(5) Non-metallic Ore Deposit

The pegmatite dykes, the host rock of mica deposits, are accompanied by veins of leucocratic granite, both of which are considered to belong to crystallization in the later stage of intrusion of foliated granite distributed to the west. The kyanite showings are also all distributed in the surrounding area of foliated granite mass. It is likely that the mineralization of mica and kyanite was brought about by the intrusion of the foliated granite.

3-6-3 Details of Mineralized Zones

(1) Alluvial Gold Deposit at Suam-Turkwel River

Location and Access:

The alluvial deposit is distributed from the vicinity of Korpu Camp in the lower stream of the Suam River through Turkwel Gorge to Twin Island in the Turkwel River.

A road for jeep or lorry leads from Kanyao near the western part of the survey area to Korpu Camp, and can be reached by two-hour drive. The road is closed in rainy season. The road distance between Nasalot and Twin Island, the eastern end of the placer, is 15 kilometers, which can be driven in one hour. A mountain path connects Korpu Camp and Twin Island, which is difficult for walking.

History and Outline:

The deposit was discovered in 1953, and it is recorded that 1,160.86 fine ounces of gold and 54.38 ounces of silver were produced during the period from 1953 to 1960. At present mining by panning is carried out from December to March

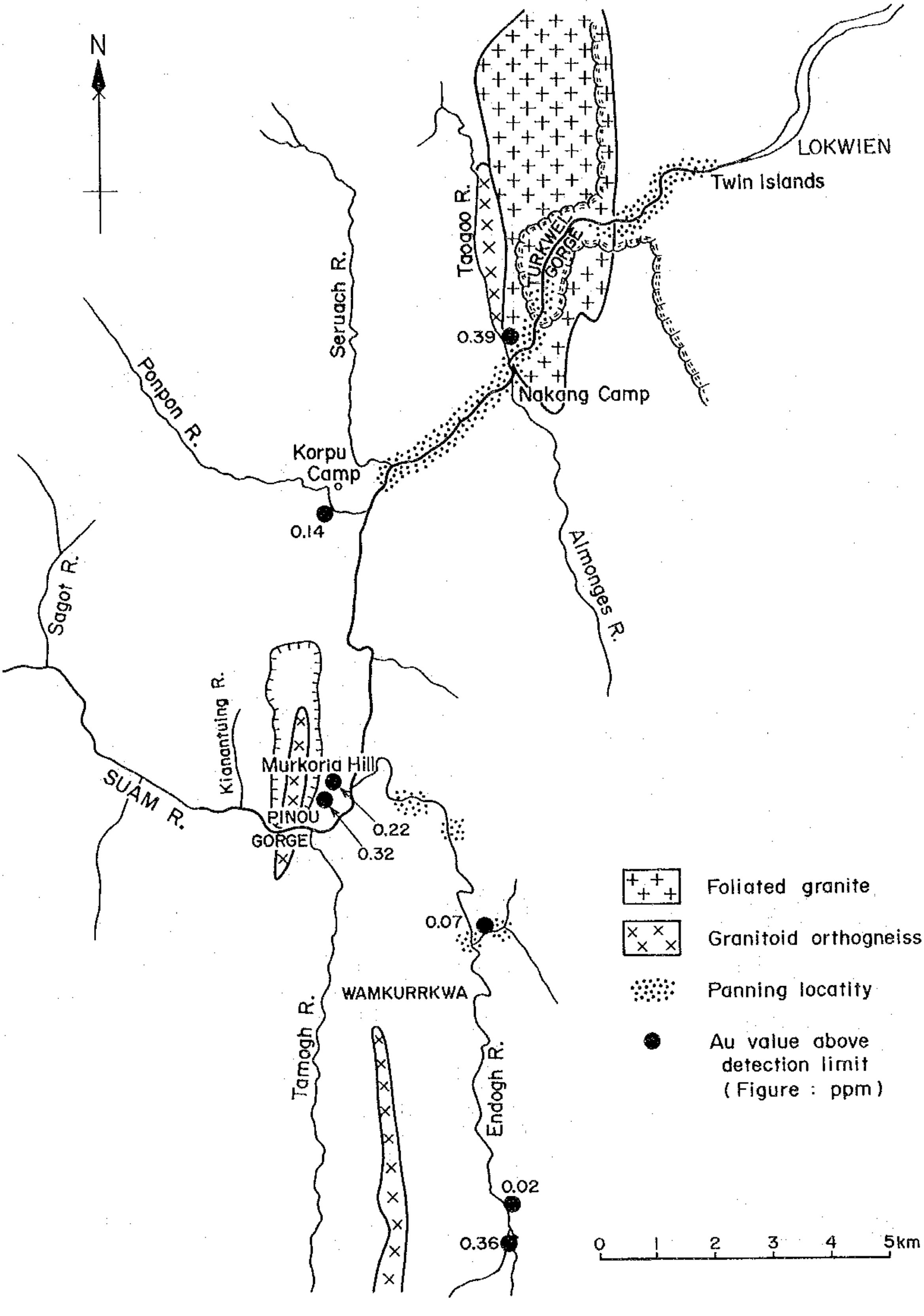


Fig. 3-15 Geological Sketch Map of Suam-Turkwel Alluvial Gold Area

when the river runs dry by unlicensed prospectors and local residents. It is said that the river is crowded by more than 2,000 panners in the season.

Geology and Ore Deposit:

These are compiled by McCall (1964) as follows.

(a) The alluvial gold is contained in gravel covered by surface sand, and the thickness of the surface sand is several feet.

(b) Gold is hardly found beyond Korpu in the upper reaches. The placer gold is distributed in a form of patch between Korpu and Nakang.

(c) A rich placer gold is also found in Turkwel Gorge, but it is not mined because of severe topography.

(d) Although the auriferous gravel beds are found in the lower reaches of Gorge, the grain size becomes finer gradually.

(e) The gold forms thin lenticular particles by abrasion, becoming smaller in size toward Twin Island in the lower reaches.

(f) The gold grain in the vicinity of Korpu Camp is bigger than that of the Kianantuing River which is considered to be the source of the former. It is because of the result of stretching out that the grain size in the vicinity of Korpu Camp became bigger. The grain size of the Kianantuing River is smaller because it has undergone less abrasion.

(g) The source of the placer gold can be attributed to granitoid gneiss of the Murkoria Hill which forms the Pinou Gorge. An assay value of aplite sheet in this gneiss showed 1.5 dwt/short ton Au.

Fig. 3-15 shows the distribution of the intrusive rocks in the surroundings of the deposit, the panning locality and the position where gold was detected by geochemical survey in the values above detection limit.

In the geochemical survey, the samples were collected at almost all the mouths of creek flowing into the Suam-Turkwel River in the upper reaches of the Turkwel Gorge in order to pursue the source of gold.

The result is shown in Table 3-2.

Table 3-2 Assay Result of Au in Suam-Turkwel Area

Sample No.	Au Content ppm	Location	Geology of Background
A-310	0.39	First eastern branch of Taogoo stream	Foliated granite
C-316	0.14	Small branch of Ponpon riv. near Korpu Camp	Gneiss, schist
F-29	0.32	Eastern slope of Murkorio	Granitoid orthogneiss
F-30	0.22	"	"
A-371	0.36	Western branch of middle stream of Endogh river	Granitoid ortho-gneiss, Gneiss, Schist
A-373	0.02	Small branch of Endogh riv.; middle stream	Gneiss, Schist
C-406	0.07	Eastern branch of lower stream of Endogh river	"

The result shows that the placer gold of the area has not always been brought from only one place of Murkorio Hill, but that it is also brought from the auriferous rock in the upper stream of the Endogh River and foliated granite on the eastern bank of the Taogoo River.

In the upper stream of the Endogh River, the eluvial gold deposit is distributed, where gold mining is actively carried out.

(2) Alluvial Gold Deposit at Marun River

Location and Access:

The main panning locality is between Wakorr and Marich Pass in the lower stream of the Marun River.

A paved road has been completed along the Marun River from Kapenguria to Lodwar, and the area is 100 kilometers apart from Kitale to be reached by one and half an hour drive.

History and Outline:

The deposit was discovered in early 1951, and the record of production shows that four private prospectors recovered 232.72 fine ounces of gold and 9.09 fine ounces of silver. Although Tharaka Mining Company operated in 1976, no record of production is available. At present, panning is being continued by the local resident on a small scale.

Geology and Ore Deposit:

Fig. 3-16 shows the distribution of the intrusive rocks in the surroundings of the deposit, the panning locality and the position where gold was detected by geochemical survey of this survey in the values above detection limit.

The occurrence of the placer gold is almost similar to that of the Suam-Turkwel River. Gold is markedly concentrated in the Marich Pass and becomes fine-grained toward the lower stream.

The result of survey in the lower reaches of Marich Pass shows that the placer gold is concentrated at a depth of eight meters (Theuri, 1976).

Miller (1956) investigated the variation of grade of gold along the Marun River, and attributed the source of gold to granitoid orthogneiss at Sondhang.

On the other hand, McCall (1964) assumed that the source of gold was the gold dissemination in schist and gneiss occurred in the area based on the reasons, such as, that he paid attention to that the Marun River had brought a marked concentration of gold to a short interval in the adjacent area of the Marich Pass and in it and that the production of gold had been recorded in the vicinity of the confluence of two rivers of Iang and Marun, having led to attribute the source of gold to the place near the Marich Pass along the Iang River, in such gold as disseminated in schist and gneiss distribute in the area.

The geochemical survey conducted this phase resulted in to detect gold above detection limit in several places along the branches of two rivers such as Iang and Marun. It was also observed that panning was being carried out throughout, though small in scale, in the areas such as between Wakorr and Ortum along the Marun River, the lower to middle reaches of the Iang River and also along the tributaries of the above including Tamogh and Sergoi.

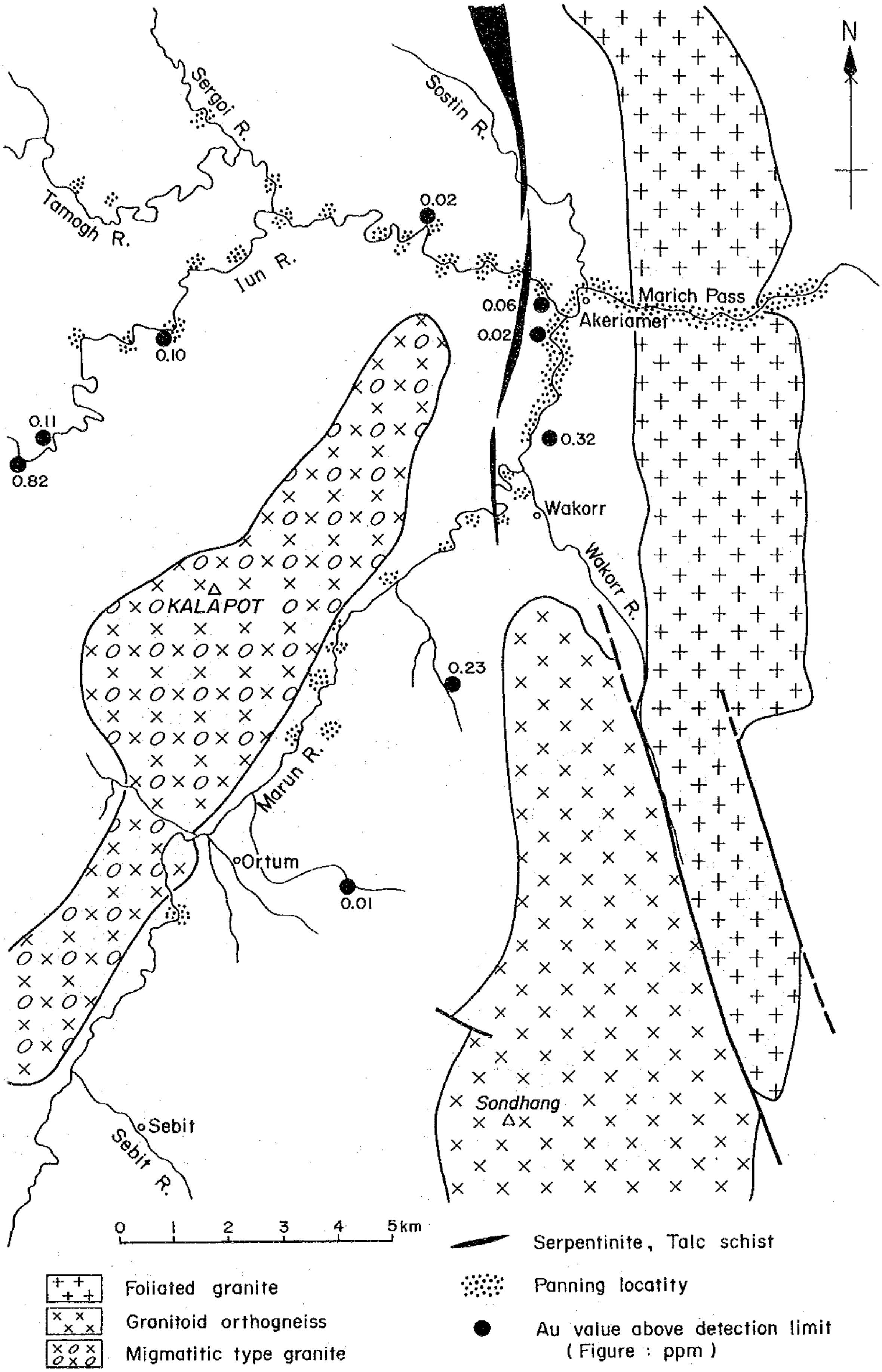


Fig. 3-16 Geological Sketch Map of Marun River Alluvial Gold Area

Accordingly, it seems to be unreasonable to limit the source of gold to one place as both McCall (1964) and Miller (1956) did. An assumption to attribute the origin to the two rivers of Iang and Marun will lead to reasonable explanation on the most concentration of gold in the vicinity of Marich Pass where the two branches merge in a flow running there.

(3) Eluvial Gold Deposit in the Upper Reaches of Endogh River

Location and Access:

The deposit is situated five kilometers to the north-west of the top of Mt. Mtelo, facing to the left bank of the upper reaches of the main stream of Endogh River at an altitude of 1,700 meters above sea level.

History and Outline:

No record is available for the deposit. Local residents likely to be more than 1,000 in number are working for panning at present.

Geology and Ore Deposit:

Geology in the adjacent area is composed of a series of zone consisting of talc schist, serpentinite and amphibole schist in which chromite deposits such as Tulot and Kamngeyon are emplaced. The rocks strike approximately N40°W and dip 70°NE.

The placer gold is mined from the weathered part of white talc schist about 100 meters thick at the boundary with amphibole schist or from the talus deposit of it. It is considered that the talc schist was formed by alteration of ultrabasic rock, and the mineralization is likely to be associated with the intrusion of ultrabasic rock.

(4) Chromite, Nickel and Gold Deposit at Tulot (Telot)

<u>History and Outline:</u>

The chromite and nickel deposits at Tulot (Telot) were first discovered in 1956. Since then, New Consolidated Gold Field Ltd. of South Africa carried out exploration works by 1958, and concluded that both the chromite and nickel deposits were not economical at that time (Kaye, L. 1968, File 3510A). The exploration works include geological mapping, geochemical survey for nickel (soil?), and trenching.

In 1957, McCall from Department of Mines and Geology (D.M.G.) tried to re-assess the economic feasibility of the prospect, and concluded that both the nickel and chromite deposits were infeasible (McCall 1964).

In April 1967, Kaye from the D.M.G. investigated the prospect and recommended to carry out further exploration. Following the recommendation, the D.M.G. carried out an exploration programme in a period between December 1967 and September 1968. The programme includes ground magnetic survey (9.76 line·km), trenching and pitting (152.5 m), and 11 holes of short Winkle DDHs (totalling 88.15 m). Based on the result, Kaye (1968) estimated following reserves, and concluded that (1) more development work to increase the proven chromite reserves, and (2) further development work to up-grade the possible indicated reserves to the proven were justified.

Chromite

Proven	13,000 long T
Probable	6,500 long T
Possible	40,000 long T
Total	59,500 long T

at 49.17% Cr_2O_3 with Cr/Fe ratio = 3.12

Nickel

Probable indicated	5,333,000 long T, slightly less than 1% Ni
or	
Possible indicate	14,425,500 long T (0.7% Ni)

In 1977, a Japanese consortium, Nippon Kokan K.K., Kokan Mining Co. Ltd. and C. Itoh & Co. Ltd. undertook to explore the chromite deposit. It is said that they had carried out 11 DDHs totalling 412 m and trencing and other excavation of about 1,400 m before they withdrew. However, no detailed information such as drill location, assay results etc. is available for us, so that the result of the work and their conclusion are uncertain.

Location and Access:

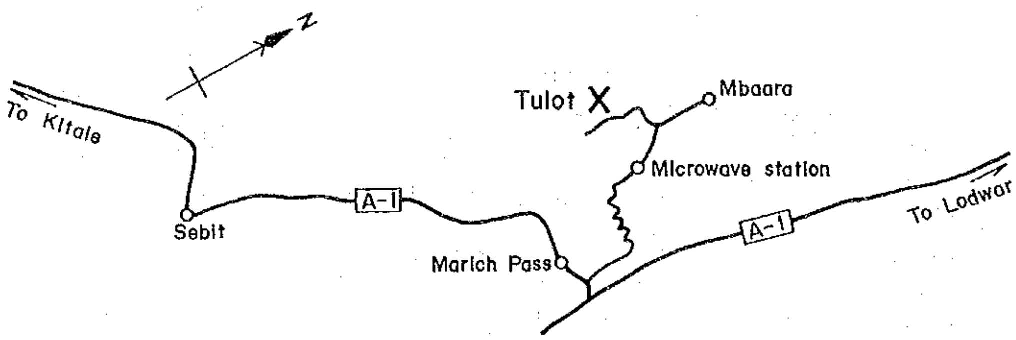
The prospect is located in the Sekerr Mountain Range, some 8 km northwest of Marich Pass, at approximately latitude 1°40'N and longitude 35°20'E. The known chromite outcrops and ore floats occur at an elevation between 2,200 and 2,240 m a.s.l. on the eastern flank of a NNW-trending ridge.

The prospect is presently accessed via foot paths and a rough road which can be motorable only by 4WD vehicles. The latter road runs zigzag on the steep fault scarp from the Route A-1 up to the microwave station. The elevation difference between the station and the foot of the scarp is about 900 m, whereas the horizontal distance between two is 3.5 km. However, the road condition is rather good in this section.

The road hence to the junction of Mbaara road and Tulot trail is so rough that it is inevitably required to improve if any exploration work is resumed.

Trails lead from the junction to the prospect (about 2 km, elevation difference 200 m, 30 minutes' walk).

The access route is schematically shown below.



General Geology:

The Tulot (Telot) Ni-Cr-(Au) prospect occurs in a lenticular serpentinite mass which is some 3.5 km long (NNW-SSE) and about 1.3 km wide (ENE-WSW). The serpentinite occurs within a amphibole schist unit (BIVas) which approximately 2 km thick in the vicinity of the prospect, and is bordered by talc schist at its eastern and northwestern boundaries. The talc schist extends a few km further both to the north and south beyond the serpentinite mass.

The serpentinite mass is likely to occur at the core of a regional syncline, and it dips to the west in the eastern part and to the east in the western.

Known chromite deposits seem to occur in a sheared zone that is some 100 m wide and strikes in a N15°-20°W direction with a steep dipping.

Mineralization:

The chromite outcrops and float zone were quickly re-investigated during the present field survey. The trench of No. 2 Vein was cleaned in order to observe a typical occurrence of chromite mineralization, and was mapped in a 1/200 scale. However, No. 1 Vein and trenches in its vicinity were only roughly mapped as the surface condition are not so good as around No. 2 Vein.

The weathered serpentinite with garnierite and/or limonite were locally sampled just to check Ni values, during the mapping of the chromite showing and geochemical sampling of soil along ridges and trails. However, no systematic sampling for Ni was carried out in the present work, so that the assay results do not indicate any representative significance for certain reserves.

Eluvial gold is currently being recovered by local people in a very small scale from the same serpentinite body which is the very host of the chromite and nickel deposits. They seem to have been testing soil everywhere in the area on an entirely trial and error basis, and, as a result, the soil on an ESE-trending ridge, some 800 to 1,000 m north of the known chromite outcrops, has being scraped most intensively. This may imply the part is the richest in the area. The soil is being transported everyday by women to river sides for panning.

(A) Chromite

Two major massive chromite lenses, No.1 and 2 Veins, have so far been located by the previous explorations.

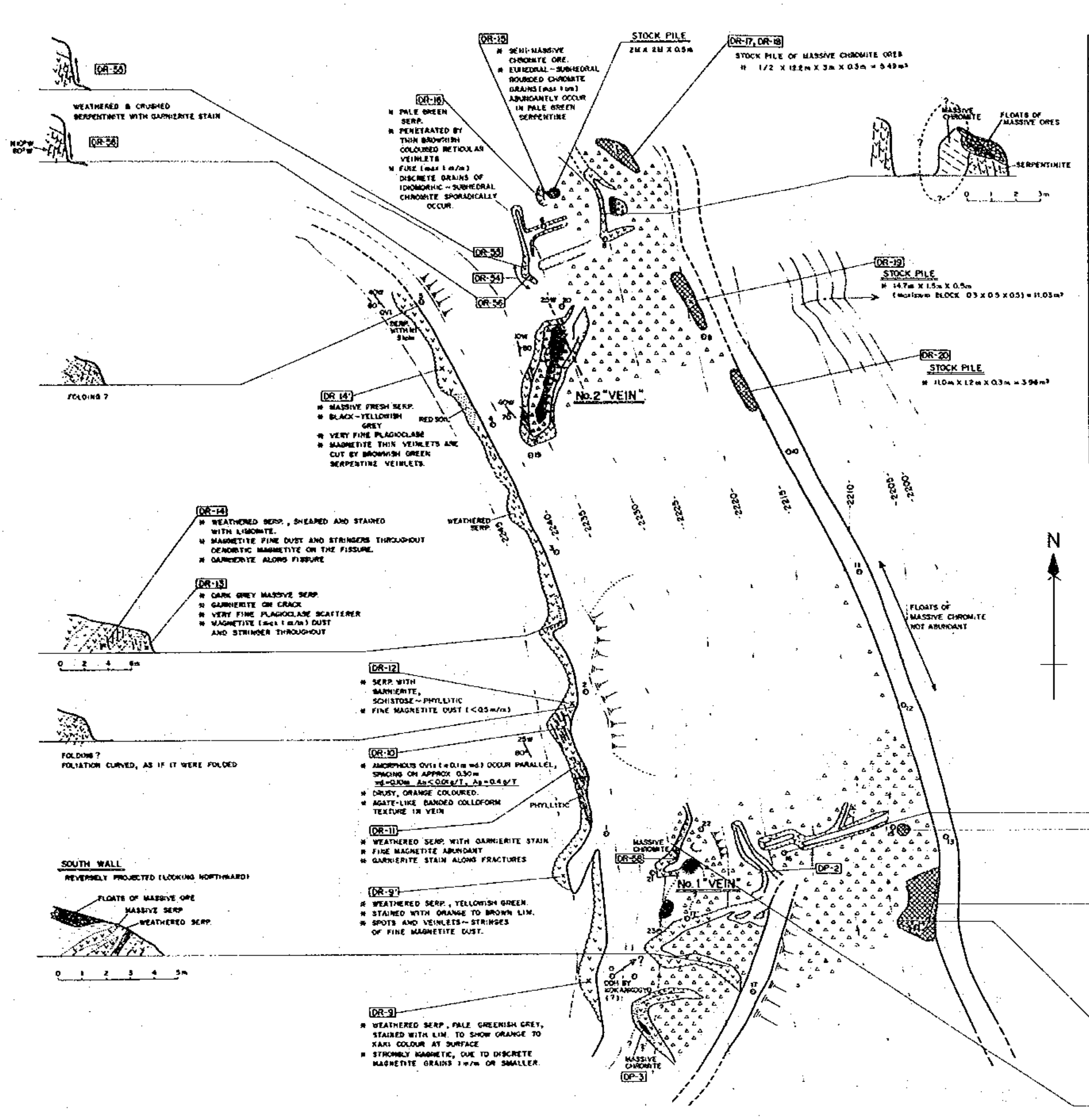
The two occur apparently en echelon within a distance of about 130 m (NNW-SSE): Each strikes N15°-30°E and dips steeply to the west (No. 2) or vertical (?). The dimension of the No. 2 vein in the trench is 21 m long with an average width of ca. 1.7 m measured on a 1 m-interval (maximum 4 m), having a ca. 35.1 m^2 area on plan. This gives reserves of 158 t/vertical m, assuming 4.5 for specific gravity. The dimension of the No. 1 is uncertain, as the surface is now covered by debris, soil etc. However, it is likely to be of the same order to No. 2. Therefore, the reserves of a single body might be in the order of a few to several thousand tonnes, if the depth is assumed 10 to 30 m. As a whole, it may be guesstimated that up to several bodies might occur within the prospect. If we had acquired results of the last exploration by the Japanese firms, we could have estimated by far the more precisely.

The average grades from five samples which were taken on a 5 m-interval from No. 2 vein are as follows.

33.27% Cr, 12.71% Fe, 2.36% Al, Cr/Fe = 2.62
length = 21 m, average width = 1.41 m (1.71 m when measured on a 1 m interval)

The average grades for four stock piles which are weighted by each volume are as follows.

36.67% Cr, 14.8% Fe, 2.4% Al, Cr/Fe = 2.67

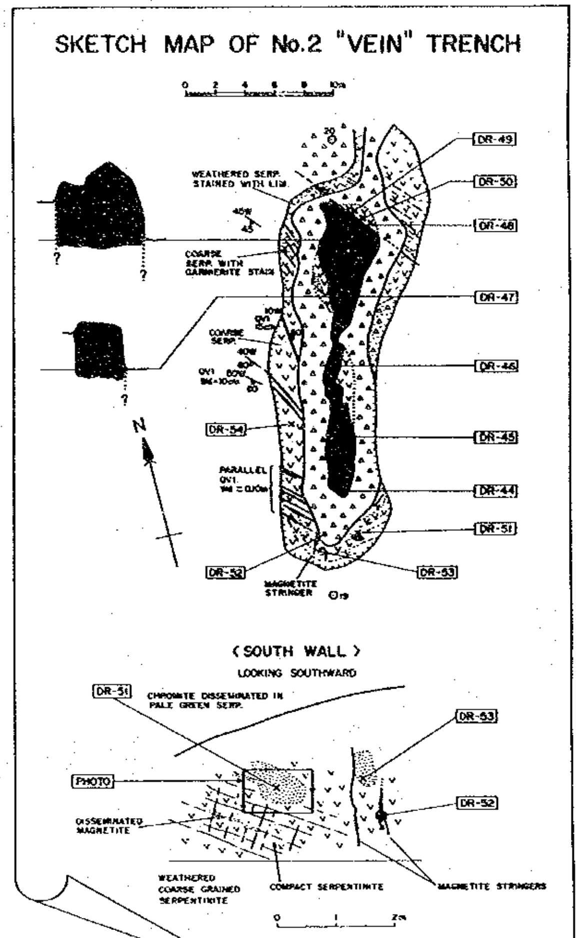


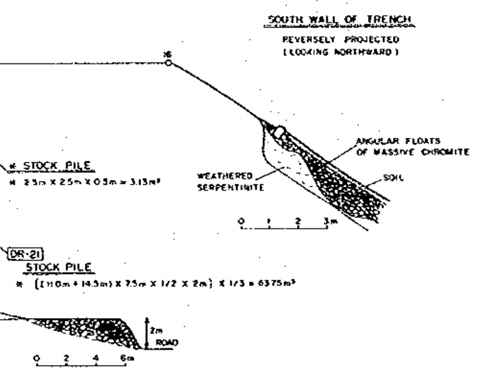
⟨ CHROMITE MINERALIZATION ⟩

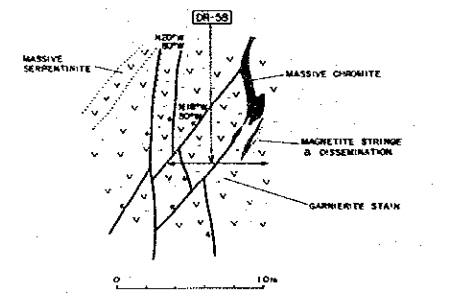
	SAMPLE No.	TYPE	THICK-NESS (m)	Cr (%)	Fe (%)	Al (%)	Pt (g/T)	V (ppm)	Ni (%)	Co (%)	Cu (%)	REMARKS
STOCK PILES	DR-17	MASSIVE ORE	—	39.90	15.2	2.4	<0.05	150	0.05	<0.01	<0.01	5.49m³ (DR-17, DR-18)
	DR-18	〃	—	41.25	12.7	2.8	<0.05	250	0.05	<0.01	<0.01	
	DR-19	〃	—	37.45	12.4	2.4	<0.05	200	0.08	<0.01	<0.01	11.03m³
	DR-20	〃	—	33.60	16.2	2.1	<0.05	175	0.08	<0.01	<0.01	3.96m³
	DR-21	〃	—	36.25	15.2	2.4	0.05	175	0.08	<0.01	<0.01	63.75m³
	ARITHMETIC AVERAGE			38.13	14.3	2.4	<0.05	190	0.06	<0.01	<0.01	Cr/Fe=2.67
	WEIGHTED AVERAGE *			36.67	14.8	2.4	0.05	180	0.08	<0.01	<0.01	Cr/Fe=2.48
IN SITU MINERALIZATION	DR-15	SEMI-MASSIVE ORE		27.35	19.4	1.1	<0.05	125	0.09	<0.01	<0.01	
	DR-44	MASSIVE ORE	1.00	37.70	13.0	2.1	0.05	50	0.07	<0.01	<0.01	
	DR-45	〃	1.30	28.00	10.6	2.4	<0.05	200	0.12	<0.01	<0.01	
	DR-46	〃	0.45	28.90	12.4	2.4	<0.05	250	0.14	<0.01	<0.01	
	DR-47	〃	1.80	33.50	14.6	2.4	<0.05	200	0.13	<0.01	<0.01	
	DR-48	〃	2.50	34.65	12.4	2.4	<0.05	225	0.08	<0.01	<0.01	
	DR-44~-48 AVERAGE		1.41	33.27	12.71	2.36	<0.05	191	0.10	<0.01	<0.01	Cr/Fe=2.62
			Σ7.05									
	DR-51	DISSEMINATED										SOUTHERN EXTENSION OF MASSIVE ORE OF No.2 "VEIN"
	DR-53	〃		28.15	17.6	2.5	<0.05	175	0.11	<0.01	<0.01	

⟨ SERPENTINITE WITH GARNIERITE ⟩

SAMPLE No.	ROCK TYPE	SAMPLING INTERVAL (m)	Ni (%)	Co (%)	Cu (%)	REMARKS
DR-11	WEATHERED SERPENTINITE	—	0.89	0.02	<0.01	
DR-12	PHYLLITIC SERPENTINITE	—	0.97	0.01	0.02	
DR-54	LIM. STAINED SERPENTINITE	—	0.96	0.01	<0.01	WEST WALL OF No.2 VEIN TRENCH
DR-54'	〃	3.50m *	0.36	0.01	<0.01	* SAMPLED HORIZONTALLY
DR-55	CRUSHED SERPENTINITE	1.00m	1.08	0.01	<0.01	* SAMPLED VERTICALLY
DR-56	〃	1.00m	1.03	0.01	<0.01	〃
DR-57	WEATHERED SERPENTINITE	2.15m	0.36	0.01	<0.01	〃
DR-58	〃	0.70m	2.61	0.02	<0.01	* SAMPLED HORIZONTALLY







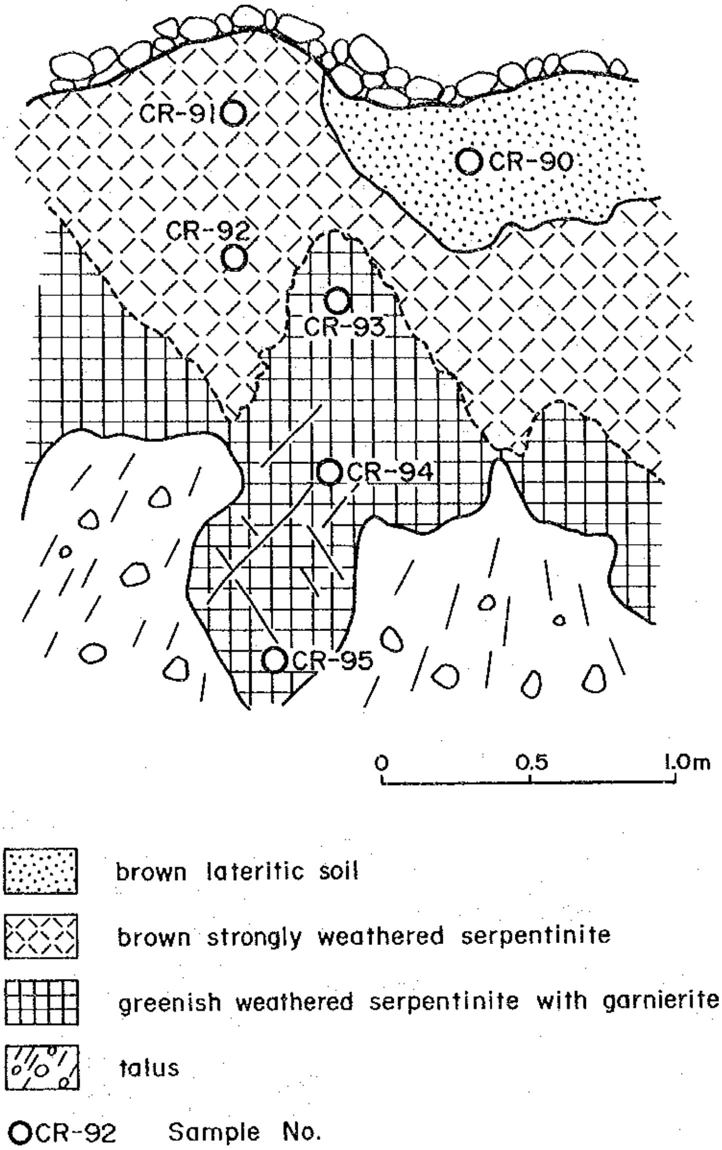
LEGEND

- DR-57 SAMPLE No.
- DP-3 PHOTOGRAPH No.
- ○20 STATION No.
- MASSIVE CHROMITE ORES (IN SITU)
- 〃 (FLOATS) (PLANE/SECTION)
- 〃 (STOCK PILE)
- MAGNETITE (STRINGERS & DISSEMINATED)
- QV1 QUARTZ VEINS & VEINLETS
- LIMONITE STAIN
- GARNIERITE STAIN
- MASSIVE SERPENTINITE } & FLOATS
- WEATHERED SERPENTINITE }
- SOIL (SECTION)
- STRIKE & DIP (VEIN)
- 〃 (FOLIATION)
- 〃 (FAULT & FISSURE)
- SHEARED

* REMARKS :
TOPOGRAPHY IS SURVEYED WITH A "CLINO-COMPASS" AND "ESLON" CHAINS & THE GROUND ELEVATION OF STA-0 IS ASSUMED AS 2240m ABOVE SEA LEVEL FROM THE READING OF ALTITUDE METER.

0 10 20 30m

Fig.3-17 Geological Sketch Map of Tulot Chrome-Nickel Prospect



Assay Results

Sample No.	Ni %	Co %	Cu %
CR-90	0.84	0.03	< 0.01
CR-91	0.46	0.02	< 0.01
CR-92	0.42	0.02	< 0.01
CR-93	1.36	0.02	< 0.01
CR-94	1.81	0.02	< 0.01
CR-95	2.79	0.02	< 0.01

Fig. 3-18 Profile Showing Ni-Mineralization in Weathered Serpentinite, Tulot

The detail of the occurrence and assay results are shown in Fig. 3-17, and test data of the ores and host rocks are prsented in Table A-2 and A-3, and photographs in Photo A-3.

(B) Nickel

During the present study, no systematic sampling of either rock chips or channels was carried out. However, the geochemical nickel anomaly delineated by 7000 ppm which is in Fig. 2 of Kaye's report (1968) shows some 2.1 km x 200 - 300 m areal extent. This seems to suggest that there is enough space to include some ore grade portions in the anomaly.

The assay results of 15 "reference" samples (Table A-6) of weathered serpentinite (lateritic and/or with visible garnierite) taken during the present programme range from 0.36%<(DR 54' and 57: lateritic. Fig. 3-17) to 2.79% (CR 95: with garnierite, Fig. 3-18). This explicitly shows that it is necessary to explore the extent and frequency of higher "economic grade" portions in the anomaly. For this purpose, the systematic sampling by means of some sort of drilling is considered to be useful.

(C) Eluvial gold

In order to delimit the eluvial gold distribution in the prospect, 61 soil samples which had been taken within an area 5 km (NS) by 2 km (EW) that covers the prospect were tested additionaly for gold as well as other six elements. The samples were collected approximately on a 250 to 300 m - interval along six E-W to NW-SE trending ridges which cross-cut the general trend of rock units in the area. Stream sediments from tributaries in the area were also collected and tested for gold (Plate 15, 16).

The result is shown in Table A-7 and illustrated in Plate 10 and 11. As seen in these maps, there is a conspicuous gold anomaly elongated in N-S direction, in which 11 soil and stream sediment samples that exceed the detection limit (0.01 ppm) are included. The maximum value in the anomaly is 0.12 ppm for soil and 0.3 ppm for sediment respectively. The anomaly clearly overlays the eluvial gold works.

In order to check the potential hosts of gold, siliceous materials of following 3 types were tested for gold and silver.

(a) Agate-like amorphous quartz veinlets several to 10 m wide, which show often lenticular form and occur parallel in the N15° - 20°W direction on a 30 to 50 cm spacing. (DR-10;Au less than 0.01 ppm, Ag = 0.4 ppm. DR-61; Au less than 0.01 ppm, Ag = 0.6 ppm). (cf. Fig.3 and Photo A-3)

(b) Thin (0.1 - 3 mm) white quartz veinlets, which occur reticularly in the serpentinite (DR-62; Au less than 0.01 ppm, Ag less than 0.2 ppm). (cf. Photo A-3).

(c) Silified serpentinite (DR-60; Au less than 0.01 ppm, Ag less than 0.2 ppm).(cf. Photo A-3).

Though none of these show the gold value more than the detection limit, it is noteworthy that two of the agate-like amorphous quartz veinlets show the silver values greater than the limit. The fact may imply that the quartz vein of

Assay Result

Sample No.	Type	Cr %	Fe %	Al %	Pt g/t	V ppm	Ni %	Co %	Cu %
CR 201	massive ore	26.20	29.5	7.1	0.10	550	0.04	<0.01	<0.01
CR 203	〃	26.80	27.5	6.4	0.15	600	0.04	<0.01	<0.01
CR 208	〃	27.80	31.6	4.3	0.10	425	0.04	<0.01	<0.01
CR 212	〃	26.30	23.4	5.0	0.10	450	0.05	<0.01	<0.01
Average	—	26.78	28	5.7	0.11	506	0.04	<0.01	<0.01

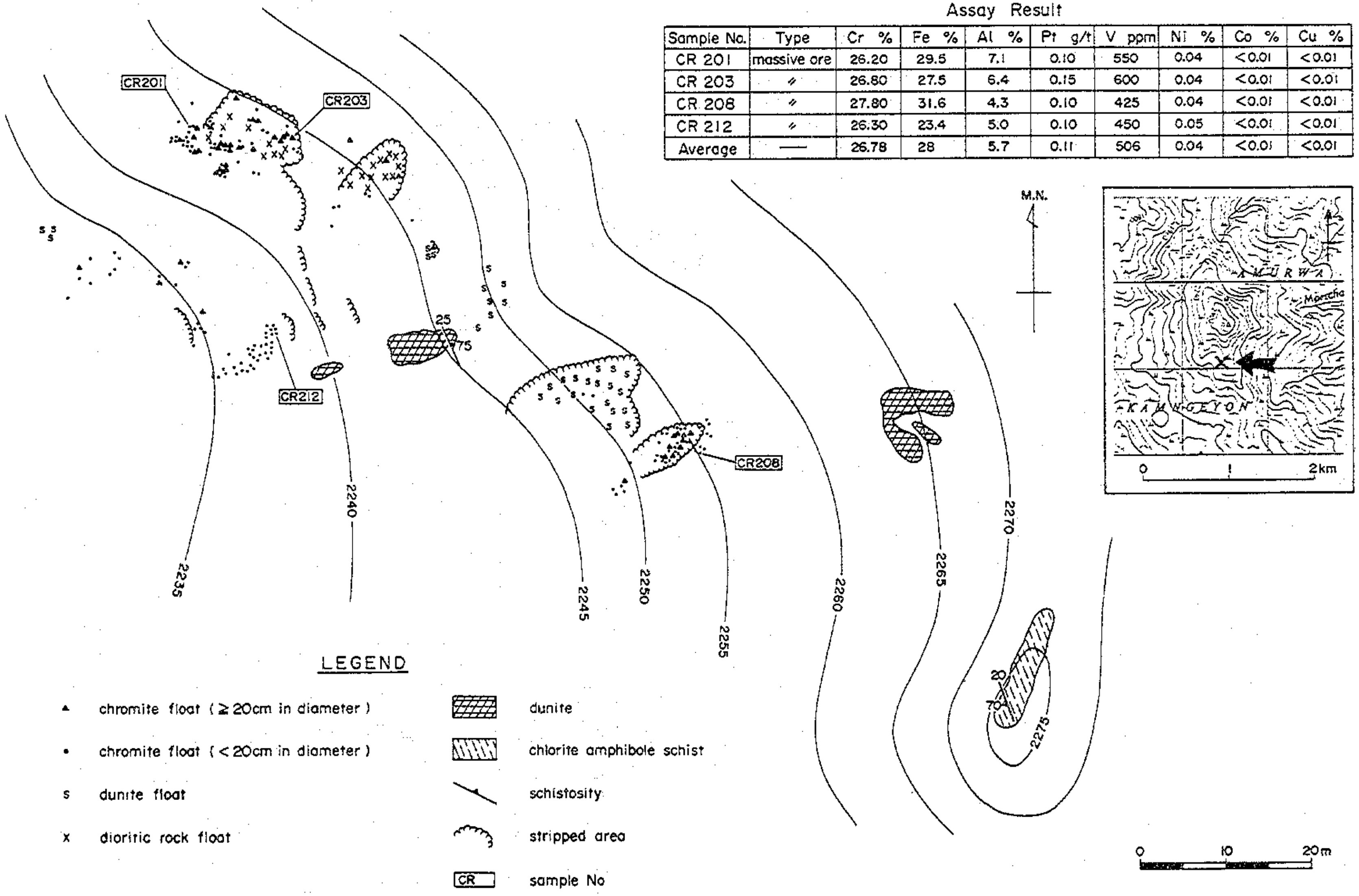


Fig. 3-19 Geological Sketch Map of Kamngeyon Chrome Prospect

this type is one of the potential hosts. Further investigation on potential gold hosts, including rock forming and sulphide minerals are needed.

(5) Kamngeyon Chromite Showing

Location and Access:

It is situated to the south of the peak of Mt. Kamngeyon rising on the west of the upper reaches of Endogh River at an altitude of 2,230 to 2,260 meters above sea level.

The two routes can be used to reach the showing: a path along the Endogh River starting from Korpu on the Suam River and another route from Mbaara in the eastern-central part through the Sekerr Forest zone along a creek to walk down along the Endogh River. Both routes are 15 kilometers in distance respectively taking about six hour on foot.

History and Outline

The occurrence of the showing was described by McCall (1964), but no record of exploration and production is available. The floats exposed by stripping are left as they are at present.

Geology and Ore Deposit:

Fig. 3-19 shows the geology of the site of showing. The exposures of serpentinite, amphybole schist and gabbro are observed in the area distributed by chromite float, being distributed by talc schist and amphibolite in the surrounding area. The schistose rocks strikes N-S to NW-SE and dips 40° to 70°E. The size of serpentinite which is likely to be the host rock of the ore deposit is assumed to be three kilometers in northerly extension and 250 meters in maximum width in E-W. The northern extension of the rock has been cut by an gabbro mass. Serpentinite is identified as dunite on the basis of microscopic observation.

The chromite ore is all composed of floats and no outcrop is observed. The floats are distributed for an extent of 80 m (E-W) x 50 m(N-S), in which three places show a little concentrated distribution. The areas of each place are 5 m x 15 m, 10 m x 15 m and 5 m x 10m. Most of the floats are 5 to 25 centimeters in diameter, reaching up to 60 centimeters.

The assay result of ore is as shown together in Fig. 3-19. The grades of chromium correspond to 38.29 to 40.63 percent when they are converted into Cr_2O_3, which are considerably lower than those of Tulot.

Although it is thought that the chromite deposit of the showing consists of small lenticular ore bodies similar to that of Tulot, the scale seems to be considerably small as compared with that of the Tulot ore body judging from the extent of serpentinite and the condition of distribution of the floats.

(6) Copper Showings

The seven copper showings found in the survey area are all small on a scale. Since these are shown in Table A-1, the two showings newly discovered by this survey are described in this clause.

(a) Parua Showing

Location and Access:

It is situated in the vicinity of Parua along the upper reaches of Sebit River. A car road leads to the site from Sebit, which can be reached by 30-minute drive for a distance of 12 kilometers.

History and Outline:

No record is available on the showing. It has been told, however, that there was a trace of old tunnel.

Geology and Showing:

The geology in the surrounding area consists of amphibolite and limestone, and the structure is complicated by a fault running in parallel with the Sebit River. The floats contaminated by malachite are distributed in a creek crossing the road.

The float is composed of quartz vein, in which bornite, chalcocite and pyrrhotite are observed under the microscope beside malachite. The assay values of ore are as follows.

DR-1; Cu : 1.1%, Co : 40 ppm, Ni : 45 ppm

(b) Talon Showing

Location and Access:

It is situated in the vicinity of Talon four kilometers to the southeast of Nasalot. It is about 10 kilometers apart from Nasalot-Lodwar Junction on the car road between Kapenguria and Lodwar, and it is a 30-minute drive to reach the showing.

History and Outline:

No record is available.

Geology and Showing:

Amphibolite is found in the vicinity of the showing, which is often intruded by leucocratic fine-grained granite dykes. A large mass of foliated granite is distributed to the west of the showing.

The ore consists of malachite dissemination along the foliation plane of amphibolite, in which no remains of sulphide mineral is found.

The assay values of the ore are as follows.

AR-2 Cu : 1.92%, Co : <0.01%, Ni : 0.01%

(7) Chaichai Molybdenum Vein

Location and Access:

The outcrop is situated in the river bed of a branch of the Mahang River at an altitude of 1,950 meters above sea leval, at the eastern end of the Sekerr Forest, 2.5 kilometers to the south-southeast of the peak of Mt. Chaichai.

It can be reached by walking a path for about 10 kilometers from Matong, the terminal of car road, and it takes about two and a half hours on foot.

History and Outline:

No record is available on the vein.

Geology and Ore Deposit:

Fig. 3-20 shows a sketch of the vein. The rocks in the vicinity of the vein consist of biotite gneiss and muscovite quartzite. The vein is found in muscovite quartzite, being

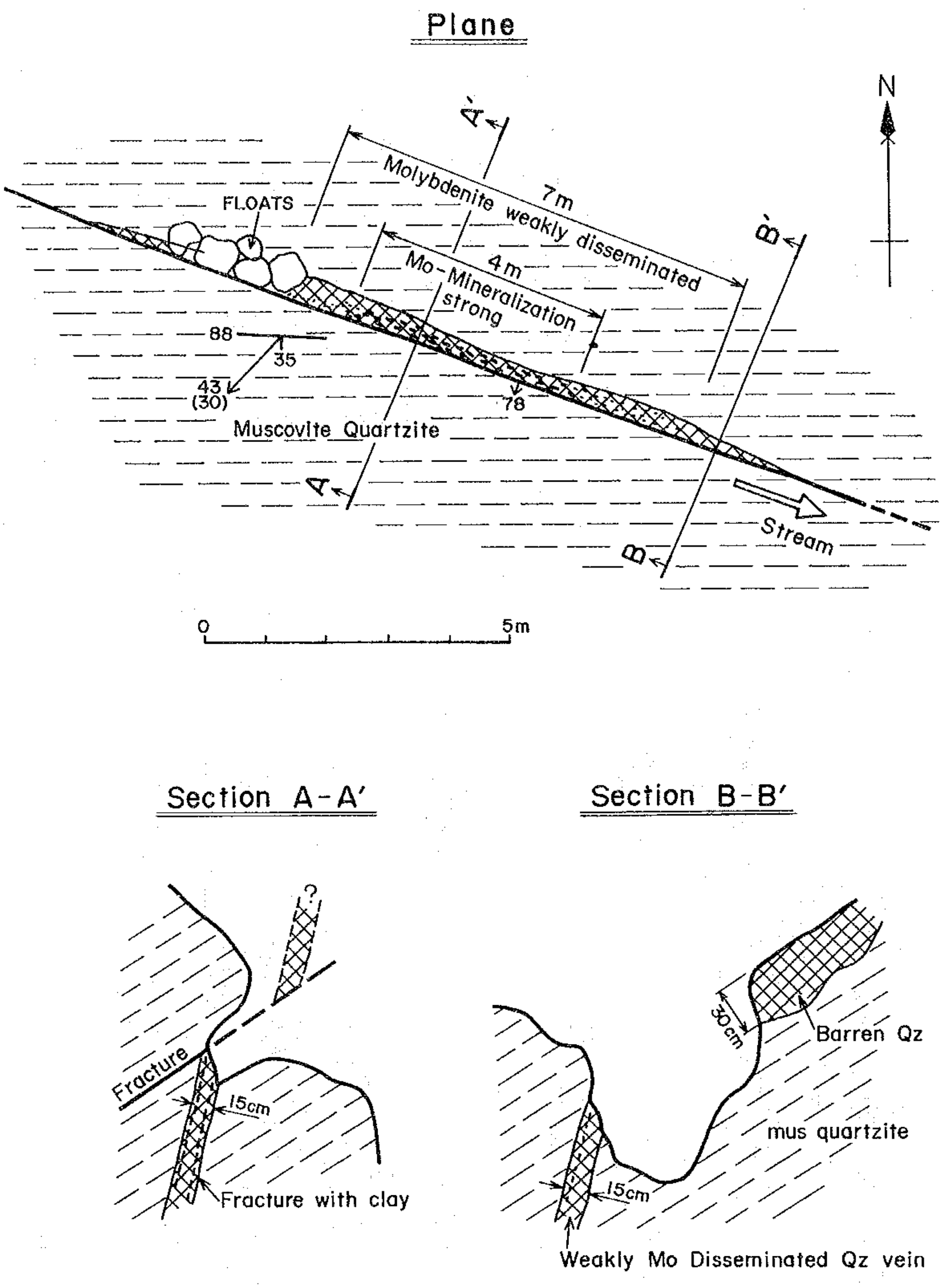


Fig.3-20 Molybdenite Mineralization at Chaichai
(Vein-width is exaggerated)

emplaced along a fault striking N70°W and dipping 70°SW, which runs in parallel with the stream of the creek.

The ore vein is composed of a molybdenite-quartz vein. Molybdenite is contained for an interval of seven meters, among which the section of four meters long shows a concentration, and the grade of molybdenum of several percent is estimated there. Molybdenite is concentrated near the wall of vein in a form of band forming the flake up to 1.5 centimeters long. The alteration zones of wall rock less than several centimeters wide are observed on both sides of the vein. As the result of X-ray diffraction, muscovite, low albite or orthoclase and low quartz were identified. Fine-grained molybdenite is sometimes contained in these alteration zones. The vein width is 15 centimeters in maximum. Although the quartz vein was traced for 15 meters, further extension could not be made clear.

Although the vein itself is small on a scale, there is a possibility of occurrence of the similar veins in the surroundings of the foliated granite mass because the vein is located close to the rock on the south of it.

(8) Nasalot Mica Deposit

Location and Access:

The deposit is situated one kilometer to the east of Nasalot. An unpaved road runs from Nasalot-Lodwar Junction along the Kapenguria-Lodwar car road for about 15 kilometers, which can be driven by 45 minutes.

History and Outline:

The deposit was discovered in 1928, and 36,450 pounds of mica ore was extracted from 17,986 tons of rock by the end of 1929, from which 3,654 pounds of cut mica was produced. Production of 0.5 tons of low-grade mica was also recorded in 1929.

Geology and Ore Deposit:

Geology in the surroundings mainly consists of amphibolite and biotite gneiss, striking N40° to 50°W and dipping 45°NE. Pegmatite dykes and small dykes of leucocratic fine-grained granite penetrate these rocks, and the trend of strike of these dykes is almost consistent with that of the host rocks. The group of pegmatite dyke occurs within a width of about 0.4 kilometer, and the dykes consist of four to five main veins composed of various composition. They are composed of potash feldspar, quartz and muscovite, among which the parts of mica concentration were the object of mining.

These pegmatites together with leucocratic fine-grained granite are considered to have been formed in the later stage of intrusion of foliated granite distributed 1.5 kilometers to the south.

The mica of the deposit seems to be of low economical value, because it is small in diameter, because the content in pegmatite is low and because extent of the concentration is narrow.

(9) Kyanite Deposit

The showings of kyanite are known at four places (Table A-1). Among these, only the Nasalot showing seems to be the one which is of a little large-scale. In the showing, kyanite is concentrated in bluish gray patches up to three inches across. It is likely to be of hydrothermal origin from its occurrence. Both the scale and grade can not be made clear because the showing is almost covered by the talus deposit.

CHAPTER 4 GEOCHEMICAL SURVEY

4-1 Outline of the Geochemical Survey

4-1-1 General Remarks

Geochemical survey was performed with the purposes of detecting the geochemical anomalies caused by mineralization and of obtaining the basic data for mineral exploration in the next phase of the project.

The first phase investigation comprises following surveys: 1) regional survey for the whole area, and 2) semi-detailed survey for the selected two areas. In the regional survey, stream sediments were collected, whereas soil samples were taken in the semi-detailed survey.

Table 4-1 gives the number of geochemical samples collected and the elements for analysis.

4-1-2 Sampling

20 to 30 gramms each of stream sediment samples screened under 80-mesh were collected from tributaries at their bifurcations, from major drainages and at their intersections with trails and roads. The screening has done at the place whether the water runs or dried up. 500 to 800 gramms each of soil samples were collected from the ridge, mountain side and mountain foot. In general, the soil of B horizon was sampled but in cases of the B horizon is lacking or too deep to take, the soil of A or C horizon was collected.

The localities of geochemical samples are shown in Plate 14 to 16 (Regional Survey Area), Plate 17 (Semi-detailed Survey Area A) and Plate 18 (Semi-detailed Survey Area B).

4-1-3 Sample Preparation

All geochemical samples were prepared at the field office in Kitale. The stream sediment samples in craft paper envelope were dried in the sun as they are. The soil samples were crushed by fingers or mallet after drying and screened under 80-mesh. About one hundred gramms of screened soil samples were taken for use in analysis.

4-1-4 Assay Method

Table 4-2 gives the detection limit and assay method for each analytical element.

4-1-5 Data Processing

The analytical results were processed after converting into common logarithmic figure.

First, univariate statistical analysis was carried out for each element of three areas. Then principal component analysis was applied for the data of Regional Survey Area and Semi-detailed Survey Area A, but only the result of Area A will be reported here because of its useful effect.

To determine the threshold value which devides the data into two groups, anomalous one and background, following standards were applied.

Standard 1: In case of the anomalous population can be extracted by the cumulative frequency distribution curve, the threshold value will be decided by the method of A.J. Sinclair (1974).

Standard 2: If it is hard to extract the anomalous population, the threshold value is Mean + 2 x Standard Devia-

Table 4-1 List of Geochemical Samples

Area	Number of Stream Sediment Samples	Number of Soil Samples	Analytical Elements	Area km^2	Sampling Density $Sample/km^2$
Regional Survey Area	1,552	-	Au,Cu,Pb,Zn,F,Cr	2,300	0.7
Semi-detailed Survey Area A	-	145	Cr,Ni,Co,V,Pt	120	1.7
do	-	61	Cr,Ni,Co,V,Pt,Au		
Semi-detailed Survey Area B	-	50	Nb,Ta,Li,Sn,W,F	25	2.0

Table 4-2 List of Detection Limits and Assay Method

Material	Element	Detection limit	Assay method	Remarks
Stream Sediment	Au	10 ppb	A.A	MIBK extraction after Agua Regia digestion
	F	1 ppm	Ion Electrode	Using NaOH fusion
	Cu	1 ppm	A.A	Using HF/Agua Regia digestion
	Pb	1 ppm	do	do
	Zn	1 ppm	do	do
	Cr	1 ppm	do	do
Soil	Au	10 ppb	A.A	MIBK extraction after Agua Regia digestion
	Cr	10 ppm		Using Na_2O fusion
	V	20 ppm		do
	Co	1 ppm	A.A	Using HF/Agua Regia digestion
	Ni	1 ppm	A.A	do
	Pt	50 ppb	Fire Assay or A.A	
	F	1 ppm	Ion Electrode	Using NaOH fusion
	Li	1 ppm	A.A	Using HF/Agua Regia digestion
	Nb	20 ppm	ICP	Using borate fusion
	Ta	2 ppm	do	
	Sn	1 ppm	do	
	W	2 ppm	do	

A.A: Atomic Absorption Measurement

ICP: Inductively Coupled Argon Plasma Emission Method

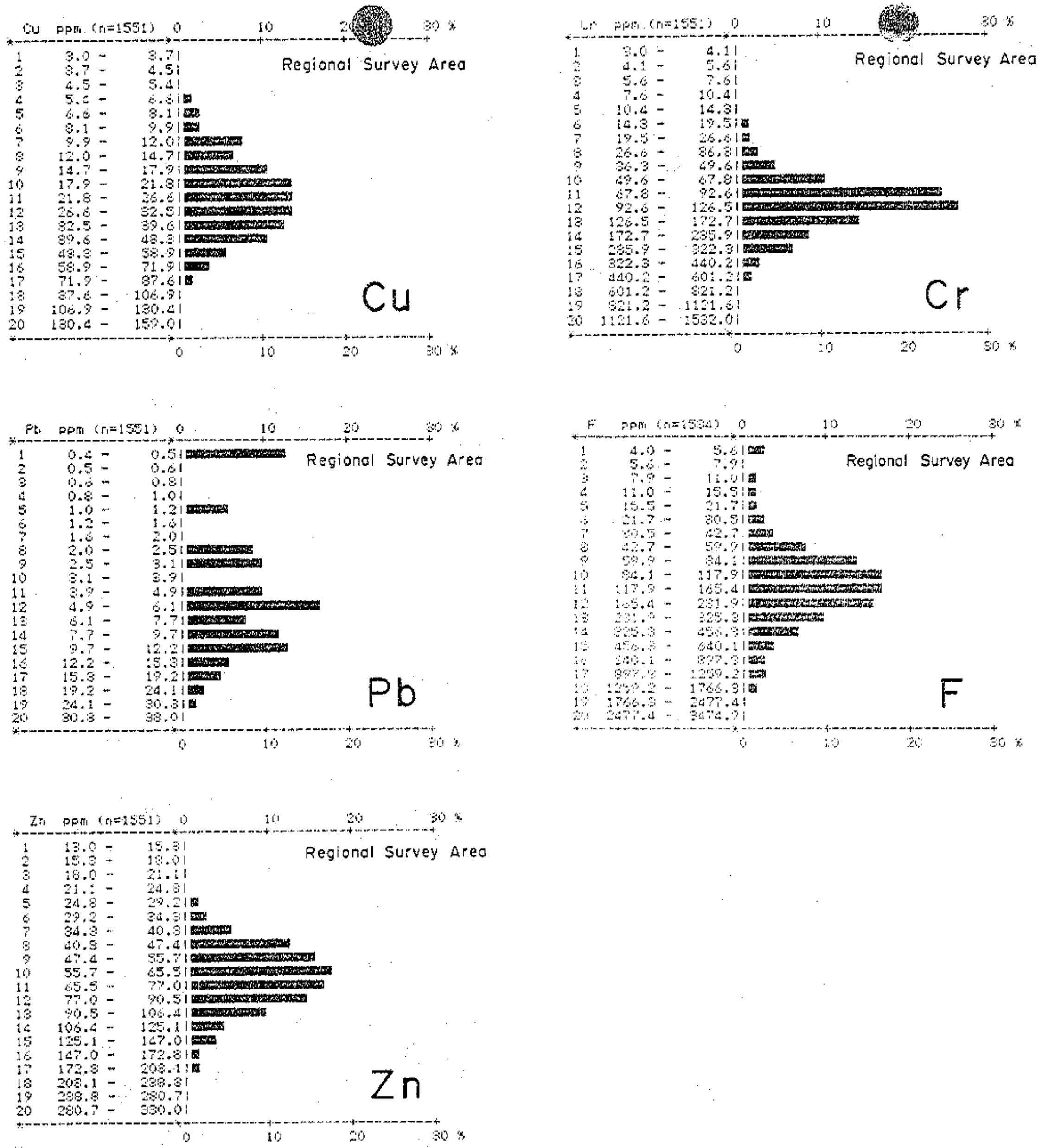


Fig.4-1 Histgram of Geochemical Data (Stream Sediment),

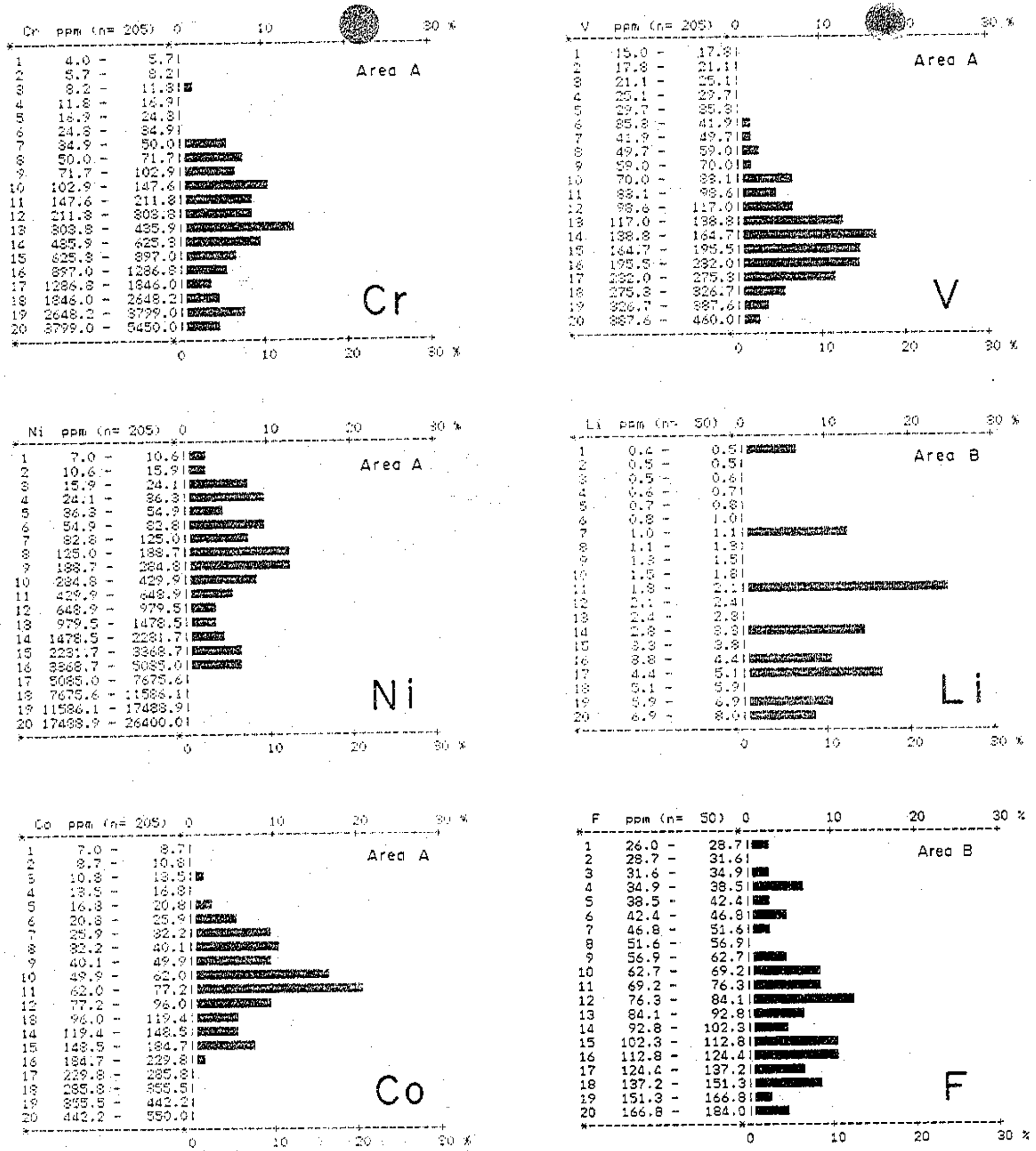


Fig. 4-2 Histgram of Geochemical Data (Soil),

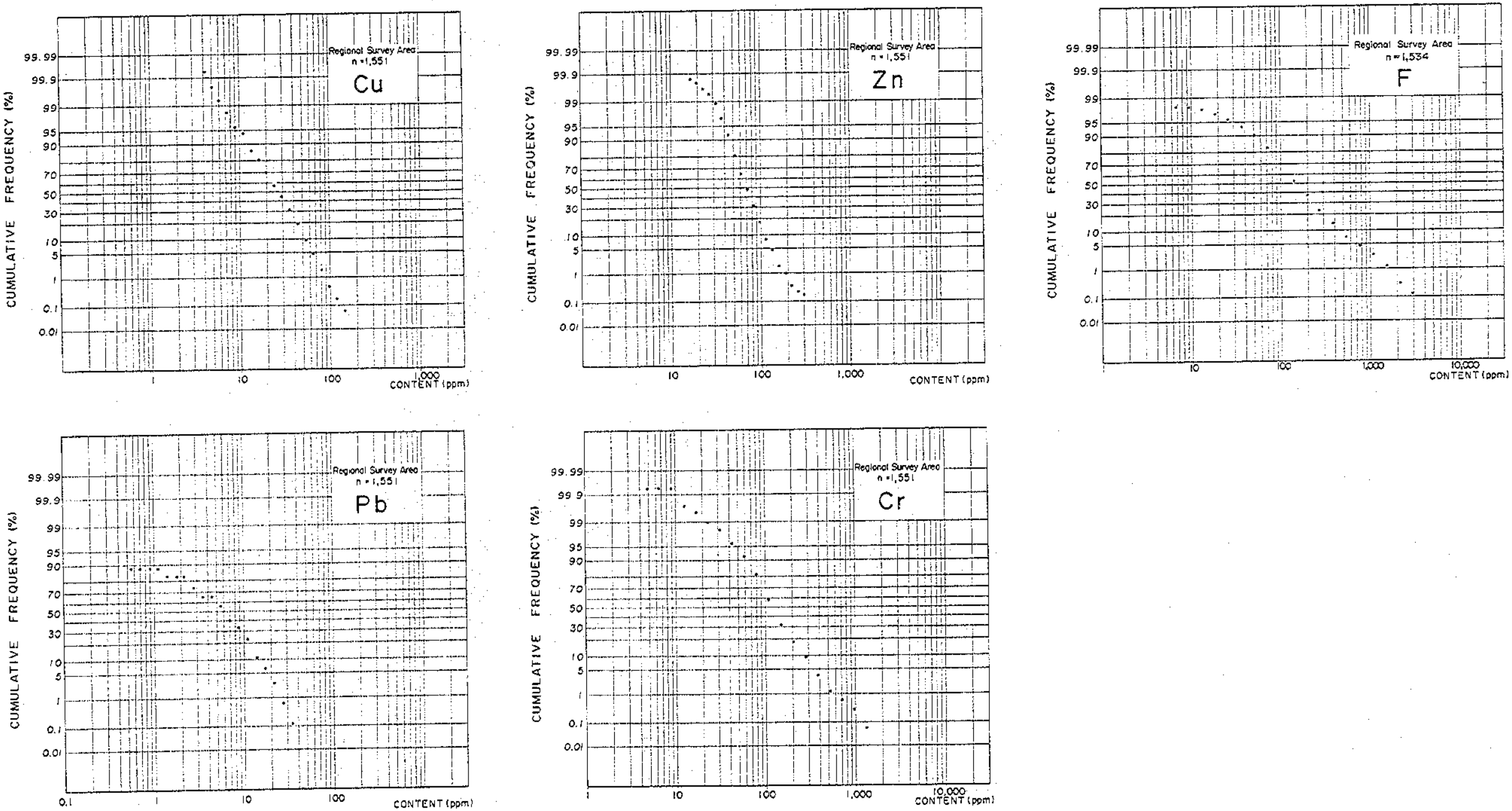


Fig.4-3 Cumulative Frequency Distribution of Analytical Element, Regional Survey Area

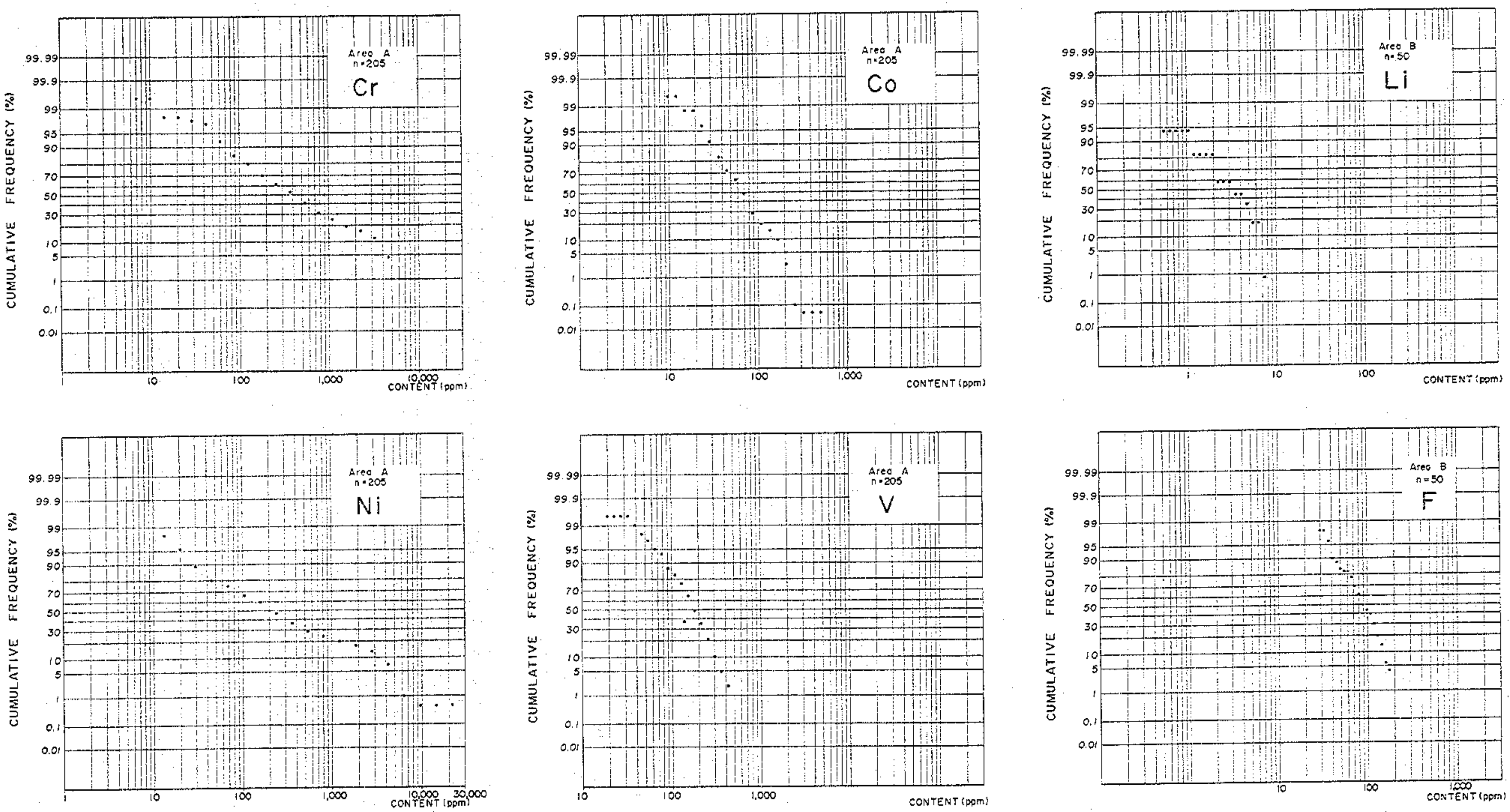


Fig.4-4 Cumulative Frequency Distribution of Analytical Element, Area A and B

tion ($\overline{x}$ + 2σ). This case means the data belonging to anomalous population are none or very few.

Standard 3: For the elements i.e. Au and Pt of which analytical data are mostly under the detection limit, 2.27 percent of number of all the samples will be selected from high value side, and the threshold value will be fixed as the minimum value in the selected data. 2.27 percent signifies the proportion over $\overline{x}$ + 2σ in a normal distribution.

The computer calculates down to 7 places of decimals therefore the values of $\overline{x}$ + nσ (n = 1, 1.5, 2, 3) are a little different from the values of them calculated by the values of $\overline{x}$ and σ on the table.

4-2 Regional Survey Area

4-2-1 Statistic Values and Distribution

Table 4-3 shows the statistic values of analytical elements. The analytical results of Au are mostly under the detection limit therefore the results were omitted from statistic treatment. The analytical results of Pb and F under detection limit were processed as 0.4 ppm and 4 ppm respectively.

Histgram and cumultative frequency distribution curve of each element are illustrated in Fig. 4-1 and Fig. 4-3.

The histograms were drawn after dividing the range into 20 classes for each element.

4-2-2 Correlation of Elements

Table 4-4 gives the correlation coefficients of the elements and |R| values of significance test. The analytical data under detection limit were excluded from the calculation. The numbers of paired samples used for calculation are written under the each correlation coefficient.

The coefficients between Au and other elements are all less than the corresponding |R| value, consequently the correlations between Au and them are denied with significance level of one percent. Other correlations are affirmative judging from the results of significance test, but they are in very weak relations except one of Cu and Zn. The correlation coefficient between Cu and Zn, namely 0.40 reveals moderately positive correlation.

4-2-3 Selection of Threshold Value

Threshold values were selected as follows on the basis of the standard above mentioned, and are listed in Table 4-5.

Au : Threshold value is determined by the standard 3.

Cu,pb,F: Threshold values are determined by the standard 2.

Zn,Cr: The cumulative frequency distribution curves indicate the existence of anomalous population with proportion of one percent under. However, they are too small to extract from background population, the threshold values were decided by the standard 2.

Anomalous values are classified, further into three groups such as group of AA-grade, A-grade and B-grade bordered by the values of $\bar{x} + 2.5\sigma$ and $\bar{x} + 3\sigma$. For Au, this classification was done based on the proportion over $\bar{x} + 2.5\sigma$ in a normal distribution. High values in the background

Table 4-3 Statistic Values of Analyzed Elements, Regional Survey Area

Element Unit	Au ppb	Cu ppm	Pb ppm	Zn ppm	Cr ppm	F ppm
Number of Samples	1,552	1,552	1,552	1,552	1,552	1,552
Minimum Value	<10	3	<1	13	3	<10
Maximum Value	14.250	159	38	330	1,532	3,475
Range	>14.240	156	>37	317	1,529	>3,465
Mean	-	23.7	4.0	64.8	103.6	124.3
S.D. (Log)	-	0.25	0.49	0.16	0.27	0.43
M + 2 S.D.	-	74	38	137	355	910
M + 3 S.D.	-	131	118	198	656	2,457
Clarke Number	4	55	15	60	100	620

Table 4-4 Correlation Coefficients, Regional Survey Area

	Au	Cu	Pb	Zn	F	Cr
Au	1.00					
Cu	0.03 (52)	1.00				
Pb	0.08 (48)	-0.23 (1361)	1.00			
Zn	0.12 (52)	0.40 (1551)	-0.23 (1361)	1.00		
F	-0.35 (52)	0.14 (1533)	0.18 (1345)	0.26 (1533)	1.00	
Cr	0.11 (52)	0.21 (1551)	-0.06 (1361)	0.20 (1551)	0.12 (1533)	1.00

(n) Number of Paired Samples

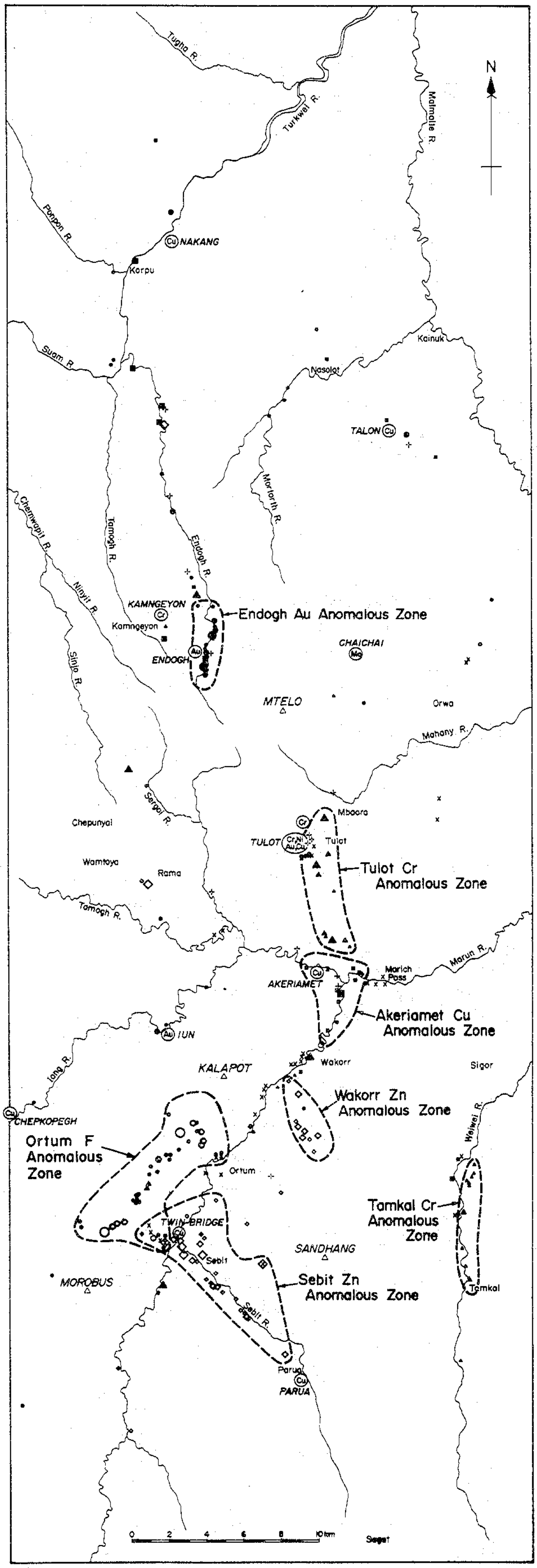
R(φ,e)
φ: degree of freedom
e: significance level

|R|(46,0.01) = 0.368
|R|(50,0.01) = 0.354
|R|(1359,0.01) = 0.070
|R|(1549,0.01) = 0.065
|R|(1343,0.01) = 0.070
|R|(1531,0.01) = 0.066

Table 4-5 Thresholds and classification of Anomalous Value

Element	Anomalies			Threshold	Background
	Grade AA	Grade A	Grade B		High-content Value
Au (ppb)	≥1,844 (2)	1,844>≥360 (8)	360>≥80 (28)	80	80>≥10 (14)
Cu (ppm)	≥131 (1)	131>≥99 (4)	99>≥74 (17)	74	-
Pb (ppm)	- (0)	- (0)	≥38 (1)	38	38>≥21 (32)
Zn (ppm)	≥198 (7)	198>≥165 (13)	165>≥137 (22)	137	-
Cr (ppm)	≥656 (7)	656>≥482 (8)	482>≥355 (22)	355	-
F (ppm)	≥2,457 (2)	2,457>≥1,459(9)	1,459>≥910(31)	910	-

( ) Number of Samples



LEGEND

Au

AA Grade Anomaly	● ≧ 1844 ppb	n=2
A 〃	1844 ppb > ● ≧ 360 ppb	n=8
B 〃	360 ppb > • ≧ 80 ppb	n=28
High Content	80 ppb > ✛ ≧ 10 ppb	n=14

Cu

AA Grade Anomaly	■ ≧ 131 ppm	n=1
A 〃	131 ppm > ■ ≧ 99 ppm	n=4
B 〃	99 ppm > ▪ ≧ 74 ppm	n=17

Pb

B Grade Anomaly	▪ ≧ 38 ppm	n=1
High Content	38 ppm > x ≧ 21 ppm	n=32

Zn

AA Grade Anomaly	◇ ≧ 198 ppm	n=7
A 〃	198 ppm > ◇ ≧ 165 ppm	n=13
B 〃	165 ppm > ◇ ≧ 137 ppm	n=22

Cr

AA Grade Anomaly	▲ ≧ 656 ppm	n=7
A 〃	656 ppm > ▲ ≧ 482 ppm	n=8
B 〃	482 ppm > ▴ ≧ 355 ppm	n=22

F

AA Grade Anomaly	○ ≧ 2457 ppm	n=2
A 〃	2457 ppm > ○ ≧ 1459 ppm	n=9
B 〃	1459 ppm > ∘ ≧ 910 ppm	n=31

Anomalous Zone

Ⓒr Mineral Occurrence

Fig.4-5 Geochemical Anomaly Map, Regional Survey Area

population were selected as high-content values on Au and Pb. The values of Au are of over detection limit and that of Pb are of over $\bar{x} + 1.5\sigma$.

Table 4-5 summarizes the classification of anomalous values, threshold, high-content values and number of samples respectively.

4-2-4 Interpretation of Geochemical Anomalies

Fig. 4-5 and Plate 10 give the distribution of anomalous samples, high-content samples and anomalous zones. Interpretaion of geochemical anomalies for each element are as follows.

(1) Au

An remarkable anomalous zone for Au was distinguished. The Endogh Au anomalous zone (Au : 90 to 14,250 ppb) including six samples of AA and A-grade anomalies, extends from Kameyen to Sikowa Ridge along the upper stream of the Endogh River. In this area, many panners have obtained eluvial gold from the residual soil of talc schist. It is apparent that the anomalous zone has its origin in this eluvial gold deposit. In the zone the Au anomalies were obtained from many tributaries of Endogh River, and this proves that the distribution area of eluvial gold deposit is wider than the area worked at present. Mixing of placer gold in the geochemical sample seems to have caused the extraordinarily high content of the sample with maximum gold value.

Three anomalous samples (Au : 80 to 300 ppb) and three high-content samples are in the Tulot area. These are sure to reflect the eluvial gold deposit in the area. Some anomalous samples are found sporadically in the Turkwel River, Endogh River, Iang River and Marun River, and they have been known as the places of production of placer gold. Three samples with B-grade anomalies (Au : 110 to 250 ppb) were taken from the tributaries of Mortorth River near Nasolot. But no production of placer gold has been reported in the river.

(2) Cu

Threshold value, 74 ppm and the maximum value, 159 ppm of Cu are not very high values in comparison with the Clarke number of it.

Only one anomalous zone extracted for Cu is the Akeriamet Cu Anomalous zone. The zone extends from the north of Wakorr to Akeriamet Shop area and consists of a A-grade and eight B-grade anomalies (Cu : 77 to 159 ppm). Vein-type copper mineralization known as Akeriamet copper showing is located in the zone, and is considered to the cause of the anomalies.

Along the Endogh River four A-grade anomalies and three B-grade anomalies scattered, however, no copper meneralization has been observed in that area.

The fact that the six known copper showings except Akeriamet showing did not cause any anomalous zone suggests that the copper mineralization is rather weak generally in the project area.

(3) Pb

The analytical values of Pb are all low in grade.

The anomalous sample is only one and its value, 38 ppm is merely two and half times as large as Clarke number. For this reason, it seems difficult to expect any economical lead deposits in the project area.

The samples with high-content value are mainly distirbuted from Sebit to Marich along the Marun River. The existence of Marun fault along the river might have relations with the relatively high concentration of Pb.

(4) Zn

Two anomalous zones selected for Zn are placed in the southern tributaries of Marun River. The large one named Sebit Zn anomalous zone is distributed in the lower reaches of the Sebit River with long axis of about 10 km and short axis of 2 to 4 km extending in the NW-SE direction. The zone contains 26 anomalous samples (Zn : 137 to 300 ppm) which correspond to the 62 percent of the total number of anomalous samples.

No zinc mineralization has been reported in the zone, but two copper showings of vein-type mineralization, Twin Bridge copper showing and Parua copper showing, are known in and around the zone. Judging from the facts that generally, zinc indicates the base metal mineralization of vein-type well in geochemical exploration and the correlation coeficient between Cu and Zn, 0.40 shows the moderately positive correlation, the anomalies could reflect the vein-type copper mineralization with zinc. Eight AA and A-grade anomalies are gathered around Sebit near the Twin bridge copper showing, and it appears that the area has been subjected to a relatively intense mineralization in the zone.

The small one, Wakorr Zn anomalous zone, is about 3 km south of Wakorr, including five A-grade anomalies and four B-grade anomalies (Zn : 140 to 194 ppm). None of mineralization has been known in and around the zone. However, it could be remarked that the anomalies were occurred by the copper mineralization with zinc similar to it presumed in Sebit Zn anomalous zone.

(5) Cr

With respect to the distribution of the chromium anomalies, two main anomalous zone, the Tulot Cr anomalous zone and the Tamkal Cr anomalous zone, can be distinguished. The former is located in the Tulot area extending to N-S with E-W width of about 2 km and N-S length of about 8 km. The zone contains 12 anomalies (Cr : 357 to 1,532 ppm) and corresponds clearly to the distribution of ultrabasic rocks in which the Tulot chromite deposit occurrs.

The latter extends 7 km in a N-S direction from Tamkal in the middle reaches of the Weiwei River. Most of the ten anomalous samples (Cr : 363 to 488 ppm) in the zone are obtained from the eastern-side branchies of the Weiwei River. No outcrops of ultrabasic rock were found by the survey of this phase, however, the small bodies of ultrabasic rock could be expected to distribute in the upper stream area of the branchies.

It appears that the ultrabasic rock belt accompanied with chromium mineralization and extending to the north and south from Tulot, caused some anomalies sporadically scattered along the Marun River and Endogh River. Four anomalous samples (Cr : 387 to 515 ppm) gathered in some degrees are situated about 4 km west of Ortum. Though none of ultrabasic rock is reported in this area, unconfirmed ultrabasic rock might be expected within the vicinity.

(6) F

A distinct anomalous zone named Ortum F anomalous zone (F: 920 to 3,475 ppm) is to the west of Ortum. The zone is elliptical in form extending to NE-SW with long axis of about 10 km and width of about 3 km. All anomalous samples of AA and A-grade and 83 percent of the total number of anomalous samples are included in the zone.

No mineralization thought to concern F anomalies has been found in the zone. The facts that the zone extends in parallel with the geological structure and that migmatitic type granite, augen gneiss and pegmatite, especially latter two are developped in the zone might show the relationship between concentration of F and ultrametamorphism in some local conditions.

4-3 Semi-detailed Survey Area A

4-3-1 Statistic Values and Distribution

Table 4-6 lists the statistic values of analytical elements. Au and Pt were excluded from statistic treatment because analytical results of them are mostly under the detection limits. The high values of Cr, Co and Ni reflect the distribution of ultrabasic rocks accompanied with chromium and nickel mineralizations.

Fig. 4-2 and Fig. 4-3 show the histgram and cumulative frequency distribution curve for each element except Au and Pt.

4-3-2 Correlation of Elements

Table 4-7 gives the correlation coefficients of the elements and $|R|$ values of significance test.

As the result of significance test, the correlations between Au and other elements and between Pt and them are refused in significance level of one percent. The correlations among Cr, Ni, Co and V are affirmative without it between Co and V in significance level of one percent. The correlation coefficients among Cr, Ni and Co are over 0.80, which reveal very strong positive correlation. Negative correlations are between Cr and V and between Ni and V, but they are no more than very weak mutuality.

4-3-3 Selection of Threshold Value

Threshold values were selected as follows based on the standard, and are shown in Table 4-8.

Cr, Ni, Co, V : Threshold values are determined by standard 2.

Pt, Au : Threshold values are determined by standard 1.

Since the number of samples over threshold value are very few, high values in the background population are selected as high-content values on each element. The values of Cr, Ni, Co and V are of over $\bar{x} + 1.5\sigma$ and that of Pt and Au are of over detection limit.

Table 4-6 Statistic Values of Analyzed Elements, Semi-detailed Survey Area A

Element Unit	Cr ppm	Ni ppm	Co ppm	V ppm	Pt ppb	Au ppb
Number of Samples	205	205	205	205	205	59
Minimum Value	4	7	7	15	<50	<10
Maximum Value	5,450	26,400	550	460	100	120
Range	5,446	26,393	543	445	>50	>120
Mean	339.6	195.6	59.6	155.3	-	-
S.D. (Log)	0.62	0.74	0.27	0.23	-	-
M + 1.5 S.D.	2,891	2,520	151	344	-	-
M + 2 S.D.	5,919	6,022	211	446	-	-
Clarke Number	100	75	20	135	5	4

Table 4-7 Correlation coefficient, Semi-detailed Survey Area A

	Cr	Ni	Co	V	Pt	Au
Cr	1.00					
Ni	0.87 (205)	1.00				
Co	0.81 (205)	0.89 (205)	1.00			
V	-0.20 (205)	-0.25 (205)	-0.12 (205)	1.00		
Pt	-0.03 (17)	0.00 (17)	0.08 (17)	-0.12 (17)	1.00	
Au	0.15 (58)	0.16 (58)	0.18 (58)	0.04 (58)	0.00 (7)	1.00

( ) Number of Paired Samples

$R(\phi,e)$
ϕ: degree of freedom
e: significance level

$|R|(5,0.01) = 0.875$
$|R|(15,0.01) = 0.606$
$|R|(56,0.01) = 0.336$
$|R|(203,0.01) = 0.180$

Table 4-8 Thresholds, Semi-detailed Survey Area A

Element	Anomalies	Threshold	Background High-content value
Cr (ppm)	≥5,919 (0)	5,919	5,919>≥2,891 (20)
Ni (ppm)	≥6,022 (2)	6,022	6,022>≥2,520 (22)
Co (ppm)	≥211 (2)	211	211>≥151 (15)
V (ppm)	≥446 (1)	446	466>≥344 (8)
Pt (ppb)	≥100 (4)	100	100>≥50 (13)
Au (ppb)	≥120 (1)	120	120>≥30 (4)

( ) Number of Samples

Table 4-8 gives the anomalous values , high-content values and number of samples corresponding to them for each element.

4-3-4 Interpretation of Geochemical Anomalies

Plate 11 shows the distribution of anomalous samples and high-content samples. Anomalous zones for Cr, Ni and Co could be drawn easily, however, because of their intimate relationship the anormalous zone will be shown later through the results of principal component analysis.

The followings are the interpretation of geochemical anomalies for each element.

(1) Cr

No anomalous sample is in the area. Twenty of high-content samples are distributed concentrically in the two areas, Tulot and Kamngeyon. It is evident that the ultra-basic rocks in which Tulot and Kamngeyon chromium deposits are emplaced, cause the high-content value samples. Eighty-five percent of the high-content samples are in Tulot area, this reflects the difference of the size of ultrabasic rock mass in Tulot and Kamngeyon.

(2) Ni

Two anomalous samples (Ni : 6,300, 26,400 ppm) collected from residual soil of serpentinite, are in the Tulot area. These anomalies reveal nickel mineralization and the maximum value is of economical grade. No anomalous samples were obtained, however, around the known garnierite nickel showing. The distribution of high-content samples is mostly same as it of Cr.

(3) Co

Tulot serpentinite mass is the parent rock of two anomalous samples (Co : 260, 550 ppm). The lower grade one was taken near the garnierite nickel showing. The distribution of high-content samples is mostly same as it of Cr and Ni.

(4) V

Anomalous sample (V : 460 ppm) is only one, and was taken in a point about 3 km south of Tulot. The distribution of the anomalous and high-content samples shows a limited range centering around the three areas, Kamngeyon, Gato and the area to the southwest of Tulot. The parent rocks of the samples are mostly green schist. No relation to mineralization might be estimated.

(5) Pt

Four anomalous samples (Pt : 100 ppb) and thirteen high-content samples (Pt : 50 ppb) were collected in the area. It seems that the distribution of anomolous and high-content samples bears no relation to the ultrabasic rocks but with the green schist it relates in some degree. No connection with mineralization might be pointed out.

(6) Au

Fifty-nine soil samples in and around the Tulot serpentinite mass were additionally analyzed for Au in consideration of eluvial gold production in the area. An anomalous sample (Au : 120 ppb) and four high-content samples (Au : 30 to 110 ppb) were all collected from the area where the serpentinite is distributed as parent rock. The result corresponds well to the known gold occurrence in the residual soil of serpentinite. However, no correlations between Au and Cr, Ni and Co might suggest the different behaviour and mineralization between Au and the three elements.

4-3-5 Principal Component Analysis

(1) General remarks

Judging from the high correlation coefficients and the similar distribution of high-content samples in Tulot and Kamngeyon area, the elements Cr, Ni and Co must behave geochemically in the same manner. From this viewpoint, principal component analysis has carried out in order that the informations of the three elements may be represented

It seems that no or very small ultrabasic rock mass must be distributed in the sampled area except for the two zones in the Area A. The high score samples over C grade are all in the Tulot high Z_1 score zone especially in the eastern half, whereas, the samples in Kamngeyon high Z_1 score zone are of D or E grade. These facts are sure to suggest that Kamngeyon area is inferior to Tulot area concerning not only the size of ultrabasic rock mass but also the degree of mineralization.

With respect to the relation with the geochemical anomalies for Cr, Ni and Co obtained by the univariate statistical analysis, all the high-content samples of Cr, Ni and Co are included in the samples of high score population of Z_1. Two anomalous samples of Ni are ranked in B and C grades, and two anomalous samples of Co are ranked in A and B grades. The samples near the occurrences of chromite and garnierite in Tulot serpentinite mass are ranked in B or C grades.

Table 4-12 shows the statistic values of three elements for the 36 samples which belong to the high Z_1 score population. The statistic values are of the samples collected mostly from the residual soil of ultrabasic rokcs or talc schist. If the number of samples collected from the residual soil of ultrabasic rocks or talc schist is abundant, an anomalous population indicating mineralization of Cr or Ni can be extracted by the statistic analysis for them, and the target area will be limited. by a parameter selected objectively.

Correlation matrix given in Table 4-7 was used for the treatment except for the coefficient relating Pt and Au. Table 4-9 lists the results of principal component analysis.

The first principal component, Z_1 represents 69 percent of total amount of information on the analytical data, and is strongly affected by the values of Cr, Ni and Co in almost same rate. This means that Z_1 is the proper indicator representing the elements. The high values and anomalous values of Z_1 are expected to indicate the distribution of ultrabasic rocks and mineralization of chromium or nickel respectively.

The second principal component, Z_2 represents 24 percent of total amount of analytical data information, and is decided mainly by the value of V. Since the bahaviour of Z_2 is estiamted to be almost same as it of V, no further consideration was needed. Regarding Z_3 and Z_4, their

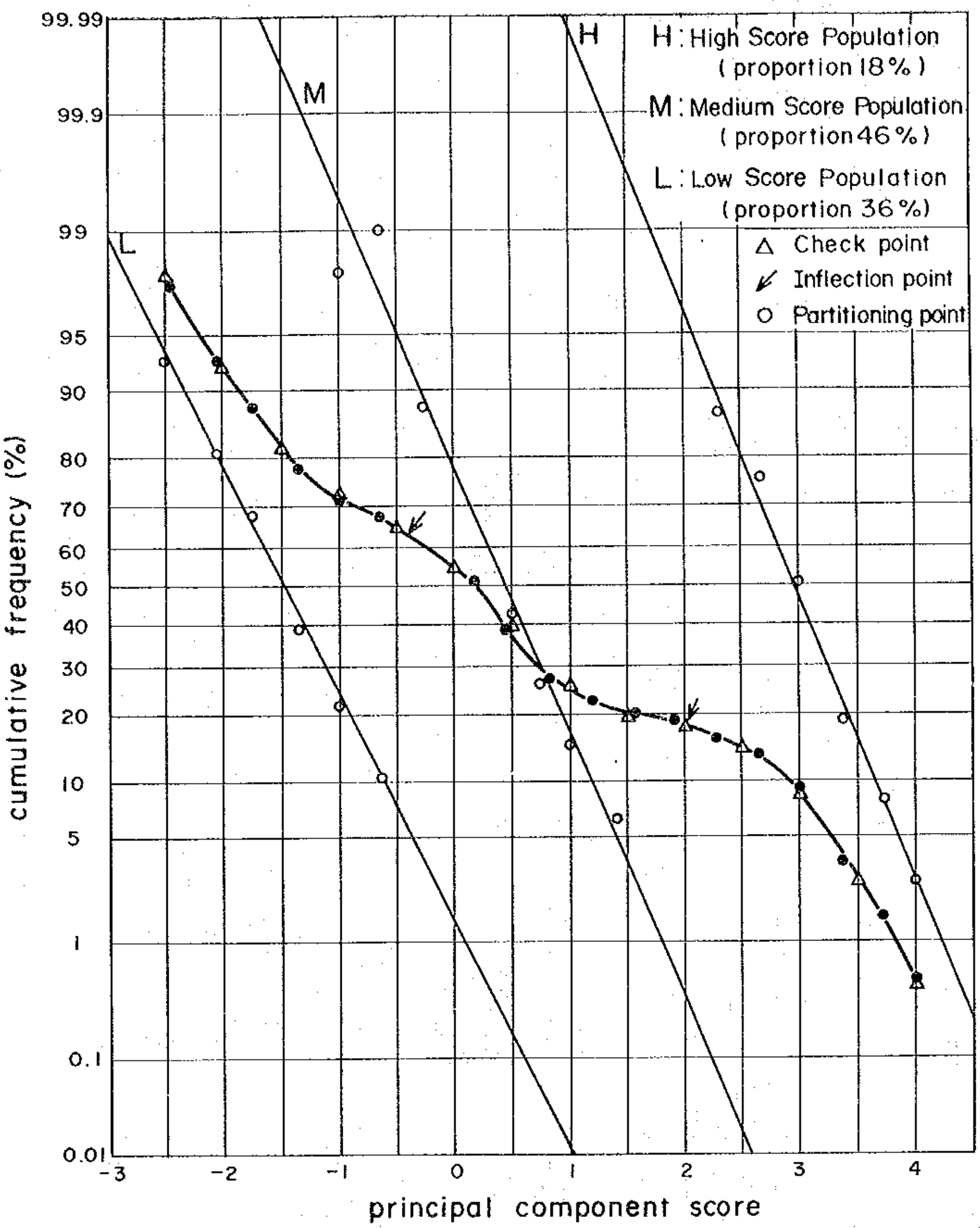


Fig.4-6 Cumulative Frequency Distribution of Z1 Scores and Separated Three Lognormal Populations, Area A

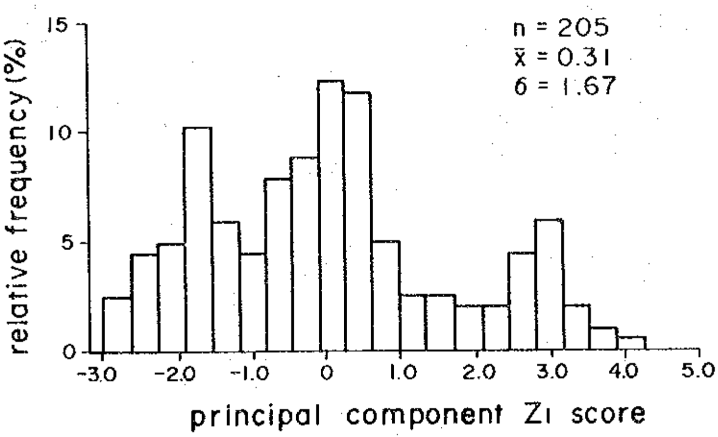


Fig.4-7 Histgram of Principal Component Score Z1, Area A

Table 4-9 Results of Principal Component Analysis, Semi-detailed Survey Area A

Principal Component	Eigen Value	Principal Contribution Ratio %	Cumulative Contribution Ratio %	Eigen Vector				Factor Loading			
				Cr	Ni	Co	V	Cr	Ni	Co	V
Z1	2.77	69	69	0.56	0.58	0.56	-0.18	0.93	0.97	0.93	-0.3
Z2	0.94	24	93	0.08	0.05	0.18	0.98	0.08	0.05	0.18	0.95
Z3	0.19	5	98	-0.77	0.11	0.63	-0.06	-0.34	-0.05	-0.23	-0.26
Z4	0.09	2	100	-0.30	0.80	-0.51	-0.08	-0.09	0.24	-0.15	0.02

Table 4-10 Statistic Values of Principal Component Z1

Principal Component	Number of Cases	Minimum Value	Maximum Value	Mean	Standard Deviation
Z1	205	-3.0062	4.263	0.3106	1.6656

Table 4-11 Classification of Z1 Scores in High Score Population

Grade	A	B	C	D	E
Score	≥4.05	4.05>≥3.50	3.50>≥2.95	2.95>≥2.40	2.40>≥1.70
Number of Samples	1	3	12	13	7

Table 4-12 Statistic Values of Geochemical Data belonging to High Score Population by Zn Scores

Element Unit	Cr ppm	Ni ppm	Co ppm
Number of Samples	36	36	36
Minimum Value	845	1,230	93
Maximum Value	5,450	26,400	550
Range	4,605	25,170	457
Mean	2,923	3,127	153
S.D. (Log)	0.1764	0.2280	0.1330
M + S.D.	4,388	5,286	208
M + 2 S.D.	6,586	8,936	283

Table 4-13 Statistic Values of Analyzed Elements, Semi-detailed Survey Area B

Element Unit	Nb ppm	Ta ppm	Sn ppm	W ppm	Li ppm	F ppm
Number of Samples	50	50	50	50	50	50
Minimum Value	< 10	<2	<1	<2	<1	26
Maximum Value	<10	2	4	16	8	184
Range	-	>2	>4	>16	>8	158
Mean	-	-	-	-	2.7	82.8
S.D. (Log)	-	-	-	-	0.327	0.20
M + S.D.	-	-	-	-	5.7	130.5
M + 2 S.D.	-	-	-	-	12.2	205.8
Clarke Number	20	3.4	2	1.3	20	620

principal contribution ratio are very low, hence the futher consideration was omitted.

(2) Distribution and Classification of Z_1 Score

Univariate statistical analysis was carried out for the population comprizing principal component scores of Z_1. Table 4-10 gives the statistic values of Z_1 score. Fig. 4-6 and Fig. 4-7 show the cumulative frequency distribution curve and histgram of Z_1 score respectively.

Three populations, high score, medium score and low score population with proportion of 18%, 46% and 36% respectively, have resolved from the frequency distribution curve of Z_1 score by the method of A.J. Sinclair (1974). The partitioned three lognormal distributions and check points obtained by combinig three populations in the ratio mentioned above, are shown on Fig. 4-6. The check points have plotted nearly on the original curve, and this proves a proper partitioning of original population.

The high score population with proportion of 18% is composed of 36 samples collected from residual soil of ultrabasic rocks or talc shcist. The population was classified into five groups, A to E group, bordered by values of 99% level, 84.1% level ($\bar{x} - \sigma$) 50% level ($\bar{x}$), 15.9% level ($\bar{x} + \sigma$), 2.3% level ($\bar{x} + 2\sigma$) in probability scale. The value of 99% level distinguishes the high score population from medium score population.

Table 4-11 gives a classification of Z_1 scores in high score population. Plate-12 illustrates the distribution of high score samples classified.

(3) Results of Principal Component Analysis

The 36 samples of high score population center in two areas as Tulot high Z_1 score zone and Kamngeyon high Z_1 score zone, reflecting obviously the distribution of ultra-basic rocks mineralized and talc schist. The former zone contains thirty high score samples which mean 83% of total ones, and covers the Tulot serpentinite mass and talc schist in which chromium and nickel mineralizations occurr. The latter zone consists of six high score samples and covers serpentinite body in which Kamngeyon chromium showing is emplaced.

4-4 Semi-detailed Survey Area B

4-4-1 Statistic Values and Distribution

Table 4-13 gives the statistic values of analytical elements. Four elements, Nb, Ta, Sn and W were excluded from statistic processing because their analytical results are mostly under the detection limits. The analytical results of Li and F under detection limit were calculated as 0.4 ppm and 4 ppm respectively. Histgram and cumulative frequency distribution curve for Li and F are illustrated in Fig. 4-3 and Fig. 4-4.

4-4-2 Correlation of Elements

No correlation coefficient was obtained because of the existences of abundant analytical results under detection limit except it between Li and F. The correlation coefficient and the |R| (48,0.01) value between Li and F are 0.18 and 0.361 respectively, but they show that the correlation is denied with significance level of one percent.

4-4-3 Selection of Threshold Value

No threshold value is determined for Nb, Ta, and Sn because their analytical values are mostly under detection limit and their maximum values are so low as they are almost same as the Clarke number or under it. The maximum value of W, 16 ppm is remarkably high compared with all other results under 4 ppm, therefore 16 ppm was decided as threshold value of W. For Li and F, threshold values are determined by the standard 2, but no sample over threshold values was found. High-content samples whose values are over $\bar{x} + \sigma = 5.7$ ppm, were distinguished for Li, because they show maldistribution.

Plate-13 gives the distribution of anomalous sample and high-content samples.

4-4-4 Interpretation of Geochemical Anomalies

All the analytical results are very low in grade. As to Nb, Ta, Li and F even the maximum values are under Clarke number. No anomalous samples were selected except W. For W, it seems that the value of anomalous sample is not so high as the mineralization can be expected.

The fact that no anomalous sample possibly reflecting the mineralization has not been found is consistent with the field observation that abundant pegmatites are there in the Area B but no mineralized one is.

High-content samples of Li, seven samples, are distributed along the Tamogh River, extending 2 km in the E-W direction. It appears that pegmatites have intruded in the area so many that the area becomes rich in Li relatively.

CHAPTER 5 CONCLUSION AND RECOMMENDATION

5-1 Conclusion

(1) Geology

Findings on geology in the project area which have been obtained in the present phase are as follows.

(A) The present study has revealed that the geological structure of the project area comprises a major regional syncline and subordinate overturned folds, in contrast to the previous interpretation (McCall: 1964, Miller: 1956) in which the geological structure is considered to be simply monoclinal dipping to the east.

(B) The discrepancy in the continuation of geological units which is observed between the previous two geological maps Sekerr (McCall, 1964) and Kitale-Cherangani Hills (Miller, 1954) is accounted for by the existence of a major fault and the displacement of rock units at the both sides of it.

(2) Mineral Deposits

Findings on mineral occurences in the project area obtained during the present work are as follows.

(A) Gold deposits comprise alluvial (Suam-Turkwel, Marun, etc.) and eluvial (Endogh, Tulot, etc.). The former is interpreted to be derived from the rocks weakly mineralized by the intrusions of granitic and/or ultrabasic rocks, whereas the latter direcly derives from the ultrabasic rocks.

(B) Ni-Cr deposits (Tulot and Kamngeyon) are associated with ultrabasic rocks; chromite deposits occur as small lenticular bodies of massive chromite in the serpentinite host, and nickel occurs as stain and crack-filling garnierite in weathered serpentinite.

Assay results for Ni of the samples collected during the present work are fairly high, although no systematic sampling has yet been carried out.

(C) There are seven Cu showings which have so far been located: The known five are small in size and low in grade. The assay results of two float samples from two localities are 1.92% Cu (Talon) and 1.10% Cu (Parua). All these copper showings are in or close to intrusive bodies.

(D) A molybdenite-quartz vein was confirmed at south of Chaichai in the vicinity of granite body. However, the dimension of the outcrop is small.

(E) Non-metallic minerals such as mica and kyanite occur in the adjacent areas of granite bodies. However, their grades and dimensions so far observed are poor and small in general.

(3) Geochemical Exploration

Findings from geochemical exploration are as follows.

(A) Au anomalies well reflect the known gold deposits: The Endogh anomaly occurs in the area where eluvial gold is being mined by local people, and it has a dimension of some 5km long (NS) and shows high gold values (90 to 14,250 ppb). At Tulot, also some anomalous Au values are crowded in an area.

(B) Anomalies of Ni, Cr, and Co also well coincide with the distribution of ultrabasic rocks in which known Ni-Cr deposits are emplaced. The distribution of high Ni values at Tulot is fairly extensive in area, sohwing a possibility that there might be a promising deposit. A Cr anomaly is detected at Tamkal, which may suggest the existence of undiscovered ultrabasic bodies.

(C) Two weak Zn anomalies were located; one is located between Sebit and Parua, and another is at the south of Wakorr. The Sebit-Parua anomaly (137-300 ppm) has a fairly large extent (10 km x 4 km) and is approximately situated at the intersection of the major Marun and Sebit faults, implying that it may be derived from some sort of mineralization along the structural lines.

(D) A weak Cu anomaly (70-159ppm) is located at Akeriamet in the south central part of the project area. This may reflect the nearby known Cu showings. However, there are also some other anomalous values which apparently occur close to the granite that accompanies skarn in places.

(E) No anomalous value in Nb, Ta, Sn, W, Li and F has so far been detected in the Area-B wihch was originally designed to explore minerals related with pegmatite.

5-2 Recommendation to the 2nd Year Programme

Based on the above-mentioned conclusion, following works are recommended for the 2nd year programme, as well as some new additional reconnaissance to the further south beyond the present project area.

(1) Tulot Ni-Au mineralization in the Semi-detailed Area-A.

Further detailed geological and geochemical exploration works are recommended in order to delineate the nickel and gold mineralization and to reveal its characteristics.
The recommendation is justified by the following observations; A fairly large geochemical nickel anomaly is located by soil sampling, and comparatively high Ni values are obtained among the mineralized samples taken in the present programme.

Gold anomalies from both soil and stream samples superimpose the nickel anomaly.

(2) Zn-(Cu) Anomaly between Sebit and Parua in the Regional Survey Area

Follow-up works to delineate the mineralization and to reveal its characteristics are recommended.

The anomaly is situated at the intersection of the NE-trending Marun Fault and NW-trending Sebit Fault: The Zn anomaly has a fairly large extent and includes two copper showings within it.

(3) Akeriamet Anomaly in the Regional Survey Area

Follow-up works are recommended in order to reveal the characteristics of the mineralization which causes the anomaly, and to delineate the mineralization.

The copper anomaly may reflect the known showing, however, some skarn has newly been located during the present programme.

(4) Trace of the further extension of the skarn "zone"

Skarn is likely to occur along the granite intrusive body, and it is expected to extent further to the south beyond the southern limit of the present project area. Therefore, trace of the "zone" may be justified.

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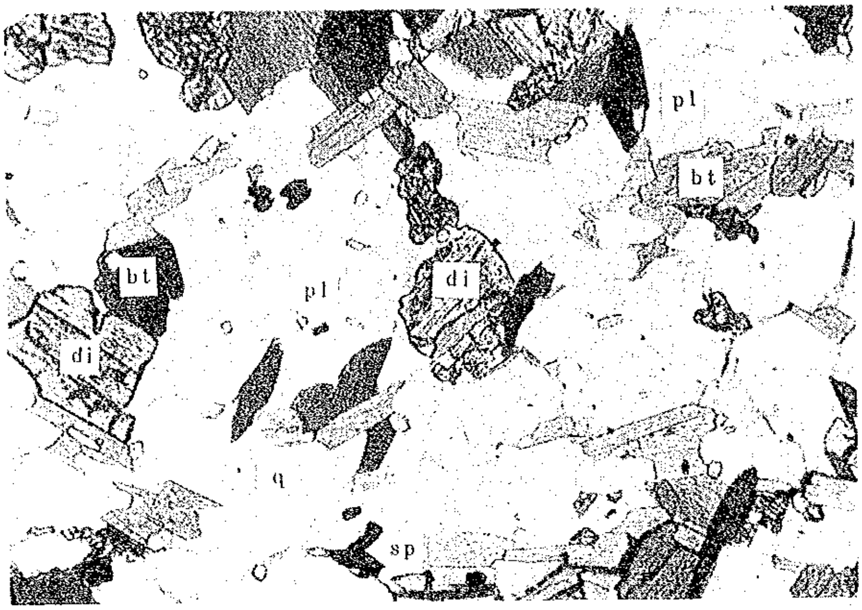
APPENDICES

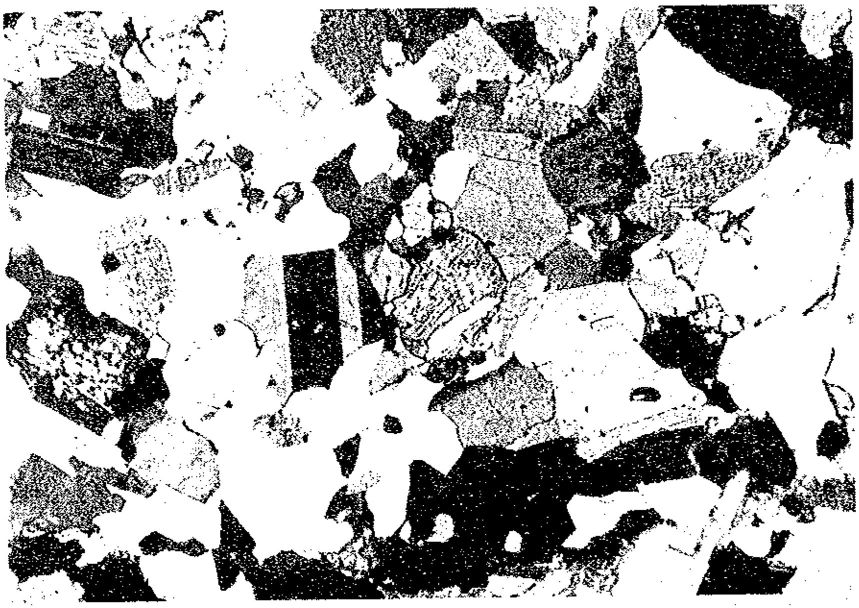
Photo A-1 Microphotograph of Thin Section

Abbreviations

q	:	quartz
kf	:	potash feldspar
pl	:	plagioclase
bt	:	biotite
mus	:	muscovite
hb	:	hornblende
di	:	diopside
ol	:	olivine
act	:	actinolite
gt	:	garnet
ep	:	epidote
zo	:	zoisite
chl	:	chlorite
ant	:	antigolite
sp	:	sphene
st	:	staurolite
ca	:	calcite
ap	:	apatite
cr	:	chromite
op	:	opaque mineral



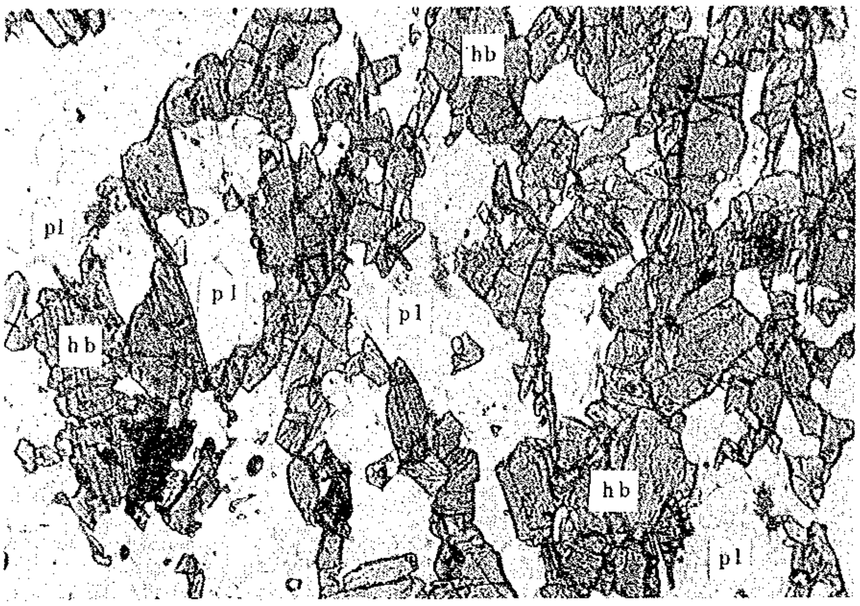
Only lower polar



Crossed polars

0 1mm

Sample No. : CR-43
Location : X=759 Y=155
Rock name : Diopside-Biotite Gneiss
Formation : B III



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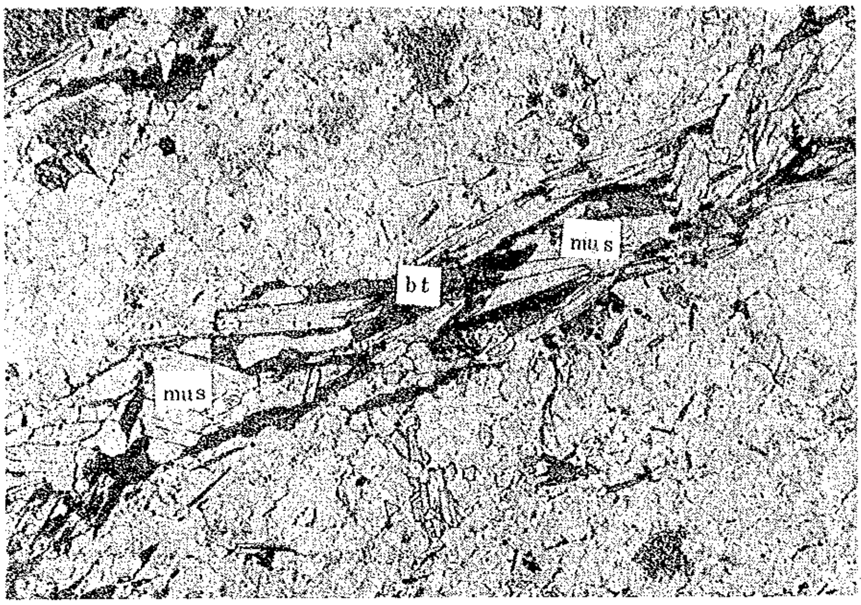
Crossed polars

0 1mm

Sample No. : DR-41
Location : X=769 Y=173
Rock name : Gneissose Amphibolite
Formation : B II



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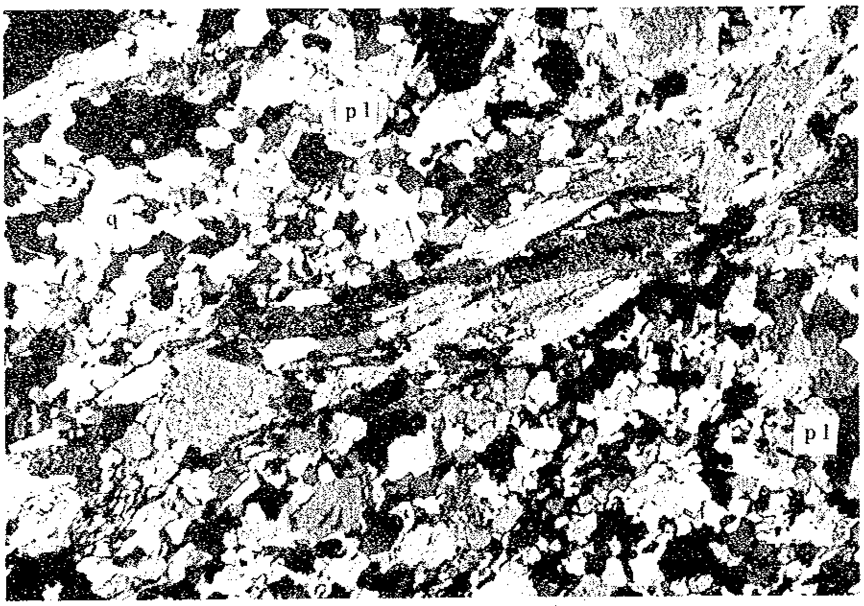

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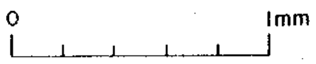
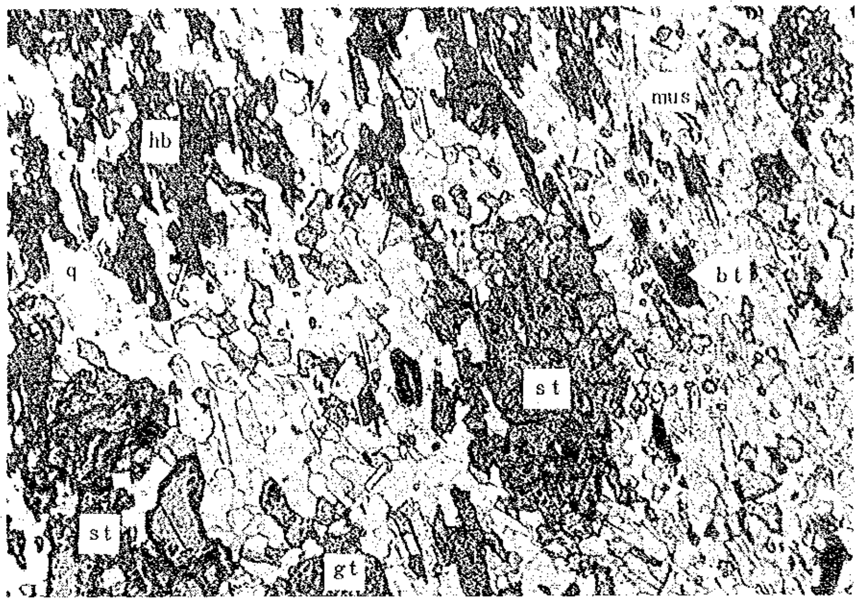
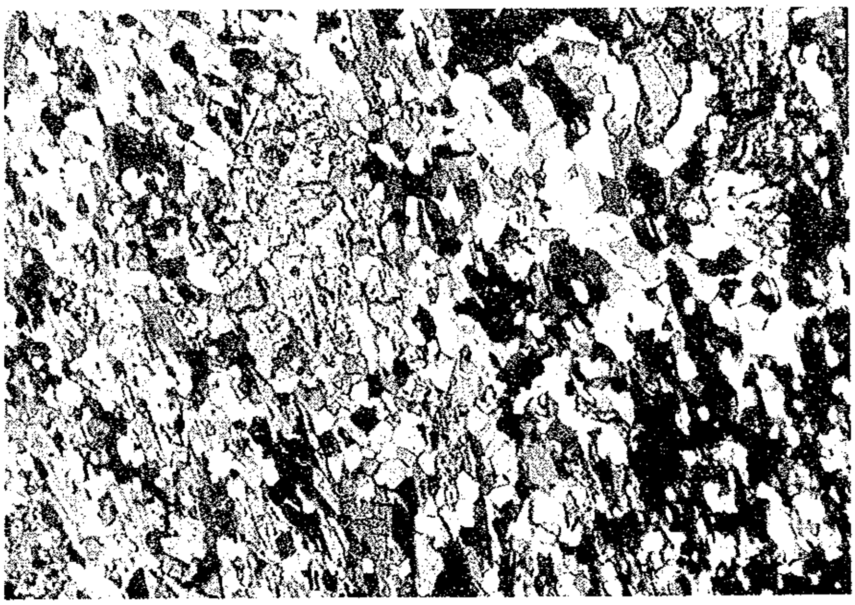


Sample No. : AR-176
Location : X=767 Y=167
Rock name : Muscovite-Biotite-Quartz Schist
Formation : B III



Only lower polar



Crossed polars

0 1mm

Sample No. : CR-126
Location : X=758 Y=201
Rock name : Garnet Spot Staurolite-Hornblende Schist
Formation : B II