No. 34

REPORT
ON
THE COOPERATIVE MINERAL EXPLORATION
IN
THE KRA BURI AREA, THE KINGDOM OF THAILAND

PHASE Ⅲ

MARCH 1994

JAPAN INTERNATIONAL COOPERATION AGENCY

METAL MINING AGENCY OF JAPAN

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PREFACE

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

The JICA and the MMAJ sent to the Kingdom of Thailand a survey team headed by Dr. Hiroyuki Takahata from July 5 to August 9, 1993.

The team exchanged views with the officials concerned of the Government of the Kingdom of Thailand and conducted a field survey in the Kra Buri 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.

November, 1993

Kensuke Yanagiya

Kensuke Yanagiya

President

Japan International Cooperation Agency

Takashi Ishikawa

Takashi Ishikawa

President

Metal Mining Agency of Japan

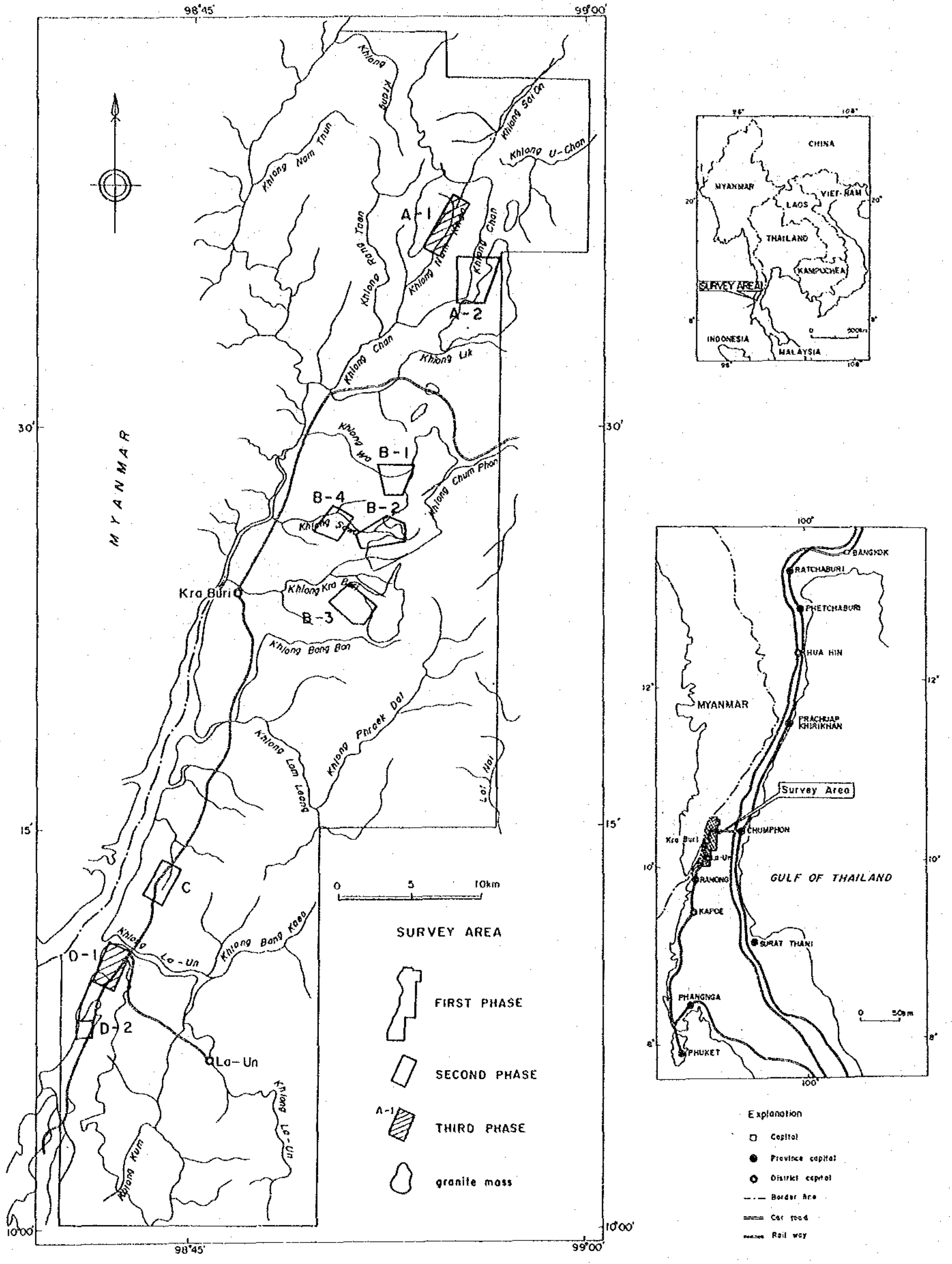

Fig. 1 Location map of the survey area

SUMMARY

This survey is of the third phase program of the Cooperative Mineral Exploration Project in the Kra Buri Area, the Kingdom of Thailand. The objective of the project is to examine the potential for tin, tungsten, tantalium and niobium resources, as well as rare earth elements.

The survey area is an area of 1,500 km^2, 80 km north to south and 20 km east to west, in the Kra Buri Area, Ranong Prefecture, in the Peninsula of Thailand, where is the northern extension area of the Ranong-Phuket Area, the largest tin producing area in Thailand.

The area is underlain by sedimentary rocks of Silurian, Devonian, and Jurassic ages, granites intruded in the above mentioned sedimentary rocks, and Quaternary alluvial sediments. Several major faults showing the trend of NNE-SSW is characteristic in the area, and the granite masses of Cretaceous age intruded accordance with this trend in the northern, central, and southern areas.

The third phase survey was planned based on the second phase survey results. Pit and drill surveys in the Area A-1 and a drill survey in the Area D-1 have been performed.

In Area A-1, relatively high grade tin deposits have been found in the river bed sediments which are distributed along Khlong Nam Khao and its tributaries at the southern part. The ore deposits are composed of five separated parts, and the total ore reserve is estimated to 780,000 m^3, 360 to 1,500 g/m^3 in tin. The secondary ore contains not only tin but also tantalum, niobium, rare earths, and titanium. It seems that the ore deposits are of economical, if the all elements are technically recoverable. The area is presently used for agriculture, therefore it is necessary to compare their economical preferability.

Some parts concentrated by rare earth elements have been found in the Area D-1, however their reserves and grades are not enough for economical mining, in addition to that the ores are situated in an environmental conservation area.

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PART I GENERAL REMARKS

Chapter 1 Introduction

1-1 Background

Thailand is one of the major tin producing countries in the world. Besides of tin, she produces rare metals such as niobium and tantalum, which are associated with tin, and rare earth elements such as samarium and cerium as byproducts.

Demand for rare earth elements increases recent years, and in reflect such background, the Government of Thailand requested the Japanese Government to conduct a cooperative mineral exploration project for rare earth elements in the tin producing area in southern Thailand. In response to the request, the Japanese Government dispatched a preliminary survey mission to Thailand, and finally the Japan International Cooperation Agency and the Metal Mining Agency of Japan entered into an agreement with the Department of Mineral Resources, Ministry of Industry, Thailand on 27th, February 1991. Based on this agreement, a three years' program of cooperative mineral resources exploration in the Kra Buri area, the Peninsula of Thailand, was supposed to conduct from 1991.

The objective of the project is to assess the potential for tin, tungsten, niobium, tantalum and rare earth elements, and to select potential areas, by means of integrated interpretation of geology, geological structure, mineral occurrences, and geochemical characteristics.

1-2 Conclusion and Recommendation of the Second Phase Survey

1-2-1 Conclusion

The second phase survey was conducted to find sedimentary basins for secondary ores in nine areas in the four selected areas based on the first phase survey results, as well as to assess the potential for primary ores and adsorption type rare earth ores in some areas. The applied method for the survey was soil geochemical survey.

The survey results revealed that the geochemical anomalies were classified into two groups, one consisting of Sn, W, Nb, Ta, and another consisting of rare earths, Th, U. It is presumed, based on their distribution in the granite, that the rare earth minerals were settled in the early stage of the differentiation of granite and Sn and W were settled in highly differentiated facies of granite, upper parts of the granite bodies. Also an extension of sedimentary basins containing cassiterite and rare earth minerals was presumed due to the distribution of the geochemical anomalies. The areas assessed are as follows.

(1) Area A-1

Four anomaly zones are distributed in northern, central, southwestern, and southeastern parts in this area, well corresponding with the distribution of talus deposits and stream sediments. The total estimated ore reserve is 1.15 million m^3 of cassiterite ore, 0.126 kg/m^3 of cassiterite in grade, and 2.2 million m^3 of rare earth ore, 1.315 kg/m^3 of monazite and 0.236 kg/m^3 of xenotime in grade.

(2) Area A-2

The area is underlain by argillaceous granite, and contains high rare earth anomalies in the first phase survey. It was accordingly expected existence of adsorption type rare earth ore deposits. However, the second phase survey results revealed that those anomalies were accompanied by hard fresh granite rocks. It is estimated that the potential for secondary rare earth ores is low. Judging from the small-scale geochemical anomalies, the ore reserve for secondary ores is estimated to less than 0.3 million m^3.

(3) Areas B-1 to B-4

The areas are distributed in a narrow sedimentary basin along a river surrounded by mountains and hills. The estimated ore reserve is 0.06 to 0.3 million m^3, and the grade is low.

(4) Area C

The second phase survey revealed that Sn anomalies were in silicified rocks in the northwestern area and rare earths anomalies were in mountainous terrain in the southeastern area. The estimated secondary ore reserve is 0.1 million m^3 of cassiterite ore and 0.6 million m^3 of rare earth ore, and the grades for those are low.

(5) Area D-1

The area is in mangrove terrain, and the surface is extensively covered by mangrove soil. Accordingly, no significant geochemical anomaly has been detected in the area, however, it is evaluated that the potential for deep buried ores are high. The ore reserve is estimated to 7 to 14 m^3, more than 0.222 kg/m^3 of cassiterite, 1.480 kg/m^3 of monazite, and 0.167 kg/m^3 of xenotime in grade. This is the largest in the surveyed nine areas.

(6) Area D-2

The area is in mangrove terrain as same as the Area D-1, and no high geochemical anomaly exists. The estimated ore reserve is 1.6 million m^3, but the grade is low.

1-2-2 Recommendation

The second phase survey reveals that the A-1 and D-1 areas are in sedimentary basins where some potential in grade and scale expected. It is necessary to examine vertical profiles of the distribution of heavy minerals to evaluate more exact ore reserves.

It is suggested that the bit drill method is suitable in the Area A-1, because the sediments in the area contain a large amount of boulders. Two zones being duplicated by Sn and rare earth anomalies are enough for such drilling survey.

It is suggested that the Banka drill method by man power is suitable in the Area D-1, because the area is in mangrove terrain and cleaning for transportation should be minimized. The area is also in a high tidal area, and normally submerged in high tide times. It is presumed that the sediments in the area are 20 meters in thickness. Three or four zones are recommended for drill survey sites to ensure horizontal extension of ores.

1-3 Outline of the Third Phase Survey

1-3-1 Survey Area

The survey area is situated in a narrow northern part of the Peninsula of Thailand. The area occupies an area of 1,500 square kilometers, 80 kilometers north to south, and 20 kilometers east to west, along the Mae Nam Kra Buri in Amphoe Kra Buri, Ranong Province. It is situated about 150 kilometers northwest of Surat Thani, one of the biggest city in southern Thailand. The area administratively belongs to Amphoe Kra Buri and, Amphoe La-Un, and Amphoe Muang Ranong of Ranong Province, whereas a small part of the northeastern area belongs to Amphoe Tha Sae and Amphoe Muang Chumphon, Chumphon Province.

Based on the second phase survey results, the A-1 and D-1 areas were selected for the third phase survey. These areas were evaluated some potential for secondary ores.

1-3-2 Objects of the Survey

The principal object of the Cooperative Mineral Exploration Project is to discover new ore bodies by means of integration of geological setting and situation of ore deposits in the Kra Buri Area. This phase survey is the third stage of the project. The object of this phase survey is to ensure ore reserves and grades in the selected potential areas based on the first and second phase programs by means of pit and drilling surveys.

1-3-3 Survey Method

Pit and drilling surveys in the Area A-1, and drilling survey in the Area D-1 have been applied to assess potential for Sn and rare earth minerals.

Sites of pits and drill holes have been located based on topographic and geologic conditions, and mapped by simple survey method using topographic maps on a scale of 1:10,000 enlarged from original 1:50,000 scale maps.

The pit survey has been principally performed till to reach on the hard rock surfaces, however in some cases it had to give up to reach because of much ground water and huge boulders bigger than 1.5 meters in diameter. Ten pits, total depth of 40 meters, have been initially planned, but 14 pits, total 44.5 meters, have been performed. Immediately after finishing pitting, geological sketch and channel sampling along 50 centimeters lines have been performed. The pits have been filled back after all surveys completed.

The drilling survey has been performed using bunker drilling machines that were possessed by DMR. In the Area A-1, 15 holes, total length of 74.7 meters, have been drilled. In the Area D-1, 16 holes, total length of 162.6 meters, have been drilled. Hundred per cent core recovery has been successively reached through the whole drill length except the bottom part of KBD-16 hole. Geological drill logs have been made by means of geological observation, and sampling through each 0.6 to 3 meters' section, judging from geological conditions, has been performed. The samples have been measured their weight and volume to investigate suitable mining methods, and panned to obtain heavy minerals for chemical assay.

Table 1 shows the survey areas and the contents and quantities of the survey works.

Table 1 Contents of the Survey

Areas and sites		
Pit survey	Area A-1	14 sites
Drilling survey	Area A-1	15 sites
	Area D-1	16 sites

Assay items and quantities	
Polished ore	41 samples
X-ray diffraction analysis	5 samples
Modal analysis for minerals	20 samples
Chemical assay for soil and heavy mineral	
Sn, W, Ta, Nb, Ce, Eu, La, Nd, Sm, Tb	216 samples
Th, U, Y, Gd, Dy, Pr (16 elements)	3,456 components

Table 2 shows contents of the pit and drilling survey.

Table 2 Achievements of pit and drilling survey

1) Area A-1, pit survey

Hole	Length	Period	Samples
KBA-P01	4.0	July 12 - 13	8
KBA-P02	3.0	12 - 13	6
KBA-P03	2.5	14 - 16	5
KBA-P04	4.5	14 - 16	9
KBA-P05	4.0	18 - 19	8
KBA-P06	3.0	18 - 19	6
KBA-P07	3.0	20 - 22	6
KBA-P08	3.0	20 - 22	6
KBA-P09	2.5	20 - 22	5
KBA-P10	5.0	23 - 25	10
KBA-P11	2.0	18 - 19	4
KBA-P12	2.0	23 - 25	4
KBA-P13	3.0	23 - 25	6
KBA-P14	3.0	27 - 28	6
Total	44.5m		89

2) Area A-1, Banka drill survey

Hole	Length ft	m	Period		Samples
KBA-B01	19.0	5.8	Aug.	1	4
KBA-B02	16.5	5.0		1	4
KBA-B03	17.0	5.2		1-2	4
KBA-B04	14.0	4.3		2	3
KBA-B05	17.0	5.2		2	4
KBA-B06	18.0	5.5		3	4
KBA-B07	13.0	4.0		3	3
KBA-B08	10.0	3.1		3	3
KBA-B09	14.5	4.4		4	4
KBA-B10	20.0	6.1		4	4
KBA-B11	10.5	3.2		5	3
KBA-B12	14.0	4.3		5	3
KBA-B13	22.0	6.7		6	4
KBA-B14	24.5	7.5		6-7	6
KBA-B15	15.0	4.6		7	4
Total	245.0	74.7			57

3) Area D-1, Banka drill scurvy

Hole	Length ft	m	Period		Samples
KBD-01	35.0	10.7	July	7	1
KBD-02	47.0	14.3		8	5
KBD-03	42.5	13.0		11	4
KBD-04	42.5	13.0		13	6
KBD-05	41.0	12.5		14-15	6
KBD-06	33.0	10.1		18	5
KBD-07	43.0	13.1		17	7
KBD-08	27.0	8.2		19	3
KBD-09	40.0	12.2		20-21	6
KBD-10	34.0	10.4		22	4
KBD-11	29.0	8.8		23	4
KBD-12	32.0	9.8		27	4
KBD-13	32.0	9.8		24	4
KBD-14	32.0	9.8		25	4
KBD-15	23.0	7.0		26	3
KBD-16	44.0	13.4		29-30	4
Total	533.0	162.6			70

1-3-4 Survey Mission Personnel

Japan

Planning and coordination

Toshio SAKASEGAWA	Metal Mining Agency of Japan
Jiro OHSAKO	ditto
Yasuhisa YAMAMOTO	ditto
Takafumi TUJIMOTO	ditto
Satoshi SHIOKAWA	ditto
Kousuke TAKAMOTO	ditto
Masayashi SHIMODE	ditto, Bangkok Office

Pit and drilling survey

Hiroyuki TAKAHATA	Geologist
Yasunori ITO	ditto

Thailand

Planning and coordination

Boonmai Inthuputi	Department of Mineral Resources
Phairat Suthakorn	ditto

Pit and drilling survey

Peerapong Khuenkong	Geologist, Department of Mineral Resources
Karoon Tonthongchai	ditto
Boonruam Songkran	Field assistant, ditto
Taval Japakasetr	ditto

1-3-5 Survey Period

Period: from June 28, 1993 to November 30, 1993
(Field survey: from July 5,1993 to August 9, 1993)

Chapter 2 Geography

2-1 Topography and Drainage

In the Peninsula of Thailand, the Tenasserim Mountains extend from the western mountains of the Indonesian Peninsula to Ranong Provinces, and the Phuket Mountains extend from the Tenasserim Mountains to Chumphon, Phangnga, and Krabi Province, forming the backbone mountains of the peninsula.

The survey area is situated in the boundary between above mentioned two mountains, and 90 percent of the land is mountainous area showing altitude of 100 to 700 meters, but no high mountain exists.

The principal mountain ridges show a clear trend of NNE to SSW, characterized by narrow ridge lines and steep mountainside slopes. This trend coincides with the geological structure of the sedimentary formations in the area. Also the lens-shapes of granites distributed in the northern and southwestern areas show same trend, having relatively flat tops and steep flanks, where many water falls and steep cliffs exist.

Drainages in the area also show the trend of NNE to SSW, and alluvial extends into the narrow up-stream areas of the drainage systems. Crossing this main drainage trend, many minor streams cut the steep mountain flanks.

The Mae Nam Kra Buri runs NNE to SSW along the border with Myanmar, the western edge of the survey area. Alluvial plains are distributed along its river sheds. Large alluvial plains are distributed in the water sheds of the Khlong Chan in the northern area and the Khlong La-Un in the southern area. A lowland swamp area extends in between the mouths of the Khlong Chan and Khlong La-Un.

2-2 Climate and Vegetation

The Peninsula of Thailand is situated in the tropical monsoon area. The rainy season by the southwest monsoon ranges from May to November, and the dry season by the northeast monsoon ranges from December to April. Between February and April, it is the warmest time in a year due to weaken northeast winds.

The monthly temperature data in the recent six years in Ranong City, to the south of the survey area show that the average monthly temperatures are almost in a flat line, between 26 and 30°C. However daily changes in the dry season are rather larger, from 19 to 38°C, than those in the rainy season, from 22 to 33°C.

The monthly precipitation data in the recent five to six years in Kra Buri Town and La-Un Town show that the annual precipitation in the towns ranges between 1,800 and 3,000 mm. Ninety percent of the precipitation is concentrated in the rainy season.

The vegetation in the area is mainly of tropical monsoon forest in mountainous areas, artificial forest in hilly plantation areas, and agricultural land in flat areas. The mountain forest is of virgin heavy deciduous trees mainly consisting of teak wood, oak, bamboo, etc. In the hilly areas, artificial plantation forests consisting of tropical fruits, gum tree, oil palm, and coffee are mixed with natural virgin forest. In the plains, large areas are cultivated as rice fields and vegetable gardens. Mangroves are seen in the lowland swamp area in the mouths of the Khlong Kra Buri and Khlong La-Un.

Chapter 3 Geological Information

3-1 Existing Geological Information of the Kra Buri Area

Southeast Asia including the Malay Peninsula has undergone four major orogenic movements in late Precambrian, Variscan (Hercynian) in the late Paleozoic, Indonesian in the Triassic to Jurassic, and Alps in the Cretaceous to Tertiary times. The area among the Khorat Plateau, eastern Myanmar, Malay Peninsula and Borneo Island has been deformed by a tectonic holding movement accompanied by igneous activity in the Indonesian age.

The granites distributed in the zone are commonly called tin-granite or tin-tungsten granite according to their associated minerals. Hatchison and Taylor (1978) subdivided the tin-granite into three belts, the Eastern, Main Range, and Western Belts. Furthermore, Hatchison (1983) divided the Western Sub-belt into two belts. One is the Northern Area dominated by Triassic granites redefined as the "Northern Thailand Granite Area". Another is the Southern Area dominated by Cretaceous granites redefined as the "Southern Thailand Granite Area".

The survey area is situated in the southern Western Belt. The area is located in the area along the Ranong Fault, between the Ranong Fault which extends along the Khlong Kra Buri from Ranong to Prachuap Khirikhan situated in the Thailand Bay side and the Khlong Marui Fault which extends from Phangnga to Surat Thani. The area is called Western Phuket Belt, and the geological structure tends to NNE to SSW, in contrast with NNW to SSE in the northern Western Belt.

The Western Phuket Belt is underlain by clastic rocks and limestones of Cambrian to Jurassic time and intruded Cretaceous granites. No Cambrian and Ordovician rock is distributed in the survey area. The main constituting rocks are mudstones and sandstones of the Silurian to Devonian, mudstones and sandstones of the Carboniferous, limestones of the Permian, sandstones and conglomerates of the Jurassic, and intruded Cretaceous granites.

The survey area, based on the geological map 1:250,000 in scale published by DMR, 1985, is underlain by the Kra Buri Formation of the Tanaosi Group of the Silurian to Devonian, the Matri Formation of the Carboniferous, the Chumphon Formation of the Ratburi Group of the Permian, and intruded Jurassic granites and Cretaceous andesites to rhyolites.

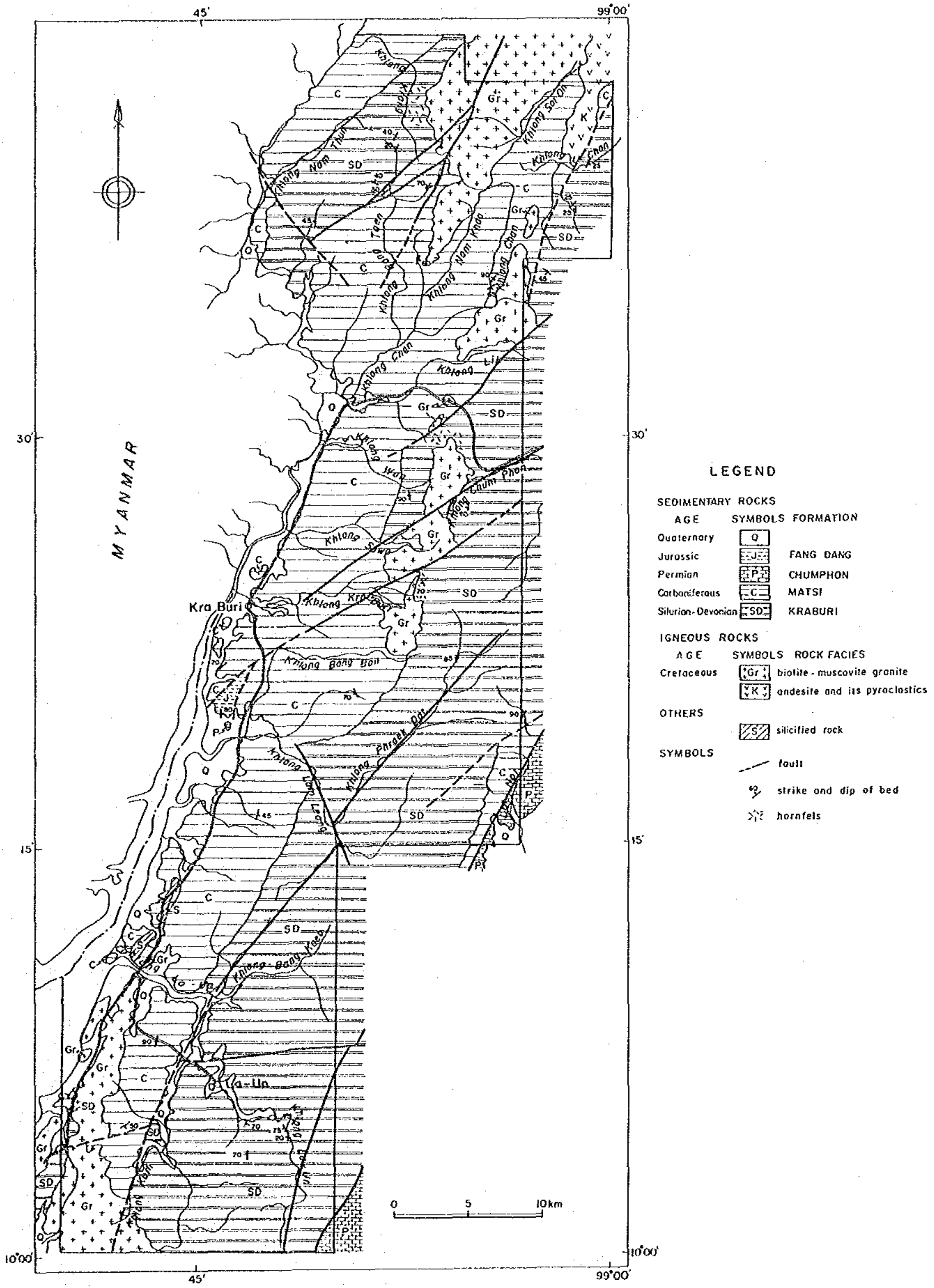


Fig. 2 Geologic map of the Kra Buri Area

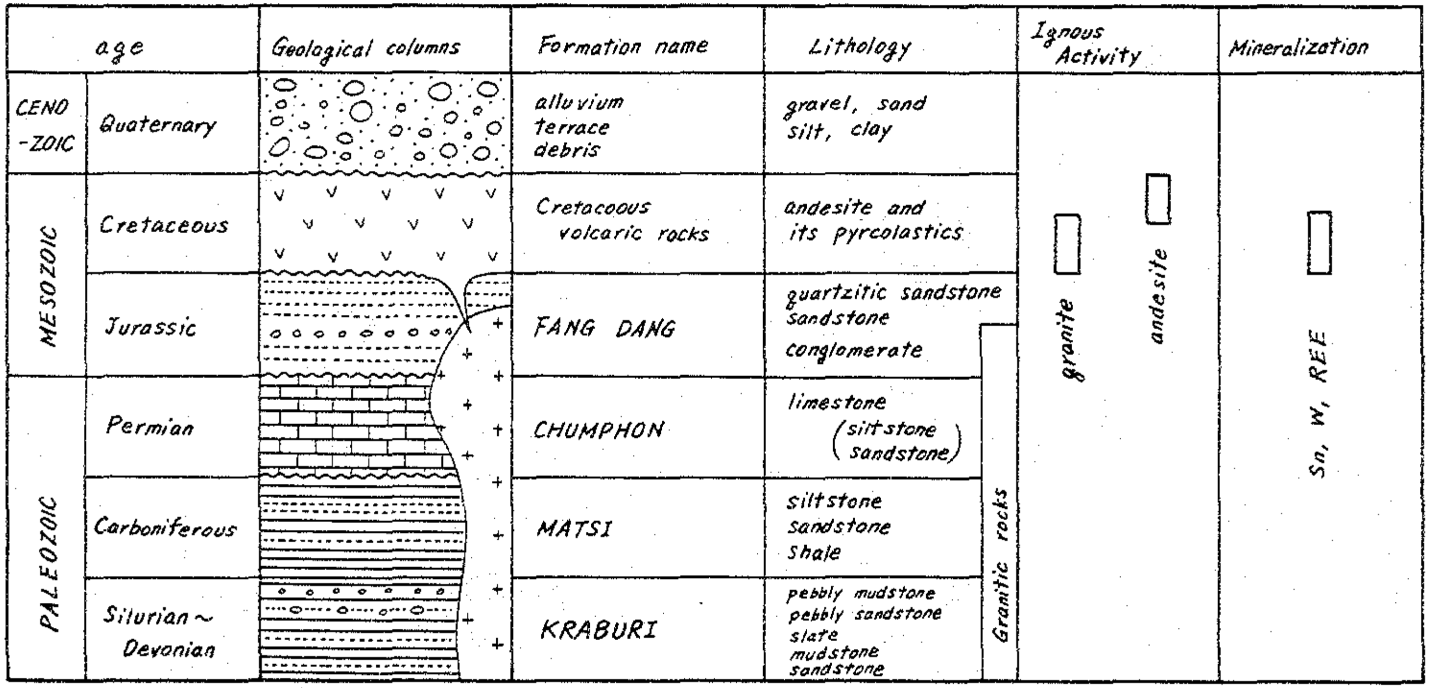


Fig. 3 Schematic geologic column of the Kra Buri area

The geological structure of the area shows a general trend of NNE to SSW controlled by the Ranong Fault and Khlong Marui Fault. The granite intrusions were also controlled by those directions.

Many tin mines have been known in the Malay Peninsula for many years, and one of the largest tin producing area in the world. The peninsula of Thailand is in the northern tin producing area, and the Ranong to Phuket area to the south of the survey area is one of the major tin producing areas in Thailand. The tin deposits are classified into to categories, the secondary ore deposits containing in river flood plains and beach sands, and the primary ore deposits containing in granites as argillaceous-disseminated type and in pegmatites.

Many secondary ores in flood plains around granite bodies have been mined in the survey area in one time, and old pits are scattered in the area.

3-2 Mining Activity in the Survey Area

The tin mining activity in southern Thailand has been performed for 400 years at least. When Portuguese set up their trading station in Phuket in the 16 century, already several tin mines were in operation. Dredge mining for tin was first started in the Port Thung Kha 1906, then Australian, British, and Chinese people came to begin dredge mining operation. Five hundred eighty tin mines were registered in southern Thailand in 1965. Almost of all were small-scale private operations applying dredging or gravel pumping methods.

Since then, tin mining in Thailand expanded their activities mainly in the peninsula areas, and reached its peak in 1979. However, after that year, many small to medium scale mining operations have been forced to close their operations due to low market price caused by the development of competitive new materials such as plastics, and the development of new mining operations in Brazil and China. A few mines only for tin are active in Thailand at present, and only one dredging boat is in operation in the survey area, although many old workings are scattered in the area.

Table 3 shows the tin mining activities during the period from 1988 to June 1992. The registered mining claims and operating mines in Ranong County are decreasing in the recent years. The operating mines except one dredging boat for tin are for kaolin, and heavy minerals such as tin, ilmenite, monazite

Table 3 Mining situation in Ranong Province

	1988	1989	1990	1991	1992/6
Leisenced area	106	88	72	68	68
Working mines	20	13	11	12	13
Registered kind of Mining	cassiterite,wolframite,kaolinite associated minerals as tantalite-columbite,monazite,xenotime,zircon				
Minerals	Productin by year (Unit: tonne)				
cassiterite	1,059.74	950.58	985.51	940.28	432.38
wolframite	20.22	3.90	9.60	9.42	-
kaolinite	26,090.00	29,568.00	38,297.00	52,708.00	23,398.02
xenotime	3.00	-	-	8.00	-
monazite	9.00	-	66.00	116.00	-
zircon	266.00	-	20.24	118.70	-
columbite-tantalite	8.00	-	97.25	-	-
Minerals	Market price (Baht/tonne)				
cassiterite	184,387	218,440	155,674	139,667	165,218
wolframite	98,902	80,151	64,007	117,636	94,009
kaolinite	700	700	700	700	700
xenotime	69,604	68,604	69,604	69,604	69,604
monazite	12,559	12,559	13,737	13,737	13,737
zircon	7,901	13,207	13,203	13,207	13,207
columbite-tantalite	61,645	52,983	52,983	52,983	52,983
Minerals	Market price (Yen/tonne)				
cassiterite	923,780	1,094,384	779,925	699,732	827,741
wolframite	495,501	401,555	320,675	589,358	470,987
kaolinite	3,507	3,507	3,507	3,507	3,507
xenotime	348,716	343,706	348,716	348,716	348,716
monazite	62,921	62,921	68,822	68,822	68,822
zircon	39,584	66,167	66,167	66,167	66,167
columbite-tantalite	308,841	265,445	265,445	265,445	265,445

is recovered as byproducts. Annual production of kaolin per one mine is 4,000 tons, in contrast with 1 ton for heavy minerals. Market prices applied for minerals are of those settled by DMR Ranong Branch.

Minerals including rare earth elements such as monazite and xenotime were treated as waist in the active tin producing age. However, those are going to being recovered from the waist and "amang" reflecting the increase of the demand for rare earth elements in the recent years. The reserves and grades of those waists have not been definitely estimated yet, and no economical evaluation has been done.

Many of the tin mines recovering the secondary ores in land areas by the local people in the Ranong area are small in scale, and no precise production records and information for the ores are available. Major mining methods used by those people are gravel pumping and open pit, and the later is preferable for selective mining of high grade ores. The lowest grade for the economical operation is estimated to 0.3 katty/yd^3 (237.31 g/m^3) for both types of mining methods. The cost for opening new mine is estimated to 4 million bahts for the gravel pumping method, and 10 million bahts for the open pit method, based on the experience of DMR Ranong Branch. Also, tax for claims of 0.6 to 0.7 million bahts per 300 rai (1 rai = 16 ares) is required.

Chapter 4 Comprehensive Discussion

The first phase survey revealed that the granite was divided into four bodies, and secondary ores of tin were possibly distributed around those granite bodies.

The second phase survey was planned to select potential sedimentary basins for secondary ores from nine geochemical anomaly areas defined in the first phase survey. Also potential for primary ores and absorption type rare earths ores were investigated. Results of the soil geochemical survey revealed some potential anomalies for secondary ores in these areas, and the A-1 and D-1 areas were the best targets for further exploration activity. It leads to the conclusion that it was necessary to confirm the vertical distribution of heavy minerals to estimate their accurate ore reserves.

Following the second phase survey results, pit and Banka drill surveys have been conducted in the Area A-1, and a Banka drill survey has been conducted in the Area D-1 in this year.

Area A-1

Following anomaly areas in the Area A-1 were selected for this phase survey.

1. Northern Geochemical Anomaly Zone (1)
2. Northern Geochemical Anomaly Zone (2)
3. Central Geochemical Anomaly Zone
4. Southeastern Geochemical Anomaly Zone
5. Southwestern Geochemical Anomaly Zone

The results of this phase pit and drill surveys have revealed following facts.

The Northern Geochemical Anomaly Zone (1) is underlain by talus deposits containing much amounts of fresh granite pebbles and colluvial or redepositional weathering residual deposits of granite. Secondary ores in the weathering residual sediments were expected in the area. However no economical value in the assay results has been found from the pit survey. The Northern Geochemical Anomaly Zone (2) is situated in an alluvial lowland area along Khlong Nam Khao, and underlain by a sand layer mixed with silt, a white clay layer mixed with sands, and a sand and gravel layer from the top to the bottom. Heavy minerals are concentrated in the lower sand and gravel layer. The turning point in the down stream area of the Khlong Nam Khao, down stream wards from the geochemical anomaly zone, shows the best concentration of heavy minerals. A hill consisting of weathering residual sediments extends to the southeast in the south of the anomaly zone, and the sedimentary basin shows a pocket shape. It is said that the cut-off grade of tin placer deposits is 100 g/m^3, therefore, a very small area around KBA-B03 and KBA-B06 contains possibly economical ores.

The Central Geochemical Anomaly Zone was evaluated as a potential area for secondary ores in talus weathering residual sediments in the northwestern part of the anomaly, and secondary ores in alluvial stream sediments in the southeastern part of the anomaly. However, colluvial sediments and redepositional weathering residual sediments are extensively distributed in the northwestern side. Therefore the potential for heavy minerals has been evaluated as low as those in the Northern Geochemical Anomaly Area (1). An area around KBA-B05 is situated in a lowland, and underlain by a sand layer mixed with silt in the upper and a sand and gravel layer in the lower. The assay results show very high values for tin in the lower zone. Rare earths are concentrated in the upper part of the sand and gravel layer. This sedimentary basin is small in size, however shows very high contents for tin, about 1,700 g/m^3.

The Southeastern Geochemical Anomaly Zone is situated in the lowland along the Khlong Nam Khao corresponding with the distribution of stream sediments, and expected as a potential area for secondary ores in sands and gravel layers. The area is underlain by a surface layer consisting of sandy silt, and a sand and gravel layer underneath the surface layer, 1 to 3 meters in thickness. Zones highly concentrated by tin are generally on the distribution area of the sand and gravel layer. However tin grade in the upper parts of the sand and gravel layer is low around KBA-B08 and KBA-P08. The highest grade zones are in the sandy silt layer above the sand and gravel layer around KBA-B10 in the down stream area of the river. Rare earths are highly concentrated around KBA-B11, central part of the anomaly zone, in the sand and gravel layer in the upper stream area, but in the silt layer above the sand and gravel layer in the down stream area.

The Northern (2), Central, and Southeastern Geochemical Anomaly Zones distributed along the Khlong Nam Khao are characterized by high concentration of tantalum and niobium, Ta_2O_5= 10.6 to

20.5 g/m^3, Nb_2O_5= 18 to 70 g/m^3, accompanied by tin and rare earths anomalies. Niobium is apparently related with the behavior of rare earths rather than tin. Thorium, zirconium, and titanium also have high correlation with the behavior of rare earths.

The Southwestern Geochemical Anomaly Zone was evaluated as a high potential zone for secondary ores in the talus weathering residual sediments around the granite body and in the alluvial stream sediments along the rivers, as well as the Central Zone. The results of pit and drilling surveys have revealed that tin anomaly zones were located only in the stream sediments along the rivers, and no rare earths anomaly was detected. The sedimentary basin of the stream sediments for secondary tin ores is distributed in two small areas along the river. The upper sandy silt and clay layer is 4 to 6 meters in thick. The sand and gravel layer is 1 meter in thickness around KBA-B13 in the eastern anomaly area. Tin is concentrated only in the sand and gravel layer, SnO_2=1,500 g/m^3 in the highest. Rare earths, titanium, and zirconium are low in the western anomaly zone, however high tin anomaly zones are distributed from the bottom of the sediments across the layers, 2 to 3 meters in thickness, accompanied by tantalum and niobium anomalies.

Five potential zones for secondary ores are located in the Area A-1 (Fig. 4). The total probable ore reserves of the three zones along Khlong Nam Khao are 639,000 m^3, and the grades are as follows.

SnO_2	; 500 g/m^3
Ta_2O_5	; 10 g/m^3
Nb_2O_5	; 36 g/m^3
TR_2O_3	; 135 g/m^3
ThO_2	; 18 g/m^3
Zr_2O_3	; 23 g/m^3
TiO_2	;1,025 g/m^3

The total probable ore reserves of the two zones in the western side are 146,000 m^3, and the grades are as follows.

SnO_2	;1,000 g/m^3
Ta_2O_5	; 15 g/m^3
Nb_2O_5	; 24 g/m^3
TR_2O_3	; 50 g/m^3
ThO_2	; 6 g/m^3
Zr_2O_3	; 16 g/m^3
TiO_2	; 290 g/m^3

Area D-1

No significant geochemical anomaly zone, except rare earths anomaly zones in the coarse sands layer

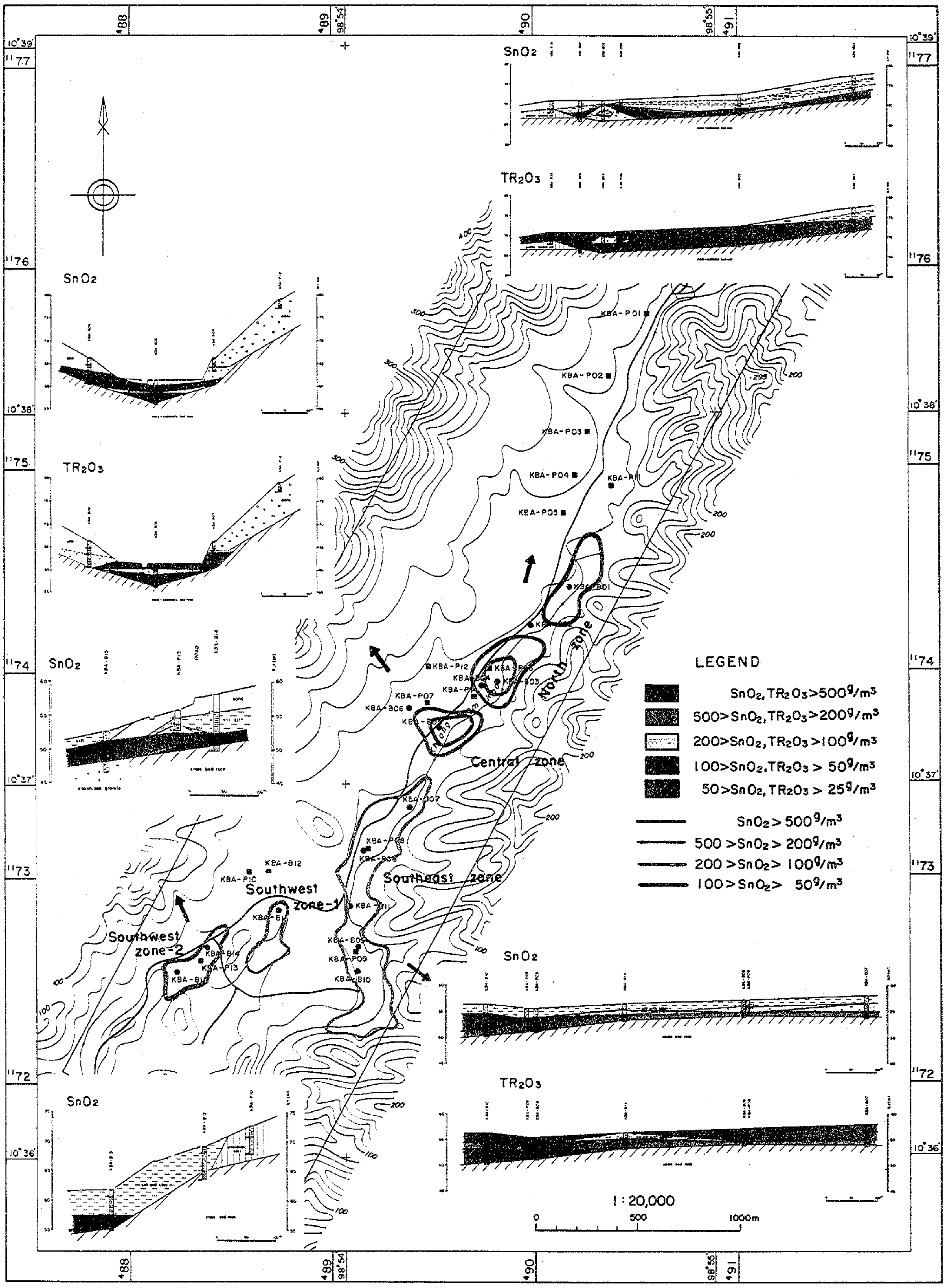


Fig. 4 Results of pit and drilling survey in Area A-1

along the land area, was found in the Area D-1 in the second phase geochemical survey, because almost all area was underlain by mangrove soil. However, high potential for tin was expected underneath of the mangrove soil in the Area D-1, because secondary tin ores were situated to the east of the Area D-1, eastern side of the granite body, and about 10 kilometers south of the Area D-1.

The results of the drilling survey have revealed that the sedimentary basin in the Area D-1 significantly increased its thickness in the boundary area with the land area, 10 to 14 meters in depth, and the bottom of the basin in the boundary zone was flat in shape. It is judged from the topographic characteristics that the land of the basement was marine erosion or wave erosion platform. The sand and gravel layer and the sands layer covering the basement are 3 to 5.5 meters in thickness around KBD-03 and KBD-09, but no overlying sediments are seen around KBD-08 and KBD-11 to KBD-16. This feature tells us that the sediments in the area deposited under the sedimentary environment of talus or fan. It is presumed that the area around KBD-01 to KBD-07 and KBD-09 to KBD-10 is in the watershed of the buried ancient river, and was under the coarse sands sedimentary environment. The sand and gravel layer, and sands layer consist of felsic sands and pebbles containing granite pebbles, but quite fewer amounts of colored minerals.

The assay result reveals that all elements assayed are generally low in grade, and the potential for ores is low. High rare earths and titanium anomaly zone is in the lower parts of KBD-09 and KBD-10, which are in the sand and gravel layer deposited in the ancient river of the Khlong Sai Deang (Fig. 5).

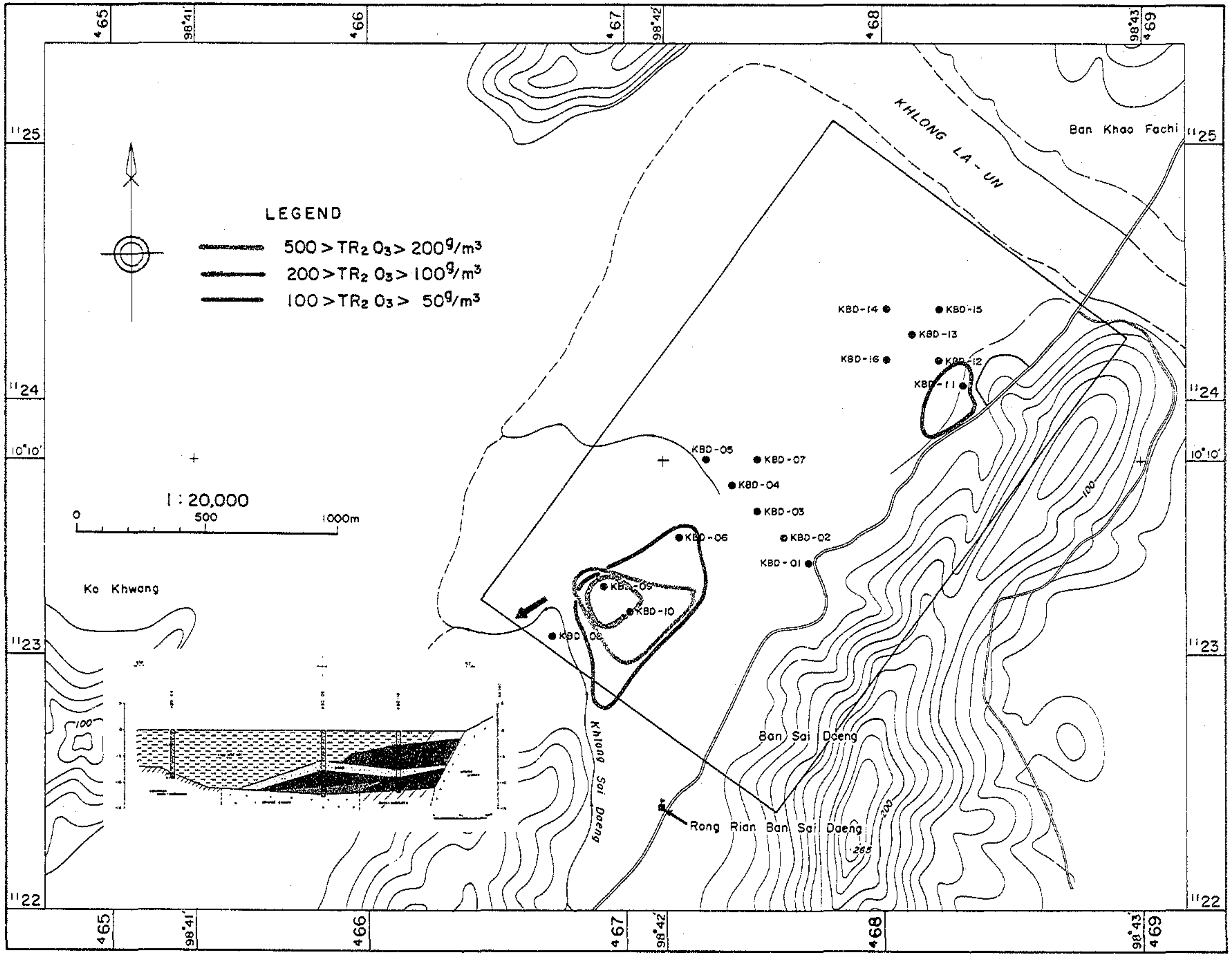


Fig. 5 Results of drilling survey in Area D-1

Chapter 5 Conclusion and Recommendation

5-1 Conclusion

This phase survey was planned to examine potential for secondary ores in the A-1 and D-1 areas, which were selected based on the second phase survey results. Pit and Banka drill surveys have been performed in the Area A-1, and a Banka drill survey in the Area D-1. The conclusions of this phase survey are as follows.

5-1-1 Area A-1

(1) Potential for secondary ores in talus weathering residual deposits and stream sediments has been expected in the Area A-1. The survey results have revealed that potential for secondary ores in stream sediments was high in this area.

(2) The areas evaluated as of high potential for secondary ores in talus weathering residual deposits based on the second phase survey results have been surveyed, and the assay results show that the grades of ores are one fifties to one thousands less than those in the second phase results. The differences between those are due to the different sample treatment methods. Actual mining grades would be close to this phase result.

(3) Tin concentrated zones in secondary ores are in the lower parts, and rare earths concentrated zones tend to situate above the tin zones. It possibly shows that timing of supply for tin and rare earths in the sedimentary basin are different.

(4) Content of rare earths is correlate to that of tritium, zirconium, titanium, niobium, and tantalum. The sedimentary basins along the Khlong Nam Khao contain much tantalum and niobium.

(5) Five potential zones for secondary ores are located in the Area A-1. The total probable ore reserves of the three zones along Khlong Nam Khao are 639,000 m^3, and the grades are as follows.

SnO_2	;	500 g/m^3
Ta_2O_5	;	10 g/m^3
Nb_2O_5	;	36 g/m^3
TR_2O_3	;	135 g/m^3
ThO_2	;	18 g/m^3
Zr_2O_3	;	23 g/m^3
TiO_2	;	1,025 g/m^3

The total probable ore reserves of the two zones in the western side are 146,000 m^3, and the grades are as follows.

SnO_2	;	1,000 g/m^3
Ta_2O_5	;	15 g/m^3
Nb_2O_5	;	24 g/m^3
TR_2O_3	;	50 g/m^3
ThO_2	;	6 g/m^3
Zr_2O_3	;	16 g/m^3
TiO_2	;	290 g/m^3

5-1-2 Area D-1

(1) The Area D-1 is dominantly underlain by mangrove soil, however preferable sedimentary basins for secondary ores were expected underneath the mangrove soil in the area. The survey results reveal that no significant sand and gravel layer exists in the area, and fewer amounts of useful minerals are contained in the sediments.

(2) Major parts of the sediments, except some areas around ancient river systems, in the area have deposited under the quiet reductional environment, and contain little amounts of coarse heavy minerals.

5-2 Recommendation for the Future Works

The secondary ores confirmed in the Area A-1 show significantly high contents of tin, accompanied by *tantalum, niobium, rare earths, titanium, and zirconium*. Even though the scale of the ore deposits is small, however, it is evaluated that the ores are of economical. The separation of drill holes was too large to precisely evaluate the ores, therefore it is recommended that further detailed surveys are performed before the final decision for development. Furthermore, it should be reminded that the area is utilizing for agriculture, and economical compensation will be required for development of mining. Total economical tradeoff consideration is necessary.

Through the three phase programs, secondary ores containing not only tin but also rare earths have been the main target because of low tin market price. Speaking of tin, the old mining site in the watershed of the Khlong Kum, southern Kra Buri area, has the highest potential, and the upper stream area of the Khlong Lam Leang has high potential for primary ores. It is recommended further exploration activities to evaluate ore deposits in this area.

PART II DETAILED DESCRIPTION

Chapter 1 Area A-1, Pit and Drilling Survey

1-1 Selection of Location

The pit and drilling surveys have been conducted to confirm its reserves and grades of expected ores in the zones selected by the second phase programs. The second phase programs consisted of soil geochemical survey and revealed that there existed potential for promising secondary ores in several zones.

The Area A-1 is situated in the inner mountain alluvial basin along the valley of the Khlong Nam Khao. *Geochemical anomalies consisting of tin and rare earths are distributed in four zones, northern,* central, southwestern, and southeastern parts of the area. These anomalies are corresponding to the distribution of talus deposits brought from granite terrains in the western area and river sediments along the Khlong Nam Khao and its tributaries.

The northern geochemical anomaly zone consists of R-1-1, S-2, and R-1- 2, which spread over a large area along the Khlong Nam Khao. The anomalies are of rare earths, but of rare earths and tin at the central part. The zone is mostly underlain by colluvial and redepositional residual sediments derived from the granites distributing to the west. It was expected potential for weathered residual ores and secondary ores in river beds along Khlong Nam Khao.

The northern geochemical anomaly zone consists of R-2 and S-2, which are distributed in a fan shape along the tributaries of the Khlong Nam Khao, surrounded by small hills being composed of the Matri Formation of the Carboniferous. The anomaly is of tin and rare earths. It was expected potential for secondary ores in river beds.

The southwestern geochemical anomaly zone consists of S-3 and R-4. The former is of tin, and situated in a large area along the tributaries of the Khlong Nam Khao, in the same geological situation as the central anomaly zone. The latter is of rare earths, and distributed in a small area in the upper stream area of a tributary of the Khlong Nam Khao. The main target in this zone is secondary ores in river beds for tin.

The southeastern geochemical anomaly zone consists of R-4, which is coincident with the distribution of the stream sediments along the Khlong Nam Khao. The anomaly is of rare earths. It is expected potential for secondary ores.

The pit survey program has been initially performed for the potential zones of secondary ores in this year, afterwards the drilling program using the Banka drill method has been conducted in the selected promising zones along the Khlong Nam Khao. Each survey site is shown in Fig. 6.

The pits were principally planned to dig 1.5 x 1.5 meters in size and 4 meters in depth to reach basement rocks, but some pits were unable to reach basement rocks because of underground water or boulders exceeding 1 meter in size. Some pits are 3 meters in depth. The number of pits dug in the area is 14, and total depth is 44.5 meters.

The Banka drilling was planned to confirm ores at 15 sites around promising pits. All holes have reached to basement rocks. The total depth of the holes is 74.7 meters.

Sketching of all walls, 1:25 in scale, has been done after completion of the pits. Then, 50 centimeters long channel sampling has been performed due to their geological conditions, and collected samples have been panned to separate heavy minerals, which have been chemically assayed and made polished sections for microscopic observation.

Columnar sections, 1:50 in scale, have been made for all length of the drill holes by geological observation for each core tube section. Samples for every 1.5 meters section have been collected, and measured their volume and weight. These samples have been panned to separate heavy minerals, which have been chemically assayed.

1-2 Geology of Pits and Drill Holes

1-2-1 Northern Geochemical Anomaly Zone (1)

The pit survey has revealed that R-1-1 and S-1 were in talus deposits derived from granites and R-1-2 was corresponding with distribution of the river bed sediments along the Khlong Nam Khao. Only the pit survey has been performed in R-1-1 and S-1, on the other hand the pit and drill surveys have been conducted in R-1-2, depending on their geological conditions. Survey results for those two conditions are separately described in two sections, Northern Geochemical Anomaly Zone (1) and (2).

The section (1) describes survey results of the six pits, KBA-P01, P02, P03, P04, P05, and P11, total depth of 20 meters. Geologic profiles in this zone are shown in Figure 7 (A)-(C).

A − 1

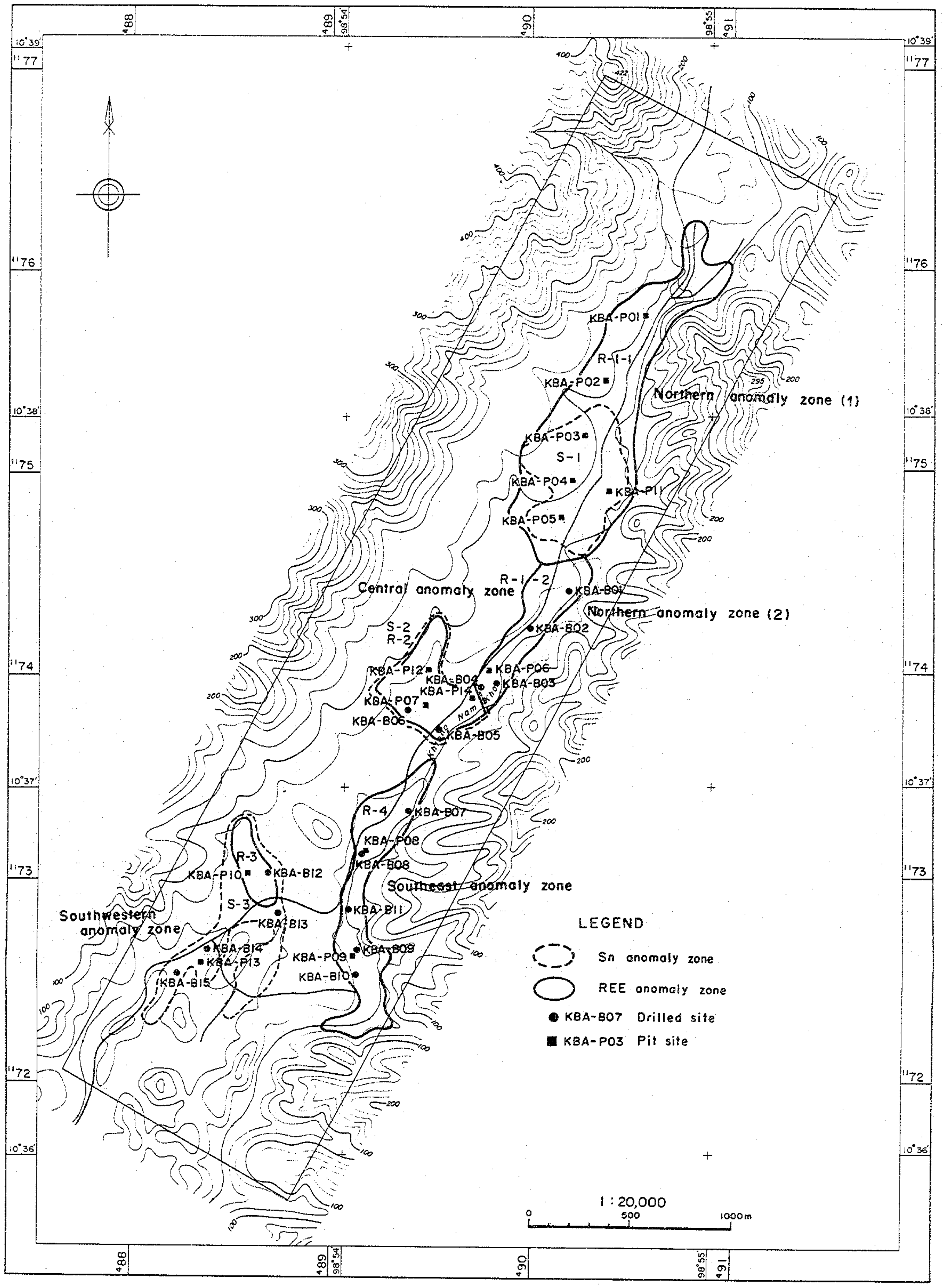


Fig. 6 Locality map of pit and drilling survey in Area A-1

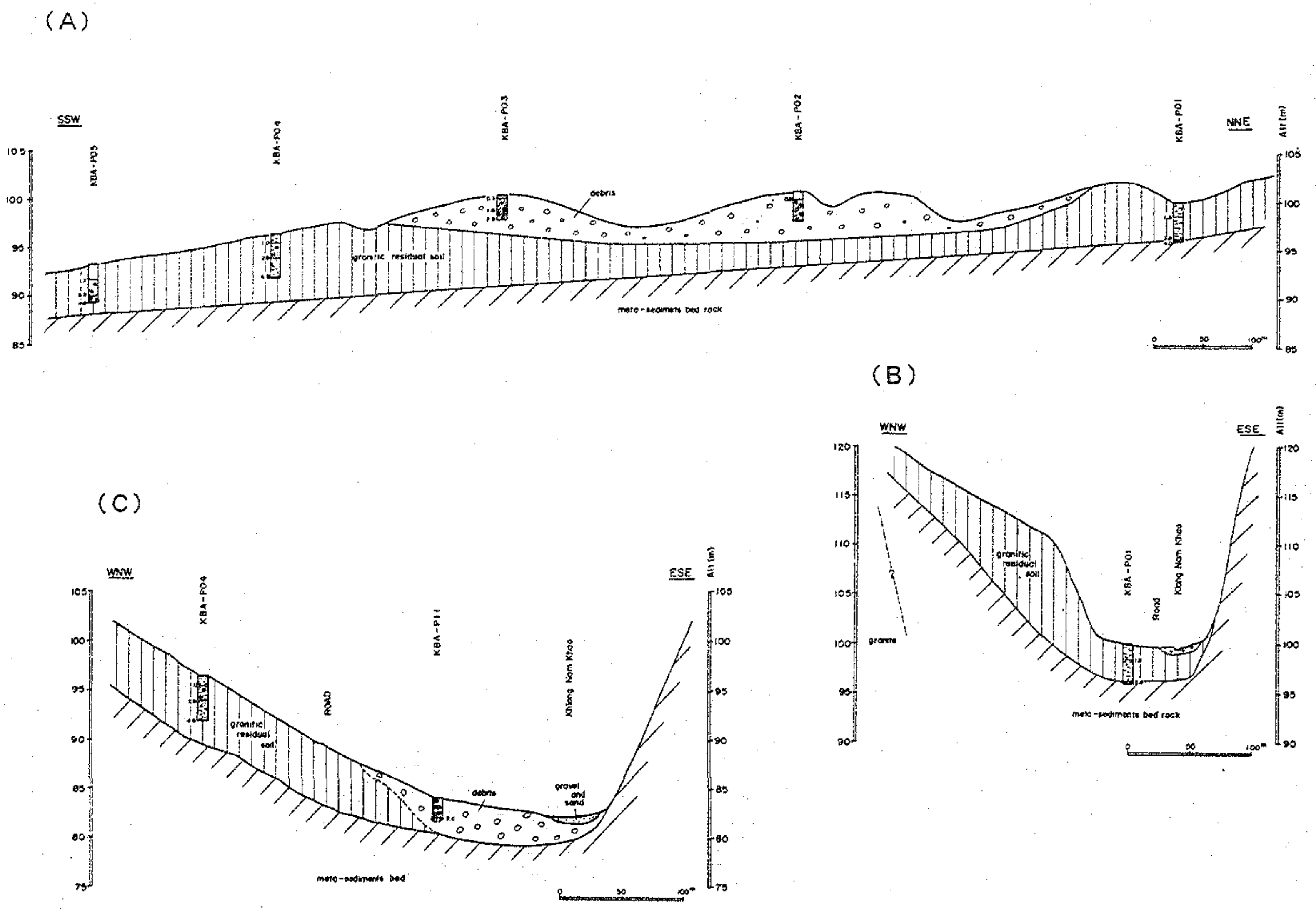


Fig. 7 Geologic profile in Northern geochemical anomaly zone (1)

(1) KBA-P01; depth 4.0 m, El. 100 m

The pits of KBA-P01, P02, P03 were planned to confirm geological setting and to evaluate the potential of secondary ores in the northern half of R-1-1 anomaly area.

From the top to the bottom, unconsolidated sands, colluvium and redepositional residual soil derived from granites, and weathered mudstone (basement rock) are seen in the pit.

The unconsolidated sands are seen at the top 0.2 meter section, and consist of reddish brown coarse grained granitic sand fragments.

The colluvial and redepositional residual soil consisting of granitic materials are seen at the depth between 0.2 and 3.8 meters, and 10 centimeters thick of the uppermost part consists of black organic silts containing coarse sands. The part at the depth from 0.3 to 0.6 meters consists of dark brown silts containing fine grained sands. These two parts correspond to the A soil zone.

The part at the depth from 0.6 to 1.5 meters consists of brown granitic coarse sands containing granitic pebbles, 10 to 20 millimeters in diameter.

The part at the depth from 1.5 to 3.8 meters consists of reddish brown to orange granitic soils and sand layer, containing pebbles, cobbles and boulders of granite, aplite, quartz, etc. The granitic boulders are soft because of weathering, and easily collapsed by hammers. The pebbles, cobbles and boulders of this layer are sub-angular in shape, and the matrix of the layer contains large amounts of granitic coarse sands, therefore it is judged that this layer is of colluvial.

The mudstone of the basement is whitish to gray argillaceous meta- sediment, not containing quartz grains.

Water sprigs out from the boundary between the basement and colluvial layers at the rate of 5 litters per minute.

The assay results of this pit show as follows.

SnO_2	; 0.3 to 2.9 g/m^3
TR_2O_3	; 3.7 to 56.5 g/m^3
ThO_2	; 0.5 to 8.8 g/m^3
Zr_2O_3	; 1.3 to 10.8 g/m^3
TiO_2	; 33.8 to 575.2 g/m^3

Tin is concentrated at the bottom of the pit. On the other hand other elements are concentrated at the depth between 1.0 and 1.5 meters.

(2) KBA-P02; depth 3.0 m, El. 101 m

The upper part of this pit consists of coarse sands containing pebbles, and the lower part consists of granite boulders.

The part from the surface to the depth of 0.8 meters consists of granitic coarse sands containing brown silt and small amount of fresh hard granite cobbles.

The part at the depth 0.8 meters to the bottom consists of conglomerate containing fresh hard granite boulders, and the matrix of the conglomerate consists of silts and granitic coarse sands. The granite boulders are angular to sub-angular, 1.5 meters in diameter of the largest. Almost no sorting and grading are seen in the layer.

Some amount of ilmenite and zircon, but small amount of cassiterite, are seen in the panned samples. The assay results of this pit are as follows.

SnO_2	;	0.6 g/m^3 or less
TR_2O_3	;	29.0 g/m^3 or less
Zr_2O_3	;	0.9 to 6.7 g/m^3
TiO_2	;	20 to 138 g/m^3

The lowest part of the pit shows the lowest values in almost all elements except tin, and the other part shows almost flat value distribution.

(3) KBA-P03; depth 2.5 m, El. 100.5 m

The layers of this pit are divided into three.

The upper part from the surface to the depth of 0.3 meters consists of dark reddish brown silt and fine sands.

The middle part at the depth from 0.3 to 1.6 meters consists of dark brown clay and sandy clay, containing round granite pebbles, which are weathered and softened, 30 per cent at the rate of volume. The pebbles are 5 to 30 centimeters in diameter.

The lower part at the depth from 1.6 to 2.3 meters consists of compact conglomerate containing angular to sub-angular pebbles, larger than 6 centimeters in diameter. Twenty centimeters of the bottom part consists of granite boulders, 1 to 2 meters in diameter. Digging had to be given up at the bottom. Almost all boulders are weathered in some grade, and about a half of them are strongly weathered and softened.

The assay results of this pit are as follows.

SnO_2	;	0.3 g/m^3 or less
TR_2O_3	;	25.0 g/m^3 or less
Zr_2O_3	;	1.1 to 5.7 g/m^3
TiO_2	;	24 to 167 g/m^3

The uppermost part shows the best values.

(4) KBA-P04; depth 4.5 m, El. 96.5 m

This pit was planed at the site showing duplicated tin and rare earths anomalies, as well as the case of KBA-P05.

The pit is geologically divided into five zones.

The uppermost zone from the surface to the depth of 0.3 meters consists of dark sandy silt and sandy clay, containing humified plants. This zone is correlated with the A soil zone.

The second zone at the depth from 0.3 to 1.0 meters consists of reddish brown to brown sandy silt and sandy clay, as same as the uppermost zone except humified plants.

The third zone at the depth from 1.0 to 2.5 meters consists of reddish brown silt and fine sands, containing strongly weathered and softened granite cobbles and boulders, 5 to 50 centimeters in diameter. The contact boundary between the boulders and matrix is usually unclear, sometimes appears gradual changes.

The fourth zone at the depth from 2.5 to 3.8 meters consists of reddish brown to brown sandy silt containing large amounts of granitic coarse sand and granules. Some parts apparently remain original granitic texture.

The bottom part from the depth of 3.8 meters to the bottom consists of sandy silt showing mixture of brownish parts and bluish parts, containing large amounts of granitic coarse sands. It is judged that this zone is of weathered colluvium because of the grade of roundness and distribution of the boulders. On the other hand there remains other possibility that this zone is of in site weathered granite because of high solidarity and well remained granitic texture.

Water springs out from the boundary between the fourth zone and bottom zone at the depth 3.8 meters, at the rate of 5 to 10 litters per minute.

The assay results of this pit are as follows.

SnO_2	;	0.8 g/m^3 or less

TR_2O_3	; 40.0 g/m^3 or less
Zr_2O_3	; 2.2 to 6.8 g/m^3
TiO_2	; 110 to 381 g/m^3

The uppermost zone shows the highest values. However difference from those of other zones is small. The results of mode analysis using polished sections show very little difference in the constituents throughout pit sections.

(5) KBA-P05; depth 4.0 m, El. 93.3 m

The surface 10 centimeters thick is covered by black humic soil and silt.

From the depth of 10 centimeters, this pit is geologically divided into three zones.

The uppermost zone at the depth from 0.1 to 1.7 meters consists of reddish brown to orange sands mixed with silt, containing small amounts of strongly weathered granite pebbles, 2 to 5 centimeters in diameter. A layer of hard granite pebbles, 3 to 5 centimeters in diameter, is intercalated at the depth 0.5 meters.

The middle zone at the depth from 1.7 to 3.3 meters consists of gray to pale gray medium to coarse granitic sands containing small amounts of strongly weathered granite pebbles. Quartz, feldspar, and tourmaline crystals are seen in the matrix, and white clay is also contained. Two hard granite boulders appeared at the uppermost of this zone.

The bottom zone from the depth 3.3 meters to the bottom consists of white to pale brown sands and gravel, consolidated in some degree. The gravels are of argillaceous granites, tourmaline-quartz veins, and various kinds of rocks. The matrix is composed of quartz, feldspar, tourmaline, etc, and large amounts of white clay, presumably kaolin are contained.

Water springs out from the depth of 3.4 meters to the bottom in the wall.

The assay results of this pit are as follows.

SnO_2	; 0.7 to 3.1 g/m^3
TR_2O_3	; 34.0 g/m^3 or less
ThO_2	; 2.0 to 3.3 g/m^3
Zr_2O_3	; 4.1 to 9.2 g/m^3
TiO_2	; 126 to 263 g/m^3

This pit shows relatively high values in the all components compared with other pits in the northern geochemical anomaly zone (1). No vertical grade change is seen in this pit.

(6) KBA-P11; depth 2.0 m, El. 84 m

This pit was planned for confirming geological setting and the potential of secondary ores at the site duplicated tin and rare earth anomalies along Khlong Nam Khao.

The area around this pit is underlain by boulders of granites and meta-sedimentary rocks. Digging of the pit had to be given up at the depth of 1 meter because of a big boulder, more than 1.5 meters in diameter, at the bottom. The site was moved about 10 meters from the initial site, however the pit also encountered a big boulder, and digging was given up at the depth of 2 meters.

Pebbles and boulders of granites and meta-sedimentary rock are seen in the pit. A small amount of matrix is filled between those boulders from the surface to the depth of 1.5 meters, but very little amount of matrix is seen in the lower part from the depth of 1.5 meters.

Volume of heavy minerals is little in the pit because of a little matrix. The assay results show generally low values, however ThO_2 and U_2O_3 show a little higher value than those of other pits.

1-2-2 Northern Geochemical Anomaly Zone (2)

This zone was selected for the third phase survey because of its rare earths anomaly named R-1-2, which was apparently a part of the northern anomaly zone. This phase survey results, however, have revealed that the anomaly represents the distribution of river bed sediments, on the other hand the anomalies in the northern geochemical anomaly zone (1) represent the distribution of talus deposits. Gravel bed in the stream sediments, accordingly, is the object for the further exploration activity, different from those in the northern anomaly zone (1).

Two pits, KBA-P06 and KBA-P14, have been dug, and four drill holes, KBA-B01, -B02, -B03, and -B04, have been drilled in the zone this year. Geologic profile in this area is shown in Figure 8 (D).

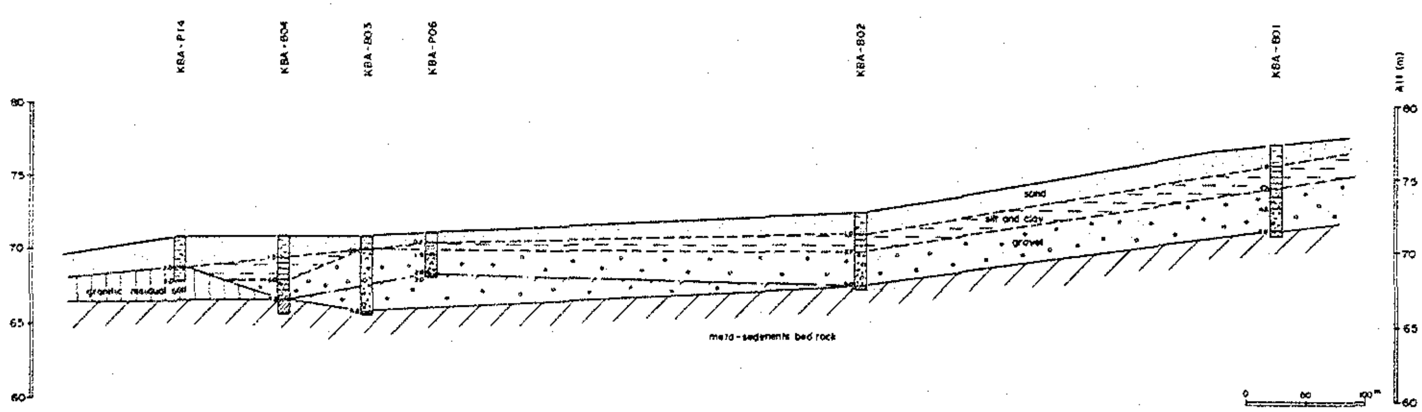
(1) KBA-B01; depth 5.8 m, El. 77.4 m

This hole was planed for confirming geological and geochemical setting in the north part of R-1-2, as well as the case of KBA-B02.

It has been confirmed that the alluvial sediments in this hole were divided into four layers, and the basement rocks consisting of gray shale were seen below the depth of 5.8 meters.

The uppermost part from the surface to the depth of 1.5 meters consists of brown silty soil mixed with medium sands.

(D)



(E)

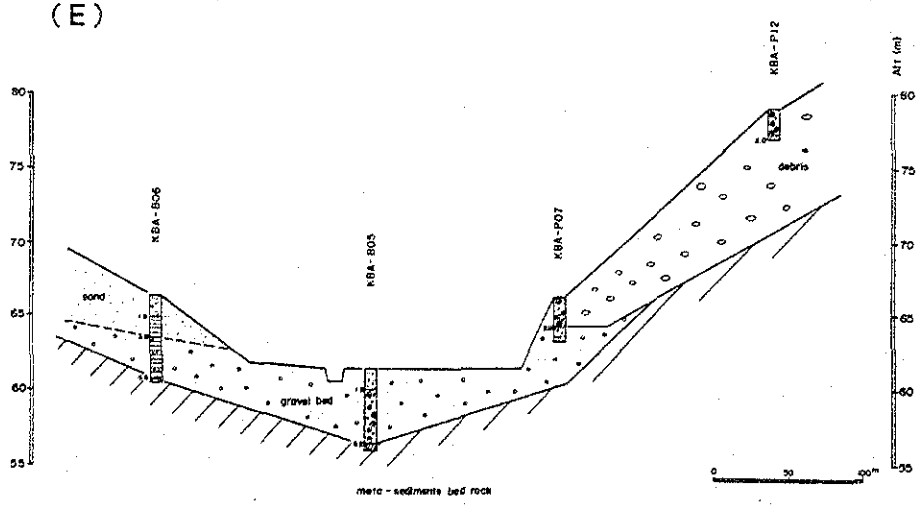


Fig. 8 Geologic profile in Northern (2) and Central geochemical anomaly zone

The second part at the depth from 1.5 to 3.0 meters consists of brown clay mixed with silt and medium sands. This part contains much more white clay than the upper most part.

The third part at the depth from 3.0 to 4.3 meters consists of brownish gray semi-consolidated clay containing coarse granitic sands, and pebbles of granite and meta-sedimentary rocks.

The fourth part at the depth from 4.3 to 5.8 meters is a sand-gravel layer consisting of rounded granules and pebbles of granite, quartz vein, mete-sandstone, meta-shale, etc. and contains many amounts of heavy minerals.

The assay results of the hole are as follows.

in the silt and clay zone

SnO_2	; 0.9 to 3.6 g/m^3
TR_2O_3	; 18.0 to 36.0 g/m^3
ThO_2	; 2.2 to 3.9 g/m^3
Zr_2O_3	; 4.7 to 8.1 g/m^3
TiO_2	; 115 to 339 g/m^3

in the sand and gravel zone

SnO_2	; 64.0 g/m^3
TR_2O_3	; 97.0 g/m^3
ThO_2	; 10.9 g/m^3
Zr_2O_3	; 12.6 g/m^3
TiO_2	; 1132 g/m^3

The elements are concentrated in the sand and gravel zone

(2) KBA-B02; depth 5.5 m, El. 73.7 m

It has been confirmed that the alluvial sediments in this hole were divided into three layers, and the basement rocks consisting of greenish gray shale were seen below the depth of 5 meters.

The uppermost part from the surface to the depth of 1.5 meters consists of brown silty soil mixed with medium sands.

The second part at the depth from 1.5 to 2.7 meters consists of gray clay mixed with silt and medium sands.

The third part at the depth from 2.7 to 5.0 meters is a sand and gravel layer consisting of rounded granules and pebbles of granite, quartz vein, meta-sandstone, meta-sedimentary rocks, etc. and contains many amounts of heavy minerals.

No semi-consolidated clay layer seen in the B01 hole is seen in this hole.

The assay results of the hole are as follows.

in the silt and clay zone

SnO_2	;	0.8 to 0.9 g/m^3
TR_2O_3	;	26.0 to 28.0 g/m^3
ThO_2	;	3.2 to 3.4 g/m^3
Zr_2O_3	;	5.6 to 7.2 g/m^3
TiO_2	;	109 to 113 g/m^3

in the sand and gravel zone

SnO_2	;	20.0 to 46.0 g/m^3
TR_2O_3	;	68.0 to 77.0 g/m^3
ThO_2	;	8.4 to 9.2 g/m^3
Zr_2O_3	;	10.8 to 12.2 g/m^3
TiO_2	;	751 to 847 g/m^3

(3) KBA-B03; depth 5.2 m, El. 71 m

This hole was planed for confirming geological and geochemical condition at the center of alluvial basin, because we could not confirm the bottom of basin at KBA-P06.

It has been confirmed that the alluvial sediments in this hole were divided into two layers, and the basement rocks consisting of gray shale were seen below the depth of 5.2 meters.

The uppermost part from the surface to the depth of 0.9 meters consists of brown silty soil containing fine sands.

The second part at the depth from 0.9 to 5.2 meters is a white coarse sand and gravel layer containing rounded pebbles and cobbles of granite, tourmaline quartz vein, meta-sedimentary rocks, 5 to 20 centimeters in diameter. The basal part is composed of very course sands containing much amounts of colored minerals. This sand and gravel layer is thickest in this hole. No clayey middle layer has been seen in this hole.

The assay results of the sand and gravel layer of this hole are as follows.

SnO_2	;	137 to 202 g/m^3
Ta_2O_5	;	4.0 to 11.0 g/m^3
Nb_2O_5	;	18.0 to 44.0 g/m^3
TR_2O_3	;	55.0 to 180 g/m^3
ThO_2	;	6.4 to 27.2 g/m^3
Zr_2O_3	;	5.5 to 25.8 g/m^3
TiO_2	;	603 to 1521 g/m^3

The values are extensively high in this hole. The tin contents show the highest in the middle of the layer, on the other hand rare earths, niobium, tantalum, and titanium are high in the upper part, and grading down to the bottom.

4) KBA-B04; depth 4.3 m, El. 71.2 m

This hole was planed to check southern boundary of this alluvial basin.

It has been confirmed that the alluvial sediments in this hole were divided into three layers, and the basement rocks consisting of brownish gray weathered shale were seen below the depth of 4.3 meters.

The uppermost part from the surface to the depth of 1.5 meters consists of brown silty soil containing fine sands.

The second part at the depth from 1.5 to 3.0 meters consists of gray hard clay containing fine to medium sands.

The third part at the depth from 3.0 to 4.7 meters consists of coarse granitic sands and brownish gray semi-consolidated clay containing fragments of granite and meta-sedimentary rocks. This layer is similar to the third layer of KBA-B01.

The assay results of this hole are as follows.

SnO_2	; 3.6 to 50.0 g/m^3
TR_2O_3	; 13.0 to 35.0 g/m^3
ThO_2	; 1.6 to 24.3 g/m^3
Zr_2O_3	; 3.8 to 7.7 g/m^3
TiO_2	; 70 to 152 g/m^3

The value of tin is highest in the lowermost clay layer, and rare earths, titanium, etc. are high in the first layer.

(5) KBA-P06; depth 3.0 m, El. 71.3 m

This pit was planed at R-1-2 anomaly area for confirming geological and geochemical condition.

It has been confirmed that the alluvial sediments in this hole were divided into three layers, and the basement rocks consisting of white to pale gray weathered paraschist were seen at the bottom 20 centimeters thick.

The first part from the surface to the depth of 0.7 meters consists of reddish brown to pale brown, medium to coarse felsic sands containing small amounts of silt.

The second part at the depth from 0.7 to 1.5 meters consists of medium sands containing much amounts of white clay. Main constituents of the sands are quartz, feldspar, tourmaline, ilmenite, etc. A small amount of water springs out at the depth of 1 meter.

The third part at the depth from 1.5 to 2.8 meters is a white sand and gravel layer consisting of pebbles of granite, quartz vein, aplite, and meta-sedimentary rocks, 3 to 20 centimeters in diameter, and felsic coarse sands. The pebbles are relatively concentrated at the top part, and scattered at the bottom part. The distribution of colored minerals is apparently concentrated at the top rather than the bottom. Water springs out 200 to 300 litters per minute from this layer. The groundwater table after drilling is 50 centimeters from the surface.

The assay results of this pit are as follows.

in the upper two zones	
SnO_2	; 0.6 to 0.9 g/m^3
TR_2O_3	; 13.0 to 30.0 g/m^3
ThO_2	; 1.6 to 4.2 g/m^3
Zr_2O_3	; 3.6 to 9.8 g/m^3
TiO_2	; 52 to 182 g/m^3
in the sand and gravel layer	
SnO_2	; 4.2 to 80.1 g/m^3
TR_2O_3	; 50.0 to 203 g/m^3
ThO_2	; 6.4 to 24.8 g/m^3
Zr_2O_3	; 7.3 to 34.3 g/m^3
TiO_2	; 555 to 2089 g/m^3

The lower sand and gravel layer contains ten to hundred times more many minerals than the upper two zones. Nb, Ta, and U are also concentrated in the sand and gravel layer about ten times more than the upper two zones. Three samples for assaying have been collected from the sand and gravel layer, and the sample from the depth among 2.0 to 2.5 meters shows the highest Sn value, 80 g/m^3. The sample from the bottom shows still high value, 43 g/m^3, however the sample from the top shows the highest in the other elements.

(6) KBA-P14; depth 3.0 m, El. 70.9 m

The pit was planed to confirm geological condition between R-1-2 anomaly zone and Central anomaly zone (R-2,S-2).

It has been confirmed that the alluvial sediments in this pit were divided into two zones, other than the surface soil.

The upper part from the surface to the depth of 2.0 meters consists of pale brown to reddish brown sandy silt containing coarse granitic sands except in the upper 10 centimeters surface soil.

The lower part from the depth of 2.0 meters to the bottom consists of bluish gray, partly brown, very solid silty sands mixed with pebbles. Pebbles of granite and aplite, 10 to 20 centimeters in diameter, are significantly concentrated at the top. This part apparently looks redepositional residual talus deposits, however it is judged as in-site weathered granite because of its quite homogeneous matrix.

The assay results of this pit are as follows.

in the upper zone

SnO_2	;	2.3 to 3.0 g/m^3
TR_2O_3	;	14.0 to 21.0 g/m^3
ThO_2	;	1.4 to 3.9 g/m^3
Zr_2O_3	;	2.8 to 5.6 g/m^3
TiO_2	;	115 to 218 g/m^3

in the lower zone

SnO_2	;	0.7 to 1.2 g/m^3
Ta_2O_5	;	5.2 to 20.5 g/m^3
Nb_2O_5	;	18.0 to 68.0 g/m^3
TR_2O_3	;	9.0 to 15.0 g/m^3
ThO_2	;	1.1 to 1.2 g/m^3
Zr_2O_3	;	2.2 to 2.4 g/m^3
TiO_2	;	57 to 64 g/m^3

The upper zone shows higher values than the lower zone in all elements except Zr_2O_3.

1-2-3 Central Geochemical Anomaly Zone

This zone is distributed in a tributary of the Khlong Nam Khao in a shape of fan, consisting of duplication of tin and rare earths anomalies. The second phase survey revealed that this zone was underlain by coarse felsic sands on the surface, therefore the potential for secondary ores in river bed gravel along the tributary was evaluated.

Two pits, KBA-P07 and KBA-P12, and two drill holes, KBA-B05 and KBA- P12, have been completed in this zone. Geologic profile is shown in Figure 8 (E).

(1) KBA-P07; depth 3.0 m, El. 66.6m

This pit was planed for confirming geological and geochemical condition at the site showing duplicated tin and rare earths anomalies.

It has been confirmed that this pit was geologically divided into three layers.

The top part from the surface to the depth of 0.3 meters consists of pale gray fine to medium silty sands containing much amounts of quartz grains.

The second part at the depth from 0.3 to 2.0 meters consists of huge granite boulders. The top of this part at the depth from 0.3 to 1.0 meter consists of more than 70 per cent of fresh granite boulders, which are larger than 1 meter in diameter and show subangular to angular shape. The matrix consists of silt containing coarse sands. The bottom of this part at the depth from 1.0 to 2.0 meters consists of smaller and fewer amounts of boulders, which are subjected to weathering, and subrounded to subangular in shape.

The third part at the depth from 2.0 to 3.0 meters is a pale brown sand and gravel layer containing rounded granules and pebbles, 2 to 25 centimeters in diameter. The matrix consists of medium to coarse felsic sands, containing certain amounts of colored minerals.

Water sprigs out at the depth of 2.20 meters at the rate of less than 10 litters per minute.

The assay results of the pit are as follows.

in the top zone

SnO_2	;	2.0 g/m^3
TR_2O_3	;	35.0 g/m^3
ThO_2	;	5.0 g/m^3
Zr_2O_3	;	9.0 g/m^3
TiO_2	;	173 g/m^3

in the middle zone

SnO_2	;	1.6 to 4.0 g/m^3
TR_2O_3	;	15.0 to 16.0 g/m^3
ThO_2	;	1.8 to 2.2 g/m^3
Zr_2O_3	;	3.2 to 3.9 g/m^3
TiO_2	;	71 to 104 g/m^3

in the bottom zone

SnO_2	;	5.0 to 17.0 g/m^3
TR_2O_3	;	50.0 to 88.0 g/m^3
ThO_2	;	5.9 to 11.8 g/m^3
Zr_2O_3	;	8.1 to 21.0 g/m^3
TiO_2	;	300 to 499 g/m^3

The bottom zone shows the highest values in all elements, and the middle zone shows the lowest.

(2) KBA-P12; depth 2.0 m, El. 79.1m

This pit was planed for confirming geological and geochemical condition at the northern part of this anomaly zone.

It has been confirmed that this pit was in a dark brown gravel bed except soil part at the top. The gravel consists of 70 to 80 per cent of granite pebbles showing subangular to subrounded, 3 to 60 centimeters in diameter. About one half of the granite pebbles are subjected to the weathering and softened, and the pebbles at the upper part are mostly of altered. The matrix consists of silty sands and coarse felsic sands.

The assay results of this pit are as follows.

in the top zone including the surface soil

SnO_2 ; 2.0 g/m^3
TR_2O_3 ; 24.0 g/m^3
ThO_2 ; 3.4 g/m^3
Zr_2O_3 ; 6.3 g/m^3
TiO_2 ; 158 g/m^3

in the bottom zone

SnO_2 ; 0.7 to 0.7 g/m^3
TR_2O_3 ; 6.0 to 7.0 g/m^3
ThO_2 ; 0.6 to 1.0 g/m^3
Zr_2O_3 ; 0.8 to 1.5 g/m^3
TiO_2 ; 19 to 53 g/m^3

(3) KBA-B05; depth 5.2 m, El. 61.9m

This hole was planed to confirm geological and geochemical condition at the center of alluvial basin of this anomaly zone.

It has been confirmed that the alluvial sediments in this hole were divided into two zones, and the basement rocks consisting of greenish gray weathered shale were seen below the depth of 5.2 meters.

The top zone from the surface to the depth of 1.5 meters consists of brown silty soil containing coarse sands and rock fragments.

The bottom zone from the depth of 1.5 meters to the bottom is a sand and gravel layer containing rounded granules and pebbles of granite, quartz vein, meta-sandstone, meta-shale, etc., and many amounts of heavy minerals.

The assay results of this hole were as follows.

in the sand and gravel zone

SnO_2 ; 27, 1557, 1956 g/m^3
Ta_2O_5 ; 10.5 to 11.1 g/m^3
Nb_2O_5 ; 28.1 to 38.0 g/m^3
TR_2O_3 ; 62 to 124 g/m^3
ThO_2 ; 8.4 to 16.6 g/m^3
Zr_2O_3 ; 12.4 to 19.0 g/m^3
TiO_2 ; 368 to 824 g/m^3

The lower part of the sand and gravel zone has a high concentration of tin. The contents of rare earths, niobium, and uranium minerals tend to grade down from the top to the bottom.

(4) KBA-B06; depth 5.6 m, El. 61.3m

This hole was planed for checking geological condition at the western part of this anomaly zone.

It has been confirmed that this hole was geologically divided into three zones, and the basement rocks consisting of brownish gray weathered shale were seen below the depth of 5.6 meters.

The top zone from the surface to the depth of 1.5 meters consists of brown silty soil containing coarse sands and small amounts of rock fragments.

The second zone at the depth from 1.5 to 3.0 meters consists of brownish gray consolidated hard clay containing fine sands and red lateritic soil.

The third zone at the depth from 3.0 to 5.6 meters consists of brownish gray consolidated hard clay containing coarse sands, rock fragments, and lateritic soil.

No sand and gravel layer is seen in this hole. Redepositional talus deposits presumably exists to the south of the tributary. The alluvium of this hole is presumably of weathered residual material, therefore no significant mineral content is seen.

The assay results of the hole were as follows.

in the silt and clay zone

SnO_2	;	2.0 to 30.0 g/m^3
TR_2O_3	;	10.0 to 16.0 g/m^3
ThO_2	;	1.2 to 1.9 g/m^3
Zr_2O_3	;	3.9 to 6.5 g/m^3
TiO_2	;	80 to 243 g/m^3

1-2-4 Southeastern Geochemical Anomaly Zone

This zone is a rare earths anomaly zone corresponding with the distribution of alluvial deposits along the Khlong Nam Khao, and secondary ores in the river bed sediments are expected.

Two pits, KBA-P08 and KBA-P09, and five drill holes, KBA-B07, KBA-B08, KBA-B09, KBA-B10, and KBA-B11 have been completed in this zone. Geologic profile in this zone is shown in Figure 9 (F).

(1) KBA-B07; depth 4.0 m, EL. 58.1 m

This hole was planed to check geological and geochemical condition at the northern part of southeastern anomaly zone.

It has been confirmed that the alluvium in this hole was divided into two layers, and the basement rock consisting of weathered gray shale was seen at the bottom.

The upper part from the surface to the depth of 1.5 meters consists of brown silty soil containing coarse sands.

The lower part from the depth of 1.5 meters to the bottom, 4.0 meters in depth, is a sand and gravel layer containing much amounts of rounded granules and pebbles of granite, quartz vein, meta-sandstone,

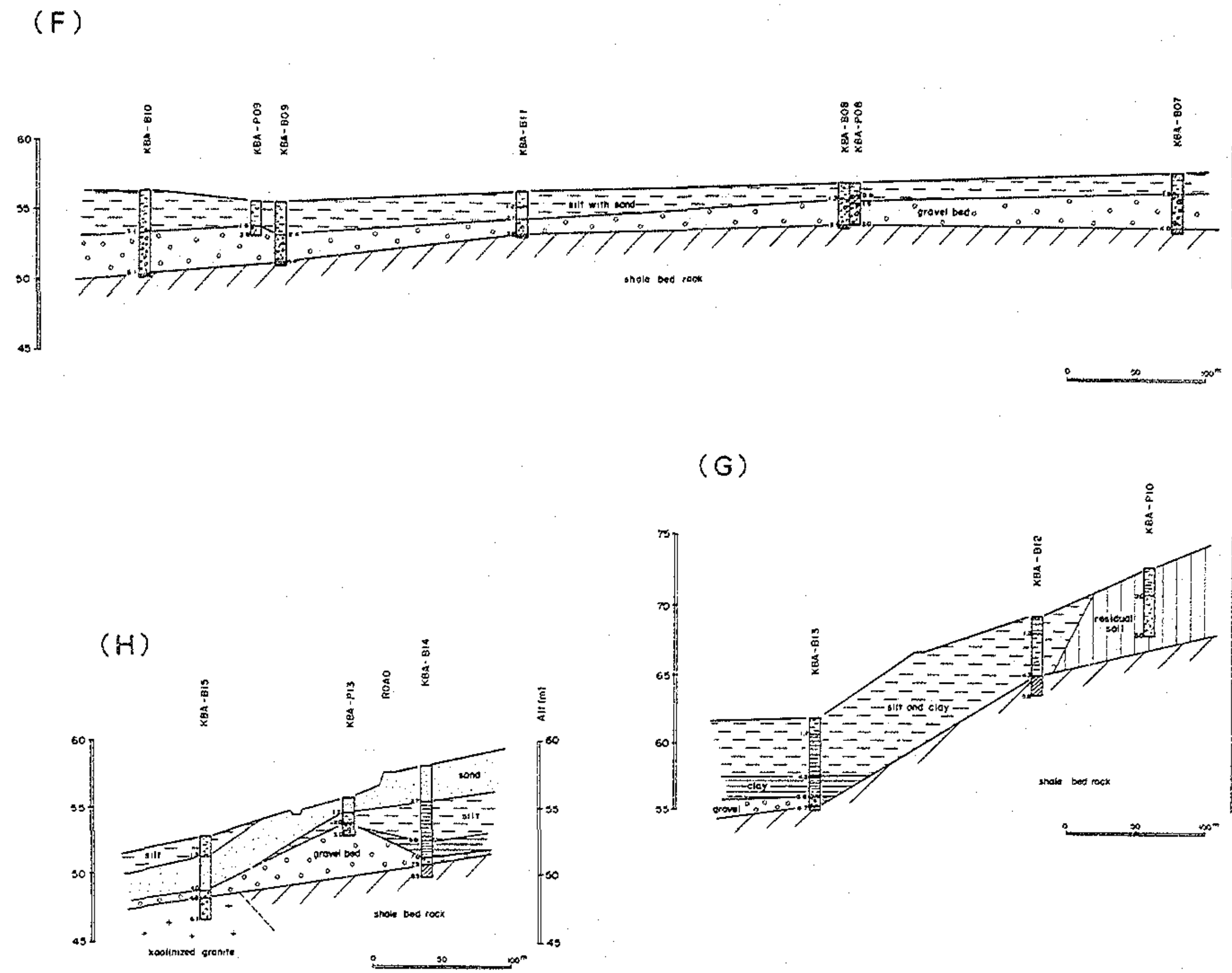


Fig. 9 Geologic profile in Southeastern and Southwestern geochemical anomaly zone

meta-shale, etc. and heavy minerals.

The assay results of this hole are as follows.

in the silt zone

SnO_2	;	3.9 g/m^3
TR_2O_3	;	27.0 g/m^3
ThO_2	;	3.4 g/m^3
Zr_2O_3	;	6.0 g/m^3
TiO_2	;	139 g/m^3

in the sand and gravel zone

SnO_2	;	108 to 362 g/m^3
Ta_2O_5	;	5.2 to 20.5 g/m^3
Nb_2O_5	;	18.0 to 68.0 g/m^3
TR_2O_3	;	55 to 244 g/m^3
ThO_2	;	6.5 to 29.4 g/m^3
Zr_2O_3	;	7.7 to 38.7 g/m^3
TiO_2	;	561 to 2525 g/m^3

The lower sand and gravel part shows high values for many elements, and the upper silty part contains heavy minerals at same grade as the case of weathered residual materials of granite.

(2) KBA-B08; depth 3.1 m, El. 57.2 m

This hole was additionally planed near KBA-08 for confirming the bottom of alluvial basin.

It has been confirmed that the alluvium in this hole was divided into two parts, and the basement rocks consisting of weathered gray shale were seen at the bottom.

The upper part from the surface to the depth of 1.2 meters consists of brown silty soil containing coarse sands.

The lower part from the depth of 1.2 meters to the bottom, 3.1 meters in depth, is a sand and gravel zone containing much amounts of rounded granules and pebbles of granite, quartz vein, meta-sandstone, meta-shale, etc., and heavy minerals.

The assay results of this hole are as follows.

in the silt zone

SnO_2	;	1.7 g/m^3
TR_2O_3	;	39.0 g/m^3
ThO_2	;	5.1 g/m^3
Zr_2O_3	;	7.7 g/m^3
TiO_2	;	156 g/m^3

in the upper part of the sand and gravel zone

SnO_2	;	156 g/m^3
Ta_2O_5	;	3.6 g/m^3
Nb_2O_5	;	15.0 g/m^3
TR_2O_3	;	55.0 g/m^3
ThO_2	;	6.8 g/m^3

Zr_2O_3 ; 8.1 g/m^3
TiO_2 ; 551 g/m^3

in the lower part of the sand and gravel zone

SnO_2 ; 374 g/m^3
Ta_2O_5 ; 20.5 g/m^3
Nb_2O_5 ; 68.0 g/m^3
TR_2O_3 ; 243 g/m^3
ThO_2 ; 29.7 g/m^3
Zr_2O_3 ; 8.1 g/m^3
TiO_2 ; 511 g/m^3

The contents of all elements are significantly concentrated in the lower part of the sand and gravel zone.

(3) KBA-P08; depth 3.0 m, El. 57.2 m

This pit was planed at the highest anomaly of northern part of this anomaly zone.

It has been confirmed that this pit was geologically divided into five zones. However, waters spring out 500 litters per minute at the depth of 2.3 meters, and sands and gravel collapsed into the pit. It had to give up to continue the work without confirmation of the basement.

The top part from the surface to the depth of 0.2 meter consists of dark brown silty sands containing much amounts of organic matters.

The second part at the depth from 0.2 to 0.9 meter consists of reddish brown fine to medium sands containing small amounts of silt and clay.

The third part at the depth from 0.9 to 1.5 meters consists of pale brown silt containing fine to medium sands.

The fourth part at the depth from 1.5 to 2.5 meters is a white sand and gravel layer consisting of felsic coarse sands and well rounded pebbles and cobbles, 1 to 15 centimeters in diameter but occasionally 20 centimeters, of quartz vein, granite, meta-sedimentary rocks. Small amounts of white clay lenses are occasionally intercalated in the zone. The layer is generally well sorted. Colored minerals are concentrated in the lower part.

The fifth part from the depth of 2.5 meters to the bottom is a white and black mixed coarse sands zone consisting mainly of quartz, feldspar, and tourmaline.

The assay results of the pit are as follows.

in the upper silt and clay zones

SnO_2 ; 0.9 to 2.0 g/m^3

TR_2O_3 ; 22.0 to 36.0 g/m^3
ThO_2 ; 3.3 to 5.4 g/m^3
Zr_2O_3 ; 6.0 to 14.4 g/m^3
TiO_2 ; 122 to 167 g/m^3

in the upper part of the sand and gravel zone

SnO_2 ; 3.1 g/m^3
TR_2O_3 ; 30.0 g/m^3
ThO_2 ; 4.0 g/m^3
Zr_2O_3 ; 7.1 g/m^3
TiO_2 ; 434 g/m^3

in the lower part of the sand and gravel zone

SnO_2 ; 108 g/m^3
Ta_2O_5 ; 3.2 g/m^3
Nb_2O_5 ; 9.1 g/m^3
TR_2O_3 ; 43.0 g/m^3
ThO_2 ; 6.8 g/m^3
Zr_2O_3 ; 7.2 g/m^3
TiO_2 ; 648 g/m^3

in the sand zone

SnO_2 ; 43.0 g/m^3
Ta_2O_5 ; 2.5 g/m^3
Nb_2O_5 ; 7.8 g/m^3
TR_2O_3 ; 51.0 g/m^3
ThO_2 ; 5.9 g/m^3
Zr_2O_3 ; 8.1 g/m^3
TiO_2 ; 694 g/m^3

No significant difference is seen in the results from the different zones except certain concentration of titanium in the upper and lower parts of the sand and gravel zone, and the sands zone.

(4) KBA-B11; depth 3.2 m, El. 56.5 m

This hole was planed for checking geological and geochemical condition at the center of this anomaly zone.

It has been confirmed that the alluvium in this hole divided into three parts, and the basement rocks consisting of weathered gray shale at the bottom.

The top part from the surface to the depth of 1.2 meters consists of brown silty soil containing fine sands.

The middle part at the depth from 1.2 to 2.1 meters consists of medium sands containing small amounts of silty soil.

The bottom part from the depth of 2.1 meters to the bottom, 3.2 meters in depth, is a sand and gravel zone containing large amounts of rounded granules and pebbles of granite, quartz vein, meta-sandstone, meta-shale, etc. and heavy minerals.

The assay results of this hole are as follows.

in the silt zone

SnO_2	; 20.0 g/m^3
Ta_2O_5	; 3.9 g/m^3
Nb_2O_5	; 14.1 g/m^3
TR_2O_3	; 194 g/m^3
ThO_2	; 31.4 g/m^3
Zr_2O_3	; 52.6 g/m^3
TiO_2	; 425 g/m^3

in the sand zone

SnO_2	; 134 g/m^3
Ta_2O_5	; 7.7 g/m^3
Nb_2O_5	; 29.1 g/m^3
TR_2O_3	; 290 g/m^3
ThO_2	; 38.7 g/m^3
Zr_2O_3	; 47.3 g/m^3
TiO_2	; 901 g/m^3

in the sand and gravel zone

SnO_2	; 845 g/m^3
Ta_2O_5	; 14.8 g/m^3
Nb_2O_5	; 47.8 g/m^3
TR_2O_3	; 213 g/m^3
ThO_2	; 29.3 g/m^3
Zr_2O_3	; 29.8 g/m^3
TiO_2	; 1531 g/m^3

The results show that the middle sand zone and bottom sand and gravel zone contain high values, and the top silt zone also contains higher values than those in the other holes.

(5) KBA-B09; depth 4.4 m, El. 55.6 m

This hole was additionally planed for checking the bottom of alluvial basin around KBA-P09.

It has been confirmed that the alluvium in this hole was divided into two zones, and the basement rocks consisting of weathered brownish gray shale were seen at the bottom.

The upper zone from the surface to the depth of 2.4 meters consists of brown silty soil containing medium sands. The lower 1 meter thick contains many sands.

The lower zone from the depth of 2.4 to the bottom, 4.4 meters in depth, is a sand and gravel layer consisting of coarse felsic sands and well rounded granules and pebbles of granite, aplite, quartz vein, meta-sandstone, etc.

The assay results of this hole are as follows.

in the upper part of the silt zone

SnO_2	; 2.3 g/m^3
TR_2O_3	; 38.0 g/m^3
ThO_2	; 5.2 g/m^3

Zr_2O_3 ; 11.6 g/m^3
TiO_2 ; 142 g/m^3
in the lower part of the silt zone
SnO_2 ; 81.0 g/m^3
Ta_2O_5 ; 9.4 g/m^3
Nb_2O_5 ; 38.9 g/m^3
TR_2O_3 ; 342 g/m^3
ThO_2 ; 44.9 g/m^3
Zr_2O_3 ; 67.9 g/m^3
TiO_2 ; 1189 g/m^3
in the sand and gravel zone
SnO_2 ; 134 to 856 g/m^3
Ta_2O_5 ; 6.4 to 6.9 g/m^3
Nb_2O_5 ; 22.1 to 22.8 g/m^3
TR_2O_3 ; 90.0 to 96.0 g/m^3
ThO_2 ; 11.9 to 13 g/m^3
Zr_2O_3 ; 13.5 to 21.2 g/m^3
TiO_2 ; 685 to 788 g/m^3

Tin is concentrated in the sand and gravel zone, and rare earths and titanium are concentrated in the lower part of the silt zone.

(6) KBA-P09; depth 2.5 m, El. 55.6 m

This pit was planed for confirming geological and geochemical condition at the southern half of this anomaly zone.

It has been confirmed that the pit was geologically divided into five zones. No basement rock, however, has been confirmed, because water sprang out 400 litters per minute at the depth of 1.5 meters, and the wall rocks fell down to the pit.

The top zone from the surface to the depth of 0.2 meter consists of black fine sands containing much organic matters.

The second zone at the depth from 0.2 to 0.6 meter consists of reddish brown fine to medium sands containing silt.

The third zone at the depth from 0.6 to 1.0 meter consists of pale gray silt mixed with clay, containing fine sands.

The fourth zone at the depth from 1.0 to 1.8 meters consists of pale gray silt containing many coarse felsic sands.

The fifth zone from the depth of 1.8 meters to the bottom, 2.5 meters in depth, is a gray to white sand and gravel zone consisting of coarse felsic sands and well rounded granules and pebbles, 2 to 20 millimeters in diameter, of quartz vein, granite, meta-sedimentary rocks.

The assay results of this pit are as follows.

in the upper zone above 1.0 meter

SnO_2 ; 0.8 to 1.1 g/m^3
TR_2O_3 ; 15.8 to 34.7 g/m^3
ThO_2 ; 2.5 to 5.0 g/m^3
Zr_2O_3 ; 5.0 to 9.9 g/m^3
TiO_2 ; 89 to 133 g/m^3

in the upper silt zone mixed with coarse felsic sands

SnO_2 ; 4.2 g/m^3
Ta_2O_5 ; 1.3 g/m^3
Nb_2O_5 ; 3.6 g/m^3
TR_2O_3 ; 56.0 g/m^3
ThO_2 ; 8.5 g/m^3
Zr_2O_3 ; 15.4 g/m^3
TiO_2 ; 224 g/m^3

in the lower silt zone and upper sand and gravel zone

SnO_2 ; 11.3 g/m^3
Ta_2O_5 ; 4.9 g/m^3
Nb_2O_5 ; 16.1 g/m^3
TR_2O_3 ; 149 g/m^3
ThO_2 ; 21.5 g/m^3
Zr_2O_3 ; 30.5 g/m^3
TiO_2 ; 1030 g/m^3

in the lower sand and gravel zone

SnO_2 ; 6.8 g/m^3
Ta_2O_5 ; 3.6 g/m^3
Nb_2O_5 ; 11.3 g/m^3
TR_2O_3 ; 84.0 g/m^3
ThO_2 ; 12.0 g/m^3
Zr_2O_3 ; 17.1 g/m^3
TiO_2 ; 816 g/m^3

Tin is not high in all zones, and rare earths and titanium are high in the sands or sand and gravel zones below the depth of 1 meter.

This pit apparently had to be given up at the upper from the high tin concentrate zone find in KBA-B09.

(7) KBA-B10; depth 6.1 m, El. 56.3 m

This hole was planed for checking geological and geochemical condition around the southern-most of this anomaly area.

It has been confirmed that the alluvium in this hole was divided into two zones, and the basement rocks consist of weathered gray shale were seen below the depth of 6.1 meters.

The upper part from the surface to the depth of 3.1 meters consists of brown silty soil containing medium sands. Many sands are contained in the part from 1.5 to 3.1 meters, mixing with coarse sands.

The lower part from the depth of 3.1 to the bottom is a sand and gravel zone consisting of coarse felsic sands and small amounts of well rounded granules and pebbles of granite, aplite, quartz vein, meta-sedimentary rocks, etc.

The assay results of this hole are as follows.

in the upper silt zone

- SnO_2 ; 5.4 g/m^3
- TR_2O_3 ; 29.9 g/m^3
- ThO_2 ; 3.7 g/m^3
- Zr_2O_3 ; 6.4 g/m^3
- TiO_2 ; 128 g/m^3

in the lower silt zone

- SnO_2 ; 802 g/m^3
- Ta_2O_5 ; 14.8 g/m^3
- Nb_2O_5 ; 101 g/m^3
- TR_2O_3 ; 210 g/m^3
- ThO_2 ; 28.2 g/m^3
- Zr_2O_3 ; 35.4 g/m^3
- TiO_2 ; 2543 g/m^3

in the upper sand and gravel zone

- SnO_2 ; 30.0 g/m^3
- Ta_2O_5 ; 1.6 g/m^3
- Nb_2O_5 ; 7.6 g/m^3
- TR_2O_3 ; 52.6 g/m^3
- ThO_2 ; 6.2 g/m^3
- Zr_2O_3 ; 11.7 g/m^3
- TiO_2 ; 231 g/m^3

in the lower sand and gravel zone

- SnO_2 ; 224 g/m^3
- Ta_2O_5 ; 2.7 g/m^3
- Nb_2O_5 ; 13.0 g/m^3
- TR_2O_3 ; 44.2 g/m^3
- ThO_2 ; 5.6 g/m^3
- Zr_2O_3 ; 11.1 g/m^3
- TiO_2 l; 488 g/m^3

Tin is concentrated in two parts, the lower silt zone and lower sand and gravel zone, and rare earths are concentrated in the lower silt zone.

1-2-5 Southwestern Geochemical Anomaly Zone

This zone is principally composed of tin anomalies in an upper tributary of the Khlong Nam Khao. The tributary starts from the southern end of the northern west granite body. A narrow rare earths anomaly zone is situated in the upper stream area close to the granite body. Redepositional residual ores and secondary ores in sand and gravel layers along the river are expected in this zone.

Two pits, KBA-P10 and KBA-P13, and four drill holes, KBA-B12, KBA-B13, KBA-B14, and KBA-B15, have been completed in this zone. Geologic profiles in this zone are shown in Figure 8 (G),(H).

(1) KBA-P10; depth 5.0 m, El. 72.8 m

This pit was planed at the site showing duplicated tin and rare earths anomalies in northern part of this anomaly zone.

It has been confirmed that granitic residual materials occupied whole pit, and those were divided into four zones.

The top zone from the surface to the depth of 0.1 meter consists of black surface silty soil containing organic matters.

The second zone at the depth from 0.1 to 2.0 meter consists of dark reddish to reddish brown sandy silt and sandy clay containing much coarse sands mainly consisting of quartz.

The third zone at the depth from 2.0 to 2.5 meters consists of reddish brown sandy silt and clay containing small amounts of strongly weathered, soft, rounded granite pebbles. Margin of those granite pebbles is generally unclear.

The fourth zone at the depth from 2.5 to 3.0 meters is an alternation layer of brown to reddish brown hard sandy silt and silt containing much granitic granules and pebbles, 1 to 5 millimeters in size.

The bottom zone from the depth of 3.0 meters to the bottom, 5.0 meters in depth, consists of yellowish gray to yellowish brown fine sands mixed with clay containing much granule size granite fragment.

The assay results show that the tin contents at the bottom are 42 g/m^3, and those in other zones are almost same, and the rare earths contents at the bottom and below the depth of 3.5 meters are 10 to 12 g/m^3, but 3 g/m^3 at the depth from 3.5 to 4.5 meters.

(2) KBA-B12; depth 4.3 m, El. 69.3 m

This hole was additionally planed near KBA-P10 to check geological condition along small drainage.

It has been confirmed that this hole was geologically divided into two parts, and the basement rock consisting of weathered brownish gray mudstone was seen at the bottom.

The upper part from the surface to the depth of 1.2 meters consists of brown hard clay containing brown lateritic soil and fine sands.

The lower part from the depth of 1.2 meters to the bottom, 4.3 meters in depth, consists of reddish brown lateritic soil containing small amounts of coarse sands.

Both zones contain fewer amounts of granitic fragments, and are seemed to be originally weathered residual deposits of sedimentary rock source.

The assay results show that the grades of the all elements are less than 15 g/m^3.

(3) KBA-B13; depth 6.7 m, El. 61.8 m

This hole was planed at eastern branch of rare earths anomaly zone.

It has been confirmed that the alluvium in this hole was divided into five zones, and the basement rocks consisting of weathered brown shale were seen at the bottom.

The top zone from the surface to the depth of 1.2 meters consists of brown silty soil containing small amounts of fine sands.

The second zone at the depth from 1.2 to 2.7 meters consists of gray clay containing small amounts of coarse sands.

The third zone at the depth from 2.7 to 4.3 meters consists of brown consolidated clay containing a little amount of coarse sands.

The fourth zone at the depth from 4.3 to 5.8 meters consists of reddish brown, partly white, hard clay.

The fifth zone from the depth of 5.8 meters to the bottom, 6.7 meters in depth, is a white sand and gravel zone consisting of coarse felsic sands, and well rounded granules and pebbles of granite, aplite, quartz vein, meta-sandstone, etc.

The assay results of this hole are as follows.

in the fourth layer
SnO_2 ; 73.9 g/m^3
in the sand and gravel zone
SnO_2 ; 1511 g/m^3
Ta_2O_5 ; 20.7 g/m^3
Nb_2O_5 ; 35.8 g/m^3

Contents of other elements such as rare earths and titanium are low in this hole.

(4) KBA-B14; depth 7.5 m, El. 58.2 m

The holes of KBA-B14, B15 and the pit of KBA-P13 were planed at western branch of rare earth's anomaly zone.

It has been confirmed that the alluvium in this hole was divided into five zones, and the basement rocks consisting of weathered greenish gray shale were seen at the bottom.

The top zone from the surface to the depth of 1.2 meters consists of gray medium sands mixed with brown lateritic soil.

The second zone at the depth from 1.2 to 2.7 meters consists of pale gray coarse sands intercalated by gray hard clay layers.

The third zone at the depth from 2.7 to 5.8 meters consists of grayish brown hard consolidated clay containing coarse sands.

The fourth zone at the depth from 5.8 to 7.0 meters consists of brownish gray consolidated clay.

The fifth zone from the depth of 7.0 meters to the bottom, 7.5 meters in depth, a gray to white sand and gravel zone consisting of coarse felsic sands, and well rounded pebbles of quartz vein, granite, meta-sedimentary rocks, etc.

The assay results of this hole are as follows.

in the clay zone from 5.8 m to 7.0 m
SnO_2 ; 710 g/m^3
in the sand and gravel zone
SnO_2 ; 2023 g/m^3
Ta_2O_5 ; 11.7 g/m^3
Nb_2O_5 ; 25.0 g/m^3

All other contents are low.

(5) KBA-P13; depth 3.0 m, El. 55.8 m

It has been confirmed that this pit was geologically divided into five zones. Water sprung out 10 litters per minute at the depth of 1.1 meters, and 400 litters per minute at the depth of 1.5 meters. Sands and gravel fell down to the pit with the water. The work, therefore, had to give up at the depth of 3.0 meters without confirmation of basement rocks.

The top zone from the surface to the depth of 0.2 meters consists of dark gray silt to fine sands.

The second zone at the depth from 0.2 to 1.2 meters consists of pale brown medium to coarse sands, being mainly composed of quartz, feldspar, and tourmaline. The sands also contain much muscovite.

The third zone at the depth from 1.2 to 2.0 meters consists of gray sandy clay containing much muscovite.

The fourth zone at the depth from 2.0 to 2.5 meters consists of gray to white coarse sands containing pebbles of quartz vein, granite, etc.

The fifth zone from the depth of 2.5 meters to the bottom, 3.0 meters in depth, consists of coarse sands containing granules and pebbles of quartz vein, granite, etc. The pebbles are smaller and less than those in the upper zones.

The assay results of this pit are as follows.

SnO_2	; 0.7 to 14.3 g/m^3
TR_2O_3	; 1.6 to 17.0 g/m^3
Zr_2O_3	; 0.5 to 9.9 g/m^3
TiO_2	; 10 to 152 g/m^3

The contents of the all elements are low in this pit.

(6) KBA-B15; depth 4.6 m, El. 52.7 m

It has been confirmed that the alluvium in this hole was divided into three zones, and the basement rocks consisting of white argillaceous, kaolinized, weathered granite were seen at the bottom.

The top zone from the surface to the depth of 1.5 meters consists of brown silty soil containing small amounts of medium sands.

The middle zone at the depth from 1.5 to 4.0 meters consists of coarse felsic sands containing gray clay.

The bottom zone from the depth of 4.0 meters to the bottom, 4.6 meters in depth, consists of coarse felsic sands containing certain amounts of colored minerals and small amounts of quartz pebbles.

The assay results of the hole are as follows.

in the coarse sands zone

SnO_2	; 243 to 581 g/m^3
Ta_2O_5	; 2.3 to 5.1 g/m^3
Nb_2O_5	; 7.0 to 13.9 g/m^3
TR_2O_3	; 30.0 to 56.0 g/m^3
ThO_2	; 3.6 to 6.73 g/m^3
Zr_2O_3	; 14.1 to 23.1 g/m^3
TiO_2	; 160 to 306 g/m^3

Tin is concentrated below the depth of 1.5 meters, but rare earths and titanium are low in the whole section.

1-3 Discussion

Following five zones were selected for further exploration activities based on the second phase survey results.

1. Northern Geochemical Anomaly Zone (1)
2. Northern Geochemical Anomaly Zone (2)
3. Central Geochemical Anomaly Zone
4. Southeastern Geochemical Anomaly Zone
5. Southwestern Geochemical Anomaly Zone

It was judged that these zones were of high potential for secondary ores.

This phase pit and drilling survey results has revealed that the Northern Geochemical Anomaly Zone (1) was underlain by talus deposits containing much amounts of fresh granite pebbles and cobbles, and colluvial or redepositional weathering residual sediments derived from granitic weathered soil, as shown in Geological Profiles (A), (B), and (C). Potential for secondary ores in talus weathering residual sediments was evaluated for this zone in second phase survey. However, the pit survey results have revealed that no economical grade ore was in this zone. The assay results of this zone are as follows.

SnO_2	; 0.1 to 3.1 g/m^3
W_2O_3	; <0.6 g/m^3
Ta_2O_5	; <1.5 g/m^3
Nb_2O_5	; <5.4 g/m^3
TR_2O_3	; 4.0 to 56.0 g/m^3
ThO_2	; 1 to 6 g/m^3
Zr_2O_3	; 1 to 11 g/m^3
TiO_2	; 20 to 575 g/m^3

The assay results of the second phase soil geochemical survey are as follows. (in average values)

SnO_2	60 g/m^3
TR_2O_3	equivalent to monazite; 1000 to 1400 g/m^3
	equivalent to xenotime; 50 to 250 g/m^3

These values are 50 to 1,000 times higher than those in this year. What caused this difference is probably different sample treatment methods for each phase program. The samples assayed in the second phase programs are of soil, which were sieved out under 80 meshes. It means that the samples contain all contents of useful elements in the soil, whether recoverable or not. On the contrary, the samples for assay in this phase program are of panned, after collected from the pits by channel sampling method. This phase samples are of propriety grain size for actual treatment, and probably close to ores obtained from actual mining activity, in other word recoverable ores by the table method.

The Northern Geochemical Anomaly Zone (2) is in an alluvial lowland along the Khlong Nam Khao, and underlain by a 1 to 2 meters thick sands mixed with silt layer, 1 meter thick white clay layer mixed with sand, and 2 to 3 meters thick sand and gravel layer, from the top to the bottom. Geological Profile (D) shows this situation. The assay results have revealed that useful minerals were commonly concentrated in the lower sand and gravel layer, and laterally concentrated in the turning flow point in the down stream area of the Khlong Nam Khao. Figure 10 shows this situation. To the south of this zone, a hilly extension of weathering residual sediments comes out from the northwest side, making a pocket shape. It is said that the cut-off grade for tin is approximately 100 g/m^3, therefore economical ores in the zone are limited in a small area around KBA-B03 and KBA-P06. The cut-off grade for rare earths is not clearly known, because rare earths have been recovered as by- products of tin until now. Presumed that the cut-off grade for rare earths is as same as that of for tin, economical ores for rare earths are also limited in the same small area designated for tin, in the lower sand and gravel layer.

It was evaluated that the potential for secondary ores in talus weathering residual sediments in the northwestern part and alluvial stream sediments was high in the southeastern part of the Central Geochemical Anomaly Zone. The area is underlain by talus deposits and redepositional weathering residual sediments in the northeastern zone. The grade for useful minerals is low as well as in the case of the Northern Geochemical Anomaly Zone (1), and the potential for ores is evaluated as low. The flat lowland in the southwestern zone around KBA-B05 is underlain by a sand mixed with silt layer in the upper, and sand and gravel layer in the lower. Tin is concentrated in the lower part of the sand and gravel layer. Figure 11 shows this situation. Rare earths are concentrated in the upper part of the sand and gravel layer. The sedimentary basin for ores is small in scale. However the tin grade is significantly high, SnO_2 1,700 g/m^3 in average in the small area around KBA-B05.

It was evaluated that the potential for secondary ores in sand and gravel layers was high in the Southeastern Geochemical Anomaly Zone, because the zone is situated in the area underlain by flat lowland stream sediments. As shown in Geological Profile (F), this zone is underlain by a 1.2 to 3.1 meters thick sandy silt surface layer and a 1 to 3 meters thick sand and gravel layer. The area highly concentrated by

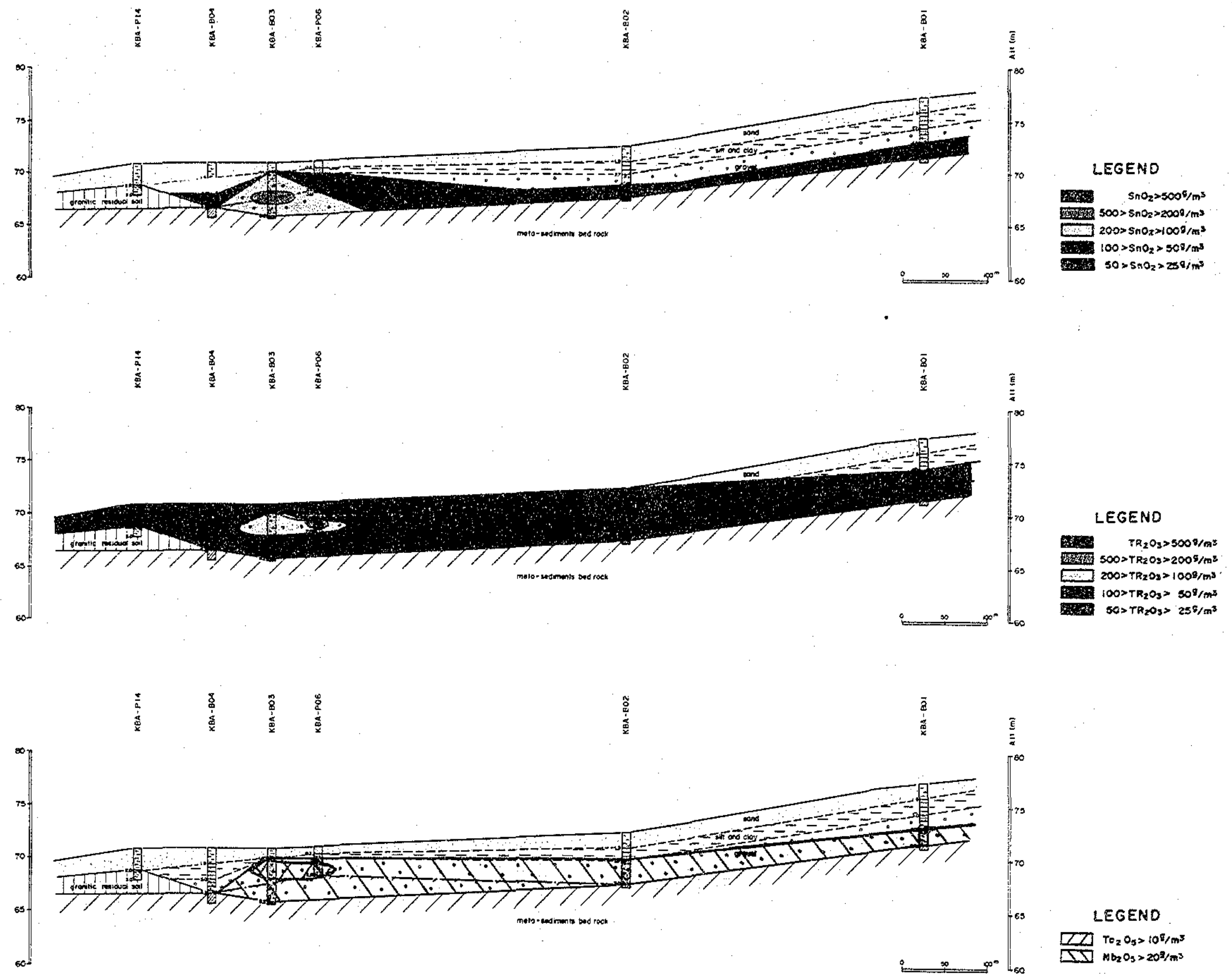


Fig. 10 Ore grade profile in North geochemical anomaly zone (2)

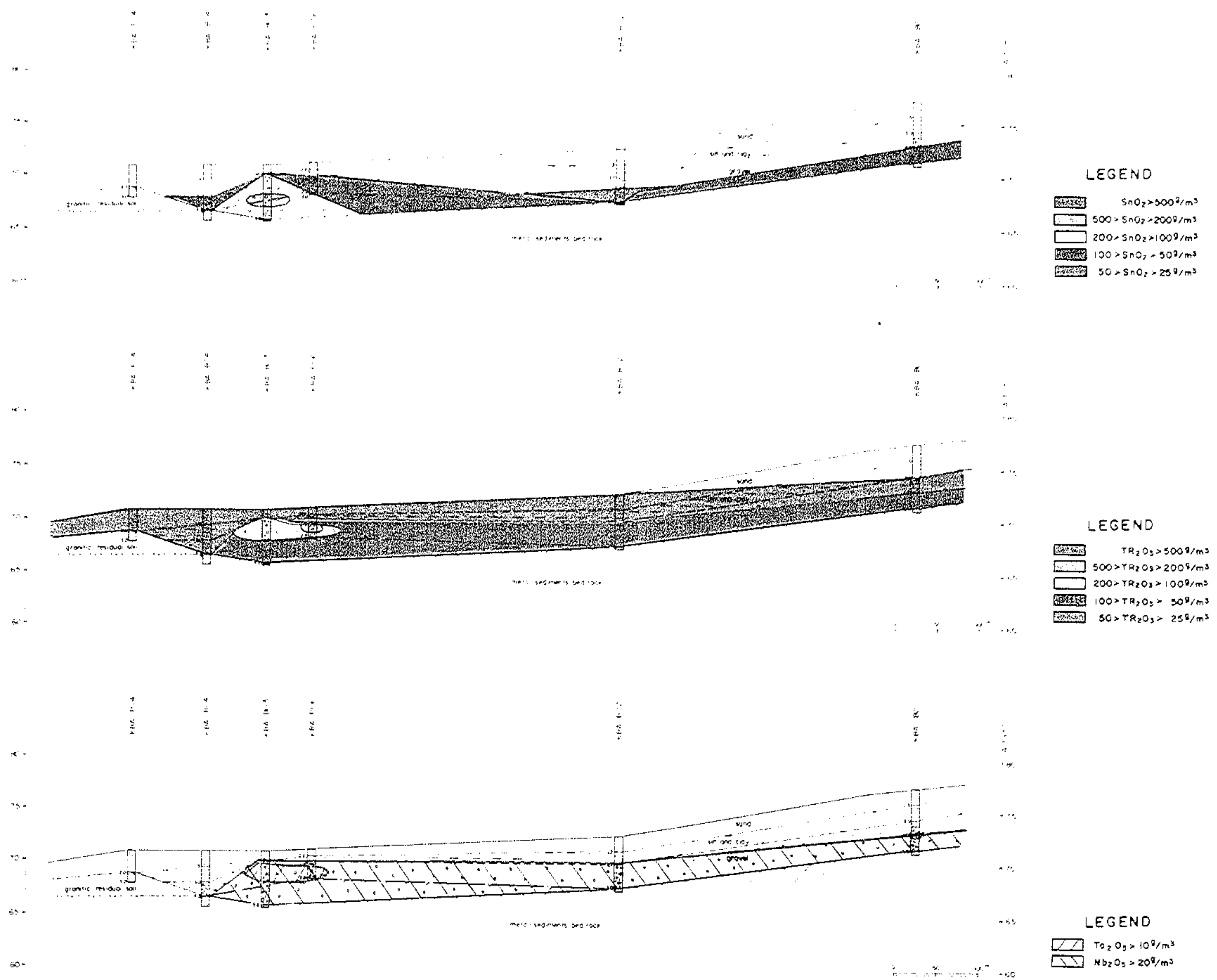


Fig. 10 Ore grade profile in North geochemical anomaly zone (2)

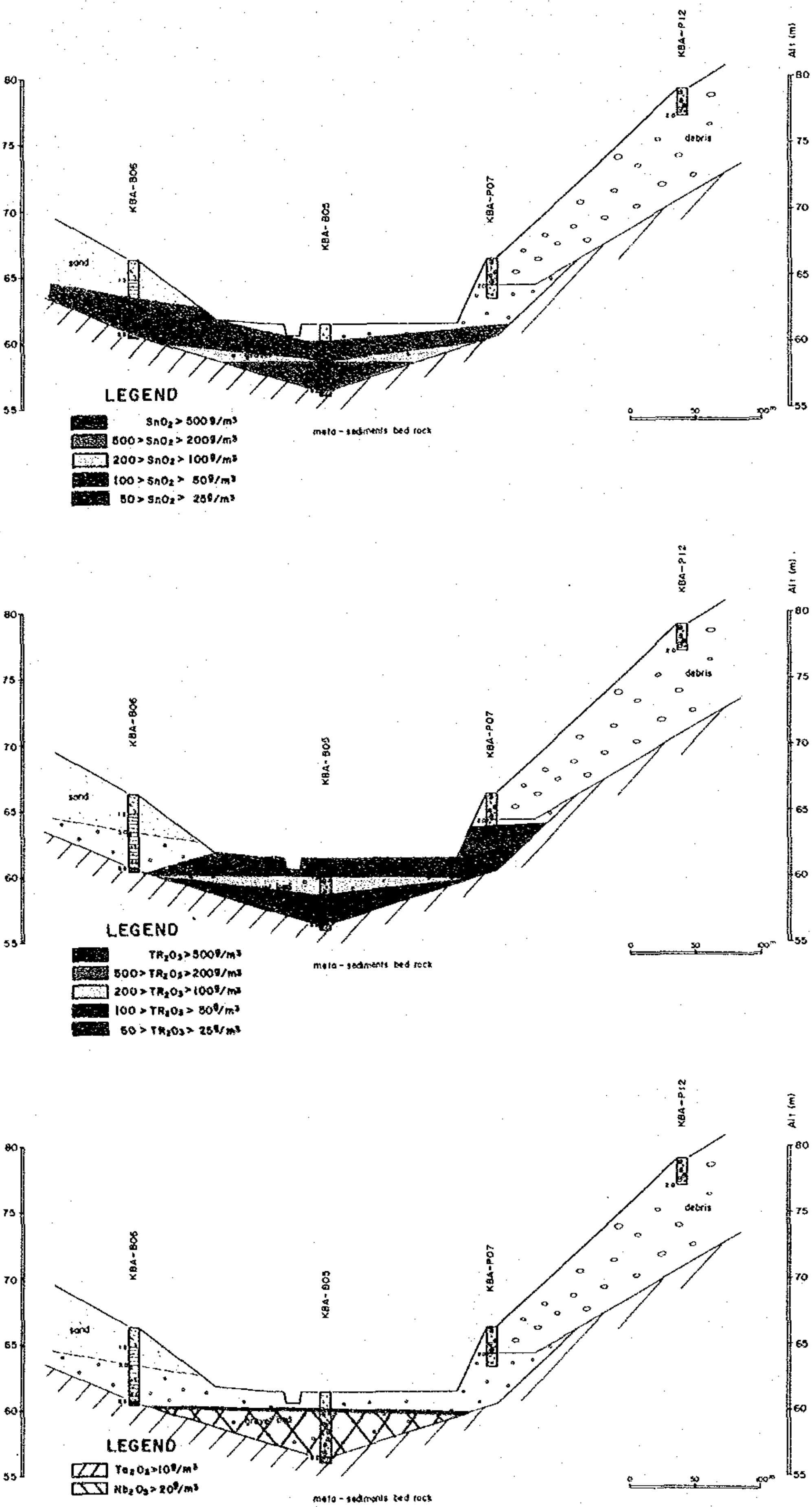


Fig. 11 Ore grade profile in Central geochemical anomaly zone

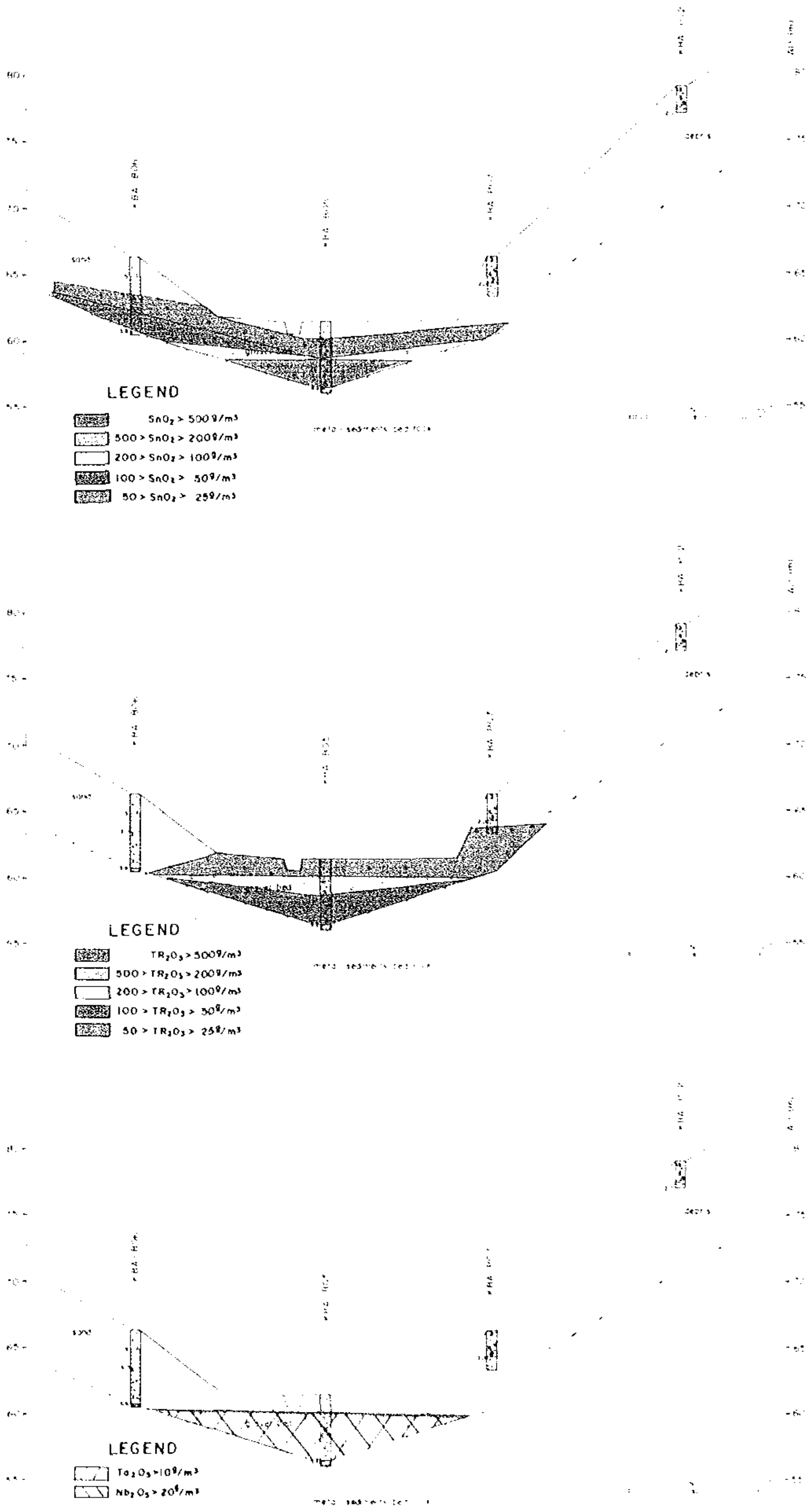


Fig. 11 Ore grade profile in Central geochemical anomaly zone

tin corresponds with the distribution of the sand and gravel layer in some degree. Tin concentration is, however, low in the upper part of the sand and gravel layer in the area around KBA-B08 and KBA-P08, and high in the overlaying sandy silt layer in the area around KBA-B10, in the down stream area. Rare earths are concentrated in the area around KBA-B11 in the central part of the zone, high in the lower part of the sand and gravel layer in the upper stream area, and in the overlaying silt layer in the down stream area, as well as behavior of tin. Figure 12 shows this situation.

The Northern (2), Central, and Southeastern Geochemical Anomaly Zones along the Khlong Nam Khao are characterized by high tantalum and niobium contents, Nb_2O_5 18 to 70 g/m^3 in the high concentration area of tin and rare earths. Behavior of tantalum and niobium are close to that of rare earths rather than that of tin. Behaviors of tritium, zirconium, and titanium have quite close correlation to that of rare earths.

It was evaluated that the potential for secondary ores in talus weathering residual sediments around the granite body and alluvial stream sediments along the river was high in the Southwestern Geochemical Anomaly Zone as well as in the Central Anomaly Zone. The pit and drilling survey results have revealed that high concentration areas were located only in the stream sediments area along the river. No high rare earths anomaly has been detected in the zone. The narrow sedimentary basins of the stream sediments, which contain secondary ores, are situated in two areas along the river. The eastern basin is underlain by a sandy silt layer in the upper part and a 4 to 6 meters thick clay layer in the lower part. The sand and gravel layer, only 1 meter thick, is seen in the lower part of KBA-B13. Tin is concentrated only in the sand and gravel layer, SnO_2 1,500 g/m^3 in grade, as shown in Figure 13.

The western basin is underlain by a 1 to 3 meters thick sands layer, a 0.7 to 3 meters thick silt mixed with sands layer, a 1.2 meters thick clay layer, and a 0.5 to 3 meters thick sand and gravel layer in the central to northern side, and a 1.5 meters thick sandy silt layer, a 2.5 meters thick sands layer, and a 0.5 meter thick sand and gravel layer in the southern side. Geological Profile (H) shows this situation. No high concentration of rare earths, titanium, and zirconium is seen in the basin, however a high tin zone obliquely cut the bottom part of the layer, 2 to 3 meters in thickness, above the basement as shown in Figure 14. Concentration of tantalum and niobium in the basin is high together with tin. Distribution of tin contents shown in profile cuts across geological units in this zone. The reason why this phenomenon happened is

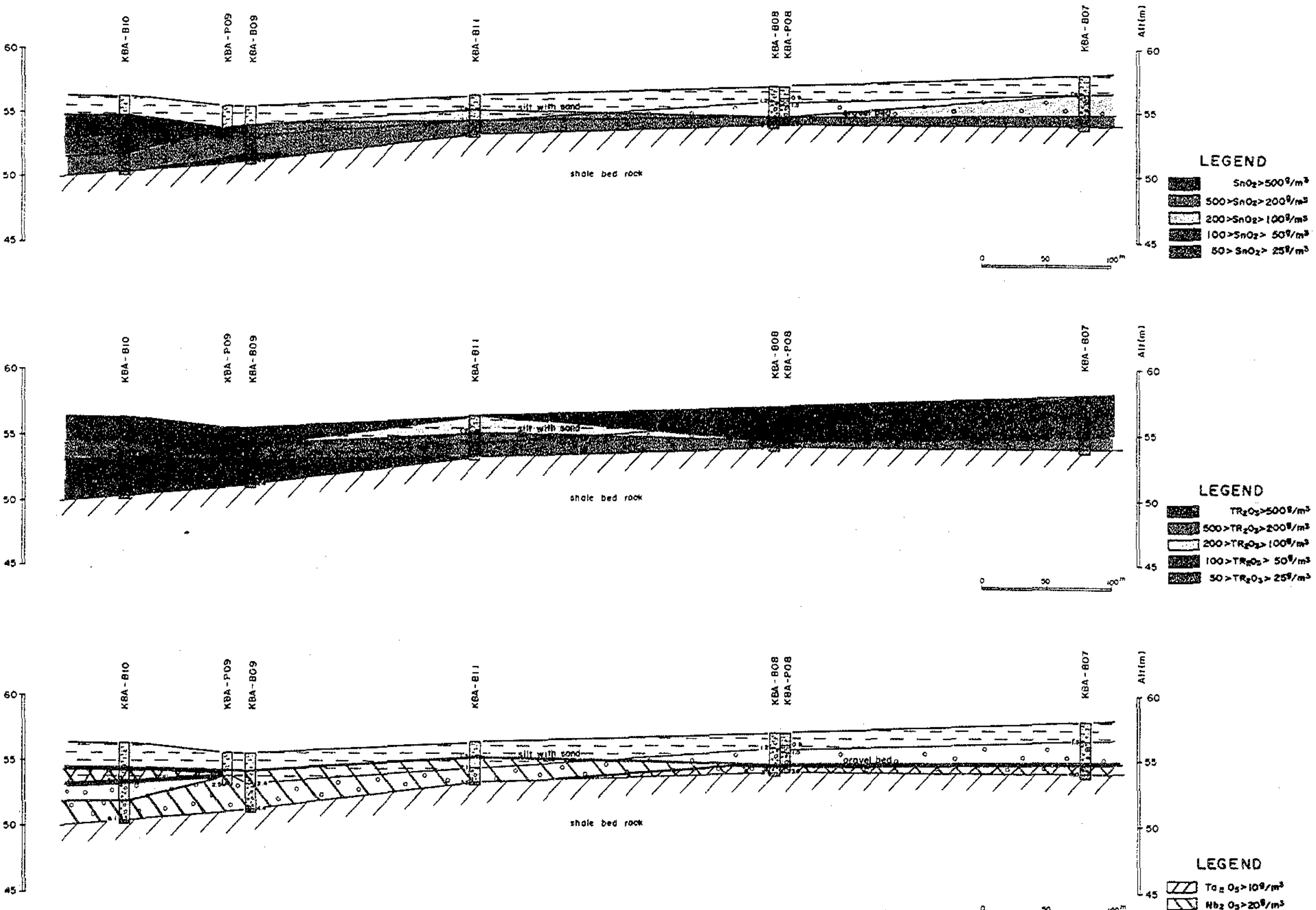


Fig. 12 Ore grade profile in Southeast geochemical anomaly zone

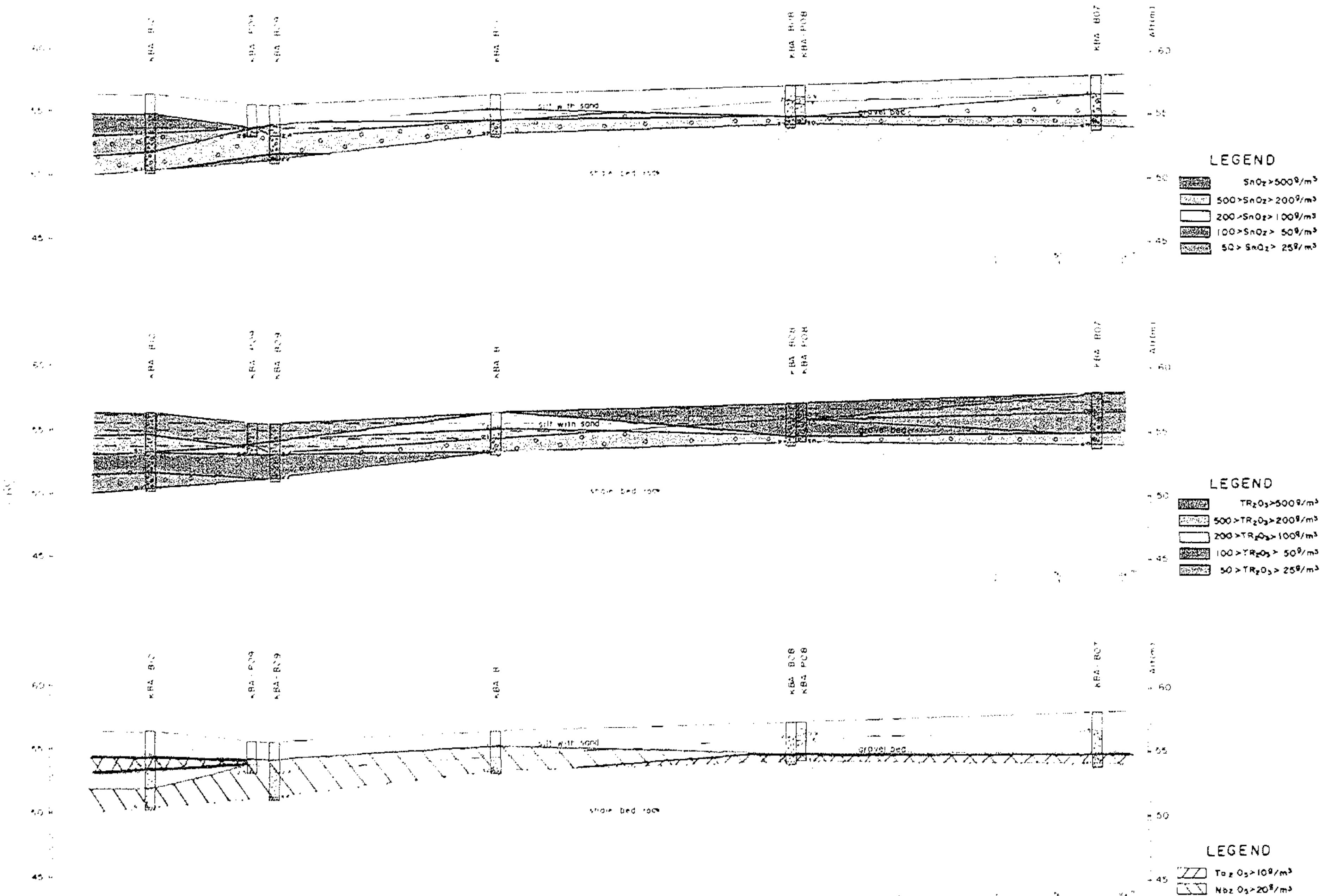


Fig. 12 Ore grade profile in Southeast geochemical anomaly zone

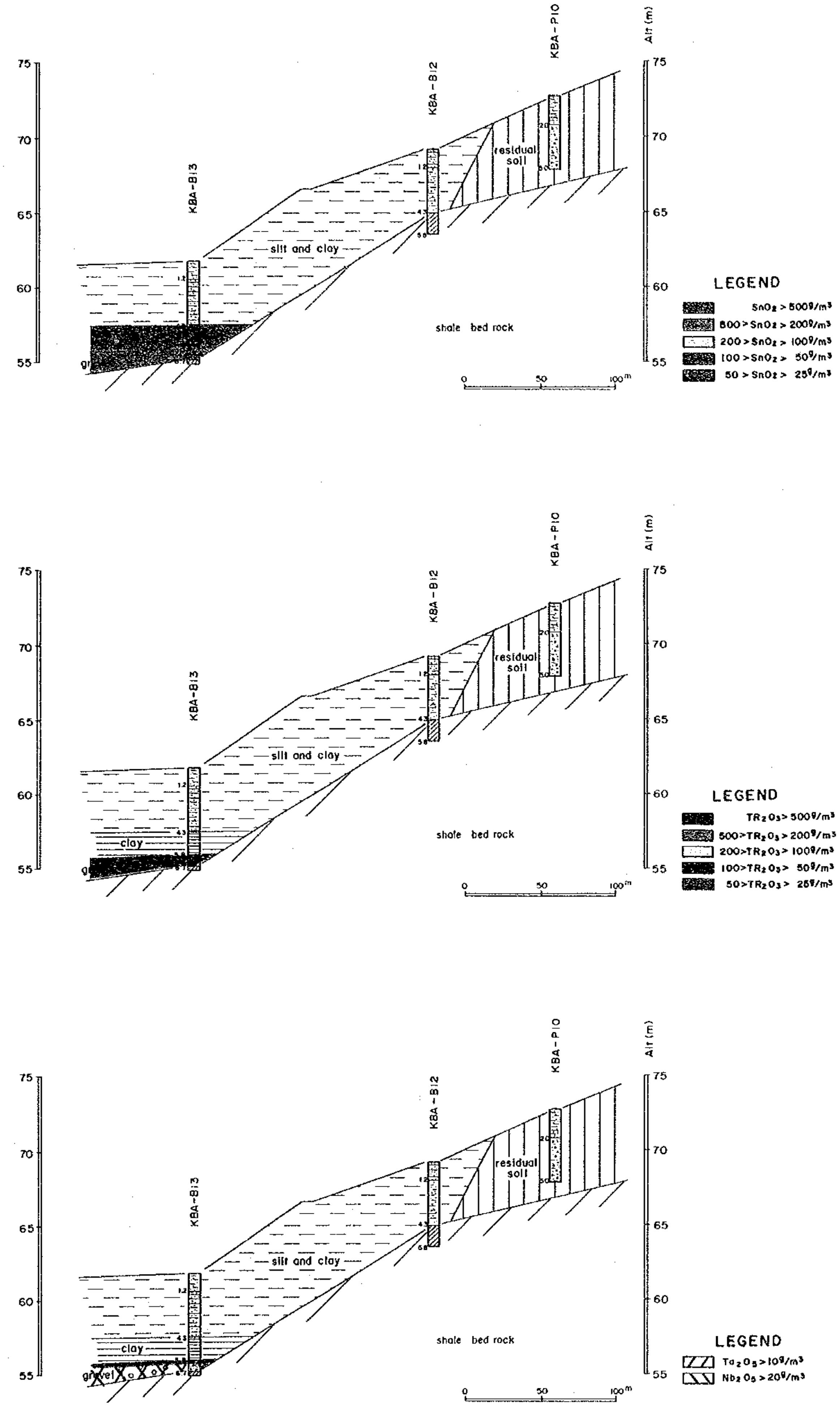
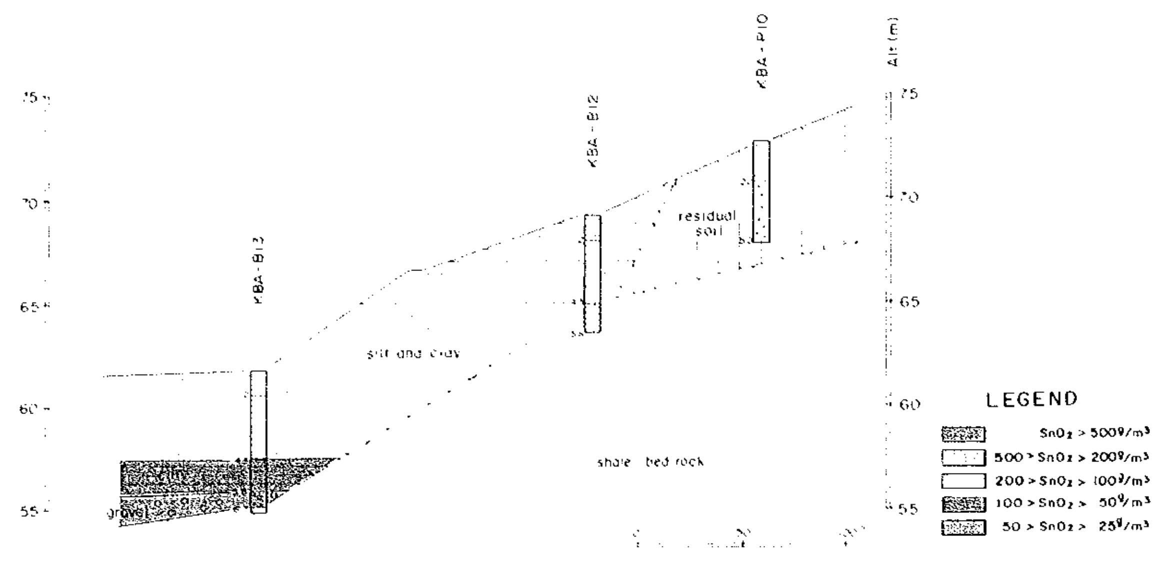
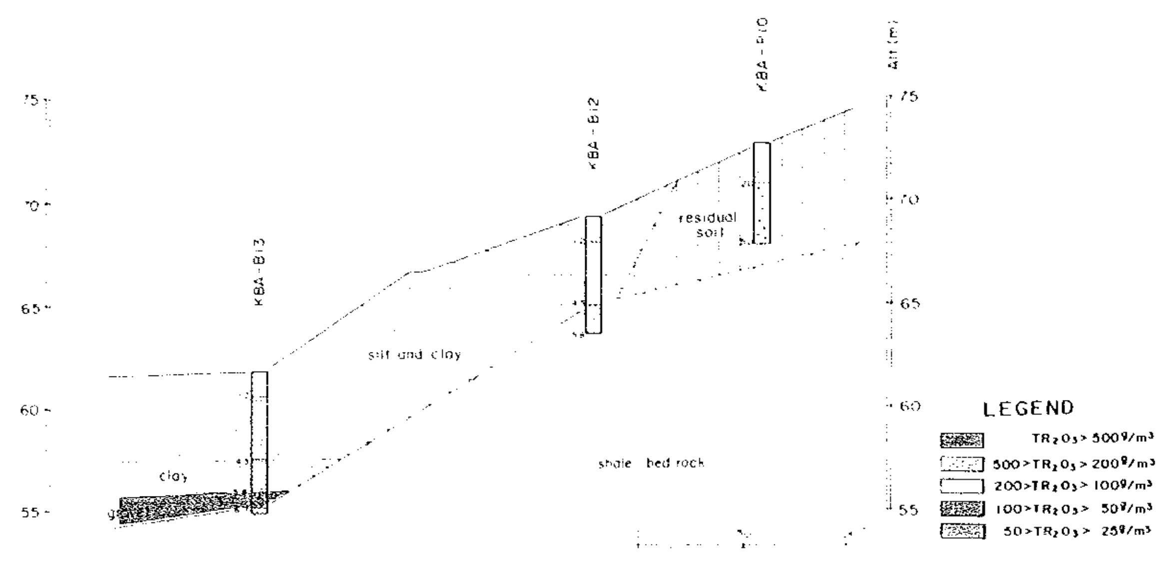


Fig. 13 Ore grade profile in East basin of Southwest geochemical anomaly zone





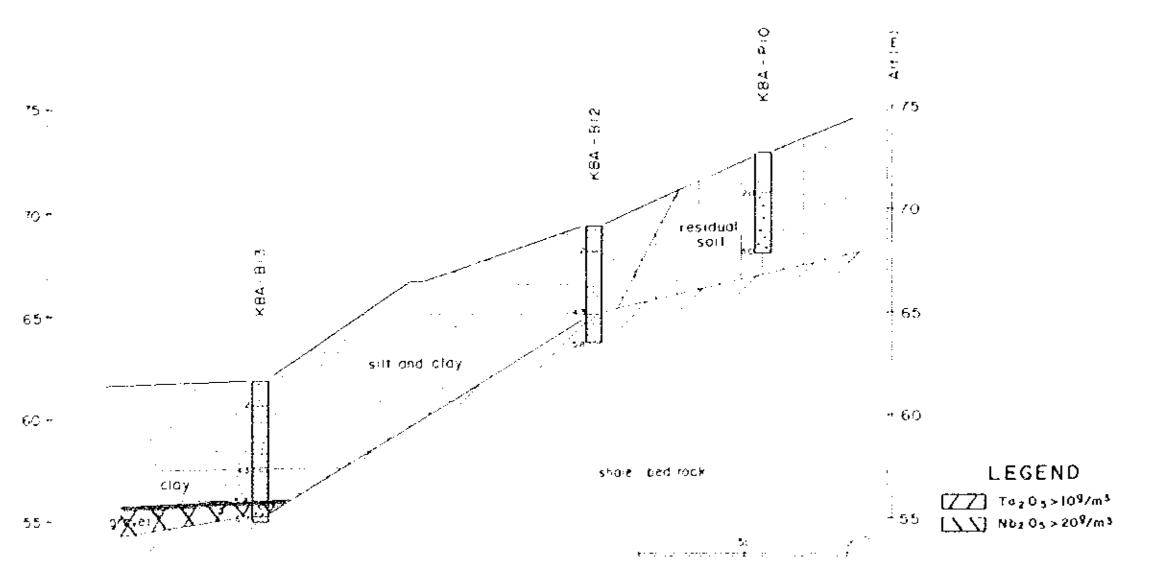


Fig. 13 Ore grade profile in East basin of Southwest geochemical anomaly zone

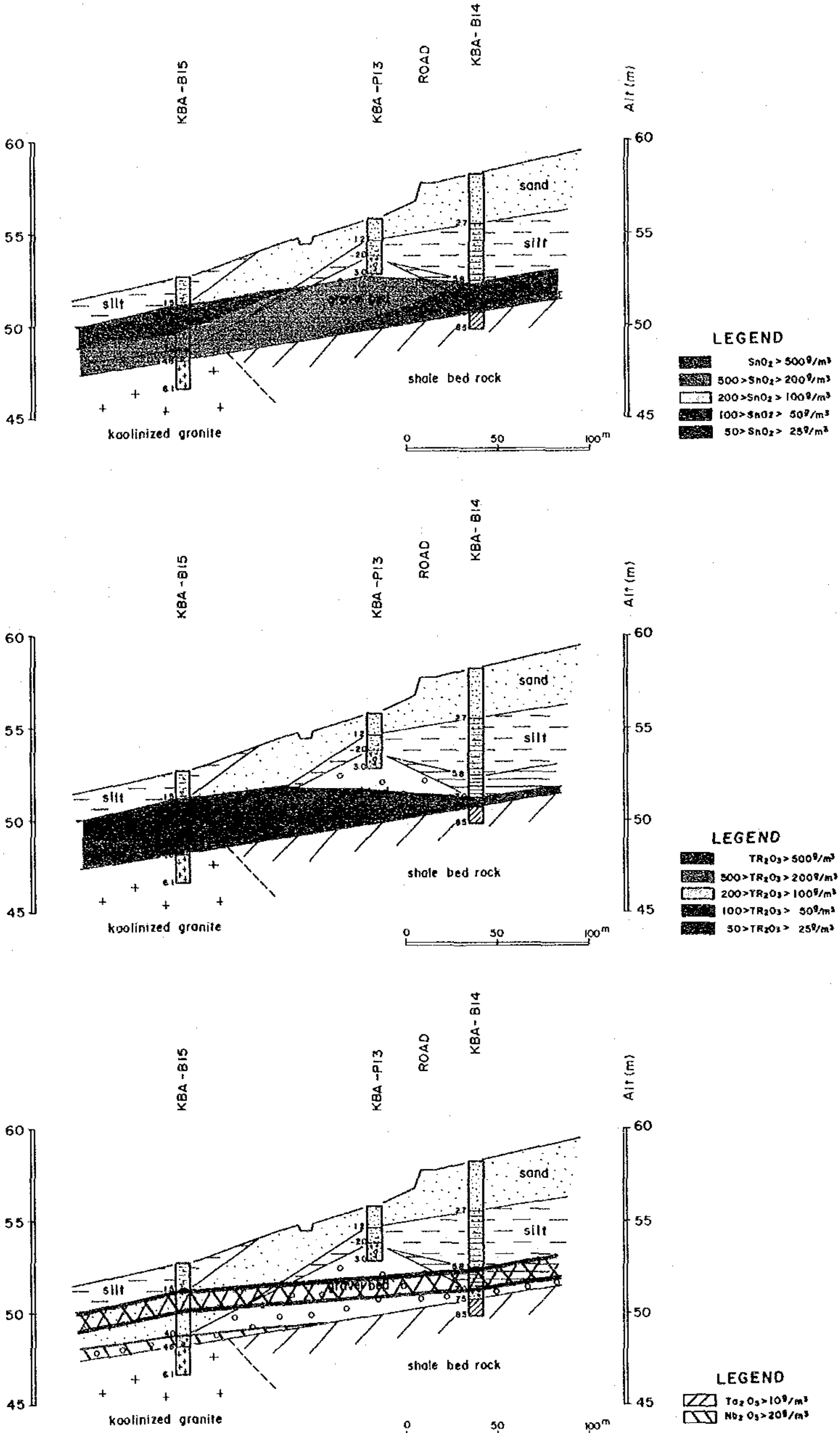


Fig. 14 Ore grade profile in West basin of Southwest geochemical anomaly zone

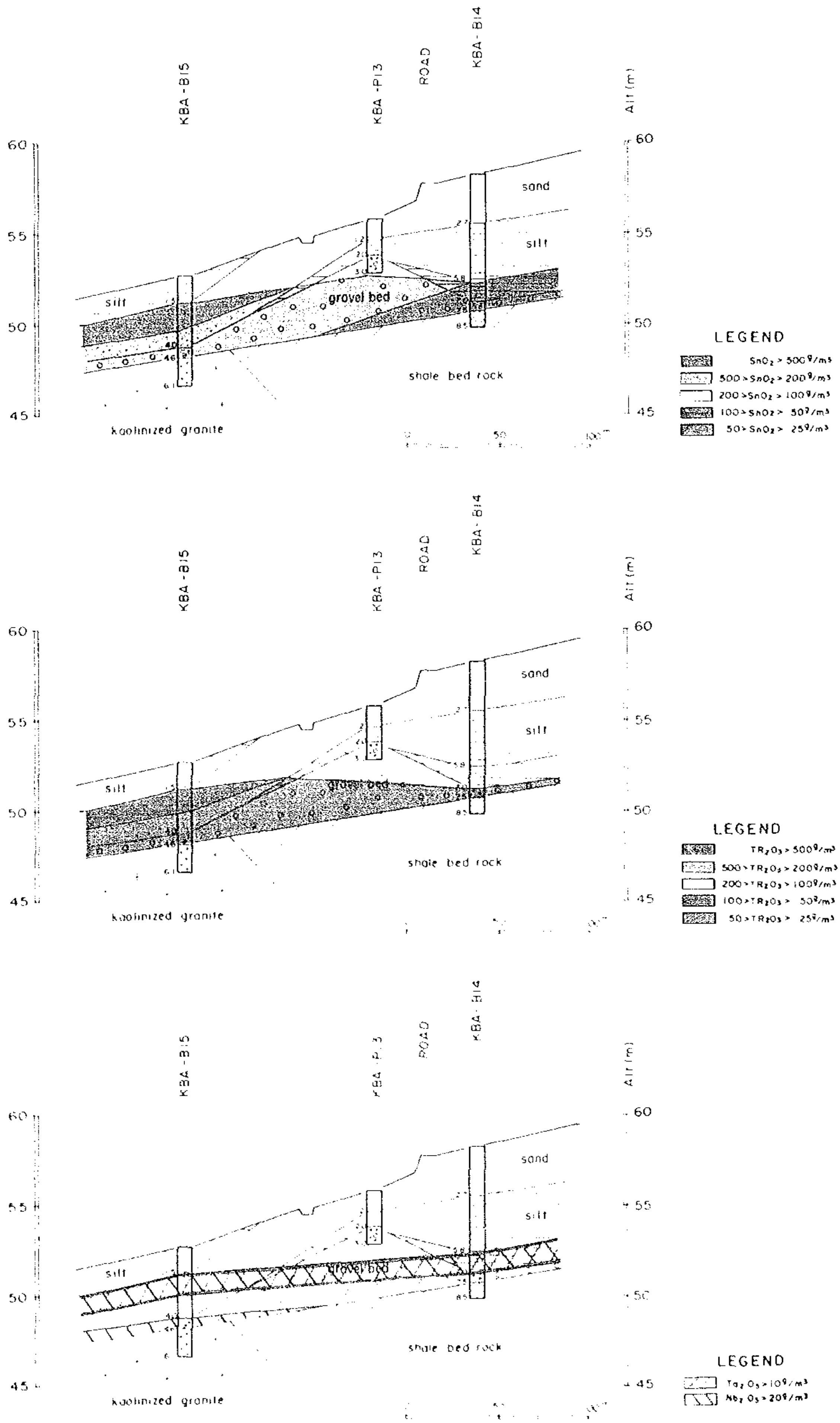


Fig. 14 Ore grade profile in West basin of Southwest geochemical anomaly zone

assumable that sorting process was poor in the transportation stage, because the basin was to close to the granite body. The secondary ores in the Southwestern Anomaly Zone are characterized by extremely low rare earths concentration compared with those of other sedimentary basins along the Khlong Nam Khao. Other characteristics are bad sorting because of short transportation distance, and many amounts of kaolinite contained in the sediments. These characteristics were probably caused by different sedimentary and erosion processes from those of other basins. It is presumed that the secondary sedimentary basin was situated near by the southeastern edge of the granite body, and the sedimentary materials were derived from greisen containing much amounts of tin in the outer edge of the granite, and erosion did not reach the core part of the granite body containing much rare earths and ilmenite.

Distribution of tin family elements and rare earths elements was studied and discussed in the second phase report, and a genetic model was proposed as shown in Figure 15. This phase survey has revealed that this model was appropriate for the genesis. In case of secondary ores, it is hard to see clearly reserved geological profiles due to disturbance, re-mobilization, and re-deposition of sediments in basins. However, it is clear that tin is concentrated in the lower parts in the sedimentary basin, and rare earths are concentrated in the upper parts, as shown in Assay Results Profiles (1), (2), and (3). It clearly indicates that sedimentation of rare earths started later than that of tin.

Table-4 Probable Ore Reserves in the Area A-1

ZONE	North	Central	Southeast	Southwest-1	southwest-2
AREAS (m^2)	22,000	52,000	217,000	38,000	45,000
THICKNESS (m)	2.1	1.8	2.3	1.0	2.4
RESERVES (m^3)	46,200	93,600	499,000	38,000	108,000
AVERAGE ORE GRADE					
SnO_2 (g/m^3)	168.3	984.2	356.4	1,511.2	658.6
Ta_2O_5 (g/m^3)	7.9	11.2	11.3	20.7	9.0
Nb_2O_5 (g/m^3)	30.7	32.7	43.6	27.7	21.1
TR_2O_3 (g/m^3)	121.3	97.2	186.9	62.4	34.8
ThO_2 (g/m^3)	16.1	16.1	23.5	8.6	4.3
Zr_2O_3 (g/m^3)	19.2	15.3	33.1	17.4	15.1
TiO_2 (g/m^3)	1,038.6	589.4	1,448.1	385.1	197.9

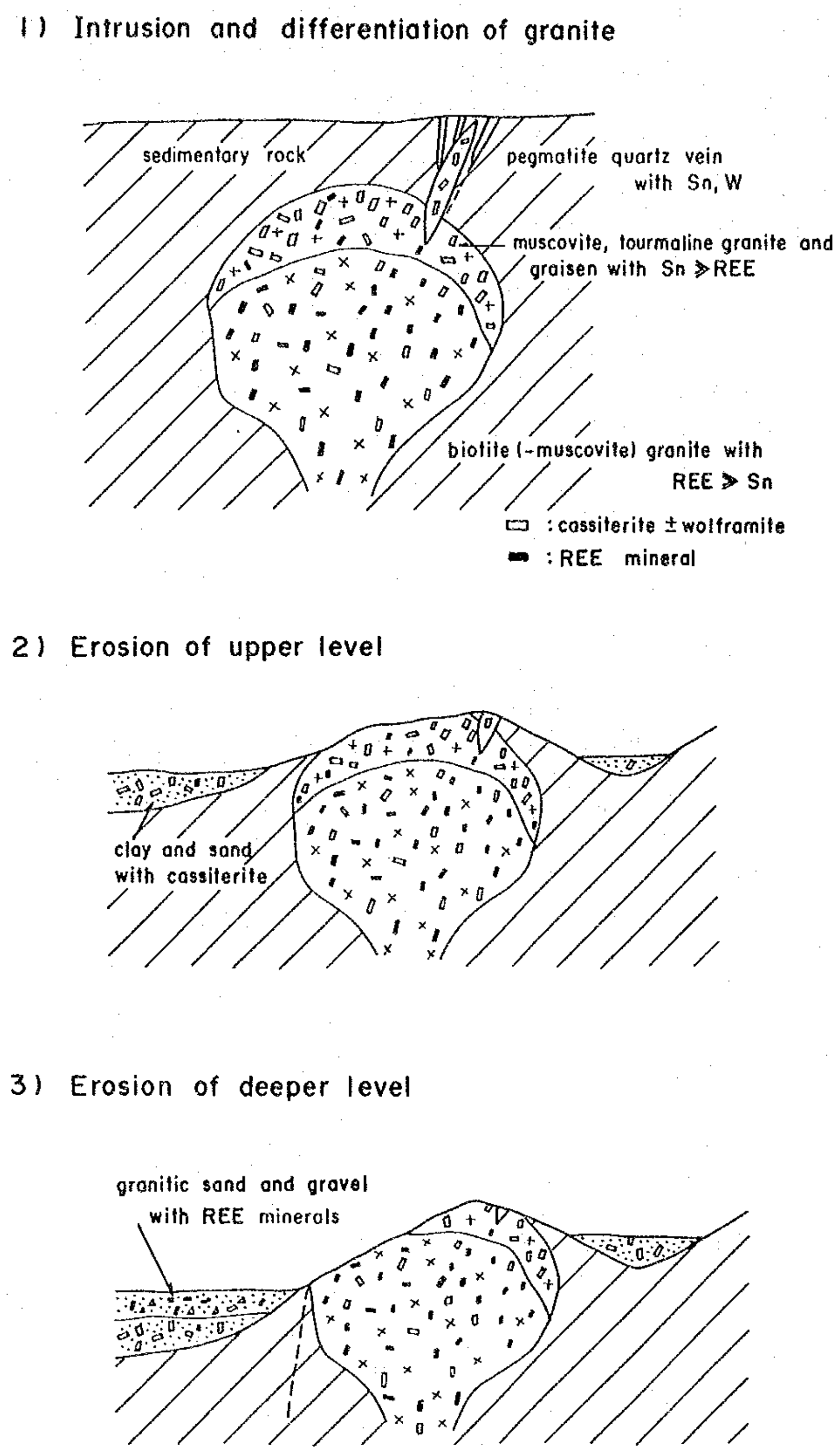


Fig. 15 Schematic profile relating the minaralization of cassiterite and rare earth minerals

Chapter 2 Area D-1, Drilling Survey

2-1 Selection of Location

The Area D-1 is situated in the junction of the Khlong Kra Buri and Khlong La-Un, where is an alluvial swamp area covered by mangrove expanding about 2 kilometers width in between highway No.4 and the Mae Nam Kra Buri.

The second phase survey revealed that this area was in favorable geological environment and had high potential for secondary ores, even though no high soil geochemical anomaly was found.

The drilling survey has been conducted to confirm the shape of the sedimentary basin and to know its state of expected secondary ores in the bottom of the basin, using Banka Drill machine owned by DMR, Thailand.

Three survey lines tending northwest to southeast at the space of 144 meters, along the second phase survey base lines to cover the mangrove area. Two other lines perpendicular to the survey lines have been set at the off-shore area (Fig. 16). The sampling method is just same as that applied in the Area A-1.

Total 16 drill holes have been completed in the area. Geologic profiles in this area are shown in Figure 17 and 18.

2-2 Geology of Drill Holes

(1) KBD-01; depth 14.0 m, El. 8.0 m

The pit has been located in the clayey margin facies zone of the southern granite body. The upper part above the depth of 10.4 meters apparently consists of weathered residual materials of granite, and the below consists of kaolinized granite.

The top zone from the surface to the depth of 1.2 meters consists of brown silty soil containing small amounts of fine sands.

The second zone at the depth from 1.2 to 5.5 meters consists of reddish brown clay mixed with small amounts of lateritic soil.

The third zone at the depth from 5.5 to 6.7 meters consists of red lateritic soil and medium felsic sands, which are weathered granite.

D

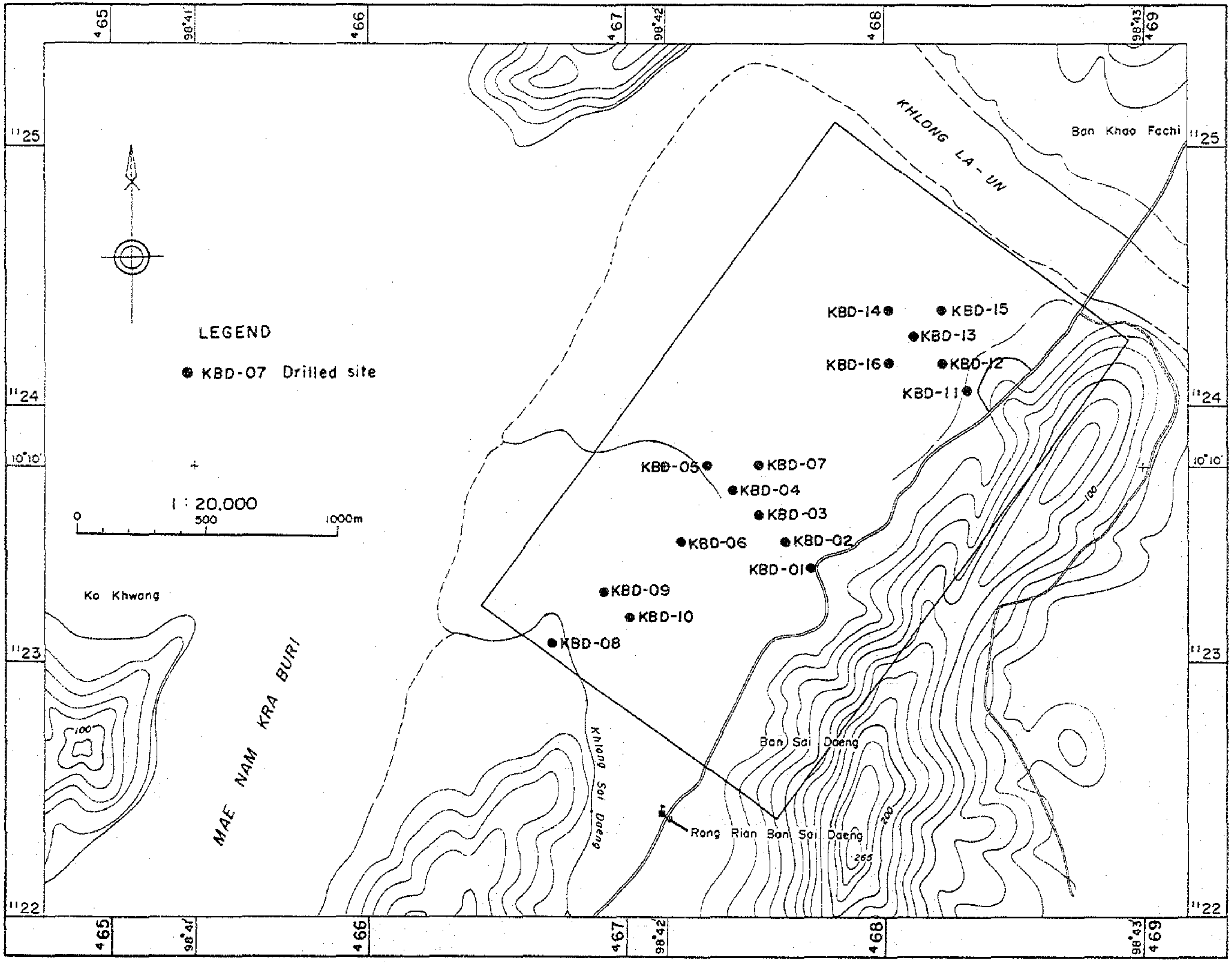


Fig. 16 Locality map of drilling survey in Area D-1

(I)

(J)

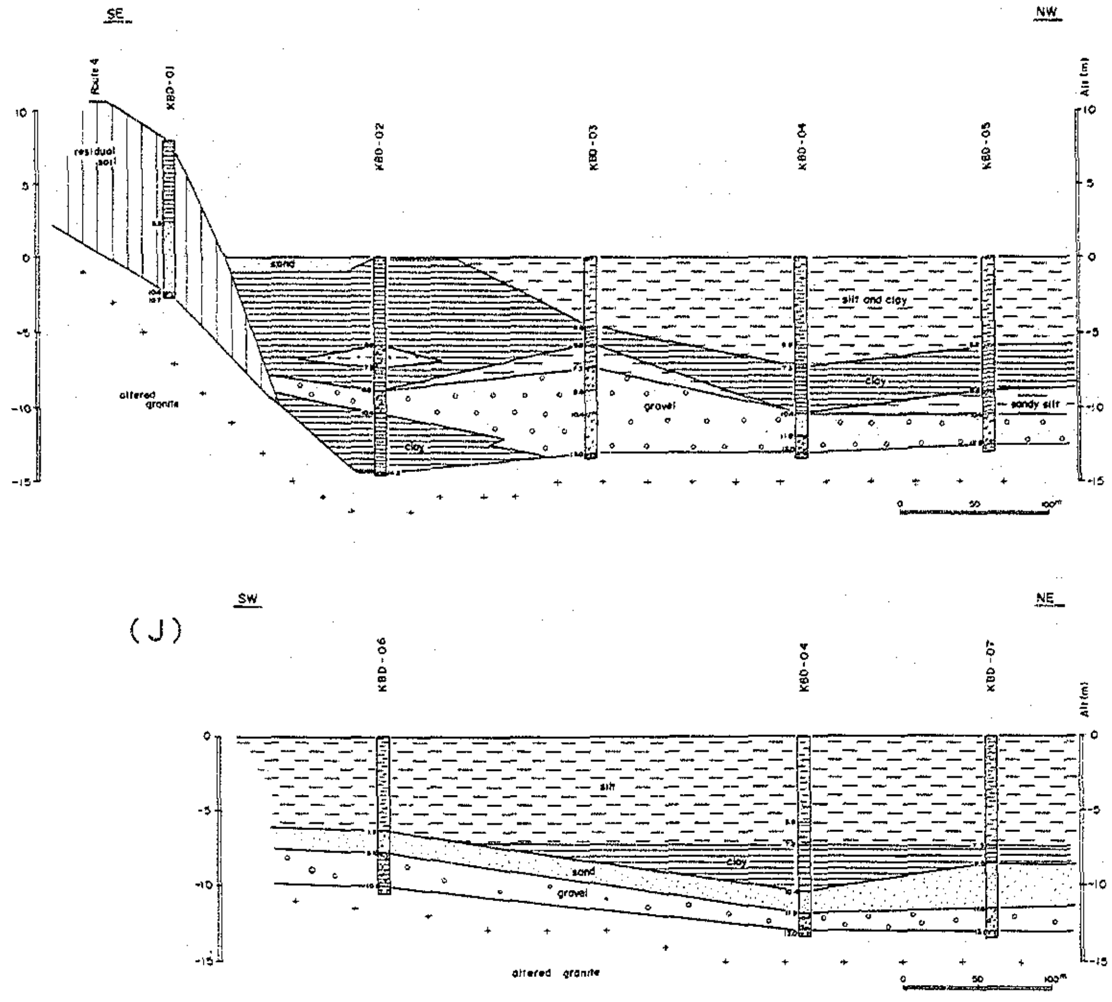


Fig. 17 Geologic profile in Area D-1 (1)

The fourth zone from the depth of 6.7 meters to the bottom, 10.4 meters in depth, consists of medium felsic sands containing reddish brown silty soil.

Sampling and panning have been performed for every zone, however, the total sample weight obtained was only 3.5 grams. All samples, therefore, were assembled in one, and assayed.

The assay results of the sample are as follows.

SnO_2	; 0.01 g/m^3
Ta_2O_5	; 0.04 g/m^3
Nb_2O_5	; 0.01 g/m^3
TR_2O_3	; 9.3 g/m^3
ThO_2	; 1.2 g/m^3
Zr_2O_3	; 0.95 g/m^3
TiO_2	; 6.2 g/m^3

(2) KBD-02; depth 14.0 m, El. 0.1 m

It has been confirmed that the alluvium in this hole divided into seven zones, and the basement rock consisting of weathered, white argillized granite were seen at the bottom.

The top zone from the surface to the depth of 1.5 meters consists of gray clay, mangrove soil.

The second zone at the depth from 1.5 to 3.0 meters consists of brownish gray hard clay containing medium sands.

The third zone at the depth from 3.0 to 5.8 meters consists of brownish gray hard clay containing a little sand.

The fourth zone at the depth from 5.8 to 7.3 meters consists of gray clay containing medium sands and small amounts of scattering granules.

The fifth zone at the depth from 7.3 to 8.8 meters consists of gray soft clay.

The sixth zone at the depth from 8.8 to 10.3 meters consists of gray clay containing medium sands and small amounts of scattering granules.

The bottom zone from the depth of 10.3 meters to the bottom, 14.0 meters in depth, consists of gray clay partly containing medium to coarse sands.

The samples for assay have been assembled to five, one from the top and second zones, one from the third zone, one from the fourth and fifth zone, one from the sixth zone, and one from the bottom zone, because of fewer amounts of heavy minerals.

The assay results of these five samples are as follows.

SnO_2	; 0.05 to 2.0 g/m^3
Ta_2O_5	; 0.05 to 0.5 g/m^3
Nb_2O_5	; 0.05 to 1.5 g/m^3
TR_2O_3	; 19.5 to 31.8 g/m^3
ThO_2	; 2.6 to 4.3 g/m^3
Zr_2O_3	; 2.3 to 5.0 g/m^3
TiO_2	; 58 to 159 g/m^3

The samples from the top, fourth, and fifth show high values in rare earths, thorium, zirconium, and titanium.

(3) KBD-03; depth 12.8 m, El. 0.0 m

It has been confirmed that the alluvium in this hole was divided into seven zones, and the basement rocks consisting of weathered meta-sedimentary rocks were seen at the bottom.

The top zone from the surface to the depth of 1.5 meters consists of brown silty soil containing small amounts of fine sands.

The second zone at the depth from 1.5 to 4.6 meters consists of gray silty soil containing small amounts of fine sands. The constituent materials are almost same as those of the top zone, but the color is different. This is the surface mangrove soil.

The third zone at the depth from 4.6 to 5.8 meters consists of brownish gray hard clay containing small amounts of lateritic soil. Euhedral spherical crystals of siderite and biological origin pyrite are seen under the microscope. Siderite is seen in the underneath zone at the depth from 5.8 to 7.3 meters and another hole KBD-04, at the depth from 5.8 to 10.8 meters. Biological origin pyrite is commonly seen in the muddy parts of all holes in the Area D-1, and most common minerals in heavy sands.

The fourth zone at the depth from 5.8 to 7.3 meters consists of gray clay containing medium sands, and siderite and pyrite grains.

The fifth zone at the depth from 7.3 to 8.8 meters consists of gray silty soil containing medium sands and small amounts of quartz granules. Pyrite is common in heavy minerals.

The sixth zone at the depth from 8.8 to 10.3 meters consists of medium sands containing small amounts of gray silt.

The bottom zone from the depth of 10.3 meters to the bottom, 12.8 meters in depth, is a sand and gravel layer consisting of quartz vein, aplite, etc. accompanied by small amounts of white clay. Heavy minerals are less in this zone.

The samples for assay have been assembled to four, one from the top and second zone, one from the fifth, seventh, and bottom zones, and others from each zone, because of less amount of heavy minerals.

The assay results show fewer contents for the elements, however the contents are much different in between the upper and lower parts bounded by the depth of 5.8 meters.

(4) KBD-04; depth 13.0 m, El. 0.0 m

It has been confirmed that the alluvium in this hole was divided into five zones, and the basement rocks consisting of weathered brown argillized granite were seen.

The top zone from the surface to the depth of 5.8 meters consists of gray clayey soil containing small amounts of fine sands. This zone is of the surface mangrove soil. Two samples for assay have been collected from this zone, because this zone was thick.

The second zone at the depth from 5.8 to 7.3 meters consists of gray clay containing medium sands.

The third zone at the depth from 7.3 to 10.3 meters consists of brownish gray hard clay containing brown euhedral siderite crystals and biological origin pyrite crystals.

The fourth zone at he depth from 10.3 to 11.9 meters consists of medium sands containing small amounts of gray clay.

The bottom zone from the depth of 11.9 meters to the bottom, 13.0 meters in depth, is a white sand and gravel layer containing granules of quartz vein, aplite, etc., and accompanied by small amounts of clay. Heavy minerals are less in this zone.

The assay results of this hole are as follows.

in the zones below the depth of 5.7 m

SnO_2 ; 2.5 to 16.9 g/m^3
TR_2O_3 ; 15 to 30 g/m^3
ThO_2 ; 2.1 to 5.9 g/m^3
Zr_2O_3 ; 22.0 to 59.6 g/m^3

in the zones below the depth of 3.1 m

TiO_2 ; 112 to 308 g/m^3

Tin, rare earths, and zirconium are high in the zones below the depth of 7.3 meters, and titanium is highest in the second zone.

(5) KBD-05; depth 12.5 m, El. 0.0 m

This hole has been located nearest to the river side in the survey lines.

It has been confirmed that the alluvium was divided into five zones, and the basement rocks consisting of weathered brown argillized granite were seen at the bottom.

The top zone from the surface to the depth of 5.8 meters consists of brownish gray clayey soil containing very small amounts of fine sands. The lower part of this zone contains biological origin pyrite crystals. Two samples for assay have been collected from this zone, because this zone was thick.

The second zone at the depth from 5.8 to 8.8 meters consists of brownish gray hard clay containing brown euhedral spherical siderite crystals.

The third zone at the depth from 8.8 to 10.4 meters consists of gray clay containing medium sands.

The fourth zone from the depth of 10.4 meters to the bottom, 12.5 meters in depth, is a white sand and gravel layer accompanied by small amounts of clay, containing granules of quartz vein, aplite, etc. The lower part below the depth of 11.9 meters contains larger granules.

The assay results of this hole are as follows.

in the two samples from the bottom sand and gravel zone

SnO_2	; 6.6 to 29.3 g/m^3
TR_2O_3	; 25 to 34 g/m^3
ThO_2	; 3.3 to 4.3 g/m^3
Zr_2O_3	; 25.0 to 42.4 g/m^3
TiO_2	; 183 to 248 g/m^3

The other zones show low values.

(6) KBD-06; depth 10.1 m, El. 0.0 m

This hole is situated 288 meters southwest of KBD-04.

It has been confirmed that the alluvium in this hole was divided into four zones, and the basement rocks consisting of weathered deep brown granite were seen at the bottom.

The top zone from the surface to the depth of 4.3 meters consists of gray clayey soil containing fine sands. The lower part of this zone, from 2.7 to 4.3 meters in depth, contains more amounts of sands than those in the upper part. Two samples for assay have been collected from this zone.

The second zone at the depth from 4.3 to 7.3 meters consists of brownish gray silty soil containing fine sands. This zone contains more sands than those in the top zone.

The third zone at the depth from 7.3 to 8.8 meters consists of medium sands containing gray silt, clay, and small amounts of quartz granules.

The bottom zone from the depth of 8.8 meters to the bottom, 10.1 meters in depth, consists of brownish gray clay containing much coarse sands mixed with small amounts of quartz granules.

Large amounts of biological origin pyrite crystals are seen from the top to the bottom in this hole, and the grains of quartz, feldspar, and heavy minerals are well rounded and small in diameter.

The assay results of this hole are as follows.

in the upper two zones

SnO_2	; 0.47 to 0.52 g/m^3
TR_2O_3	; 1.4 to 1.8 g/m^3
ThO_2	; 0.19 to 0.23 g/m^3
Zr_2O_3	; 4.2 to 4.8 g/m^3
TiO_2	; 17 to 23 g/m^3

in the lower three zones

SnO_2	; 2.6 to 6.8 g/m^3
TR_2O_3	; 33 to 85 g/m^3
ThO_2	; 0.7 to 4.1 g/m^3
Zr_2O_3	; 1.0 to 4.0 g/m^3
TiO_2	; 51 to 177 g/m^3

Tin, rare earths, and titanium are relatively high in the lower three zones, however lower than those in KBD-05.

(7) KBD-07; depth 13.1 m, El. 0.0 m

This hole is situated 144 meters northeast of KBD-04.

It has been confirmed that the alluvium in this hole was divided into four zones, and the basement rocks consisting of weathered white argillized granite were seen at the bottom.

The top zone from the surface to the depth of 7.3 meters consists of gray silt and clay containing fewer amounts of fine sands and very small amounts of biological origin pyrite crystals.

The second zone at the depth from 7.3 to 8.5 meters consists of gray clay containing medium sands.

The third zone at the depth from 8.5 to 11.6 meters consists of coarse felsic sands containing gray silt and clay, coarser in the lower part.

The fourth zone from the depth of 11.6 meters to the bottom, 13.1 meters in depth, is a sand and gravel layer mainly consisting of rounded quartz granules and pebbles.

The assay results of this hole are as follows.

in the upper silt and clay zones

SnO_2	; 0.08 to 0.77 g/m^3
TR_2O_3	; 0.5 to 9.2 g/m^3
ThO_2	; 0.07 to 1.16 g/m^3
Zr_2O_3	; 0.4 to 6.7 g/m^3
TiO_2	; 7 to 119 g/m^3

in the lower sand, and sand and gravel zones

SnO_2	; 7.3 to 37.3 g/m^3
TR_2O_3	; 11.5 to 16.4 g/m^3
ThO_2	; 1.28 to 2.31 g/m^3
Zr_2O_3	; 29.4 to 39.9 g/m^3
TiO_2	; 114 to 140 g/m^3

Tin and zirconium are high in the lower zones, but all elements are low in the upper zones.

(8) KBD-08; depth 7.3 m, El. 0.0 m

This hole was planed to know the state of the sedimentary basin around the Khlong Sai Deang as well asKBD-09 and KBD-10. KBD-08 and KBD-09 are situated in the extension of the line connecting KBD-04 and KBD-06. KBD-10 is situated in between KBD-09 and the land area.

It has been confirmed that the alluvium in this hole was divided into two zones, and the basement rocks consisting of schistose meta-mudstone were seen at the bottom.

The top zone from the surface to the depth of 2.7 meters consists of gray silt and clay containing fine sands.

The bottom zone from the depth of 2.7 meters to the bottom consists of brownish gray clay containing coarse sands.

The assay results of the hole are as follows.

SnO_2	; 0.04 to 0.24 g/m^3
TR_2O_3	; 6.0 to 17.6 g/m^3
ThO_2	; 0.73 to 2.57 g/m^3
Zr_2O_3	; 1.7 to 6.1 g/m^3
TiO_2	; 7.8 to 15.5 g/m^3

All elements are low in this hole.

(9) KBD-09; depth 11.6 m, El. 0.0 m

It has been confirmed that the alluvium in this hole was divided into five zones, and the basement rocks consisting of weathered granite were seen at the bottom.

The top zone from the surface to the depth of 2.7 meters consists of gray silt and clay containing fine sands.

(K)

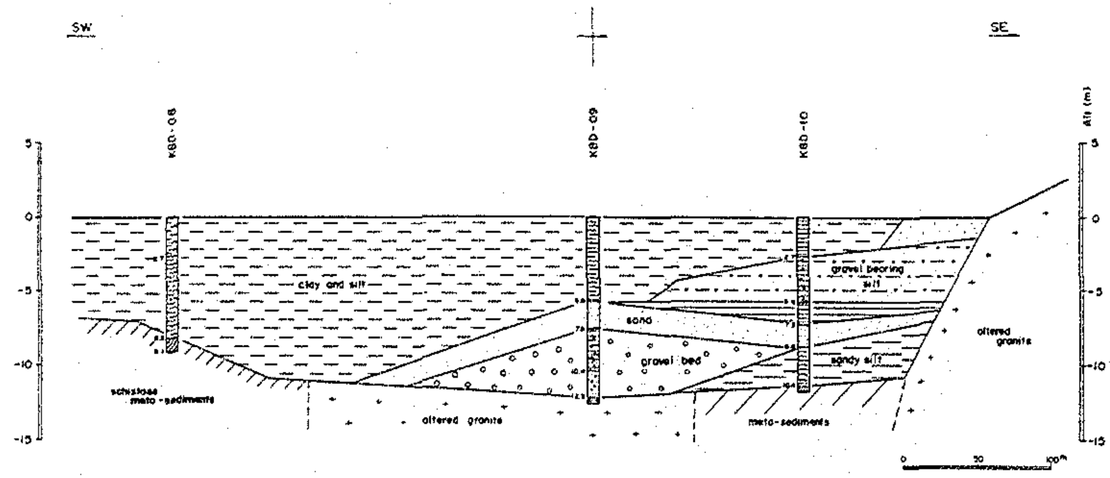


Fig. 18 Geologic profile in Area D-1 (2)

The second zone at the depth from 2.7 to 5.8 meters consists of gray clay containing fine to medium sands. The top and second zones contain many biological origin pyrite crystals.

The third zone at the depth from 5.8 to 7.6 meters consists of medium felsic sands containing gray clay.

The fourth zone at the depth from 7.6 to 10.4 meters consists of gray clay containing coarse felsic sands and rounded quartz granules.

The bottom zone from the depth of 10.4 meters to the bottom, 11.6 meters in depth, is a white sand and gravel layer consisting of coarse felsic sands and rounded quartz granules.

The assay results of this hole are as follows.

in the upper silt and clay zone

SnO_2 ; 0.06 to 0.09 g/m^3
TR_2O_3 ; 1.8 to 4.1 g/m^3
Zr_2O_3 ; 0.8 to 1.5 g/m^3
TiO_2 ; 21 to 31 g/m^3

in the middle sands zone

SnO_2 ; 0.27 g/m^3
TR_2O_3 ; 129 g/m^3
ThO_2 ; 24.6 g/m^3
Zr_2O_3 ; 22.5 g/m^3
TiO_2 ; 316 g/m^3

in the clay containing sand and granules zone

SnO_2 ; 0.16 to 0.25 g/m^3
TR_2O_3 ; 58.0 to 80.9 g/m^3
ThO_2 ; 11.1 to 14.5 g/m^3
Zr_2O_3 ; 11.8 to 13.2 g/m^3
TiO_2 ; 141 to 322 g/m^3

in the sand and gravel zone

SnO_2 ; 5.14 g/m^3
TR_2O_3 ; 256 g/m^3
ThO_2 ; 55.5 g/m^3
Zr_2O_3 ; 39.2 g/m^3
TiO_2 ; 636 g/m^3

Rare earths, thorium, zirconium, and titanium are high in the middle sands zone and bottom sand and gravel zone. The zone in between these two shows relatively high values.

(10) KBD-10; depth 10.4 m, El. 0.0 m

It has been confirmed that the alluvium in this hole was divided into five zones, and the basement rocks consisting of brownish gray shale were seen at the bottom.

The top zone from the surface to the depth of 2.7 meters consists of gray silty clay.

The second zone at the depth from 2.7 to 5.8 meters consists of gray sandy clay containing granules.

The third zone at the depth from 5.8 to 7.3 meters consists of brownish gray clay containing small amounts of sands.

The fourth zone at the depth from 7.3 to 8.8 meters consists of gray sandy clay containing much amounts of quartz granules.

The bottom zone from the depth of 8.8 meters to the bottom, 10.4 meters in depth, consists of brownish gray consolidated clay.

The assay results of this hole are as follows.

in the second, third, and bottom zones

SnO_2	; 0.16 to 0.47 g/m^3
TR_2O_3	; 41.5 to 79.3 g/m^3
ThO_2	; 7.2 to 15.3 g/m^3
Zr_2O_3	; 7.3 to 10.2 g/m^3
TiO_2	; 233 to 270 g/m^3

in the fourth clay mixed with granules zone

SnO_2	; 0.47 g/m^3
TR_2O_3	; 202 g/m^3
ThO_2	; 38.6 g/m^3
Zr_2O_3	; 27.5 g/m^3
TiO_2	; 529 g/m^3

The fourth zone shows high values, and other zones except the top show relatively high.

Six holes, KBD-11 to KBD-16, have been planed to know the state of the alluvium near by the Khlong La-Un. KBD-11, -12, -13, and -14 have been arrayed 144 meters apart from southeast to northwest. KBD-15 is situated northeast of KBD-13, and KBD-16 is southwest of KBD-13.

(11) KBD-11; depth 8.8 m, El. 0.2 m

It has been confirmed that the alluvium in this hole was divided into three zones, and the basement rocks consisting of weathered brownish gray argillized granite were seen at the bottom.

The top zone from the surface to the depth of 5.8 meters consists of gray clay containing fine sands.

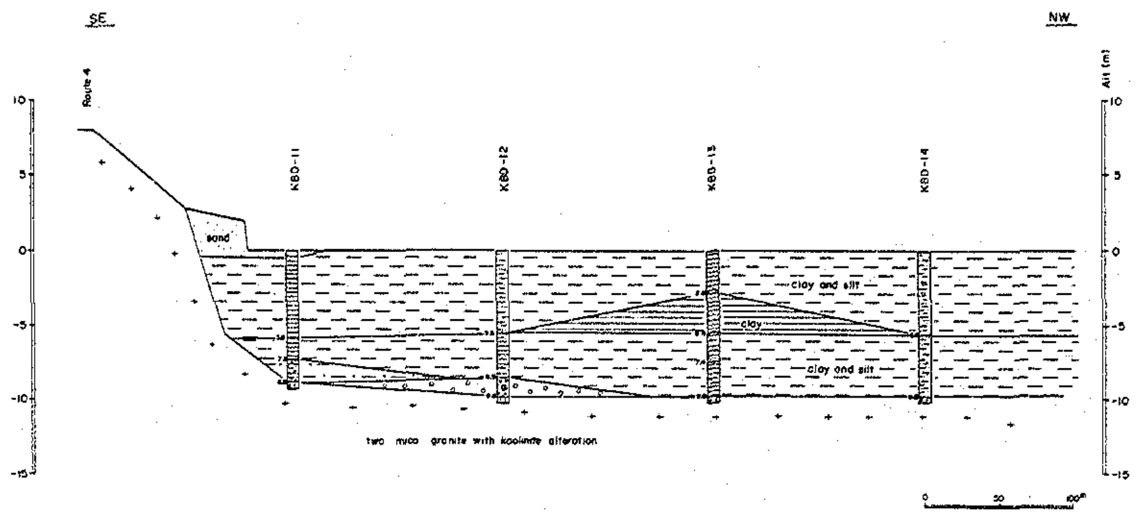
The second zone at the depth from 5.8 to 7.3 meters consists of brownish gray clay containing medium sands.

The bottom zone from the depth of 7.3 meters to the bottom, 8.8 meters in depth, consists of brownish gray clay containing much amounts of coarse sands, and certain amounts of quartz fragments.

The assay results of this hole are as follows.

SnO_2 ; 0.21 to 0.77 g/m^3

(L)



(M)

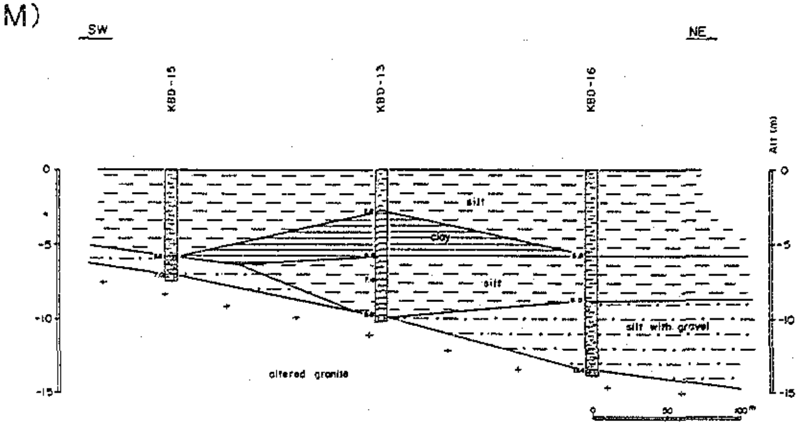


Fig. 19 Geologic profile in Area D-1 (3)

TR_2O_3	; 12.5 to 66.5 g/m^3
ThO_2	; 1.5 to 4.3 g/m^3
Zr_2O_3	; 3.2 to 7.0 g/m^3
TiO_2	; 233 to 270 g/m^3

Titanium is generally high, and rare earths are relatively high in this hole.

(12) KBD-12; depth 9.8 m, El. 0.0 m

It has been confirmed that the alluvium in this hole was divided into four zones. However, it is hard to judge whether the bottom zone is of redepositional residual weathering residual sediments or in-site weathered granite. The basement rocks consisting of white altered, kaolinized, coarse grain granite were confirmed at the bottom of the hole.

The top zone from the surface to the depth of 2.7 meters consists of gray silt and clay containing small amounts of fine sands.

The second zone at the depth from 2.7 to 5.5 meters consists of gray silt and clay containing coarse sands.

The third zone at the depth from 5.5 to 8.5 meters consists of gray clay containing coarse sands.

The bottom zone from the depth of 8.5 meters to the bottom, 9.8 meters in depth, mainly consists of brown clay containing coarse sands and granules of granite, quartz, feldspar, etc. As mentioned before, it is possible that this zone is of in-site granite. It has been judged, however, that the zone was of redepositional residual weathering residual sediments, because the boundary between the zone and underlying hard granite was very clear.

The assay results of this hole are as follows.

in the top silt and clay zone

SnO_2	; 0.31 g/m^3
TR_2O_3	; 10.6 g/m^3
ThO_2	; 0.93 g/m^3
Zr_2O_3	; 2.49 g/m^3
TiO_2	; 74.9 g/m^3

in the second silt and clay zone

SnO_2	; 0.66 g/m^3
TR_2O_3	; 16.4 g/m^3
ThO_2	; 1.68 g/m^3
Zr_2O_3	; 4.47 g/m^3
TiO_2	; 121 g/m^3

in the third clay zone

SnO_2	; 0.15 g/m^3
TR_2O_3	; 2.25 g/m^3
ThO_2	; 0.34 g/m^3

Zr_2O_3 ; 1.12 g/m^3
TiO_2 ; 23.9 g/m^3

in the bottom residual sediments zone

SnO_2 ; 1.00 g/m^3
TR_2O_3 ; 46.0 g/m^3
ThO_2 ; 5.74 g/m^3
Zr_2O_3 ; 13.8 g/m^3
TiO_2 ; 350 g/m^3

The third zone shows the lowest values.

(13) KBD-13; depth 9.8 m, El. 0.0 m

It has been confirmed that the alluvium in this hole was divided into four zones, and the basement rocks consisting of weathered brownish gray granite were seen at the bottom.

The top zone from the surface to the depth of 2.7 meters consists of gray clay containing fine sands.

The second zone at the depth from 2.7 to 5.8 meters consists of gray soft clay containing much amounts of coarse grain pyrite crystals.

The third zone at the depth from 5.8 to 7.3 meters consists of gray clay containing medium sands.

The bottom zone from the depth of 7.3 meters to the bottom, 9.8 meters in depth, consists of brownish gray clay mixed with silt, containing coarse sands. Iron oxides cohere the sediments.

The assay results show that cerium group elements and titanium are a little high in the bottom zone, but values of almost all zones are less than 1.0 g/m^3.

(14) KBD-14; depth 9.8 m, El. 0.0 m

It has been confirmed that the alluvium in this hole was divided into two zones, and the basement rocks consisting of weathered granite were seen at the bottom.

The upper zone from the surface to the depth of 5.8 meters consists of gray silt and clay containing small amounts of fine sands.

The lower zone from the depth of 5.8 meters to the bottom consists of gray silt and clay containing small amounts of medium to coarse sands.

The assay results of this hole are as follows.

in the upper and lower zones

Zr_2O_3 ; 33.1 to 39.8 g/m^3
TiO_2 ; 73 to 164 g/m^3

The other elements show quite low values, less than 9.

(15) KBD-15; depth 7.0 m, El. 0.0 m

It has been confirmed that the alluvium in this hole was divided into two zones, and the basement rocks consisting of weathered white granite were seen at the bottom.

The upper zone from the surface to the depth of 5.8 meters consists of gray silt and clay containing small amounts of fine sands. This zone contains many amounts of pyrite granules.

The lower zone from the depth of 5.8 meters to the bottom consists of brownish gray very hard clay containing small amounts of coarse sands.

The assay results show that values of all elements except titanium are quite low.

(16) KBD-16; depth 13.4 m, El. 0.0 m

It has been confirmed that the alluvium in this hole was divided into three zones, and the basement rocks consisting of weathered brown granite were seen at the bottom.

The top zone from the surface to the depth of 5.8 meters consists of gray silt and clay containing small amounts of fine sands.

The middle zone at the depth from 5.8 to 8.8 meters consists of gray silt and clay containing small amounts of fine sands and scattered shell fragments.

The bottom zone from the depth of 8.8 meters to the bottom, 13.4 meters in depth, consists of gray soft water bearing clay containing small amounts of fine sands and scattering shell fragments. The core recovering rate in this zone has been relatively low because of high water bearing.

The assay results show that values of all elements except zirconium and titanium in the lower zone are quite low.

2-3 Discussion

No significant geochemical anomaly, except a small area of high rare earths content, has been found in the Area D-1 in the second phase survey, because the area is extensively underlain by mangrove soil. However, high potential for secondary ores underneath mangrove soil was expected, because secondary ores are situated in the east side of the southern granite body and 10 kilometers south of the area.

The drilling survey results have revealed that the sediments in the basin increased its thickness in the boundary zone to the land area, and the base of the basin formed a flat plain at the depth of 10 to 14 meters. It seems that the topography is of abrasion or wave erosion platform by coastal erosion. This is much different from the underground structure presumed in the second phase survey, gently dipping toward the Mae Nam Kra Buri. The sand and gravel layer and sands layer overlaying the basement are 3.5 to 5.5 meters thick around KBD-03 and KBD-09. However no sand and gravel layer exists around KBD-08 and KBD-11. The sand and gravel layer is distributed in the steep cliff along the edge of the basin, accordingly it is presumed that the sediments deposited under the talus environment. The area around KBD-01 to KBD-07 and KBD-09 to KBD-10 was probably under the coarse grained fragment sedimentation environment along an ancient river watershed judging from the surface topography. The sand and gravel layer and sands layer consist of felsic sands, granules, and pebbles containing granitic fragments, but fewer amounts of colored minerals.

The overlaying layer of the sand and gravel layer in the northeastern part and central to southeastern part of the Area D-1 consist of gray to dark gray silt and clay containing much amounts of organic origin pyrite. It is presumed that the sediments deposited under the calm reductional environment. The silt and sands layers overlaying the sands layer in an area around KBD-03 and KBD-04 contain much amounts of oolitic siderite grains

This phase survey has revealed that the coarse grained sands layer distributed along the boundary between the basin and land area, which was revealed by the second phase survey, is limited on the surface. The sands layer has been probably transported by the present river system and deposited after the sedimentation of mangrove soil. In the second phase survey, the sand layer was designated as a geochemical anomaly zone, due to its high rare earths content reflecting its background geochemical character. The ore reserve, accordingly, was estimated based on an assumption that the sands layer extended underneath the mangrove soil. This assumption is, of cause, not correct, and the ore reserve estimated in the second year is worthless.

The assay results show that all elements are low in grade over the Area D-1, and it is judged that potential for ores is low. High content of rare earths and titanium is seen only in the lower parts of KBD-09 and KBD-10. This is in the sand and gravel layer deposited in the ancient river system along the Khlong Sai Deang.

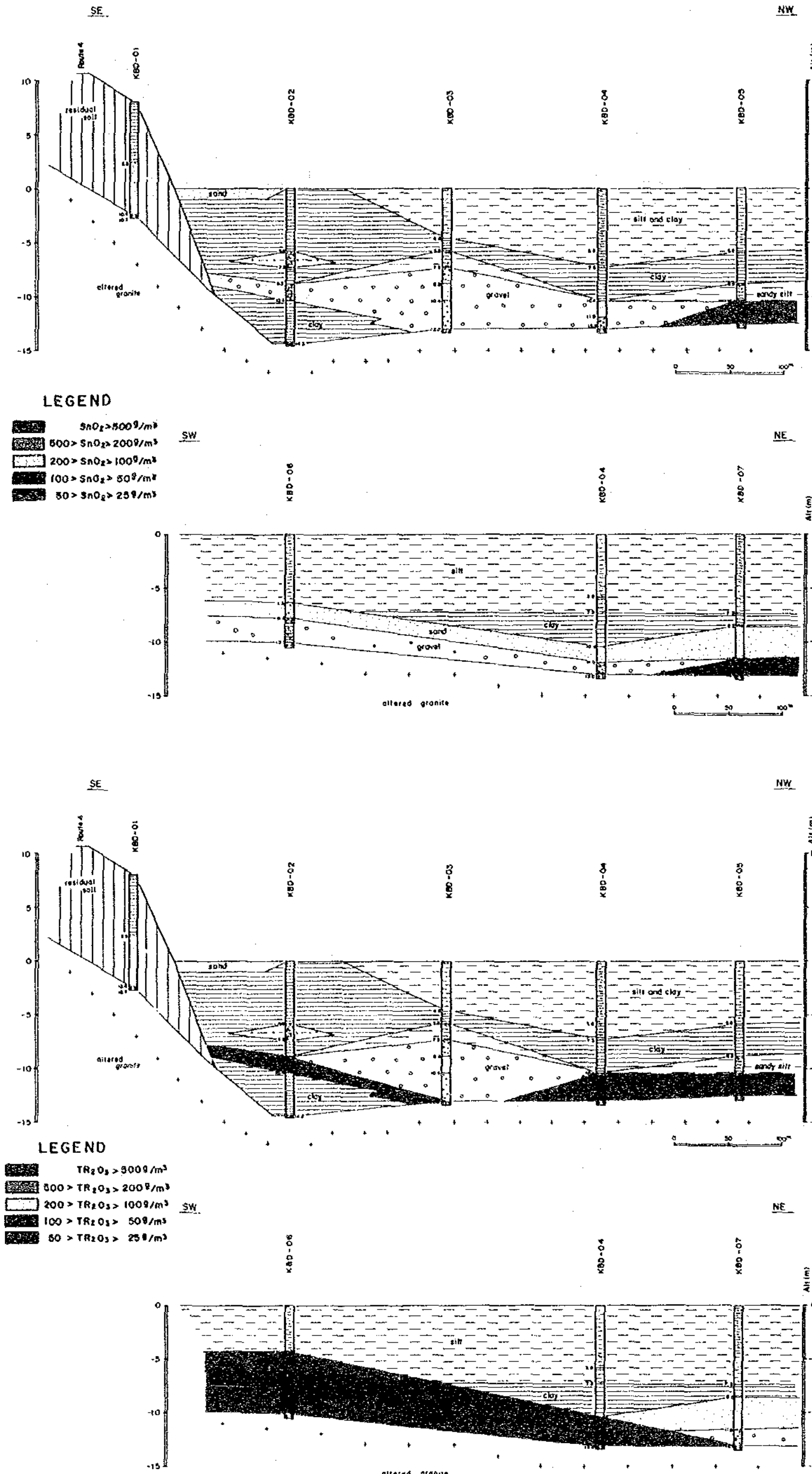


Fig. 20 Ore grade profile in Area D-1 (1)

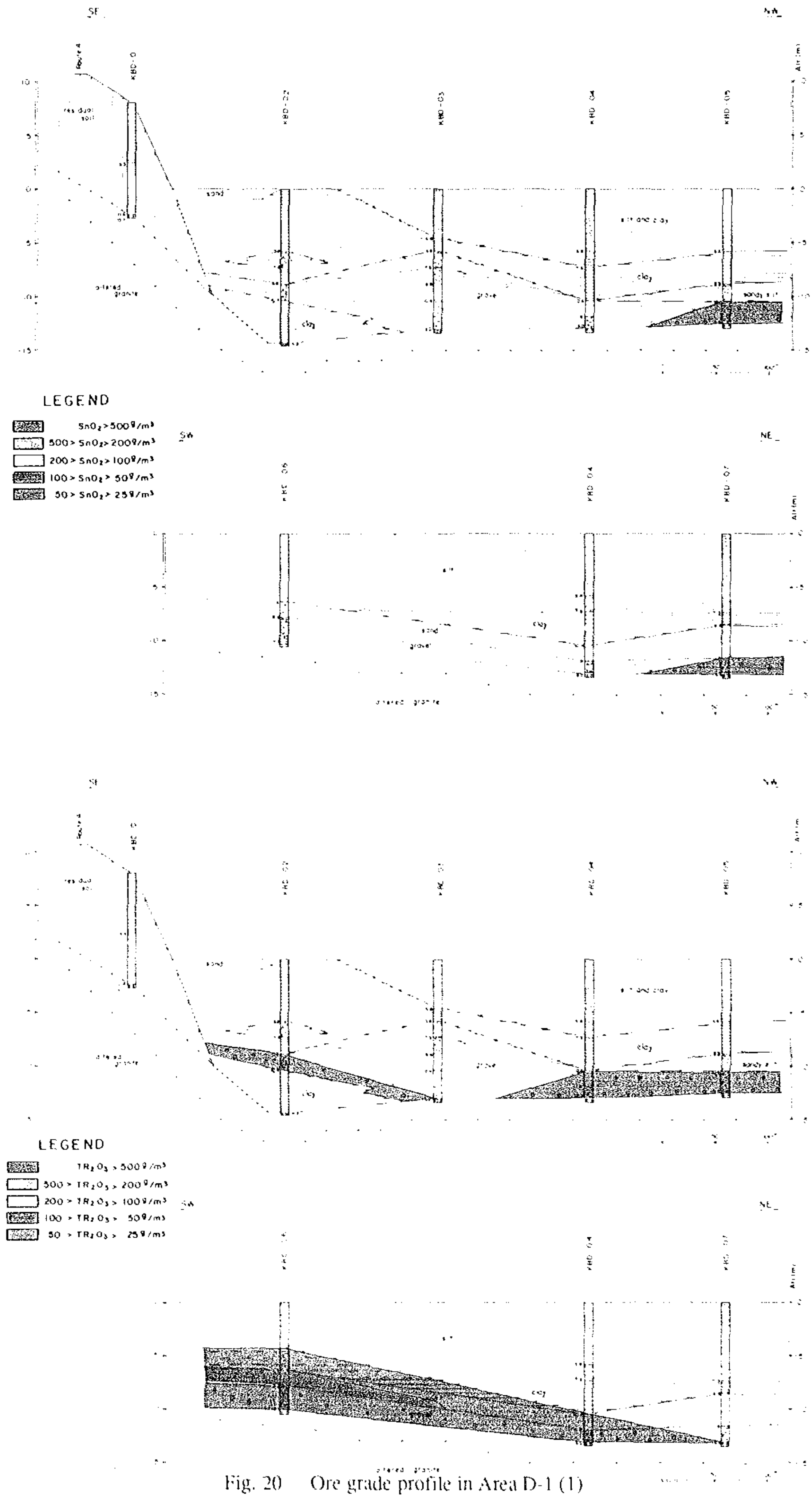


Fig. 20 Ore grade profile in Area D-1 (1)

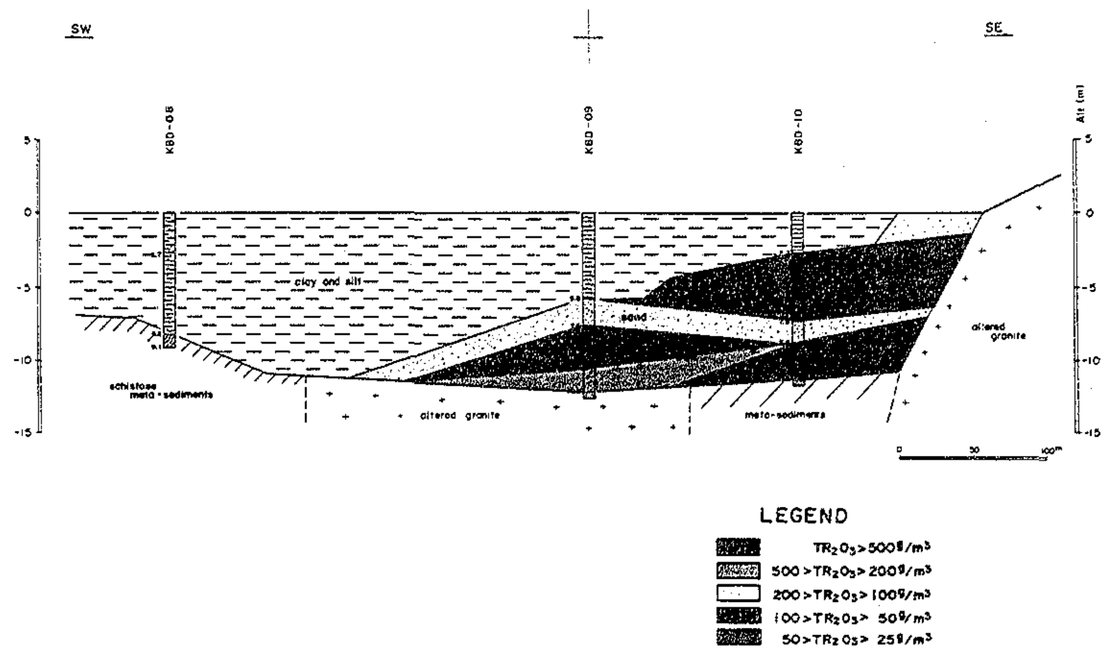


Fig. 21 Ore grade profile in Area D-1 (2)

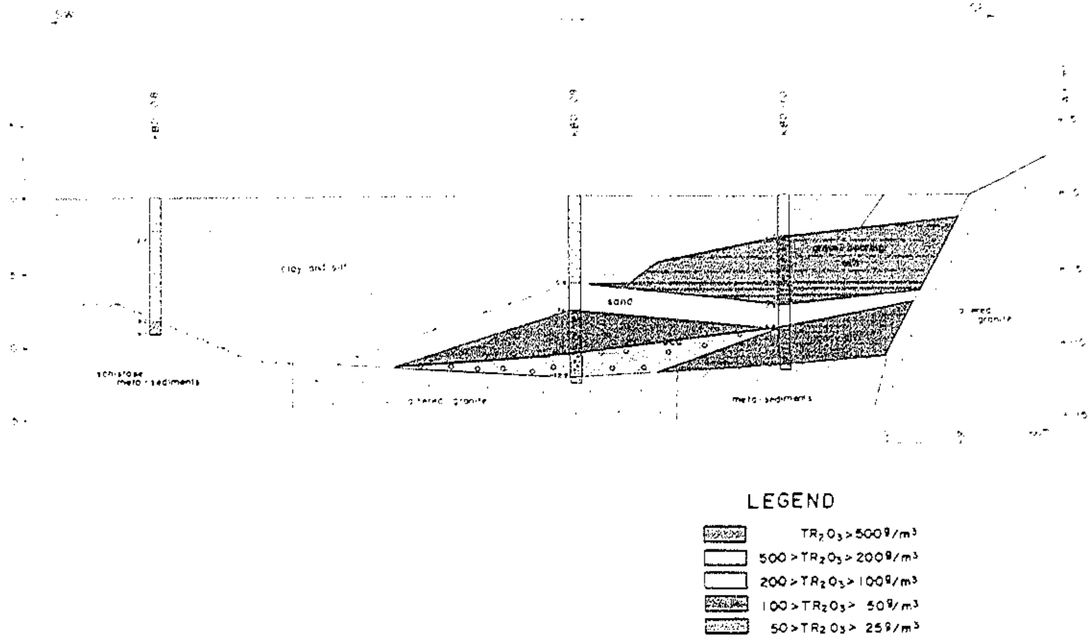


Fig. 21 Ore grade profile in Area D-1 (2)

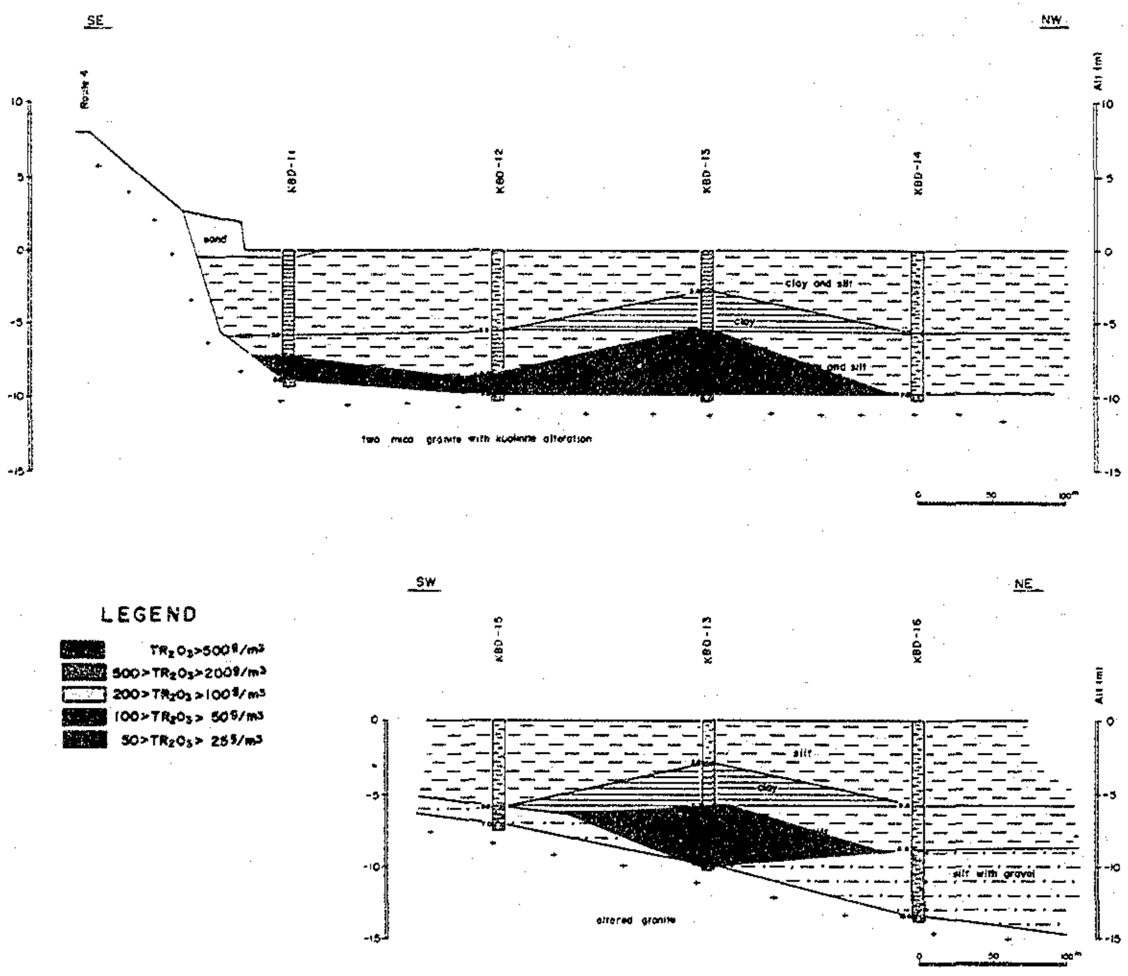


Fig. 22 Ore grade profile in Area D-1 (3)