soil.

Horizon B is 80∿200cm in thickness, and consists of pale gray to brown granitic soil. Near the surface, color is gray, while near the underlying granite it is brown. Around the pegmatite vein it is heavy in pegmatite mineral content.

Granite consists of weathered pale gray to yellowish gray, medium grained, porphyritic biotite granite.

One pegmatite vein consisting mainly of feldspar was seen in the granite. Vein width is 40cm. Strike and dip are E-W/72°S, and are assumed to be creeping.

A whitish gray, heavily weathered aplite vein was found at the northern end of the trench. Vein width is over 60cm, and strike and dip are N85°E/60°E.

One small quartz vein 1cm in width is seen in the granite.

Results of analysis of the 1 sample from the pegmatite vein are Nb: 23ppm, Ta: < 10ppm, Sn: 50ppm and W: 300ppm.

T-10:

The trench sequence from the top is horizon A, horizon B, granite and pegmatite and aplite veins intruding the granite.

Horizon A is 0∿15cm thick, and consists of darkish gray to black organic soil.

Horizon B is 80 ∿ over 200cm in thickness, and consists of pale gray to pale yellowish gray granitic soil. The layer is thick at the south side of the trench and thin at the north side.

Granite consists of weathered reddish brown, coarse grained porphyritic biotite granite. A cluster of thin tourmaline veins was seen in the granite.

One pegmatite vein consisting mainly of feldspar was seen in the granite. Vein width is 10cm. Apparent strike and dip are E-W/55S.

Aplite was found at several locations in the trench, and is whitish gray, yellowish gray and brownish gray in color. It is heavily weathered, and appears in both vein and massive form. Width is 30∿200cm.

Results of analysis of a sample from the pegmatite vein are Nb: 16ppm, Ta: < 10ppm, Sn: 30ppm and W: 60ppm. Results of analysis of a sample from the quartz vein are Nb: 16ppm, Ta: < 10ppm, Sn: 30ppm and W: 60ppm.

1–2–2 South Subarea

1. Anomaly zones for tin, tungsten and niobium

Trenches T-11, T-12, and T-15 were excavated in the area of high geochemical anomaly for tin, tungsten and niobium.

T-11:

The trench sequence from the top is horizon A, horizon B, granite and pegmatite and quartz veins intruding the granite.

Horizon A is 10∿40cm thick, and consists of darkish gray to black organic soil. The layer is slightly thinner than for other trenches.

Horizon B is 50 ∿ over 200cm in thickness, and consists of pale brown gray to pale yellowish gray granitic soil. The layer is thicker at the north side of the trench. Cobbles of weathered granite, 10∿40cm in thickness were seen in the layer.

Granite consists of pale brownish gray, coarse grained, porphyritic biotite granite.

Pegmatite in irregular massive form with diameter of 10∿40cm was found at the boundary between horizon B and weathered granite. The pegmatite consists of feldspar, quartz and tourmaline.

Several small veins of quartz 1cm thick were found near the south end of the trench. Strike and dip are N66°E/44°N, N48°E/30°SE, N25°E/85°E. Quartz blocks 10∿20cm in dia. were found at the boundary between horizon B and weathered granite.

Results of analysis of a sample from the quartz vein are Nb: 4∿6ppm, Ta: $<$ 10ppm, Sn: 10∿30ppm and W: 10∿40ppm.

T-12:

The trench sequence from the top is horizon A, horizon B, granite, and pegmatite and quartz veins intruding the granite.

Horizon A is 20∿40cm thick, and consists of dark gray organic soil. The layer is slightly thicker than for other trenches.

Horizon B is 100 ∿ over 200cm in thickness, and consists of granitic soil reddish orange color near the surface and pale brown to yellowish gray towards the weathered granite side. Weathered granite gravels, 10∿50cm in thickness were seen in the layer.

Granite consists of pale gray, coarse grained, porphyritic biotite granite.

The pegmatite vein consists of muscovite, feldspar and quartz. It intrudes into horizon B at the northern end of the trench. Vein width is 5∿7cm, and apparent strike and dip are N40°W/65°E.

Fine quartz veins, 1∿3cm in width, were seen at several locations. In one portion as well, 20∿30cm dia. quartz blocks were found.

Results of analysis of the pegmatite vein are Nb: 170ppm, Ta: 160ppm, Sn: 130ppm and

W: 90ppm. Results of analysis of the quartz fragments are Nb: 6ppm, Ta: ⟨ 10ppm, Sn: 10∿30ppm and W: 10ppm.

T-15:

The trench sequence from the top is horizon A, horizon B, granite, and pegmatite and quartz veins intruding the granite.

Horizon A is 10∿35cm thick, and consists of black to dark brown organic soil.

Horizon B is 50 ∿ over 200cm in thickness, and consists of yellowish brown to pale brown granitic soil. The boundary with underlying weathered granite is transitional rather than distinct.

Granite consists of gray to whitish gray, coarse grained, porphyritic biotite granite. A cluster of fine tourmaline veins were seen in one portion with 0.5∿2mm width and strike and dip of N80° E/58° N, N85° E/70° N, N78° E/64° N.

One pegmatite vein consisting of muscovite, feldspar, quartz and tourmaline is bound at the north end of the trench. Vein width is over 30cm, and strike and dip are N40° W/65° E. EPMA analysis of a panning sample from the pegmatite vein indicated the presence of garnet, zircon, tantalite-columbite, wolframite and pyrite. Microscopic observation of the sample showed a small amount of cassiterite.

One small quartz vein, 0.5∿1cm in width was found in the center of the trench with strike and dip of N85E/65S.

Results of analysis of the quartz vein are Nb:8∿12ppm, Ta: ⟨ 10ppm, Sn: 40∿110ppm, and W: 90∿160ppm. Results of analysis of the pegmatite vein are Nb: 45ppm, Ta: 110ppm, Sn: 110ppm and W: 90ppm.

2. Anomaly zones for tin and tungsten

Trenches T-13 and T-14 were excavated in zones of high geochemical anomaly for tin and tungsten.

T-13:

The trench sequence from the top is horizon A, and horizon B. Several quartz veins are seen in horizon B. Neither granite nor pegmatite were observed.

Horizon A is 5∿40cm thick, and consists of dark gray to dark brown organic soil.

Horizon B is over 200cm thick. It is granitic soil, brown to dark yellowish red near the surface, and dark yellow at the deeper part of the trench. A granitic texture was seen in the dark yellow portion of horizon B. Scattered quartz fragments 1∿3cm in dia. are present.

The quartz vein is 1∿20cm in width, with apparent strike and dip of N80° W/45° S, N85° W/15. Quartz blocks 15∿40cm in dia. were seen.

Results of analysis of the quartz vein are Nb: 3∿7ppm, Ta: ⟨ 10ppm, Sn: 10∿20ppm, and W: 50∿110ppm.

T-14:

The trench sequence from the top is horizon A, horizon B and grante.

Horizon A is 5∿40cm thick, and consists of dark gray organic soil.

Horizon B is 100 to over 200cm thick. It is granitic soil, pale brownish gray near the surface, and pale yellowish gray near the granite. The layer contains 10∿50cm granite gravels near the boundary with the underlying granite.

Granite consists of yellowish gray, weathered, coarse grained, porphyritic biotite granite. Biotite is concentrated in veins in one portion of the granite. Veins are 3∿10cm thick, with strike and dip of N20°W/40°W, N35°W/30°W.

Results of analysis of the quartz including the concentrated portion of biotite are Nb: 21ppm, Ta: ‹ 10ppm, Sn: 70ppm and W: 16ppm.

3. Anomaly zones for tin and tantalium

Trenches T-16, T-17, T-18, T-19 and T-20 were excavated adjacent to one another in the zone of high geochemical anomaly for tin and tantalum.

T-16:

The trench sequence from the top is horizon A, horizon B, granite, and pegmatite and aplite veins intruding the granite.

Horizon A is 15∿25cm thick, and consists of dark gray to dark brown organic soil.

Horizon B is 80 ∿ over 200cm in thickness, and consists of yellowish brown granitic soil. The layer contains pegmatite mineral fragments around the pegmatite veins.

Granite consists of weathered, coarse grained, porphyritic biotite granite.

One pegmatite vein consisting of muscovite, feldspar, quartz and tourmaline was found in the granite. Vein width is 40cm, and apparent strike and dip are N65°E/75°W. An analysis of a panning sample from the pegmatite vein indicated the presence of garnet and small amounts of heavy minerals.

One aplite vein, 8cm in width was found in the north end of the trench with strike and dip of N80°E/55°N. The vein contains tourmaline.

One small quartz vein, 5cm in width was found in the granite.

Results of analysis of the pegmatite vein are Nb: 58ppm, Ta: 96ppm, Sn: 90ppm and W: 40ppm. Results of analysis of the quartz vein are Nb: ‹ 0ppm, Ta: ‹ 10ppm, Sn: 0ppm and W; 0ppm.

T-17:

The trench sequence from the top is horizon A, horizon B, granite, and pegmatite veins intruding the granite.

Horizon A is 10∿30cm thick, and consists of black organic soil.

Horizon B is 70∿200cm in thickness, and consists of pale yellowish granitic soil. Fine, bleached biotite was seen in the layer. Fragments of pegmatite minerals including feldspar, quartz, muscovite and tourmaline were seen.

Granite consists of weathered, coarse grained porphyritic biotite granite.

Five pegmatite vein consisting of muscovite, feldspar, quartz and tourmaline were found in the granite. Observed veins have the following widths, strikes and dips: w=25cm:E-W/86°S, w=22cm:N85°W/63°S;N70°W/44°S, w=68cm:N60°E/58°S, w=30cm:N62°E/60°SE. Analyses of 4 panning samples from the pegmatite vein indicated the presence of garnet and small amounts of heavy minerals.

Results of analysis of the pegmatite veins are Nb: 69∿170ppm, Ta: 110∿300ppm, Sn: 90∿110ppm and W: 40∿70ppm.

T-18:

The trench sequence from the top is horizon A, horizon B, granite, and numerous pegmatite veins intruding the granite.

Horizon A is 10∿40cm thick, and consists of black to dark gray organic soil.

Horizon B is 100 to over 200cm in thickness, and consists of yellowish gray granitic soil. Numerous fragments of pegmatite minerals including feldspar, quartz, muscovite and tourmaline were seen at the ends of pegmatite veins intruding into the layer. These are creeping in the direction of the stream.

Granite consists of weathered, coarse grained, porphyritic biotite granite. Boundary with horizon B is irregular, and numerous gravels of weathered granite 10∿50cm in dia. were seen in the overyling layer.

Ten pegmatite vein consisting mainly of muscovite, feldspar, quartz and tourmaline were found in the granite. Observed veins have the following widths, strikes and dips: w=20cm: N75°E/88°N, w=35cm:N40°W/18°S, w=60cm:N65°E/85°S, w=30cm:N80°W/36°S, w=40∿50cm: N78°W/44°S w=25cm:N65°W/70°S, and all show effects of creep.

Analysis of panning samples from 2 pegmatite veins indicated the presence of garnet and small amounts of heavy minerals.

Results of analysis of 3 pegmatite veins are Nb: 49∿130ppm, Ta: 37∿200ppm, Sn: 40∿180ppm and W: 40∿80ppm.

T-19:

The trench sequence from the top is horizon A, horizon B, granite, and numerous pegmatite veins intruding the granite.

Horizon A is 5 to 25cm thick, and consists of dark gray orgarnic soil.

Horizon B is 80 to over 200cm in thickness, and consists of yellowish gray to brownish gray granitic soil.

Granite consists of weathered, coarse grained, porphyritic biotite granite. Boundary with horizon B is irregular, and gravels of weathered granite 10∿80cm in dia. were seen in the overlying layer.

Nine pegmatite veins consisting mainly of muscovite, feldspar, quartz and tourmaline were found in the granite. Numerous fragments of pegmatite minerals including feldspar, quartz, muscovite and tourmaline were seen at the ends of pegmatite veins intruding into horizon B. These are creeping in the direction of the stream. Observed veins have the following widths, strikes and dips: w=40cm:N70°E/42°S, w=35cm:N65°E/54°W, w=45cm:E-W/45°S, w=20cm: E-W/90°, w=50cm:N80°E/41°S, w=30cm:N20°E/43°S, w=70cm:N85°E/56°S and w=40cm: E-W/32°S, and all show effects of creep.

Analyses of panning samples from 2 pegmatite veins indicated the presence of garnet and small amounts of heavy minerals.

Results of analysis of 4 pegmatite veins are Nb: 45∿72ppm, Ta: 20∿140ppm, Sn: 40∿80ppm and W: 20∿40ppm.

T-20:

The trench sequence from the top is horizon A, horizon B, granite, and pegmatite veins intruding the granite.

Horizon A is 0∿30cm thick, and consists of dark gray to black organic soil.

Horizon B is 80 to over 200cm in thickness, and consists of pale brownish gray granitic soil. Scattered fragments of pegmatite minerals including feldspar, quartz, muscovite and tourmaline are present.

Granite consists of weathered, coarse grained porphyritic biotite granite, with weak schistose structure. Boundary with horizon B is irregular, and gravels of weathered granite 10∿ 50cm in dia. were seen in the overlying layer.

Five pegmatite veins consisting mainly of muscovite, feldspar, quartz and tourmaline were found in the granite. Numerous fragments of pegmatite minerals were seen at the ends of pegmatite veins intruding into horizon B. These are creeping in the direction of the stream. Observed veins have the following apparent widths, strikes and dips: w=15cm:N80°E/50°S, w=14cm:N65°W/47°S, w=50cm:N85°W/45°S and w=70cm:E-W/52°N.

Analyses of panning samples from 2 pegmatite veins indicated the presence of garnet, zircon, and small amounts of heavy minerals.

Results of analysis of 3 pegmatite veins are Nb: 30∿72ppm, Ta: 32∿64ppm, Sn: 80∿120ppm and W: 20∿60ppm.

1–3 Result of the trench survey

A trench survey was conducted on geochemical high anomalous zones of niobium, tantalum, tin and tungsten.

This area is composed mainly of biotite granite of the Triassic and two mica granite of the Cretaceous. These granites are widely decomposed in the area and dikes, which consist mainly of pegmatites and small amount of aplites and quartz veins, intrude into these granite. These dikes crop out only along the main streams, though a large amount of pegmatite fragments are scattered in some places.

Through the trench survey, many dikes were observed in the trenches. Pegmatites were observed in every trench except trench T–6. Aplites were only found in three trenches, and quartz veins in five trenches.

The results of the trench observations in each anomalous zone are as follows (Fig. 4, 5):

(a) Anomalous zones of niobium and tantalum (T–1 to T–3)

Pegmatites are composed mainly of feldspar, quartz and muscovite. A large amount of pegmatites, 10 to 120cm in width, and a small amount of quartz veins, 1 to 2cm in width, were seen.

(b) Anomalous zones of niobium and tungsten (T–4, T–5)

Pegmatites, less than 20cm in width, are composed mainly of quartz and feldspar.

(c) Anomalous zones of niobium, tantalum and tungsten (T-6 to T-8)

Pegmatites, 10 to 80cm in width, are composed of mainly feldspar, quartz and muscovite and small amount of tourmaline.

(d) Anomalous zones of tungsten (T–9, T–10)

A few of pegmatites, 10 to 40cm in width, composed mainly of feldspar and aplite veins, 40 to 200cm in width, were seen.

(e) Anomalous zones of tin, tungsten and niobium (T–11, T–12, T–15)

Few pegmatites were seen. Quartz veins and tourmaline veins, 0.5 to 3cm in width, were observed.

(f) Anomalous zones of tin and tungsten (T–13, T–14)

Pegmatites were not seen. Quartz vein, 5 to 20cm in width, were observed.

(g) Anomalous zones of tin and tantalum (T–16 to T–20)

A large amount of pegmatites, 20 to 70cm in width, composed mainly of muscovite, quartz, and feldspar, partially accompanied with tourmaline, were seen.

The general features of these dike rocks are as follows :

A large amount of pegmatites are distributed in this area. These pegmatites vary markedly in width from 5 to 140cm, and branch and wind irregularly. Most of them are composed mainly of quartz, feldspar, muscovite and tourmaline, although some have other accessory minerals. Garnet and zircon were detected by panning from pegmatites in the trench. A very small amount of cassiterite, tantalite-columbite, rutile, scheelite and wolframite were identified by microscopic observation and EPMA qualitative analyses (Table 2 to 5).

A small number of quartz veins, 1 to 10cm in width, and quartz blocks were seen in five trenches. Some of these quartz veins contain tourmaline.

Several aplite veins were observed in T–9 and T–10.

In terms of direction the above dikes were extremely irregular. However, they did show a tendency to strike N60°E to E-W and dip to the south.

1–4 Result of Chemical Analyses

The Nb, Ta, Sn and W contents of the dikes observed in the trenches are as follows: Geochemical anomaly data are taken from the report of phase II.

a) Anomalous zones of niobium and tantalum (T–1 to T–3)

		Nb (ppm)	Ta (ppm)	Sn (ppm)	W (ppm)
Pegmatite	ave.	44	28	60	10
vein	max.	82	48	110	10
(9 samples)	min.	15	<10	10	0
Quartz vein (1 samples)		5	<10	10	10
Geochemical anomaly		25 to 48	17 to 22	49 to 58	7 to 8

b) Anomalous zones of niobium and tungsten (T–4, T–5)

		Nb (ppm)	Ta (ppm)	Sn (ppm)	W (ppm)
Pegmatite	ave.	36	14	20	10
vein	max.	98	31	40	10
(5 samples)	min.	11	<10	10	0
Geochemical anomaly		31 to 42	10 to 11	37 to 46	69 to 180

c) Anomalous zones of niobium, tantalum and tungsten (T–6 to T–8)

		Nb (ppm)	Ta (ppm)	Sn (ppm)	W (ppm)
Pegmatite	ave.	40	19	40	14
vein	max.	88	39	120	20
(7 samples)	min.	12	<10	10	10
Geochemical anomaly		23 to 24	11 to 35	45 to 51	78 to 83

d) Anomalous zones of tungsten (T–9, T–10)

		Nb (ppm)	Ta (ppm)	Sn (ppm)	W (ppm)
Pegmatite	ave.	40	19	40	14
vein	max.	88	39	120	20
(7 samples)	min.	12	<10	10	10
Geochemical anomaly		23 to 24	11 to 35	45 to 51	78 to 83

e) Anomalous zones of tin, tungsten and niobium (T–11, T–12, T–15)

		Nb (ppm)	Ta (ppm)	Sn (ppm)	W (ppm)
Pegmatite	ave.	108	135	120	90
vein	max.	170	160	130	90
(2 samples)	min.	45	110	110	90
Quartz vein	ave.	7	<10	34	62
(5 samples)	max.	12	<10	80	160
	min.	4	<10	10	10
Geochemical anomaly		15 to 23	2 to 5	61 to 84	11 to 80

f) Anomalous zones of tin and tungsten (T–13, T–14)

		Nb (ppm)	Ta (ppm)	Sn (ppm)	W (ppm)
Quartz vein	ave.	5	<10	15	80
(2 samples)	max.	7	<10	20	110
	min.	3	<10	10	50
Geochemical anomaly		18 to 20	2 to 3	78 to 82	30 to 41

g) Anomalous zones of tin and tantalum (T–16 to T–20)

		Nb (ppm)	Ta (ppm)	Sn (ppm)	W (ppm)
Pegmatite	ave.	75	97	87	42
vein	max.	170	300	180	20
(14 samples)	min.	31	20	40	70
Quartz vein (1 samples)		‹1	‹10	0	0
Geochemical anomaly		23 to 30	17 to 31	50 to 83	12 to 20

The above is summarized as follows:

The analytical values of pegmatites are Nb: 11 to 170 ppm, Ta: ‹10 to 300 ppm, Sn: 10 to 180 ppm, W: 0 to 300 ppm.

The analytical values of quartz veins are Nb: ‹1 to 12 ppm, Ta: ‹10 ppm to Sn: 0 to 80 ppm, W: 0 to 160 ppm.

It is generally recognized that the niobium, tantalum and tin content of pegmatites is higher than that of quartz veins. On the other hand the tungsten content of a quartz vein is higher than that of pegmatite veins, but there are some exceptions.

1–5 Discussion

Dikes composed mainly of pegmatite were found in most of the trenches. Analyses show that the niobium, tantalum, tin and tungsten content of these dike rocks nearly coincide with geochemical anomalous values except in the case of tungsten in the above mentioned geochemical anomalous zones (b) and (c), and tin in (f). This fact indicates that geochemical anomalies originate from pegmatites.

In the trenches T–16 to T–20, many pegmatites were observed. These pegmatites contain twice to five times as much tin, niobium and tantalum as those in other trenches. The maximum value of tungsten content in pegmatite occurred in trench T–9 and was 300 ppm. However, this is not enough to be exploited as a primary ore deposit.

Around trenches T–16 to T–20, 2 to 12g/m^3 of panning concentrates from stream sediment containing cassiterite, tantalite-columbite, rutile, monazite, ilmenite etc., were collected. Old workings of placer deposits exploited by local people are scattered along the streams. These facts suggest that the source of these placer deposits is pegmatites, and the most promising areas of placer deposits have already been mined or prospected. Therefore, it is difficult to discover new placer deposits.

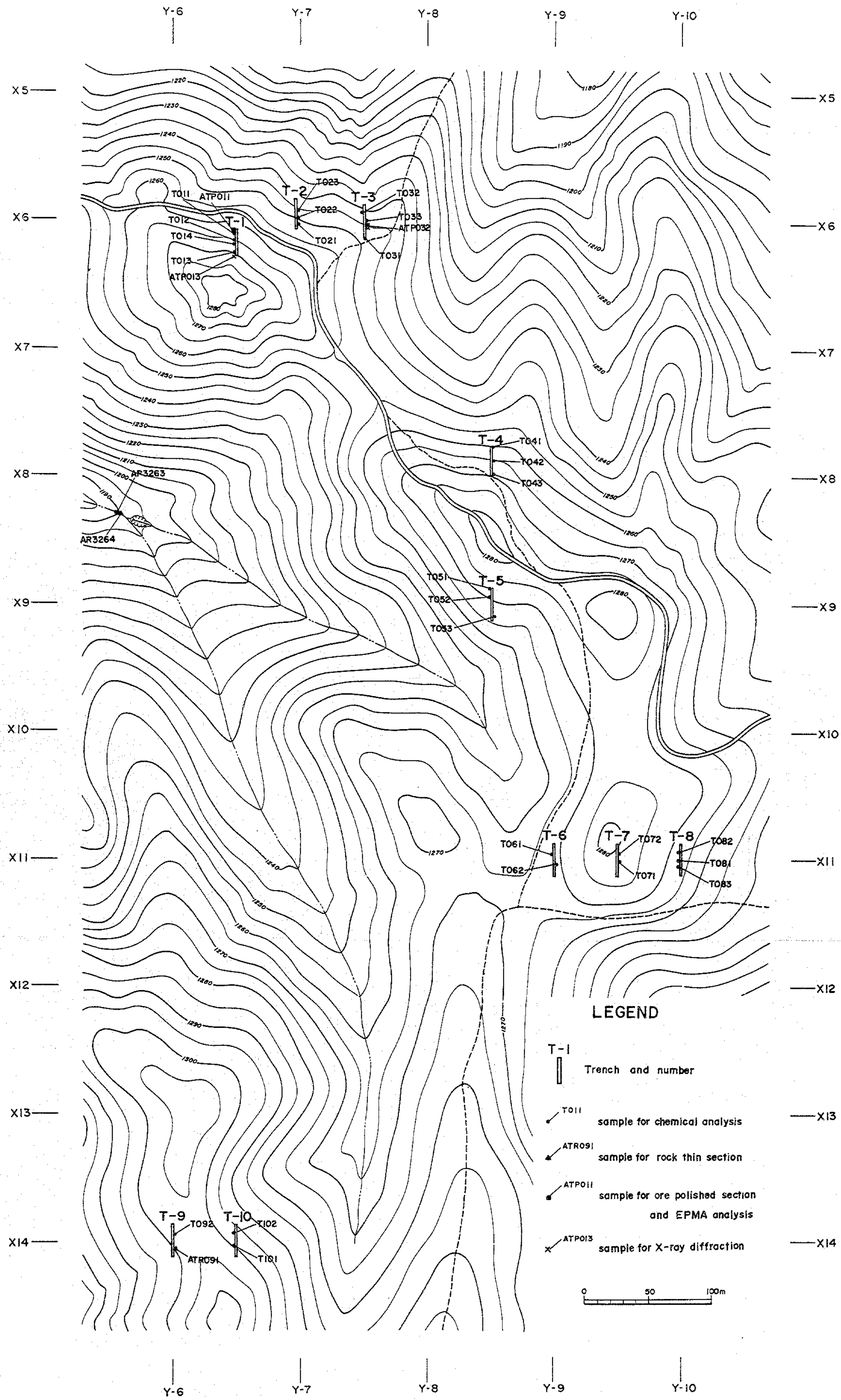


Fig.8 Location map of samples in the north subarea (Area A)

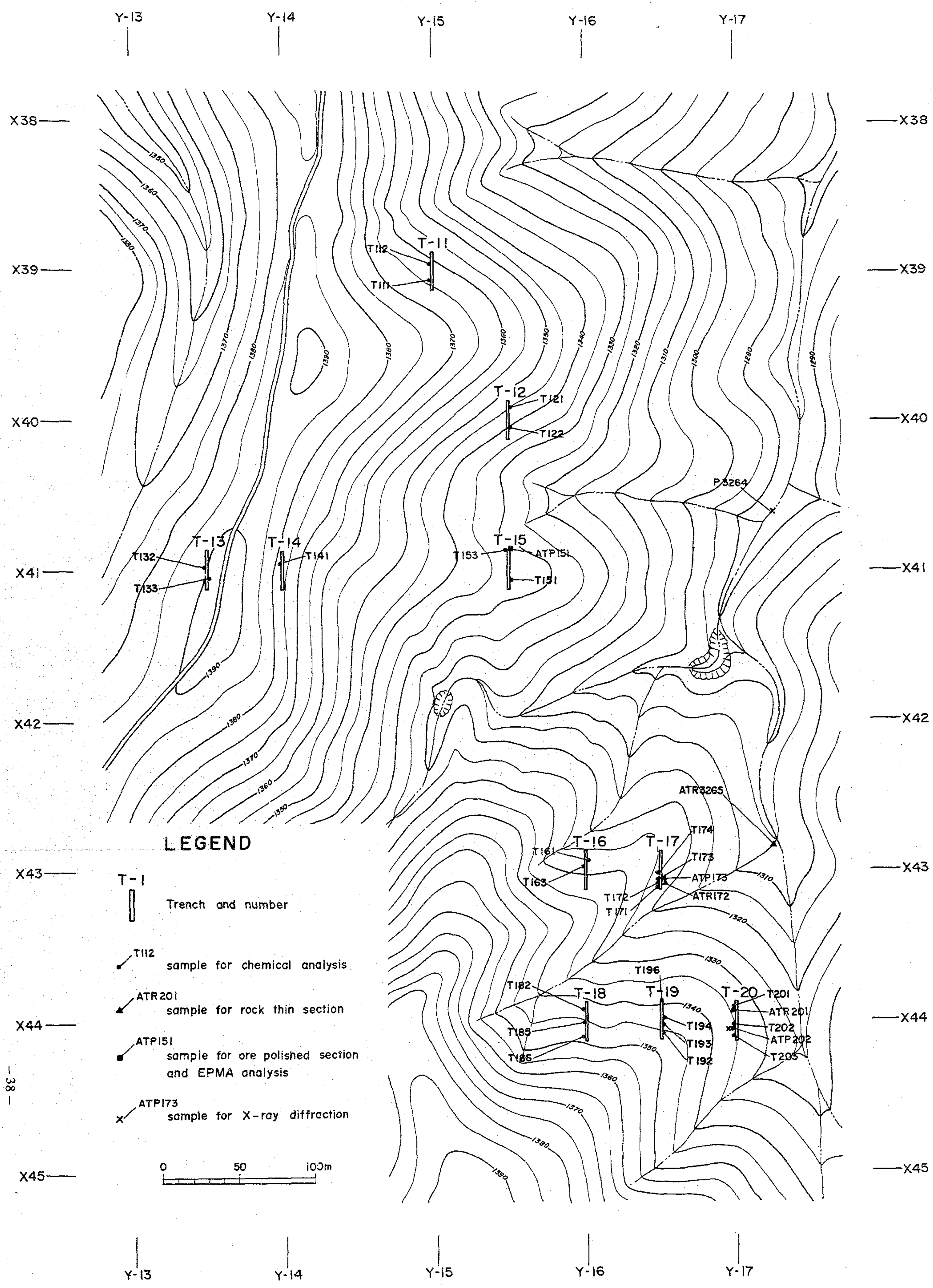


Fig.9 Location map of samples in the south subarea (Area A)

Table 2 Microscopic observation of rock thin sections (Area A)

No.	Sample No.	Locality	Rock name	Texture	Primary minerals										Secondary minerals			Description
					qz	pl	kf	bi	ms	tl	ap	zr	gt	op	ch	sr	ka	
1	ATP 9–1	Trench T– 9	Porphyritic biotite granite	Holocrystalline granitic	◎	○	○	○	•		•	•			∘		∘	bio→Chloritization pl, kf→Kaolinitization
2	ATP17–2	Trench T–17	Pegmatite	Pegmatitic	◎	○	○		○	○								–
3	ATP20–1	Trench T–20	Coarse grained gneissose granite	Holocrystalline granitic	◎	◎	○		∘	○	∘	•		∘				–
4	AR3264	Branch of Huai U Tum (X8, Y5.5)	Medium grained two mica granite	Holocrystalline granitic	◎	◎	○	○	○		∘	•	•	•	•	•		pl, kf→Sericitization bi→Chloritization
5	AR3265	Huai Sa Ngin (X43, Y19.5)	Porphyritic biotite granite	Holocrystalline granitic	◎	◎	○	○	∘	○	∘	∘		∘		∘		pl, kf→Sericitization

Abbreviation : qz; quartz, pl; plagioclase, kf; k-feldspar, bi; biotite, ms; muscovite, tl; tourmaline, ap; apatite, zr; zircon, gt; garnet, op; opaque, ch; chlorite, sr; sericite, ka; kaolinite

Symbols : ◎ ; abundant, ○ ; common, ∘ ; rare, • ; trace

Table 3 Microscopic observation of ore polished sections (Area A)

No.	Sample No.	Locality	Description	Ore minerals						Oxide & Silicate minerals				
				cs	sh	il	py	w	ct	qz	gt	tl	ru	zr
1	ATP011	Trench T–1	Panning concentrate (Pegmatite)	•	•	•	•		•	◯	◎	○		•
2	ATP032	Trench T–3	Panning concentrate (Pegmatite)	•					•	◯	◎	○		•
3	ATP151	Trench T–15	Panning concentrate (Pegmatite)	•			•	•	•		◎	○		•
4	APT202	Trench T–20	Panning concentrate (Pegmatite)						•	◯	◎	○	•	•
5	AP3263	Branch of Huai U Tum (X8, Y5.5)	Panning concentrate (Stream Sediment)	◎	•				•	○	◎		•	•
6	AP3264	Huai Sa Ngain (X43, Y19.5)	Panning concentrate (Stream sediment)	◎	•				•	○	◎		•	•

Abbreviations : cs; cassiterite, sh; scheelite, il; ilmenite, w; wolframite, ct; columbite-tantalite
qz; quartz, gt; garnet, tl; tourmaline, ru; rutile, zr; zircon

Symbols: ◎ ; abundant, ◯ ; common, ○ ; rare • ; trace

Table 4 Results of X-ray diffraction (Area A)

No.	Sample No.	Locality	Description	cs	ct	pl	qz	gt	tl	ru	zr	mz	ms
1	ATP013	Trench T–1	Panning concentrate (Pegmatite)	◦		◦	◦	◎	○		◦		•
2	ATP032	Trench T–3	Panning concentrate (Pegmatite)	◦		◦	◎	◎	◦		•		•
3	ATP173	Trench T–17	Panning concentrate (Pegmatite)		•	•	○	◎	◦		•	◦	
4	ATP202	Trench T–20	Panning concentrate (Pegmatite)	•	•	•	◦	◎	◦				•
5	AP3263	Branch of Huai U Tum (X8, Y5.5)	Panning concentrate (Stream sediment)	○	•	•	◦	◎		◦		•	
6	AP3264	Huai Sa Ngin (X43, Y19.5)	Panning concentrate (Stream sediment)	○	•		○	◎	•	◦		•	

Abbreviations : cs; cassiterite, ct; columbite-tantalite, pl; plagioclase, qz; quartz, gt; garnet, tl; tourmaline, ru; rutile, zr; zircon, mz; monazite, ms; muscovite

Symbols : ◎ ; abundant, ○ ; common, ◦ ; rare, • ; trace

Table 5 Results of EPMA qualitataive analysis (Area A)

No.	Sample No.	Locality	Sample name	Mg	Al	Si	S	Ca	Ti	Mn	Fe	Co	Cu	Zn	As	Zr	Nb	Ag	Sn	Ta	W	Pb	Bi	Minerals
1	ATP011	Trench T−1	Panning concentrate (Pegmatite)							○	○						○			○				Columbite
2									○	○	○						○			○				〃
3																			○	○				Cassiterite
4									○															Rutile
5									○		○						○			○				〃
6	ATP032	Trench T−3	Panning concentrate (Pegmatite)						○		○						○			○				Tantalian rutile
7									○								○			○				Rutile
8					○	○				○	○													Garnet
9									○	○	○						○			○				Columbite
10	ATP151	Trench T−15	Panning concentrate (Pegmatite)				○				○													Pyrite
11						○																		Quartz
12										○	○										○			Wolframite
13									○	○	○						○			○				Tantalite
14	ATP202	Trench T−20	Panning concentrate (Pegnatite)							○	○						○		○	○				Tantalite
15										○	○						○			○				Columbite
16										○	○						○		○	○				Tantalite
17																			○	○				Cassiterite
18	AP3263	Branch of Huai U Tom (X8 Y5.5)	Panning concentrate (Stream sediment)							○	○						○			○				Colunbite-Tantalite
19																			○					Cassiterite
20									○								○							Rutile
21																			○					Cassiterite
22						○											○		○	○				〃
23					○																			Quartz
24					○	○				○	○													Garnet
25																			○					Cassiterite
26									○											○				Rutile
27						○										○								Zircon
28	AP3264	Huai Sa Ngin (x43 Y 19.5)	Panning concentrate (Stream sediment)						○		○						○		○	○				Rutile
29									○		○						○		○	○				〃
30									○											○				〃
31									○		○						○			○				Tantalite

Chapter 2 Area C (Drilling Survey)

2–1 Drilling Survey

2–1–1 Outline of Drilling Works

On the basis of findings from the second phase survey, drilling survey was carried out in Area C to clarify details of geology, mineral indications and mineral ore deposits.

As shown in Fig.10, drilling locations are at 50m intervals along the survey line running NE–SW. Drilling depth at each hole is 30∿50m, with the exception of 2 holes at the northern limestone area where depth is 75m. All drillings are vertical; total number of holes is 56; and total drilling depth is 1,965.55m.

Two drilling rigs were used with 1 Japanese engineer, 1 Thai engineer and 2 local laborers assemed to each machine. With the exception of setup, take down and shifting of equipment, rigs were operated 24 hours a day in 3 shifts.

The survey team and drilling equipment arrived in Omkoi on 13 December 1988. Equipment was unpacked and transported to Yang Kiang from 17 December. Drilling was commenced from 23 December and progressed without incident, being completed for Area C on 27 February 1989.

Next, supplementary drilling was performed in the limestone area 1 km north of Area C. As only 1 rig was used for this work, 2 drilling engineers returned home on 3 March. All drilling was subsequently completed on 19 March, after which equipment was dismantled and shipped to Bangkok on 26 March. Recovered core samples were stored at the Chiang Mai Regional Office of the Department of Mineral Resources. Processing sheet is shown in Table 6.

2–1–2 Drilling Method and Equipment

The conventional drilling method was adopted as drilling depth was a shallow 30∿50m. At the start of drilling a 86mm metal crown was used; however, this was changed to a 86mm diamond bit at a depth of 5m. At 15m depth, the bit was again changed to a 66mm diamond bit which was used to the end of the hole. However, 86mm and 66mm crowns were employed in holes where soft, weathered rock extended into deep ground.

To shore up the hole wall, 86mm casing pipe was inserted. Clear water was used during drilling except in one portion of soft ground where CMC mud water was employed. In order to improve core recovery rate, two types of core pack tube (one for hard rock, and one for soft rock) were applied as rock conditions dictated.

Drilling rigs, appurtenant equipment and consumables are shown in Appendix 2∿4

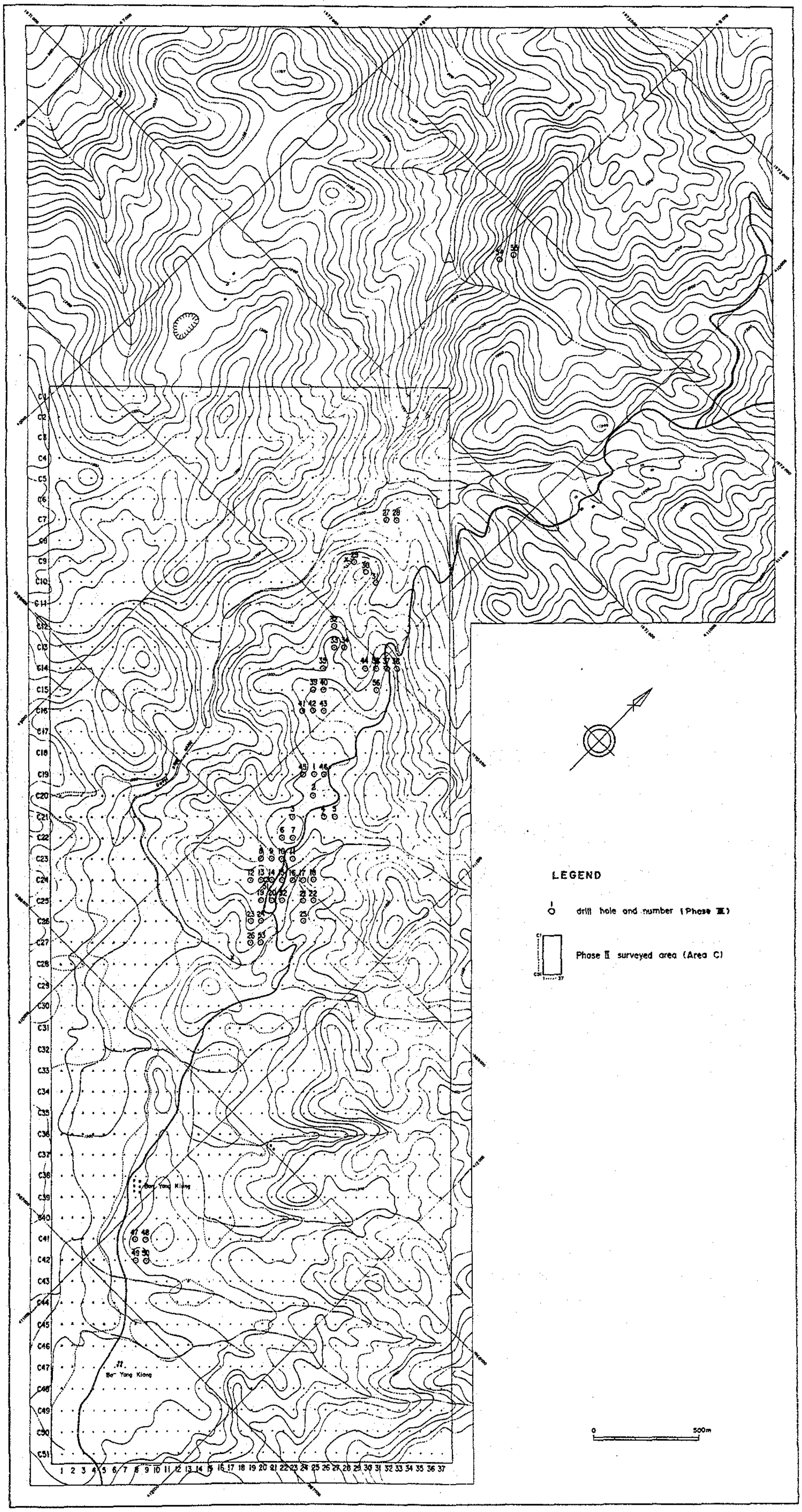


Fig.10 Location map of drilling (Area C)

Table 6 Processing sheet of the drilling works

Hole No.	Drilling Length	DEC. 1988	JAN. 1989	FEB. 1989	MER. 1989
MJTY-1	36.10		17 – 19		
2	30.00		19 – 21		
3	30.00		24 – 26		
4	30.00		23 – 25		
5	30.00		21 – 23		
6	30.00		20 – 22		
7	30.00		22 – 24		
8	30.00	27 – 29			
9	32.00	25 – 27			
10	31.00	4 – 21 – 25			
11	30.00	21 – 25			
12	30.00	25 – 27			
13	30.00	27 – 29			
14	42.50	29 –	– 5		
15	35.00		5 – 7		
16	30.00		7 – 10		
17	30.00		12 – 14		
18	30.00		10 – 12		
19	30.00	25 –	– 5		
20	47.60		6 – 10		
21	40.00		16 – 18		
22	30.00		14 – 16		
23	30.00		10 – 12		
24	41.10		14 – 17		
25	30.00		18 – 20		
26	42.35		12 – 14		
27	30.00		28 – 30		
28	30.00		26 – 28		
29	39.00			3 – 5	
30	30.00			1 – 3	
31	30.00			5 – 8	
32	30.00		30 –	– 1	
33	30.00		26 – 28		
34	35.00		28 – 30		
35	30.00			12 – 14	
36	46.30			4 – 7	
37	49.00			1 – 4	
38	32.00		30 –	– 1	
39	34.50			10 – 12	
40	38.70			8 – 10	
41	30.00			19 – 21	
42	33.00			17 – 19	
43	50.00			14 – 17	
44	30.00			25 –	– 7
45	30.00			21 – 23	
46	30.00			23 – 25	
47	30.00			11 – 13	
48	30.00			9 – 11	
49	30.00			15 – 17	
50	30.00			13 – 15	
51	35.00			17 – 19	
52	45.00			19 – 22	
53	35.00			22 – 27	
54	75.00				2 – 7
* 54	25.80			28 –	– 2
55	75.30				14 –
* 55[1]	12.00			27 – 28	
* 55[2]	33.50				7 – 10
* 55[3]	62.70				10 – 13
56	37.00				7 – 11

▬ Drilling ▭ Preparation and Removing

* Redrilled hole

2–1–3 Drilling Works

1. Setup Works

Road Preparation

Yang Kiang is located about 50km from Omkoi. Although the road connecting the two is technically motorable, unpaved poor road surface and rugged terrain require 4 hours by truck to negotiate. Accordingly, the road was widened by bulldozer, and bridges repaired prior to bringing in equipment. From this main road, access roads to each drilling site were cleared.

Bringing and Setup of Equipment

Drilling equipment marine shipped from Japan was transported to Omkoi from Bangkok by 3 ten-ton trucks and 2 seven-ton trucks. At Omkoi, equipment was unpacked and carried in a number of shipments to Yang Kiang base camp by seven-ton, 4 wheel drive truck. A crane carrier and crawler carrier were then employed to move equipment in small shipments to the drilling sites. The crane carrier was used to assemble and install equipment.

2. Shifting of Equipment

Due to the large number of drill sites, erection foundation for rigs and access roads to later sites were constructed simultaneously with drilling works at the earlier sites. In addition to the crane carrier and crawler carrier, manpower was occasionally used to shift equipment. A truck was employed where the next drill site was located at great distance.

3. Drilling Water

Drilling water was obtained from nearby streams. Water was lifted 50∿90m by pump and conveyed by 1 1/2" PVC hose a maximum distance of 900m. A collapsible water tank was used to store water during the dry season when stream discharge was low.

4. Drilling Operation

The drilling survey was performed in the area of geochemically high anomaly in Area C and the mineralization zone beneath the limestone to the north of Area C. Drilling sites can be grouped into 4 subareas, namely, 2 anomaly zones for tin and tungsten, an anomaly zone for niobium and tantalum, and a limestone area.

With the exception of the limestone area, drilling depth was shallow and interval between drill holes was small. As a result, no great variation in geology was encountered among the drill holes.

However, drilling in the limestone area showed differences with Area C due to the presence of cavities in the limestone and the greater drilling depth.

Drilling works for each subarea are described below.

Anomaly Zone for Tin and Tungsten

At holes MJTY-1∿26, 45, 46, and 51∿53, a 86mm metal crown was used to penetrate surface soil layer and weathered rock. This was changed to a 86mm diamond bit as rock hardened at greater depth.

For almost all holes, casing pipe was inserted to 10∿15m depth. However, casing was inserted to 22, 26, and 20m depths, respectively, for MJTY-12, 14, and 23 as stable rock was not encountered. Conversely, since hard rock was encountered at 10m depth at MJTY-35, casing was inserted only to 9m at this hole.

Finally, a 66mm metal crown or diamond bit was employed until the design drilling was reached.

At holes MJTY-2∿44 and 56, a 86mm metal crown was used to penetrate surface soil layer and weathered rock. This was changed to a 86mm diamond bit as rock hardened at greater depth. Casing pipe was inserted to 9∿15m depth in the holes. Finally, a 66mm metal crown or diamond bit was employed until the design drilling was reached.

Anomaly Zone for Niobium and Tantalum

At holes MJTY-47∿50, a 86mm metal crown was used to penetrate surface soil layer and weathered rock. This was changed to a 86mm diamond bit as rock hardened at greater depth.

Casing pipe was inserted to 10∿14m depth in the holes. Finally, a 66mm metal crown or diamond bit was employed until the design drilling was reached. Little variation in rock characteristics occurred, and drilling proceeded smoothly.

Northern Limestone Area

This area is located about 1km north of Area C. The area slopes steeply to the Mae Hong river. Drilling sites were located near the ridge where limestone outcrops (MJTY-55) and about 70m to the south of this point (MJTY-54). Difference in elevation between the two sites is 35m. A motorable road from Yang Kiang village and Sala Khi village runs along the eastern side of the area. An access road from this road to the sites was cleared for about 1km..

At hole MJTY-54, limestone was encountered at 4.64m depth, and a cavities at 25.80m. (MJTY-54^1). Cavities continued to be encountered to over 40m depth. It was concluded that deeper drilling at the hole would be difficult; drilling was accordingly suspended and drilling resumed at a site about 10m to the east. At this hole, drilling was commenced with a 86mm metal crown. At 3.95m depth, limestone was encountered and the bit was changed to a 86mm diamond bit. Casing pipe as also inserted to 4m depth. At 46.20m, the bit was changed to a 66mm diamond bit, which was employed to the bottom of the hole. Geology in the hole underwent transition with depth from limestone to skarn, massive sulfide, to granite. Nevertheless, all types of rock were hard, and drilling progressed smoothly.

At hole MJTY-55, drilling was commenced alongside the limestone outcrop. However, granite was encountered at 3.40m, drilling was suspended at 12.00m (MJTY-55^1) and resumed at a point 30m to the west in the limestone outcrop. Drilling was commenced with a 86mm metal crown. At 5m depth, limestone was encountered and the bit was changed to a 86mm diamond bit. at 15.50m, the bit was changed to a 66mm diamond bit.

However, an accident occurred in the hole at 33.50m depth (MJTY-55^2). Drilling was accordingly suspended and resumed at a point 1m away. At 5m depth, limestone was encountered and the bit was changed to 86mm diamond bit and 66mm diamond bit. Drilling proceeded smoothly despite encountering cavities at depths of 51.50∿52.60m, 53.00∿54.00m, and 54.40∿54.70m.

However, an accident occurred as well at this hole at 62.70m depth (MJTY-55^3) and drilling was suspended and resumed at a point several cm away. At this hole, drilling was through limestone to a depth of 49.50m, after which cavities were encountered at a depth of 49.50∿54.40m. Clayey skarn was encountered below 54.40m, whereas repeated core sticking reduced core recovery rate. Nevertheless, drilling proceeded relatively smoothly to 59.50m. However, below this depth, it became exteremely difficult to pass the rod through cavities, and 15 shifts were necessary in the 15.80m interval to the final drilling depth of 75.30m.

5. Equipment Removal

Drilling works were completed on 19 March 1989. Drilling and water pumping equipment was dismantled, loaded on a 7 ton truck and transported to Omkoi. Equipment was inspected in Omkoi, packed and shipped by 3 ten-ton trucks to Bangkok on 26 March. Sample cores were stored at the Chiang Mai Regional Office of the Department of Mineral Resources.

2–2 Geology of Drill Hole

2–2–1 Determination of Drilling Sites

Drilling was performed to determine the features of mineralization occurring in the ground in zones of geochemical anomaly for tin, tungsten, niobium and tantalum in Area C. Hole depth was to 30∿50m, with exception of one portion of the area where depth was to 75m. A total of 56 holes were drilled for a total depth of 1,965.55m.

The zone of geochemical anomaly for tin and tungsten is located in the center and north of Area C in a belt 200∿400m wide and 3km long. Sporadic outcroppings of gossan were seen in the zone.

As shown in Fig.10, 31 and 19 drill hole sites, respectively, were arranged along geochemical survey lines running NE∿SW through the center and north of Area C where high anomaly zones