(thin section)	:	Trachy dolerite
61-ST-70(upper part of Dk-6 X-ray analysis)	:	Plagioclase - potassic feldspar > quartz > - chlorite - pyrite - calcite, They are secondary except plagioclase and potassic feldspar.
(thin section)	:	Monzonite porphyry
61-ST-71(upper part of Dk-6 X-ray analysis)	:	Plagioclase - quartz > chlorite -calcite > sericite > pyrite, They are secondary except plagioclase.
(thin section)	:	Basaltic trachy andesite

The stratigraphic sequence of the hole is characterized by cloudy patterned structure in marble, water escaped structure at two places, and a large number of intercalated beds of slate and tuff, and it indicates that the hole penetrated into the pelitic-tuffaceous calcareous rock .

2-10 MJI-10

[Purpose] : The low hill of quartz monzonite runs with a NE-SW direction northeast of the MJI-1 site, and it divides into the S.Tuboh area and Kerin area. There are exposures of quartz monzonite, but no exposures of sedimentary rock in the distance of 500m between the hill and MJI-1 site. The drill was conducted in order to unravel geology in the area, and to trace the contact zone with quartz monzonite and sedimentary rock to the northeast direction. The hole site is located 30m inside of the quartz monzonite.

[Result] : Quartz monzonite at 26.00~27.30m, a skarnitized intrusion at 55.67~ 58.47m, and skarnitized unit at 138.95~139.45m occur in the hole, but there is no noticeable mineralized indication in these parts.

The quartz monzonite of 26.00~27.30m is pale greenish gray in colour by decolouring, and mafic minerals in the rock are faded with unclear crystal rims under the microscope.

In the greenish grey rock of 57.67~58.47m, quartz-garnet occurs at 57.62~57.67m (at the contact part of the upper boundary), and banded quartz-garnet at 57.97~58.05m and 58.17~58.47m.

A garnet-pyrite zone at 85.48~85.68m is accompanied by several grains of red sphalerite.

A hornfels occured at 138.95~139.45m the origin of which cannot be distinguished as tuff or igneous rock. It is dark green in colour, and contains minute-grained pyrites through its entirety, and garnets at its lower boundary.

A very course-grained marble is distributed from 97.95m to 151.00m(bottom of the hole), Fine-grained quartz-pyrite veins occur at 114.80~115.40m, 121.45~121.90m, and 133.90, 134.20m in the marble.

The marble is rather very coarse-grained, even though its origin rock is pelitic or tuffaceous calcareous rock, but fine-grained marble is continuously present from 58.47m to 97.95m, showing the following features :

60.65~61.25m	: hornfelsic pelitic tuff with lamina dipping 30°
77.10~77.20m 78.20~78.30m 83.10~83.70m	-thin tuff beds dipping 0° ~15°
81.10m,81.20m,82.20m 82.45m,82.55m,86.40m 86.75m	-water escaped structure with 3cm width in each part

Minute fractures caused by compaction appear in fine-grained white marble at 46.60m, and wavy micro-folding structure appear, in fine-grained greyish marble.

Below surface soil at 0~15.00, unconsolidated sand-pebble-cobble sediments occur down to 26.00m.

[Consideration] : The quartz monzonite occurring from 26.00m to 27.30m is a part of the large quartz monzonite body distributed extensively southeast of the drill site. The drill (MJI-10) site is located on the river terrace deposit of the above-mentioned unconsolidated sand-pebble-cobble deposit from 15.00m to 26.00m.

The river terrace deposit consists of pebbles-cobbles of silicified rock or quartz monzonite, according to the check result of the drilling sludge.

The fact that there is no mineralized zone throughout the hole, in spite of the discovery of 2 or 3 intrusive rocks and 5 skarns, is discussed in the next section. It might have been due to the difference in the physico-chemical condition during the mineralization stage.

The presence of the comparatively coarse-grained marble in the hole shows

Drill Hole No	: MJI-1		
Location	: 260N,320E	Elevation	:
Coordinate Point	:	Inclination	: -90°
Depth	: 151.00 m	Core Recovery	: 95.8%
Drilling Machine	: OE-8L	Term	: Oct.26 - Oct.29,1986

Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Mo %
4.40	N.C.	Surface soil											
12.70	M	White-grey,medium grain marble 12.50-12.95m : crushed zone	8.89-8.94m : garnet Py and very few amount of Sp with 30° dip banding										
14.80	N.C.	(cave)											
16.50	M	White-grey medium grain marble											
19.00	C	White-grey coarse grain marble											
25.45	M~F	White-grey medium~fine grain marble 22.90-23.25m : dominated thin band of slate											
29.70	C	White-grey coarse grain marble											
34.40	M~F	White-grey medium~fine grain marble 32.90-33.25m : banding of slate											
39.20	N.C.	(Cave)											
40	M~F												

Fig.28 Geologic Column of MJI-1

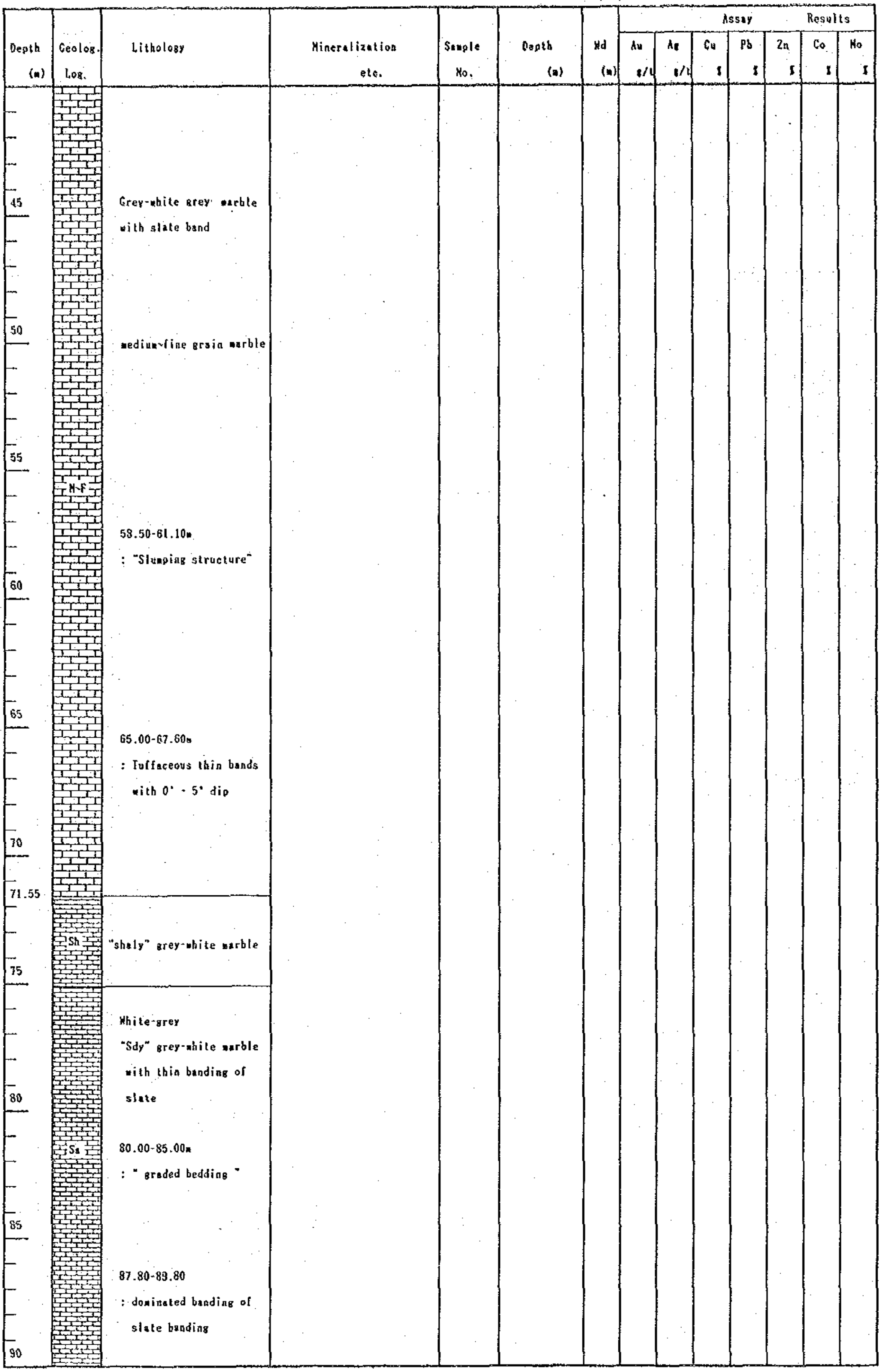


Fig.28 Geologic Column of MJI-1

Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Assay Au g/t	Ag g/t	Cu %	Results Pb %	Zn %	Co %	Mo %
– 92.40	Sa												
92.40 – 97.00 (95)	MJ	Medium grain white-grey marble with slate banding											
97.00 – 115.00 (100, 105, 110)	Sh	Grey " Shaly " marble 100.25-100.60m & 100.80 -101.50m : hornfelsic slate become whitish											
114.03		vein	114.03-114.13m : Siderite-Garnet-Py and very few amount of Sp										
115.00 – 128.90 (120, 125)	F~M	Grey-white fine grain~medium grain marble											
128.90 – 136.40 (130, 135)	C	White-grey coarse grain marble											
136.40 – 140	Sa	Grey-white " Sdy " or " Shaly" marble											

Fig.28 Geologic Column of MJI-1

Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Assay Results Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Mo %
	Sa												
145	C	Grey-white very coarse grain marble											
150													
151.00													

(Terminated)

Fig.28 Geologic Column of MJI-1

Drill Hole No	: MJI-2		
Location	: 170N,230E	Elevation	:
Coordinate Point	:	Inclination	: -90°
Depth	: 151.00 m	Core Recovery	: 84.2%
Drilling Machine	: OE-8L	Term	: Nov. 5 - Nov. 8,1986

Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Assay Results Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Mo %
5, 10	N.C.	Surface soil & Weathered, decompoused rock											
12.9 – 13.30		Ore	Qtz-Sp-(Py-Cp) ore Coarse grain of Sp	MJI-2-1	12.90～13.30	0.40	0.14	72.5	0.77	0.52	9.20	0.017	0.001
15, 20, 25	N.C.	(Cave)											
26.00 – 27.30	M	Grey-white medium grain marble											
27.30 – 29.60	N.C.	(Cave)											
29.60 – 31.80	M	Grey-white medium grain marble											
31.80 – 34.10	N.C.	(Cave)											
34.10 – 39.17	M~F	Grey white, massive, medium～fine grain marble											
39.17 – 39.50		Ore	Qtz-Sp-Gn-Gt ore Coarse grain of Sp.Mb	MJI-2-2	39.17～39.50	0.33	0.14	58.0	0.06	0.23	6.72	0.012	0.002

Fig.29 Geologic Column of MJI-2

Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Assay Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Results Mo %
	N.C.	(Cave)											
43.90													
45													
50													
	C												
55		White massive coarse grain marble											
60													
65													
70													
75		White massive coarse grain marble											
	C												
80													
85													
90													

Fig.29 Geologic Column of MJI-2

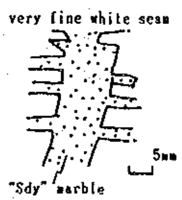
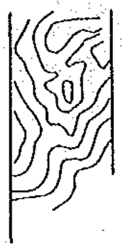
Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Mo %
95													
	C	Coarse grain white marble											
100													
105													
110													
110.10	Sa	Sandy fine white-grey marble											
112.05													
		113.75~114.00m : green patch aligned with 20° -10° dip											
115													
			117.20-122.60m : irregular bands of Py - black substance and pale -orange part with 60° ~ 70° dip										
120		White-grey very fine "sdy" marble											
	F												
125													
		15° -20° (bedding ?)											
130													
132.95		" Water escaped structure " ⇨											
133.35		↓											
135		" Slumping structure "											
	F												
		Very fine "sdy" marble											
140													

Fig.29 Geologic Column of MJI-2

Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Mo %
		"Slumping structure" ⇨											
145	F												
		150.60-150.80m : hornfelsic part and talcose part											
150													
151.00													

(Terminated)

Fig.29 Geologic Column of MJI-2

Drill Hole No	: MJI-3			
Location	: 180N,180E		Elevation	:
Coordinate Point	:		Inclination	: -90°
Depth	: 151.00 m		Core Recovery	: 100.0%
Drilling Machine	: OE-8L		Term	: Oct.14 - Oct.17,1986

Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Assay Results Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Mo %
4.00		Surface soil (N.C.)											
5 10 15 20	M-C	Grey white medium-coarse grain marble 7.90m,8.50m,11.60m,18.00m 19.15-19.25m,19.60m : mud dyke with wd. 2mm~5mm, dip 55° 4.00~22.10m : lot of fissure,limonite stainned	4.70m : wd 5mm Qtz-vein										
21.70	C	Coarse grain,light grey marble											
23.15	M	Medium grain light grey mbl. 23.45-23.75m : pale orange dyke 23.95-24.15m : pale orange breccia dyke											
25 25.20 30	C	Coarse grain, grey white marble											
31.50 35 40	M	Medium grain grey white marble	31.20m : brown Qtz-vein Wd 3mm										

Fig.30 Geologic Column of MJI-3

Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Assay Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Results Mo %
45	M	40.30m ; kaolinized dyke(?) Wd 2cm,dip 70° 44.30-48.30m : " Cloudy " pattern											
48.30, 50	C	Coarse grain whitish marble											
50.30, 55	F	Grey fine grain marble	50.30m : Qtz-vein (barren,white) 55.30m, 56.30-56.50m, 57.00-57.15m,57.80-58.30m : cherty Qtz-vein with marble breccia, dip 60° ~70°										
59.30, 60	C	Coarse grain grey white marble											
61.60, 65, 70	F	Grey fine grain marble	65.37m,65.47m,65.80m,66.40m 68.10m,68.40m : cherty Qtz-vein Wd 1mm,dip 50° ~60° 71.40-71.50m : thin bed of tuffaceous, with Py-epidote										
72.9, 75	C	White coarse grain marble											
77.10, 80, 85	M	Grey medium grain marble	84.90m, 85.20m : brown Qtz-vein, Wd 1mm, dip 75°										
85.80, 90	F	Grey-white,fine grain marble											

Fig.30 Geologic Column of MJI-3

Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Assay Results Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Mo %
	F	90.70-91.10m : Wd 3mm, Calcite vein											
92.40	C	Coarse grain,grey-white mbl	Kaolinized : 2cm wide at a upper boundary(92.90m),green (chlorite)-hematite,dip 78°										
92.90		Pale-orange dyke. (Kaolinized-silicified)											
94.50	F	Very fine grey marble (Sandy origine)"Cloudy" pattern at 96.90-97.50m	Lower boundary(94.50m) with Py., dip 68°										
97.50													
100													
105	F	Fine grain marble (below 102.00m becoming whitish)											
110													
115													
118.30		Very fine grain dark grey marble											
120	F												
121.20		Biotite hornfels											
122.35		Tuffaceous slate											
123.60		Basic lava flow(Basalt)											
124.25		Biotite hornfels Tuffaceous slate											
		Grey fine grain marble 125.40-125.70m : "Cloudy" pattern with 55° ~70° dip											
130	F	127.00-127.80m : sporadically developed of black band 132.25-133.00m : Sl-Tf banding (132.55-132.65m : lime-garnet)											
135			138.15-138.25m : calcite vein 138.25-139.85m,139.85m : Py in band										
140													

Fig.30 Geologic Column of MJI-3

Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Assay Results Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Mo %
		Grey fine grain marble											
145	F		144.60m : Py in band										
		Grey fine grain marble											
150			150.80m : Py in band										
151.00													
		(Terminated)											

Fig.30 Geologic Column of MJI-3

Drill Hole No	: MJI-4
Location	: 105N,120E
Coordinate Point	:
Depth	: 152.40 m
Drilling Machine	: OE-8L

Elevation	:
Inclination	: -90°
Core Recovery	: 100.0%
Term	: Oct. 7 - Oct.11,1986

Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Mo %
0 – 10.60	N.C.	Surface soil											
10.60 – 40		Grey-white fine grain marble "Cloudy" or "Microfolding" patterns are visible in several places Grey-white fine grain marble											

Depth marks: 5, 10, 10.60, 15, 20, 25, 30, 35, 40

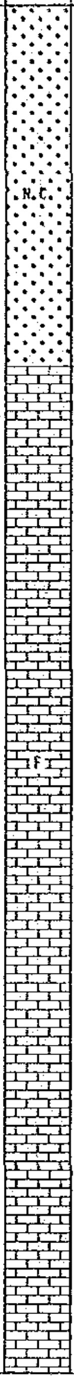


Fig.31 Geologic Column of MJI-4

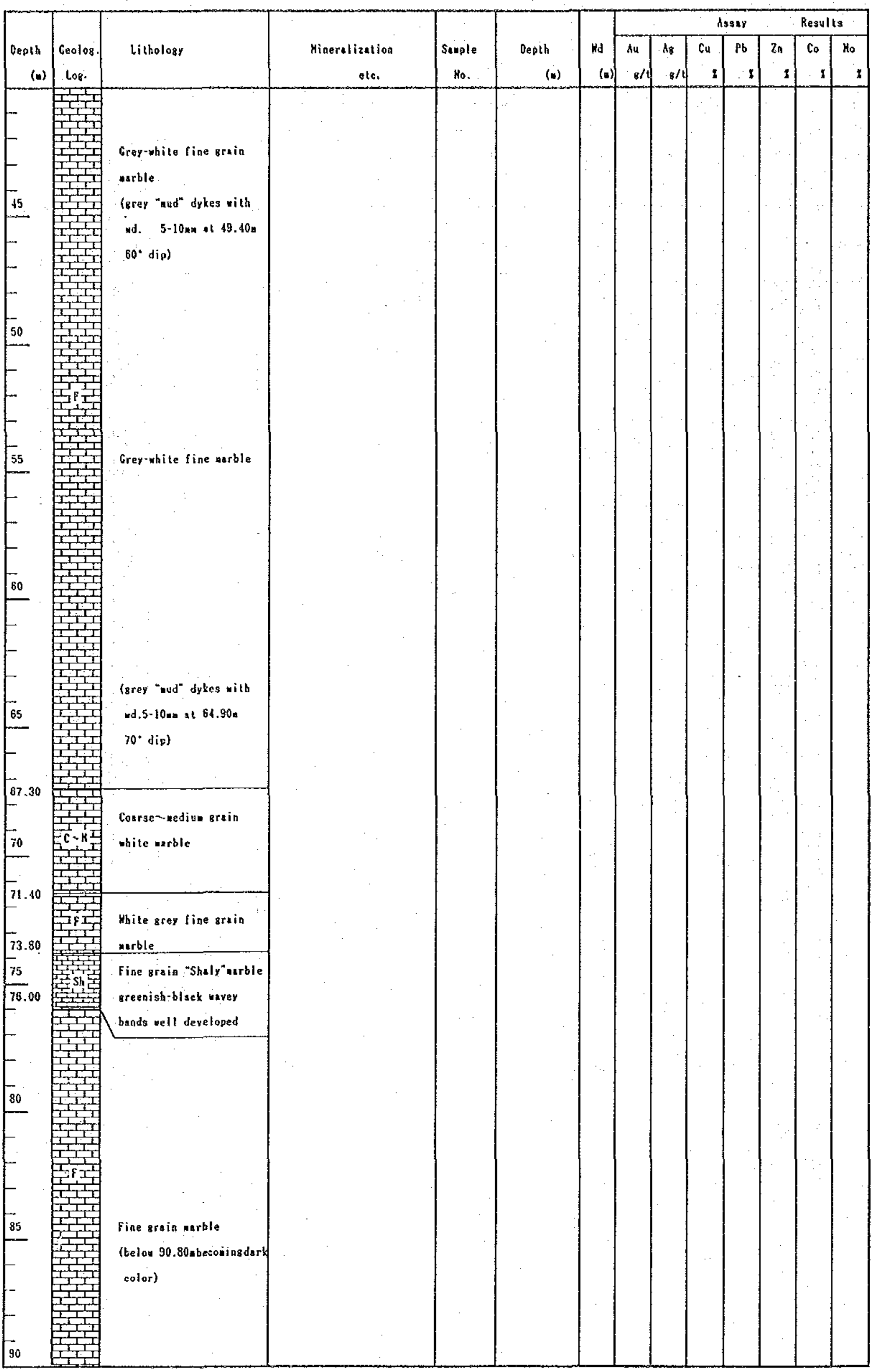


Fig.31 Geologic Column of MJI-4

Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Mo %
95 100	F	Fine grain marble 90.20-90.55m : wd 30-50mm "mud"dyke 96.20m : wd 5mm "mud"dyke	92.70m : wd 20mm white Qtz-vein										
100.10 105 109.80	Sa	" Slaty "marble 100.70-100.80m : biotite hornfels 103.40-103.20m : "Slumping"structure with thin bed of tuff 107.30-108.80m : thin (max 5mm)talcose seams	101.30m : 2-vein of Py wd 2mm										
115	F	Grey～dark grey fine grain marble											
115.30	∧ ∧ ∧	Dark greenish grey lava.	115.30-115.80m : Pyrrhotite dissemination										
115.30 117.10	F	Grey-dark grey fine grain marble											
120 125 129.70	C	Coarse grain white marble											
135 140	F	Fine grain grey-white marble with "Cloudy" patterns	⇨  Py + Silica(?)										

Fig.31 Geologic Column of MJI-4

Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Mo %
140.40 145 145.90	C	Coarse grain white marble											
150 152.4	F~M	Whitish grey fine medium grain marble "Cloudy"patterns well developed same as 129.70-145.90m											

(Terminated)

Fig.31 Geologic Column of MJI-4

Drill Hole No	: MJI-5		
Location	: 20N,100E	Elevation	:
Coordinate Point	:	Inclination	: -90°
Depth	: 151.00 m	Core Recovery	: 97.7%
Drilling Machine	: OE-8L	Term	: Sep.23 - Sep.26,1986

Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Assay Results Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Mo %
5.0	N.C.	Surface soil											
8.80	C	Grey-white coarse grain marble											
9.30	N.C.	(Cave)											
12.50 15	C	Grey-white coarse grain marble	14.10m,14.20m, : cherty Qtz-vein(wd 10~5mm). 16.00-16.50m : Py-dark Qtz film vein. 18.90-19.10m : whitish brown -yellow vein with Py-Qtz. wd 9mm,dip 70°										
19.10	×	Altered dyke	19.10-20.20m : grey,all phenocrysts have been replaced wholly by Qtz-Py -Gt.										
22.60 25 30 35 40	C	Coarse grain whitish marble below 37.50m black "Cloudy"patterns are visible sporadically	20.20-21.55m : pale orange, epidote -hematite-magnetite spotted. 21.55-22.05m : same to 19.10-20.20m. 22.05-22.25m : yellow-white, Qtz-Py 22.25-22.60m : same to18.90-19.10m with small amount of garnet at a boundary 26.20-29.50m : network of Qtz-Py vein 29.80m,30.20m : Qtz-Py vein										

Fig.32 Geologic Column of MJI-5

Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Mo %
45	C	Coarse grain whitish marble											
50													
55													
55.50	M	Medium grain white marble											
56.00	C	Coarse grain whitish marble											
58.90	M	Medium grain grey-white marble											
59.50	C	Coarse grain whitish marble											
64.40	F	Fine grain "laminated" marble	65.20-65.50m : very fine grain and hair vein of hematite. 66.95-67.15m : irregular lamination by fine grain of Py										
67.15													
70													
75	M	Dark grey～grey medium grain massive marble (below 72.00m becomecoarser than upper)											
80													
85		black banding at 85.00-85.10m											
86.00	Sh	"Shaly" or "Sandy"marble with flowage structures. (Slumping ?)											
90													

Fig.32 Geologic Column of MJI-5

Depth (m)	Geolog. Log	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Assay Results Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Mo %
92.80	Sh												
97.00	× × ×	Decolorized-skarnized dyke 50° dip at 97.00m	92.80-93.80m : Garnet-Epidote in pale-orange part. 58° dip at upper part 93.80-97.00m : Epidote- Fe oxide in grey-dark grey part (93.80-96.70m : irregular band of hematite)										
99.69	Sh	"Shaly" or "Sandy"marble											
100.15	Λ Λ Λ	Dark grey skarnized basalt lava,boundary ±0°	at upper part of 10cm, small amount of Sp-Gn are visible.										
105 110 112.15	Sh	"Shaly" or "Sandy"marble	106.65m :Qtz-Py vein with wd 9-12mm dip 70°										
115 116.70	M	Medium grain grey white marble											
120 125 126.45	Sh	Well laminated "shaly" marble	118.30m : wd 7mm of Py seam										
130 135 140	M~C	Medium~coarse grain massive grey marble											

Fig.32 Geologic Column of MJI-5

Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Assay Results Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Mo %
145	M-F	Medium~coarse grain massive grey marble											
150													
151.00		(Terminated)											

Fig.32 Geologic Column of MJI-5

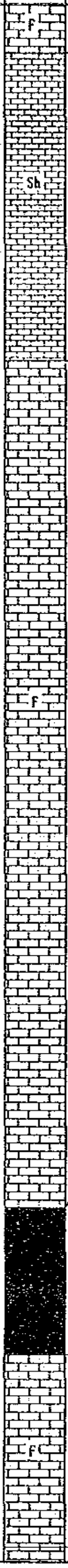
Drill Hole No	: MJI-6		
Location	: 50S, 60E	Elevation	:
Coordinate Point	:	Inclination	: -90°
Depth	: 151.00 m	Core Recovery	: 100.0%
Drilling Machine	: OE-8L	Term	: Sep.29 - Oct. 3,1986

Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Assay Results Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Mo %
5 6.30	N.C.	Surface soil	Cherty brownish Qtz-veins										
10 15 20 23.40	C	Grey-white coarse grain marble	are developed at 6.40m, 9.05m,9.50m,9.90m,10.50m, 10.90m,13.05-13.45m, 15.30-15.90m,23.20m with wd 2mm-15mm Decolorized-silicified cream-yellow~pale-orange zig-zag dyke (wd 2-3cm) at 14.25-15.20m										
25 30 35 37.5	F	Grey fine grain marble "Cloudy" patterns are common	Cherty black Qtz-vein at 24.20m,25.20m,26.95m,27.10m with wd of 1mm-3mm Cherty black Qtz-vein at 29.10-29.50m with wd of 25mm										
40	M-F	Grey-white massive medium fine grain marble											

Fig.33 Geologic Column of MJI-6

Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Mo %
	M~F												
42.20		Cream-yellow or pale-orange decolorized dyke 75° dip at 42.20m	42.20-44.00m : a lot of Qtz-Py-vein wd 1mm-3mm										
45													
46.20		40° dip at 46.20m											
50													
55	M~F	Grey-white massive medium-fine grain marble "Cloudy"patterns are rare 56.30-63.70m coarser than other part											
60													
65													
65.30													
66.25		Brecciated part(?) of marble	67.10-69.60m : hematite dissemination										
70													
		"bedding" 26°											
75	F	Grey fine grain marble (near "Shaly")											
80													
85													
90													

Fig.33 Geologic Column of MJI-6



Depth (m)	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Mo %
91.60 – 101.40	"Shaly" or "Slaty"marble banding : 0° - 35°	Thin hornfelsic thin bed at 98.85- 99.20m (this part has a possibility of lava flow)										
101.40 – 128.70	Grey fine grain marble 111.25-111.50m : biotite hornfels 113.00-113.20m : fine tuff(38° - 25° dip) 114.90m : biotite hornfels 116.55m,119.60-119.70m, 123.00m : thin slaty part	103.00-103.10m : fine tuff with Py 111.15-111.25m,111.50-111.67m : Qtz-calcite-epidote										
128.70 – 133.28	35° dip at 128.70m Ore zone	128.70-129.50m : reddish Sp	MJI-6-1	128.70-129.50	0.80	0.07	36.0	1.15	0.06	1.99	0.022	<0.001
		-black Sp-Cp-Cc-Hd.ore	MJI-6-2	129.50-130.50	1.00	<0.07	11.5	0.01	0.04	0.03	0.004	<0.001
		banding of skarn is 35°	MJI-6-3	130.50-131.50	1.00	0.96	205.0	0.03	0.79	0.02	0.008	<0.001
		129.50-131.80m : skarnized	MJI-6-4	131.50-131.80	0.30	<0.07	9.5	0.02	0.03	0.07	0.005	<0.001
		dyke (130.98-131.38m : Qtz	MJI-6-5	131.80-132.80	1.00	0.75	280.0	6.10	0.54	11.30	0.053	<0.001
		with Py-Hb dissem)	MJI-6-6	132.80-133.28	0.48	0.07	132.0	4.49	0.15	17.90	0.051	<0.001
133.28 – 139.60	28° dip at 133.28m Grey fine grain marble	131.38-133.28m : Cp-Sp-Gn high grade ore, below 133.08m : banding										

Depth scale (m): 91.60, 95, 100, 101.40, 105, 110, 115, 120, 125, 128.70, 130, 133.28, 135, 139.60

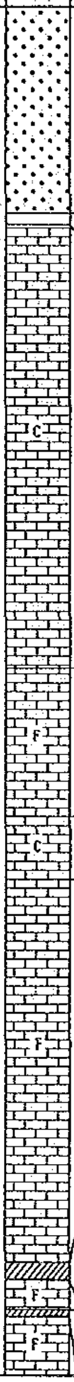
Fig.33 Geologic Column of MJI-6

Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Assay Results Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Mo %
145	C ~ M	Coarse grain-medium grain grey marble											
150													
151.00													

(Terminated)

Fig.33 Geologic Column of MJI-6

Drill Hole No	: MJI-7		
Location	: 20S, 0	Elevation	:
Coordinate Point	:	Inclination	: -90°
Depth	: 150.20 m	Core Recovery	: 99.8%
Drilling Machine	: OE-8L	Term	: Aug.28 - Sep. 4,1986



Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Mo %
5 6.00		Surface soil (N.C.)											
6.20		(N.C.)											
10 15	C	Grey coarse grain marble (grain size ≧ 2mm)	18.80-19.10m : 1mm-3mm wd Qtz-vein										
19.25	F	Grey～charcoal grey fine grain marble (grain size ≧ 2mm)											
23.70 25	C	Grey coarse grain marble											
25.50 30 35	F	Grey～charcoal grey fine grain marble	28.90m : Py band 33.96m : 4mm wd Qtz-vein 35.50m : 2cm wd Py-kaoline vein(with dyke)										
36.83	F	36.83-37.13m : dark grey dyke	Brown garnet skarn										
38.05 40	F	38.05-38.20m : pale orange dyke	Strongly altered silicified										

Fig.34 Geologic Column of MJI-7

Depth (m)	Geolog. Log	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Assay Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Results Mo %
	F	Grey～charcoal grey fine grain marble											
44.20		Ore	Sp-Gn-Cp with Qtz-Garnet-	MJI-7-1	44.20-45.20	1.00	0.21	790.0	0.20	2.87	14.60	0.024	<0.001
				MJI-7-2	45.20-46.20	1.00	0.14	420.0	0.46	1.45	32.50	0.051	0.001
46.50			Green skarn-Cc	MJI-7-3	46.20-46.60	0.40	<0.07	77.0	0.07	0.27	3.84	0.009	<0.001
47.05		Skarnized dyke		MJI-7-4	46.60-47.05	0.45	<0.07	7.0	<0.01	0.03	0.34	0.004	0.001
47.92		Ore	Sp-Cp-Gn massive ore	MJI-7-5	47.05-47.92	0.87	<0.07	88.0	0.05	0.98	6.94	0.015	<0.001
50	F	Grey～charcoal grey fine grain marble											
52.93				MJI-7-6	52.93-53.35	0.42	0.07	138.0	0.84	0.61	6.01	0.012	<0.001
				MJI-7-7	53.35-54.35	1.00	0.14	355.0	4.73	10.60	13.60	0.020	0.001
		Ore	Sp-Cp-Gn massive ore with	MJI-7-8	54.35-54.95	0.60	<0.07	200.0	0.12	2.03	10.90	0.021	<0.001
55			Skarn-Qtz	MJI-7-9	54.95-55.22	0.27	<0.07	11.0	0.01	0.11	0.33	0.002	<0.001
				MJI-7-10	55.22-56.20	0.98	0.14	114.0	0.21	0.87	7.81	0.016	<0.001
56.20		Skarnized dyke 60° dip at 56.20m 60° dip at 59.63m	56.20-56.98m : strongly skarnized with green skarn										
59.63													
65													
70	MI	Medium grain massive grey marble											
75													
80													
82.50													
85	F	Fine foliated grey marble bedding (?) by "lamination" is 30°											
90													

Fig.34 Geologic Column of MJI-7

Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Mo %
95 96.00	F	Fine foliated or laminated grey marble											
100 105 106.90	Sh	"Shaly" or "Slaty" marble "bedding" is 0° - 15°											
107.29		Basalt lava	Decolorized.skarnized										
110 112.60	M1	Grey medium grain marble											
115 120 125 126.15	Sh	"Shaly" marble 112.60-112.65m, 114.30-114.60m, 117.00-117.40m : biotite hornfels 120.15-120.45m, 122.85-122.90m : fine tuff 123.60-123.85m, 126.10-126.15m : tuffaceous slate											
130 134.98	M1	Marble with foliation (or lamination), grey ~ dark grey		MJI-7-11	134.98-135.18	0.20	0.07	285.0	1.74	15.80	19.90	0.021	<0.001
135.18		Ore	Massive Sp-Gn-Cp ore										
136.94	M	Marble with foliation		MJI-7-12	136.94-137.24	0.30	0.07	202.5	0.08	1.31	3.65	0.008	<0.001
137.24		Ore	Calcite-garnet-Green skarn -Qtz-Sp										
138.30	M	Marble with foliation		MJI-7-13	138.30-138.55	0.25	0.07	35.0	0.01	0.22	0.94	0.004	0.001
138.55		Ore	Calcite-garnet-Green skarn -Qtz-Sp										
140	×	Skarnized dyke											

Fig.34 Geologic Column of MJI-7

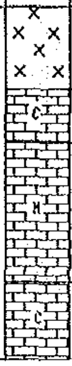
Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Assay Results Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Mo %
		Skarnized dyke											
142.35		70°											
143.95	C	White coarse grain marble											
145	M	Grey-dark grey medium grain marble											
148.00													
150	C	White coarse grain marble											
150.20		(Terminated)											

Fig.34 Geologic Column of MJI-7

Drill Hole No	: MJI-8	Elevation	:
Location	: 60S, 40W	Inclination	: -90°
Coordinate Point	:	Core Recovery	: 99.5%
Depth	: 151.00 m	Term	: Sep.8 - Sep.13,1986
Drilling Machine	: OE-8L		

Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Assay Results Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Mo %
4.50	N.C.	Surface soil											
10		Grey medium grain marble, weak black banding at 9.30-10.50m											
15	M	Weak black banding at 15.90-16.50m (microfolding)											
20													
25		Grey medium grain marble											
27.00	C	White-grey coarse grain marble											
29.50	F	Grey~charcoal-grey fine grain marble. (banding is not common) 31.50-31.80m : large crystal of calcite											
32.53		32.53-33.13m : N.C. due to druse											
33.13													
35	F	38.20m : Calcite vein with wd 3cm											
38.70		Grey~charcoal grey fine grain marble											
40													

Fig.35 Geologic Column of MJI-8

Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Assay Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Results Mo %
45, 50, 55, 60	F	Grey~charcoal-grey fine grain marble Banding is common, below 46.00m become finer than upper	63.85-64.11m : Qtz rich banded ore with Cc-Sp-Gn (low grade)	MJI-8-1	63.85-64.11	0.26	0.07	50.0	0.35	0.24	2.66	0.16	0.002
63.85		42° Ore zone 20°	64.11-64.51m : Sp-Gn-Cp-Cc-Green skarn, mass high grade ore	MJI-8-2	64.11-65.11	1.00	0.07	265.0	1.51	2.22	26.50	0.046	<0.001
65.73	N-F	Grey medium~fine grain marble	64.51-64.96m : Sp - Cp - hedenbergite ore	MJI-8-3	65.11-65.73	0.62	0.07	176.0	2.61	1.87	30.10	0.054	0.001
66.32, 70		60° Skarnized dyke	64.96-65.53m : Sp-Gn-Cp-Cc-Green skarn mass high grade ore										
71.31	Sh	50° Grey~charcoal grey "Shaly" marble	65.53-65.73m : Sp - Green skarn-Cp ore										
73.55, 75	F	Grey fine grain marble 73.55-73.75m : tuffaceous	66.32m:wd 2-10mm Green skarn 71.31-71.46m:Cc-Qtz-Green skarn with small amount of Sp										
79.35	Sh	"Shaly" charcoal grey marble											
82.40, 85	F	Grey fine grain marble											
87.80, 90	Sh	"Shaly" charcoal grey marble.89.20-90.05m:tuff											

Fig.35 Geologic Column of MJI-8

Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Assay Results Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Mo %
90.40	Sh												
95	F	Fine grain grey marble bedding (band) at 90.40m with 20°											
99.00	Sh	"Shaly" charcoal-grey marble											
100	F	Fine grain grey marble											
102.50													
103.55	Sh	"Shaly" charcoal-grey marble											
103.85		Skarnized basaltic lava											
104.50	F	Fine grain grey marble											
105.40	Sh	"Shaly" charcoal-grey marble slate patch is common											
110	F	Grey fine grain marble											
113.50													
115	Sh	"Shaly" or "Slaty" marble 114.00-114.20m, 115.85-116.05m, 116.55-116.65m : biotite hornfels											
119.30	F	Fine grain grey marble											
122.20	Sh	"Shaly" marble whitish fine tuffaceous part from 124.90-126.20m											
125													
126.25		Ore	Sp-Gn high grade	MJI-8-4	126.25-126.37	0.12	0.07	158.0	0.42	20.00	18.00	0.026	<0.001
126.37	Sh	"Shaly" marble											
129.75		Grey decolorized-skarnized dyke 70° 131.20-133.14m : stlongly skarnized	→ Hedenbergite										
133.14		Ore	Sp-Green skarn-Qtz & Gn-Qtz-Sp (banding). Sp-Gn, Sp-Cp-Gn mass	MJI-8-5	133.14-134.00	0.86	0.07	520.0	0.84	17.40	21.90	0.029	<0.001
134.00													
135	F	Fine grain marble											
138.55	Sh	"Shaly" marble with flowage patterns											
139.70													

Fig.35 Geologic Column of MJI-8

Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Assay Results						
							Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Mo %
141.90	F	Fine grain marble											
145 148.80	Sh	"Shaly"marble 142.66-142.69m : biotite hornfels 143.14-143.17m : film & seam of talc wd 7mm											
150 151.00	M	Medium grain grey -white marble											

(Terminated)

Fig.35 Geologic Column of MJI-8

Drill Hole No	: MJI- 9		
Location	: 437N, 345E	Elevation	:
Coordinate Point	:	Inclination	: -90°
Depth	: 151.20 m	Core Recovery	: 88.2%
Drilling Machine	: OE-8L	Term	: Dec.1 - Dec.4,1986

Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Mo %
0–11.20 (5, 10)	N.C.	Surface soil											
11.20–14.15	M	White medium grain marble											
14.15–29.35 (20, 25)		Partially weathered silicified part Red~red brown clay and grey clay-Qtz part with Py	14.15-29.35m : Py dissemination										
29.35–40 (35, 40)		Alterd dyke ※ 29.35-30.70m : light grey (decolorized) 30.70m →becomes brown → dark grey below 38m : greenish (※ : This is "Porphyritic", plagioclase lath texture is visible→ Trachytic dyke)	Sporadically bearing the xenoliths of Trachytic rock Calcite network with hematite is common (wd 1-5mm)										

Fig.36 Geologic Column of MJI-9

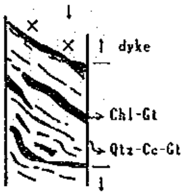
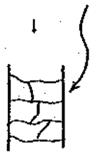
Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Mo %
40.35	X X												
41.85	N.C.	(Cave)											
42.05		Ore	Qtz-Sp ore	MJI-9-1	41.85-42.05	0.20	0.07	97.0	0.03	0.41	16.30	0.034	0.001
	N.C.	(Cave)	: reddish Sp disseminated										
44.10		Coarse grain white marble	in Qtz										
46.30	C	Epidotized-chloritized	Garnet is visible sporadically.										
46.80	N.C	altered dyke	Qtz-calcite-garnet vein.										
	X X	50.30-50.90m : greenish	65° dip (wd 1.5cm)										
	X X	dark-grey(fresh?)-phenocryst	at 50.20m with Py										
50	X	is visible	Qtz-garnet net at 51.80										
	X X	50.90-52.90m : light greyish	52.90m										
	X X	green	52.90-53.60m : dark green										
52.90	X X		chlorite-Qtz-calcite-garnet										
54.30	C C	Coarse grain marble	-Sp(?) band										
54.55		Py disseminated, grey rock											
		(dyke?) (boundaries ± 0°)											
	M	Grey " Sdy " medium grain											
60		marble											
62.30													
65													
70		" Shally " grey-white marble											
		(often medium grain)											
		" Cloudy " patterns are											
		common.											
		" net" also visible											
75	Sh												
80													
		18° dip											
85													
		Water escaped structure											
		at 89.70m.											
90													

Fig.36 Geologic Column of MJI-9

Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Assay Results Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Mo %
	Sh	Water escaped structure at 90.40-90.70m											
92.80													
93.10		92.80-93.10m : biotite hornfels upper & lower of this part 10cm each											
95		Gt-Po zone in slumping pattern.											
100	Sh												
		104.00m : irregular vein of Gt. wd 5cm with black powdery substance(carbon)											
104.25													
104.85		104.25-104.85m : biotite hornfelsic slate, banding 28°											
	Sh	106.25-106.35m : Gt+carbonaceous	106.25-106.45m : pyrrhotite disseminated										
	Sh	106.35-106.45m : calcite marble + Qtz											
110	Sh	106.45-106.65m, 108.45-108.70m : biotite hornfels (slate)											
114.75	M	Medium grain marble with black bands & seams, becomes coarse toward deeper	115.25m, 119.45m : very thin seams of talcose tuff										
119.35	Sh	"Shaly "marble											
121.50	F	"Sdy " fine grain-medium grain, grey marble. dominated in slate seams 30° - 40° dip											
125													
129.85		Biotite hornfelsic slate	Pyrrhotite concentrated layers with wd of 1-2cm intercalated										
130.55	F	"Sdy" fine grain marble											
132.45	// //	Skarnized tuff(?) Po-Gt	Po : disseminated										
133.05													
135	F	" Sdy" fine grain marble											
140													

Fig.36 Geologic Column of MJI-9

Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Assay Au g/t	Ag g/t	Results Cu %	Pb %	Zn %	Co %	Mo %
141.60	F												
145	C	Coarse grain marble(grey) black carbon substance and black band are common											
150													
151.20													

(Terminated)

Fig.36 Geologic Column of MJI-9

Drill Hole No	: MJI-10
Location	: 320N.455E
Coordinate Point	:
Depth	: 151.00 m
Drilling Machine	: OE-8L

Elevation	:
Inclination	: -90°
Core Recovery	: 90.3%
Term	: Nov.18 - Nov.21,1986

Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Assay Results Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Mo %
0 - 15.00	N.C.	Soil											
15.00 - 26.00	N.C.	Sand,gravel,boulder zone (Slime only) gravel,boulder : Silicified rock, igneous rock.											
26.00 - 27.30		Silicified,greenish grey Diorite porphyry											
27.30 - 28.40	C	Coarse grain white marble											
28.40 - 31.80	Sa	Sandy laminated marble 30° dip at 30.00m											
31.80 - 40	C	Coarse grain grey-white marble	33.60m,39.50m : wd 1mm-3mm Py-Qtz vein										

Depth scale: 5, 10, 15.00, 20, 25, 26.00, 27.30, 28.40, 30, 31.80, 35, 40

Fig.37 Geologic Column of MJI-10

Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Mo %
	C												
42.20	F	White-grey fine marble Compaction structure at ⇨ 46.60m	 										
46.70	C	Very coarse grey marble crystal max 3cm											
49.10	M	("Sandy") 49.35-49.45m ⇨ Grey, medium grain marble											
56.50	C	White, coarse grain marble	57.62-57.67m : Qtz-garnet zone										
57.67	×	Skarnized greenish-grey dyke											
58.47	Sa	Grey " Sdy " marble	57.97-58.05m, 58.17-58.47m : Qtz-garnet banded skarn dip 50°										
60.65	//	Biotite hornfelsic tuff dip of seam 30°											
61.25	Sa	Grey " Sdy " marble											
64.15	C	Very coarse grain marble											
65.20	Sa	Grey " Sdy " marble 67.20-67.70m : medium or coarse grain											
69.55	N.C.	(Cave)											
70.80	//	70.80-72.70m : tuff - slate seam, 35° dip											
72.70	Sa	Grey " Sdy " marble 79.10-77.20m, 78.20-78.30m, 83.10-83.70m : tuff seam ± 0° ~ 15° dip 81.10, 81.20, 82.20, 82.45, 82.55, 86.40, 86.75m : water escaped structure ⇨	 										
85.48			85.48-85.68m : skarn zone										
87.90		(cave) N.C.	 										
88.20	Sa	Grey " Sdy " marble											
90													

Fig.37 Geologic Column of MJI-10

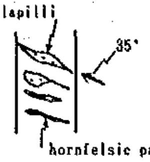
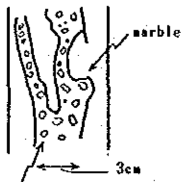
Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Assay Results Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Mo %
		Grey " Sdy "marble below 92.90m becomes white	flattened(elongated) lapilli 										
92.90	Sa												
95		Dark grey part and purplish part mixed hornfelsic											
96.10													
96.80	// // //	lapilli tuff	96.75-96.80m : garnet skarn										
97.95	Sa	White " Sdy" marble											
100													
105		Very coarse grain,grey-white massive marble											
110			114.80-115.40m : Qtz-hematite-garnet vein (matrix)										
115	C												
120			121.45-121.90m : wd 5cm Qtz.-Py vein										
125		127.30-127.50m : a few of black bands	130.60-131.10m,132.10-132.20m : black bands with Py										
130			133.90m(62°),134.20m(50°) :dark brownish Qtz-Py vein wd 1.5cm										
135													
138.95		Dyke? or tuff, dark green	Py dissemination. Garnet skarn at lower boundary, 60° dip										
139.45	// // //												

Fig.37 Geologic Column of MJI-10

Depth (m)	Geolog. Log.	Lithology	Mineralization etc.	Sample No.	Depth (m)	Wd (m)	Assay Results Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Mo %
145	C	Very coarse grain, grey-white massive marble											
150													
151.00													

(Terminated)

Fig.37 Geologic Column of MJI-10

that the large quartz monzonite had intruded adjacent to the marble. The marble sequense is correlated with the marble of 112.5.50m and deeper of MJI-2, on the basis of the existence of water escaped structure and many intercalated beds or layers of slaty and tuffaceous calcareous rock in both holes.

*Quartz monzonite of MJI-9G has been identified as quartz monzonite through microscopic test.

CHAPTER 3 SYSTHESIS OF THE S.TUBOH AREA

3-1 Geology and Geologic Structure

The S.Tuboh area of the southern Sumatra Area is situated in the southeast extention part of the large synclinorium structure, of which the axial core is occupied by the Mersip Limestone Member and Raja Granites northwest of the project area. Its axis plunges to the southeast. The Mersip Limestone Member decreases in thickness southeastward, and pelitic, sandy and tuffaceous facies tend to increase becoming alternatively predominat at the upper and lower horizons instead of the Mersip Limestone Member proper.

The detailed investigation by geological and geochemical surveys of the initial phase(1985) reveals geology and geologic structure of the S.Tuboh area as follows :

[1] In the S.Tuboh area, the S.Rawas Formation is divided on the basis of its rock facies and upper-lower relations into :

lower		upper
Andesite -Phyllite facies (A-P)	limestone -Tuff facies (L-T)	Sandstone -Slate facies (S-S)

[2] The two facieses of Andesite-Phyllite and Limestone-Tuff appear to be distributed in the S.Tuboh area, repeating, presumably, the anticline and syncline with a NNE-SSW axis.

[3] These strata have been divided and moved by two crossed fault systems (NE-SW and NW-SE systems).

[4] These strata have been furthermore divided into smaller parts by a quartz monzonite and other intrusion extending in a NE-SW direction.

Since the S.Tuboh area is a topographic plain and rocks are poorly exposed, the geology and geologic structure of the S.Tuboh area has been synthesized in a general idea, on the basis of the poor geologic data.

The results of the drilling survey,fortunately, do not contradict the synthesis in general, but amendatory facts as to rock facies and geologic structure and so on are pointed out as follows :

a.] Rock facies : The most noticeable fact compared with previous results is that marble occupies most of the geologic sequence obtained through all holes.

The photo-geologic interpretation of the initial phase survey indicated that the S.Tuboh area and its vicinity consisted presumably of calcareous rocks, because the area show doline structural features. However the whole area could not be defined as marble at that time, due to poor exposure. Only 3 exposures of marble and an exposure of tuffaceous slate were found.

The drilling survey of the second phase revealed not-so-thick limestone - origin marble as an exposure, and calcareous-origin marble with intercalations of pelitic and tuffaceous beds occupying the S.Tuboh area.

These facieses are intergradational, and a facies characterized by both Limestone-Tuff facies and Andesite-phyllitic facies constitutes strata of the area. It may be inferred that a part of the facies was deposited repeatedly in the site of the limestone sedimentation, and the facies yields slump structure, water escaped structure and graded bedding in its rock. Namely, it is pointed out that the facies having both features of Limestone-Tuff facies and Andesite-Phyllite facies presumably resulted from such mode of sedimentation.

The andesite-phyllite facies is correlative with Rw-L～Rw-T, the Limestone- Tuff facies with Rw-T～Rw-M, and the Sandstone-Slate facies with Rw-U.

b.] Geologic structure : The strata of the drill cores are correlated with each other with reference to phyllitic(shaly)marble, lamina, slump structure, cloudy patterned structure, water escaped structure,and lava, and are generalized in the geologic profile of the drill holes (Figs. 38 ~ 42). Furthermore, the geological map of the S.Tuboh area was compiled by interpreting the profiles and surface geologic data(Fig. 25).

The geologic compilation indicates that the S.Tuboh area is situated at the southeast flank of the syncline trending ENE-WSW in the northwestern part of the area. Accordingly, on the apparent geologic structure in the area, strata strike N50° E and dip 12° W in a monoclinic structure at the sites of MJI-3,4,5,6,7,8, and strike N-S to N12° W and dip 32° ~40° W in a flexure structure at the sites of MJI-1, 2, 9,10.

The geologic structure is generally coincidental with the large structure, in spite of the differences with previously known structural factors such as direction of folding axis. The geologic structure of the S.Tuboh area is unravelled finally through this drilling survey.

As mentioned below, most intrusive rock bodies range along a strike of NE-SW or ENE-WSW and a dip of 60° -70° SE, regardless of their scale, large or small. It suggests that the intrusive rocks have intruded under a tight structure-control. The initial phase survey describes two intersecting fault systems (NW-SE and NE-SW) co-exisisting in the S.Tuboh detailed survey area. The area covered by the drilling survey is very small, and no evidence of a structural influence by the NW-SE fault system is obtained by the drilling survey, but it is inferred that the NE-SW fault system could structurally control the intrusion of the intrusive rocks. It is also noticeable that the structural direction coincises with the direction of the fold axis in the northwestern and southeastern parts of the S.Tuboh area.

3-2 Igneous Activity and Intrusive Rocks

It is shown by the drilling survey that the ore deposit(ore block) is emplaced at the intersection of the intrusive rock and calcareous rock, on the

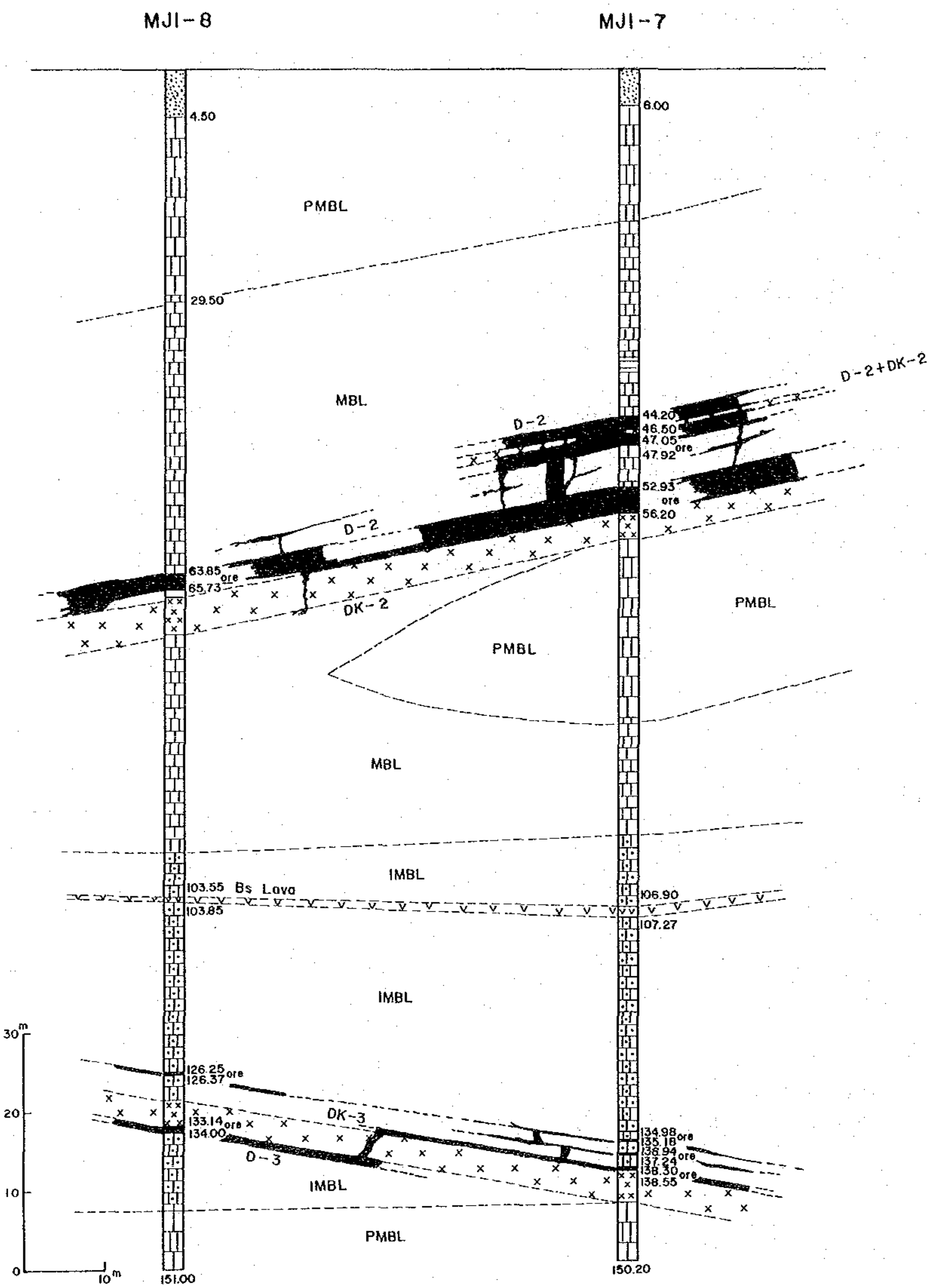


Fig.38 Profile by Geologic Columns of Drills (1)

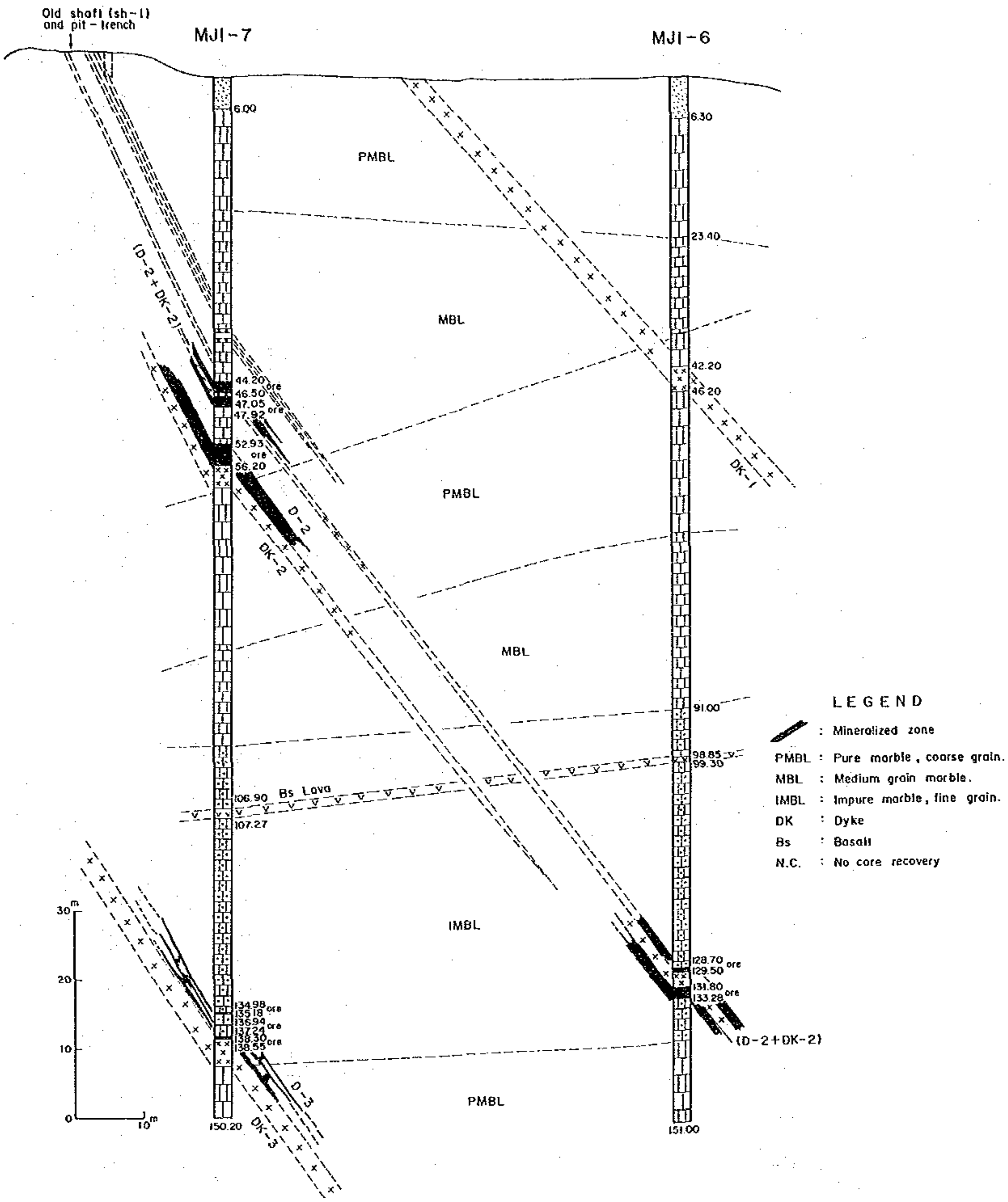


Fig.39 Profile by Geologic Columns of Drills (2)

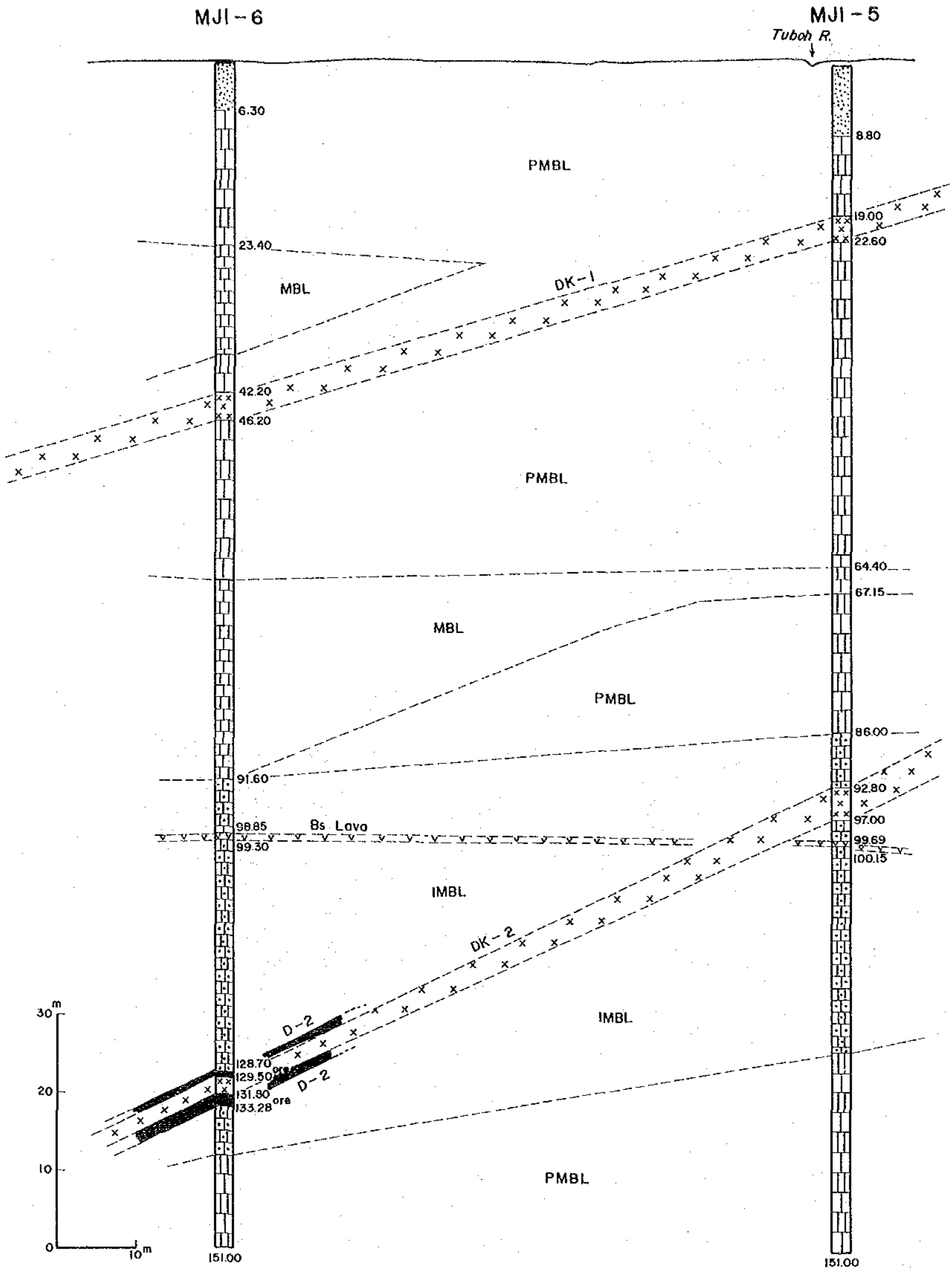


Fig.40 Geologic Profile by Geologic Columns of Drills (3)

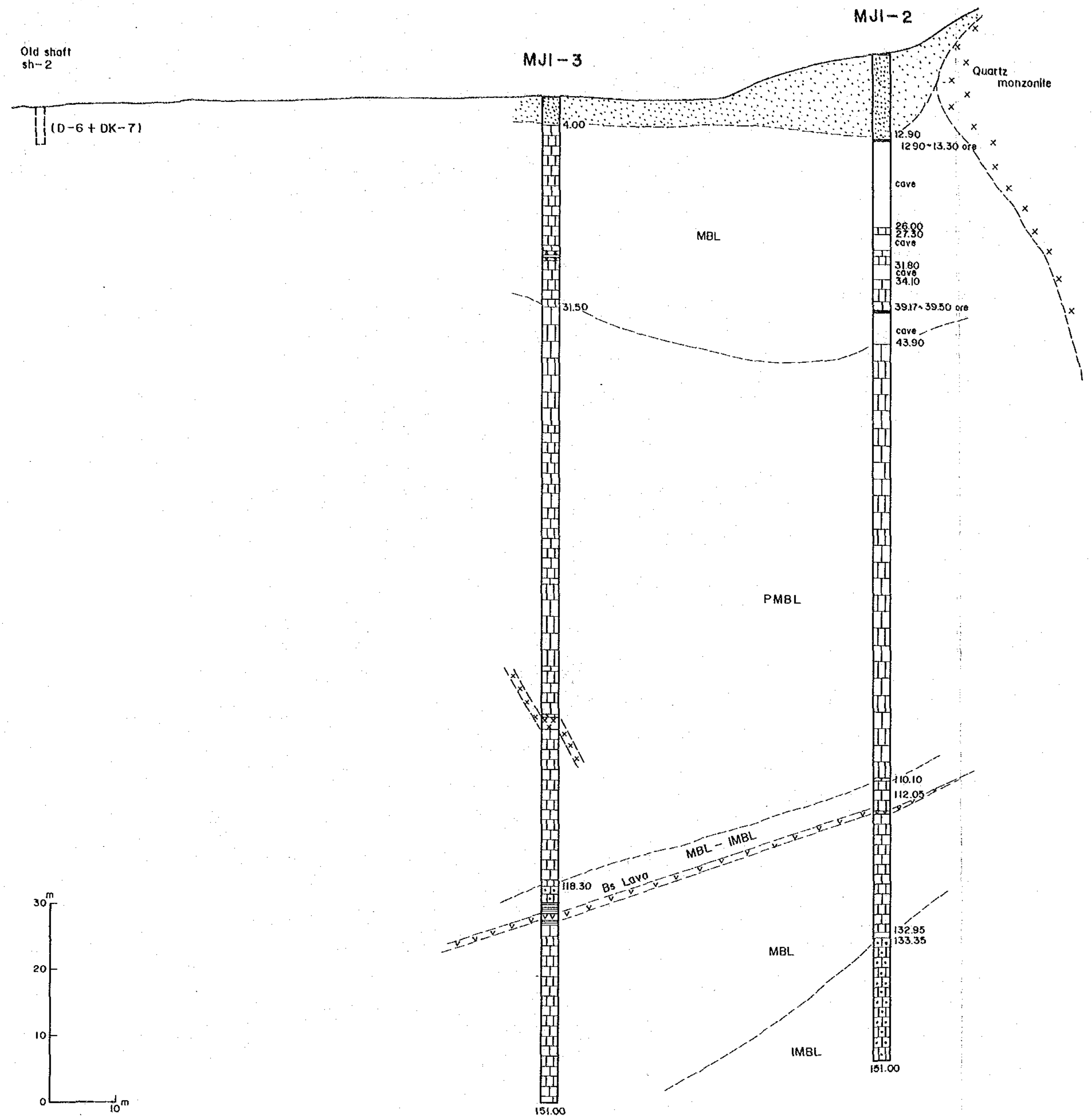


Fig.41 Profile by Geologic Columns of Drills (4)

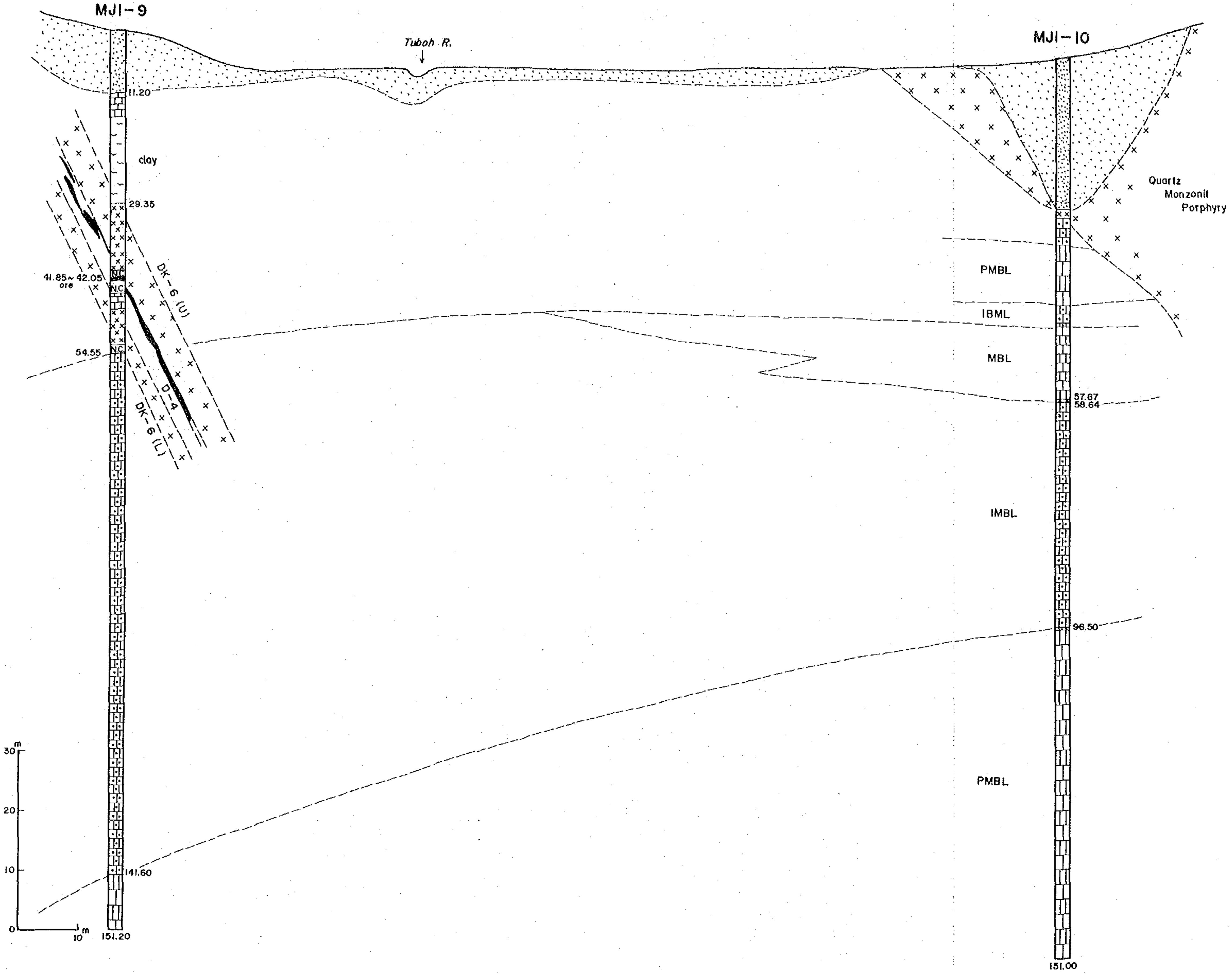


Fig.42 Profile by Geologic Columns of Drills (5)

basis of the results of the initial phase survey. However it is not certain whether the mineralization was derived from intrusive rocks, regarded as quartz monzonite or not.

In order to verify the matter, two assignments are proposed.

First assignment : igneous activity brought the mineralization

Second assignment : lithology of the intrusive rock

The intrusive rock has undergone skarnitization, mineralization and alteration, and its original rock is not distinct at the present time. However the rock has been regarded as a part of the quartz monzonite, distributed predominantly at the marginal part of the area, and has been called quartz monzonite. In fact, the rock in B_1, adjacent to MJI-5, is observed as quartz monzonite. On the other hand, some rocks of MJI-10 look like mafic volcanic rocks, and the rock in the lower boundary ore zone at depth in MJI-7 looks like fine-grained volcanic rock. It is also necessary to determine whether such occurrences of intrusive rocks are related to the mineralization or not.

Fot the first assignment, investigation by analysis of the $^{87}Sr/^{86}Sr$ ratio was applied on 6 samples.

Assayed samples of the $^{87}Sr/^{86}Sr$ ratio is as follows ;

61-St-3 : tuff-calcareous slate(Rw-L and RW-T of S.Rawas Formation

61-St-4 : quartz monzonite

61-St-5 : garnet skarn

61-St-6 : epidote-garnet

61-St-7 : weak skarnitized intrusive rock

61-St-8 : limestone(Mersip Limestone Member)

Total Sr value was also analized. The detailed results of the assay are shown in the supplementary note.

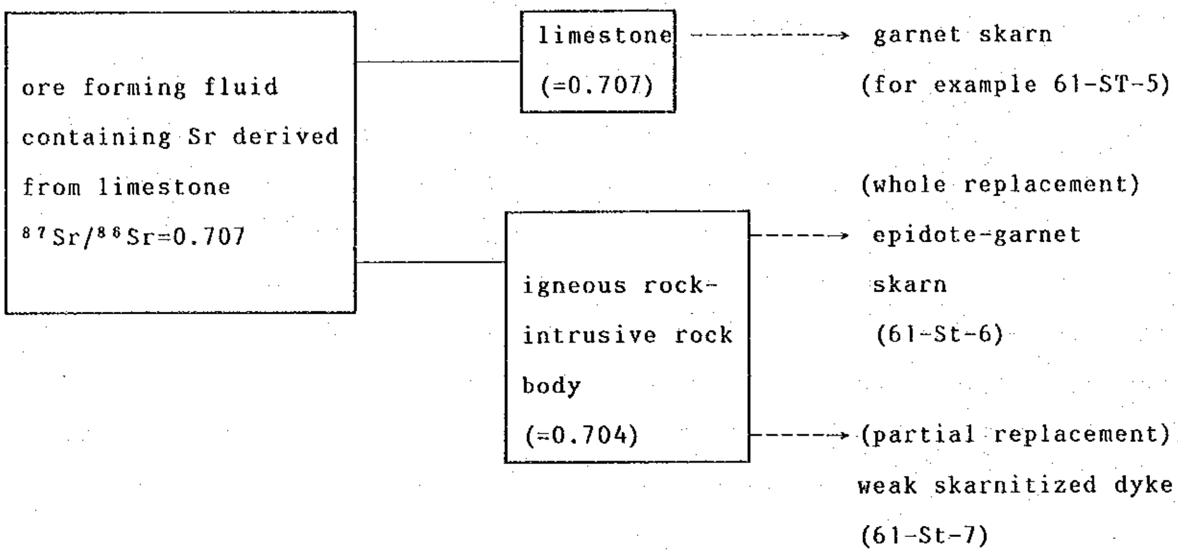
The conclusions of $^{87}Sr/^{86}Sr$ are as follows ;

i) Sr was expected from limestone owing to thermal activity.

ii) A small difference of the Sr istope ratios in the skarns depends on the type of source rock of the skarn (igneous rock or limestone) and the reaction grade.

iii) The Mersip Limestone Member was deposited during the Late Jurassic

The conclusions are generalized as follows :



Sr seems to derive from limestone and other elements (Zn,Cu,Pb,Ag etc) derived also from limestone, because it is unnatural for them to be derived from quartz monzonite into a skarn or an ore deposit, separate from the limestone.
Accordingly, it is convincingly expected that these metal elements and strontium were concentrated together in limestone (limestone strata), and brought to the present ore deposit(ore shoot) during thermal activity.

As a result, the mineralization process of the S.Tuboh area is synthesized as follows :

① Concentration of metal elements in the sedimentary rock during Mersip age(170Ma～150Ma)

↓

② Igneous activity(intrusion of quartz monzonite)

↓

③ Simultaneous and successive hydrothermal activity [forming of ore forming fluid by reaction between sedimentary rock, particularly limestone, and circulating water, and enrichment of the metal elements in the solution and transportation]

↓

④ Skarnization and mineralization by reaction of the ore forming fluid and host rocks (sedimentary rock and igneous rock)

The second assignment is described next.

The intrusive rock bodies occurring in the drill holes are listed as follows, excluding 26.00～27.30m of MJI-10 which is regarded as a part of large intrusive body(the branch intrusive dykes occurring adjacent to each other is regarded as a group of the intrusive rock).

DK-1	MJI-5 :	☆	19.10～ 22.60m (B_1 on the surface)
			42.20～ 46.20m
DK-2	MJI-6 :	☆	128.70～133.28m
	MJI-7 :		36.83～ 37.17m
			38.05～38.20m
		☆	44.20～ 47.92m
		☆	56.20～ 59.63m
	MJI-8 :	☆	66.32～ 71.31m
	MJI-5 :		92.80～ 97.00m
DK-3	MJI-7 :	☆	138.55～142.35m
	MJI-8 :	☆	129.75～133.14m
DK-4	MJI-3 :		92.90～ 94.50m
DK-5	MJI-9 :		57.67～ 58.47m
DK-6	MJI-10:	☆	29.35～ 40.35m
		☆	46.80～ 52.90m
DK-7		☆	inferred in the vicinity of old shaft(Sh-2)

(☆ : accompanied by ore shoot)

These intrusive rocks appear to be a group of parallel intrusive rocks striking in the same direction and dipping at the same degree, and it may be pointed out that these intrusive rocks have intruded from the same magmatic source .

The dykes marked by ☆ are accompanied by ore shoots(bonanza) at one or both sides of their hanging and foot boundaries, and the dykes are classified into the following two types :

Dykes with ore shoot : DK-1,2,3,6,7
Dyke without ore shoot : DK-4,5

Among them, DK-1 and DK-6 are most vary the most in facies with respect to each other in appearance, and the facies of DK-3 is in the middle of both. The others are similar in facies to that of DK-2. The intrusive rock of the S.Tuboh area has been called "quartz monzonite", but the name is not exactly in accord with the present investigation of whole rock analysis, norm calculation and microscopic observation. The intrusive rock are plotted in the two rock series region as alkali rock and non-alkali rock (but close to alkali rock) in the $SiO_2 \cdot Na_2O_3+K_2O$ figure. According also to be alkali-calc index, the former is an alkali rock series by 45～50, while the latter is alkaline-calc rock series by 57～61. The norm calculation indicates that there are many types ; namely rocks with or without nepheline, rock with over 10% or 0% of quartz, rock with over 70% of Or+ab or Or+ab<an and so on.

These rock facies are also identified as various types of quartz monzonite,gabbro, dolerite, trachyte, trachy andesite by means of microscopic observation.

In spite of this fact, it is inferred from their occurence that these rocks intruded in the same age and derived from the same magma source.

An radiometric age determination indicates them to be 40Ma(initial phase survey) and 51MA(present survey, 2 samples). The former might show a rejuvenation age owing to some effect, while the latter shows presumably rejuvenation or mineralization age.

Consequently, as mentioned in chapter 2 and chapter 5 of Part 2, the activity of the intrusiverocks of the S.Tuboh area took place at the same time as the activity of the Raja Granites, but have formed a group of intrusive rock bodies consisting of heterogenious rocks.

3-3 Mineralization and Mineral Constitution

a. Occurrence of mineralization : The relationship between the intrusive rock and the mineralization is as follows(except in the unclear case of MJI-2) ;

	hanging wall side		foot wall side	
(i)	ores ----	intrusive rock ----	ores	(MJI-6,7,8)
(ii)	ores ----	intrusive rock ----	--	(MJI-7,8)
(iii)	-- ----	intrusive rock ----	ores	(MJI-8)

The mineralization in MJI-9 seems to be a special type of (i) or (ii), but it is generally regarded as (iii). The occurrences are illustrated in Fig 38 ~ Fig 42.

The fact that the ores and the intrusive rock apparently alter their positional relationship as shown above indicates that an ore unit(ore shoot) is not continuous, and it is ifficult to prospect for an ore shoot in small scale, although extention of mineralization can be traced.

On the other hand, it seems to be possible that the ore shoot changes its emplacement position, for example (ii)→(i), (ii)→(iii), (iii)→(i), (iii)→(ii) and so on, and an ore shoot such as (i),(ii), or (iii) would be found at adjacent skarn intrusive rocks, though it contains no ore. At present, the possibility cannot be predicted using geologic information through core logging, but the ore bearing skarnitized intrusive rock and skarnized intrusive rock without ore are distinguishable by their colour tone. The former(with ore) has a tendency to be dark-green in colour, while the latter (without ore) is pale-orange in colour. It shows the difference of metamorphosed(altered) minerals during mineralization and accordingly, the difference between physico-chemical conditions of metamorphism-alteration between both cases. The difference phenomena may guide prospecting of the ore. The outcrop B_1 and core of MJI-5 are good examples of the above-mentioned feature.

The quartz monzonite in the vicinity of B_1 has undergone green alteration, while DK-1 of MJI-5 continuing presumably to B_1 is pale-orange in colour, and composed of quartz and kaoline. Regarding the garnet group of the skarn, andradite usually accompanies mineralization, while grossular is present in the barren part. The fact suggests that the forming of bonanza is attributed to physico-chemical conditions, not intrusive rocks.

The fact mentioned above reveals that a group of mineralization is embedded individually within an intrusive rock. For a good example, two ore zones, a shallow zone and a deep zone, were found in MJI-7 and 8.

On the basis of the occurrence of the mineralization and intrusive rocks, the bonanza are grouped as follows :

D-1 : combination with B_2 and DK-1 (known mineralization)

D-2 : combination with B_1, the shallow ore zone of MJI-6,7,8 and DK-2 (known mineralization)

D-3 : combination with the deep ore zone of MJI-7,8 and DK-3(newly found mineralization)

D-4 : combination with the ore zone of MJI-10 and DK-6(newly found mineralization)

The ore zone of MJI-2 is presumably connected with the weatherd mineralized part of B_4 located between MJI-1 and MJI-2, judging from their occurrence and surface exposure. The ore zone is tentatively regarded as D-5, even though the emplacement feature is not clear, and cannot be exactly grouped. Combination with old shaft Sh-2 ore and DK-7 inferred near the ore is also grouped to D-6. (see ; Fig 43.)

From this fact, the combination of ore zone and intrusive rock is really distinct, and if Dk-8,9,-- could be found , D-7,8 -- would be newly discovered.

Two other mineralized indications of S.Kering and S.Sepan are also distributed in the detailed survey area of the initial phase. Such a mineralization has not yet been discovered by the drilling survey, but the quartz-pyrite vein occurring in the shallow part of MJI-5 and 6 would form a similar silicified mieralized zone if it were to become large scale.

b. Mineral constitution : In order to identify minerals included with the ore shoot, assemblage and texture observation, microscopic observation, X-ray diffractive analysis, chemical analysis, and EPMA analysis were conduct on the drill cores, and the results are summarized as follows ;

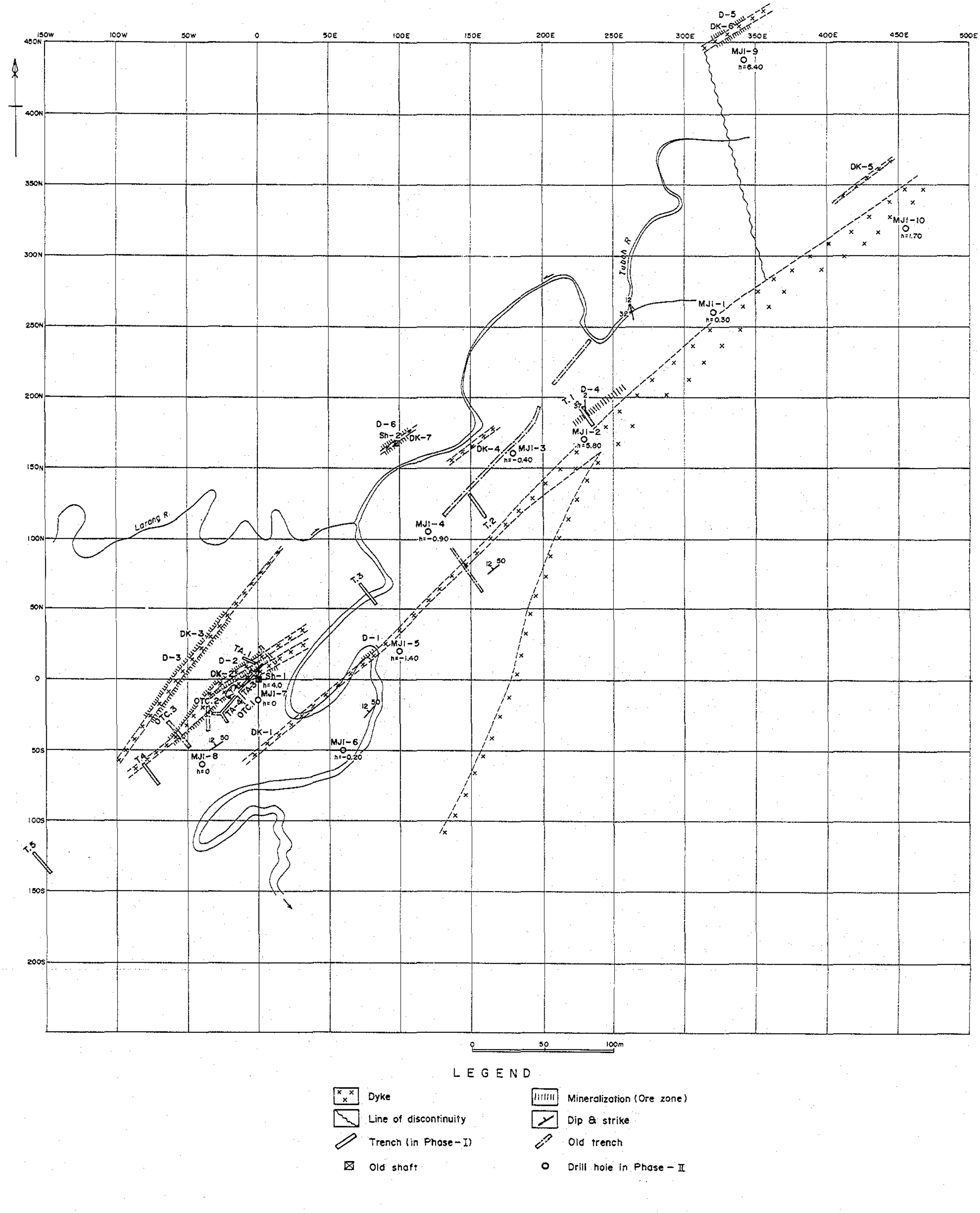


Fig.43 Distribution of Mineralized Zones and Intrusive Rocks

i) Sphalerite is the most abundant ore mineral in the ore.

ii) Andradite is usually associated with the ore as the skarn.

iii) The intrusive rock associated with ore is green~dark green in colour, and is charactorized by quartz-chlorite-calcite-epidote-(andradite). On the other hand, the intrusive rock without ore is pale-orange in colour with quartz-kaoline-calcite-(grossular).

iv) Quartz and hedenbergite have a tendency to be emplaced in the hanging wall or foot wall, or low grade part of the ore shoot. It consists of fine-grained sphalerite-calcite ore, lacking chalcopyrite.

v) Gangue minerals are rarely contained in the high grade ore part, except with only a small amount of andradite.

vi) Molybdenite occurs with quartz and pyrite in the low grade ore zone.

vii) Small amounts of fine-grained galena in contact with other ore minerals (chalcopyrite and pyrite) usually contains high silver, while large numbers of coarse-grained galena contain little silver. In the former case, gustavite occurs as the silver contained mineral.

Table 17 Mineral Assemblage of Mineral Indications in S.Tuboh Prospective Area on the basis of Tests, Analyses, and visual Observation

<table>
<tr><th></th><th>Ore mineral</th><th colspan="2">Gangu mineral・Altered mineral</th></tr>
<tr><td>Large amount, common</td><td>Sphalerite</td><td colspan="2">Quartz</td></tr>
<tr><td>Large to Intermediate
Fairly common</td><td>Chalcopyrite, Galena</td><td colspan="2">Calcite, Andradite,</td></tr>
<tr><td>samll amount,
fairly common.</td><td>Pyrite, Hematite</td><td colspan="2">Chlorite, Sericite, Epidote</td></tr>
<tr><td>Sporadic large amount</td><td>Arsenopyrite, Ilmenite</td><td colspan="2">Grossular, Talc, Kaoline, K-feldspar
Plagioclase, Hedenbergite</td></tr>
<tr><td>Rare or small amount
ordinary</td><td>Pyrrhotite, Marcasite, Magnetite
Molybdenite.</td><td colspan="2">Dolomite, Amphibole, Montomorillonite
Mixed layer mineral</td></tr>
<tr><td>Micro-grain mineral</td><td>Bismuthinite, Gustavite</td><td colspan="2">--------</td></tr>
<tr><td>Mineral assemblage</td><td>Sp-Gn-Cp-Py
Sp-Gn-Cp-Py-Asp
Sp-Gn, Mb-(Qt)</td><td>Accompanied with ore mineral
Qt, Cc, Ad, Ch
Ep, Hd, (Se)
⇩
Forming of skarn zone
Qt-Ad
Qt-Cc-Ch-Ep
Qt-Ad-Hd</td><td>Non-mineralized part
Gs, Te, Ko, Kf
Pl, Dm, Am, Mm
Mx, Qt, Cc

Non-mineralized skarn zone
Qt-Cc-Gs-(Po or Py)</td></tr>
<tr><td>Mineral assemblage
in common</td><td colspan="3">i) Sp-Gn-Qt-Hd-Ch   v) Sp-Gm-Cp-Py-Asp-(Ad)
ii) Sp-Gn-Cp-Ad   vi) Mb-Py-Qt
iii) Sp-Qt-Hd-Ch-Ep
iv) Sp-Gn-Cp-Py-(Ad)</td></tr>
</table>

注) Hematite and Marcasite are regarded as "Secondary"

PART 4 ICP ANALYSIS

PART 4 ICP ANALYSIS

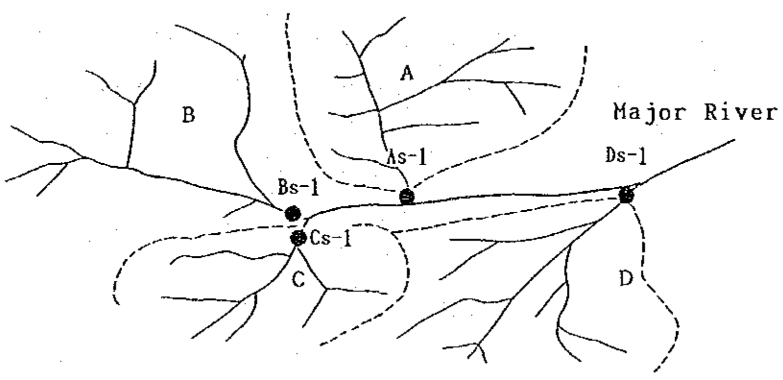
CHAPTER 1 PURPOSE

The ICP(Inductively Coupled Argon Plasma) analysis assays for many elements (24～30 elements) with a low cost and all at the same time. *Prospecting by the ICP analysis is employed to geochemically evaluate a broad* area such as 100,000 km² and larger areas for reconnaissance survey.

In accordance with a request from the Indonesian side which is conducting a reconnaissance geochemical survey in the region from northern Sumatra to southern Sumatra, ICP analysis was carried out with the aim of preparing data within the frame work of the Indonesian project.

CHAPTER 2 SAMPLES ASSAYED AND ANALYSED

The 200 samples assayed were selected from geochemical samples collected in an 1,250km² during the initial phase survey(1985). A sample has to represent individually an extensive area, and so, the sample was selected from the most down-stream location, namely from the flow part of a river basin, as shown in the following figure :



A sample per river basin is collected such as A : As-1, B : Bs-1, C : C-1, D-Ds-1 and so on. Each sample represents element-contents of a river basin.

The stream sediment samples were collected through 80 mesh sieve at the sampling sites, and dried samples were sieved again through 80 mesh sieve after being roughly pulverized, and 100g were taken. The sample was then divided into 2 parts by the quarter divide method. One part was analyzed and other part was kept as a reserve sample.

24 elements were analysed and their detection limits are as shown in Table 18:

Table 18 Analized Elements and Ddetection Limit of ICP Analysis

element	detction limit	element	detection limit	element	detection limit
Mo	1 ppm	Ni	0.5 ppm	Be	0.5 ppm
W	10 ppm	Ba	1 ppm	Ca	0.01 %
Zn	1 ppm	Fe	0.01 ppm	Cu	1 ppm
P	10 ppm	Mn	1 ppm	Ag	0.2 ppm
Pb	2 ppm	Cr	1 ppm	Ti	0.01 %
Bi	2 ppm	Mg	0.01 ppm	Sr	1 ppm
Cd	0.5 ppm	V	1 ppm	Na	0.01 %
Co	1 ppm	Al	0.01 ppm	K	0.01 %

CHAPTER 3 RESULT OF THE ICP ANALYSIS

Since the survey area (1,250km^2) is too small an area for the interpretation of the reconnaissance survey of ICP analysis, only assay results are listed in Table 19.

Table 19 List of the Results of ICP Analysis(1)

Sample No.	Mo ppm	W ppm	Zn ppm	P ppm	Pb ppm	Bi ppm	Cd ppm	Co ppm	Ni ppm	Ba ppm	Fe %	Mn ppm	Cr ppm	Mg %	V ppm	Al %	Be ppm	Ca %	Cu ppm	Ag ppm	Ti %	Sr ppm	Na %	K %
A- 1	1	<10	86	400	18	<2	<0.5	15	34	247	5.60	681	92	0.48	131	7.31	<0.5	0.19	34	0.2	0.720	84	0.64	1.32
A- 16	3	<10	28	130	16	<2	<0.5	4	4	188	2.03	262	16	0.36	36	7.16	<0.5	0.57	14	0.2	0.420	112	0.77	0.54
A- 38	1	<10	95	310	12	<2	<0.5	7	8	347	3.82	836	26	0.26	59	9.18	<0.5	0.37	32	0.2	0.880	61	0.58	0.49
A- 59	1	<10	81	410	14	<2	<0.5	25	48	232	5.72	867	132	0.77	177	8.51	<0.5	0.41	44	0.2	0.580	82	0.81	1.16
A- 79	2	<10	77	630	20	<2	<0.5	17	34	412	5.23	717	83	0.41	140	9.03	<0.5	0.33	40	0.2	0.600	188	0.78	1.61
A-114	2	<10	94	390	10	<2	<0.5	16	31	206	5.50	716	90	0.61	172	8.28	<0.5	0.35	34	0.2	0.650	84	1.24	1.28
B-019	1	<10	98	580	14	<2	<0.5	15	15	234	5.92	598	42	0.59	186	8.07	<0.5	0.33	42	0.2	0.910	78	0.73	1.20
B-024	2	<10	95	510	14	<2	<0.5	17	23	244	4.94	563	73	0.64	169	7.18	<0.5	0.39	36	0.2	0.850	81	1.23	1.23
B-032	2	<10	75	560	16	<2	<0.5	11	14	375	4.03	655	40	0.55	108	7.86	<0.5	0.49	32	0.2	0.620	108	1.12	1.62
B-043	2	<10	63	520	20	<2	<0.5	8	12	403	3.16	668	37	0.46	67	8.18	<0.5	0.49	20	0.2	0.470	100	0.95	1.63
B-068	1	<10	64	290	18	<2	<0.5	9	13	407	3.65	623	50	0.57	90	8.24	<0.5	0.41	22	0.2	0.580	112	1.14	1.70
B-104	1	<10	74	230	14	<2	<0.5	6	7	288	3.34	488	24	0.20	60	7.65	<0.5	0.21	14	0.2	0.600	50	0.54	1.15
B-126	2	<10	74	320	20	<2	<0.5	8	17	307	3.82	841	44	0.27	96	7.11	<0.5	0.20	22	0.2	0.920	44	0.37	1.37
B-139	2	<10	69	300	18	<2	<0.5	7	13	262	3.31	617	35	0.22	85	6.10	<0.5	0.24	22	0.2	0.880	49	0.42	1.15
B-140	2	<10	76	470	20	<2	<0.5	8	23	410	3.90	349	58	0.33	92	7.81	<0.5	0.10	26	0.2	0.420	44	0.39	1.94
B-151	1	<10	55	320	16	<2	<0.5	5	18	271	2.00	195	42	0.20	64	5.74	<0.5	0.12	24	0.2	0.360	34	0.30	1.24
B-187	1	<10	141	520	10	<2	<0.5	22	53	179	6.79	393	149	0.81	181	8.52	<0.5	0.11	44	0.2	0.630	35	0.42	1.36
B-195	1	<10	63	330	22	<2	<0.5	9	21	350	2.65	320	53	0.22	70	6.61	<0.5	0.07	24	0.2	0.410	38	0.30	1.67
B-198	<1	<10	68	210	18	<2	<0.5	8	19	269	2.83	790	53	0.28	72	5.17	<0.5	0.16	26	0.2	0.530	29	0.21	0.98
B-211	1	<10	64	210	22	<2	<0.5	9	23	311	3.40	406	53	0.36	68	6.95	<0.5	0.24	22	0.2	0.410	65	0.37	1.35
B-230	<1	<10	77	220	22	<2	<0.5	12	28	323	3.86	478	56	0.49	84	7.97	<0.5	0.15	26	0.2	0.430	59	0.30	1.74
B-264	1	<10	137	360	18	<2	<0.5	16	25	327	6.12	770	103	0.73	186	8.12	<0.5	0.23	30	0.2	0.960	90	0.59	1.57
B-266	<1	<10	38	260	18	<2	<0.5	15	14	208	2.12	615	41	0.19	57	5.68	0.5	0.02	22	0.2	0.390	53	0.16	1.07
B-286	1	<10	55	270	20	<2	<0.5	7	17	263	2.99	406	41	0.30	70	6.76	<0.5	0.13	22	0.2	0.460	67	0.44	1.33
B-293	<1	<10	79	580	12	2	<0.5	15	16	302	5.81	740	67	0.91	210	7.86	<0.5	1.21	58	0.2	0.700	291	1.79	1.42
B-300	<1	<10	76	390	28	2	<0.5	9	10	325	4.18	693	34	0.73	136	8.13	<0.5	1.37	26	2.8	0.630	148	1.13	1.49
B-302	1	<10	77	330	14	2	<0.5	18	47	174	5.06	734	215	0.75	181	8.20	<0.5	0.70	34	0.2	0.650	61	0.36	0.58
B-322	1	<10	68	250	14	<2	<0.5	16	32	276	3.48	366	87	0.74	94	7.05	<0.5	0.38	28	0.2	0.440	71	0.28	0.91
B-343	<1	<10	102	540	16	<2	<0.5	12	10	242	5.92	1134	39	0.47	141	7.45	<0.5	0.81	22	0.2	1.030	126	0.70	0.77
B-366	1	<10	47	250	18	<2	<0.5	8	7	145	3.89	507	31	0.33	100	4.71	<0.5	0.20	20	0.2	0.620	36	0.29	0.74
B-383	1	<10	58	220	10	<2	<0.5	14	15	129	4.05	527	55	0.43	137	5.40	<0.5	0.32	34	0.2	0.630	34	0.51	0.47
B-384	1	<10	86	250	22	<2	<0.5	7	8	257	4.52	847	21	0.46	121	7.70	<0.5	0.41	24	0.2	1.430	82	0.94	1.30
B-400	1	<10	84	340	10	2	<0.5	16	16	169	5.09	701	47	0.73	177	7.13	<0.5	0.39	46	0.2	0.980	72	1.13	0.68
B-407	<1	<10	49	260	8	<2	<0.5	18	50	143	3.86	762	118	2.04	124	5.46	<0.5	2.37	26	0.2	0.780	213	1.30	0.45
B-438	2	<10	36	90	20	2	<0.5	<1	2	257	1.75	746	5	0.07	23	4.65	<0.5	0.18	24	0.2	0.720	45	0.59	2.79
B-447	1	<10	31	80	18	6	<0.5	<1	1	234	1.19	563	3	0.08	15	3.76	<0.5	0.18	26	0.2	0.790	42	0.33	2.22
B-463	<1	<10	41	240	10	<2	<0.5	5	14	203	1.87	281	38	0.15	44	4.01	0.5	0.05	16	0.2	0.370	14	0.10	0.95
B-464	2	<10	29	90	14	2	<0.5	2	3	102	2.30	928	12	0.04	31	3.68	<0.5	0.37	26	0.2	0.870	14	0.15	1.05
B-486	2	<10	67	230	22	<2	<0.5	7	3	272	3.79	588	10	0.26	103	7.82	<0.5	0.34	14	0.2	0.760	56	0.47	1.17
B-495	2	<10	49	140	20	<2	<0.5	3	3	122	3.67	328	10	0.14	105	6.60	<0.5	0.06	14	0.2	0.940	17	0.15	0.56
B-500	2	<10	64	270	18	<2	<0.5	5	4	363	3.55	316	13	0.26	76	8.00	<0.5	0.18	20	0.2	0.760	57	0.36	1.70
B-504	1	<10	44	140	16	<2	<0.5	2	2	204	2.12	276	4	0.16	53	6.14	0.5	0.15	10	0.2	0.680	30	0.33	1.08
B-511	1	<10	43	130	28	<2	<0.5	3	1	234	2.13	432	5	0.17	57	6.02	0.5	0.41	10	0.2	0.800	64	0.78	0.85
B-512	2	<10	86	230	20	2	<0.5	7	4	179	4.68	675	9	0.35	135	8.70	<0.5	0.34	16	0.2	0.820	44	0.45	0.82
B-517	1	<10	52	200	20	<2	<0.5	5	2	246	2.69	448	11	0.18	73	6.21	<0.5	0.29	14	0.2	0.890	57	0.49	1.05

Table 19 List of the Results of ICP Analysis(2)

Sample No.	Mo ppm	W ppm	Zn ppm	P ppm	Pb ppm	Bi ppm	Cd ppm	Co ppm	Ni ppm	Ba ppm	Fe %	Mn ppm	Cr ppm	Mg %	V ppm	Al %	Be ppm	Ca %	Cu ppm	Ag ppm	Ti %	Sr ppm	Na %	K %
B-518	2	<10	58	260	20	<2	<0.5	4	3	225	3.28	671	15	0.19	103	6.01	<0.5	0.23	16	0.2	1.450	66	0.35	0.99
B-524	3	<10	75	320	18	<2	<0.5	7	5	257	3.86	397	16	0.26	73	7.35	<0.5	0.22	18	0.2	0.780	116	0.39	1.33
B-530	2	<10	94	380	12	<2	<0.5	6	3	251	4.60	673	10	0.20	171	6.46	<0.5	0.17	22	0.2	1.460	59	0.34	1.07
B-532	3	<10	32	170	22	<2	<0.5	2	3	220	2.31	162	12	0.17	40	6.44	<0.5	0.16	12	0.2	0.510	93	0.44	1.10
B-543	2	<10	45	320	18	<2	<0.5	3	3	190	2.36	312	11	0.15	51	6.33	<0.5	0.15	16	0.2	0.430	41	0.25	0.78
B-549	1	<10	48	290	16	<2	<0.5	5	5	201	2.16	242	18	0.22	40	7.14	<0.5	0.17	10	0.2	0.590	37	0.32	0.65
B-557	2	<10	41	290	22	2	<0.5	4	3	231	2.12	214	11	0.17	50	6.53	<0.5	0.16	16	0.2	0.530	41	0.31	0.80
B-560	2	<10	45	290	34	<2	<0.5	4	4	187	2.13	284	10	0.16	46	6.04	<0.5	0.18	16	0.2	0.430	43	0.27	0.74
B-573	1	<10	48	130	16	<2	<0.5	3	3	120	2.67	593	11	0.23	42	5.11	<0.5	0.52	10	0.2	2.100	72	0.61	0.33
B-584	1	<10	21	110	14	<2	<0.5	3	2	126	1.11	198	10	0.15	23	4.80	<0.5	0.55	8	0.2	0.750	87	0.74	0.32
B-586	3	<10	83	250	12	<2	<0.5	<1	5	134	7.19	1571	11	0.27	70	4.64	<0.5	0.24	14	0.2	6.836	42	0.35	0.55
B-587	2	<10	50	180	20	<2	<0.5	2	3	127	3.25	816	15	0.17	68	3.99	<0.5	0.19	12	0.2	2.310	41	0.32	0.54
B-594	2	<10	53	360	14	2	<0.5	5	4	183	3.03	303	14	0.37	35	6.65	<0.5	0.60	12	0.2	0.610	118	0.72	0.53
B-595	2	<10	47	290	16	<2	<0.5	4	4	174	2.72	353	14	0.57	36	6.80	<0.5	0.35	12	0.2	0.390	65	0.28	0.54
C-006	2	<10	135	400	18	<2	<0.5	22	16	222	8.86	1291	76	0.68	372	6.60	<0.5	0.64	38	0.2	1.890	94	0.70	0.83
C-010	1	<10	92	230	16	<2	<0.5	9	6	342	4.51	828	25	0.41	129	7.76	0.5	0.45	20	0.2	0.690	108	1.49	1.34
C-016	2	<10	185	200	14	<2	<0.5	12	8	351	9.67	1747	37	0.49	369	7.03	<0.5	0.53	18	0.2	2.270	94	1.19	1.37
C-032	2	<10	120	420	22	<2	<0.5	<1	11	306	10.93	2034	41	0.87	388	7.13	<0.5	0.93	22	0.2	4.960	162	1.01	0.85
C-044	2	<10	74	280	20	2	<0.5	12	14	384	5.90	799	68	0.72	170	8.39	<0.5	0.37	30	0.2	0.750	94	1.42	1.97
C-059	1	<10	176	310	20	<2	<0.5	11	17	227	12.41	2021	92	0.68	485	5.74	<0.5	0.68	28	0.2	3.220	98	0.95	0.96
C-087	1	<10	90	410	16	2	<0.5	15	22	350	5.47	685	125	0.63	177	7.55	<0.5	0.71	32	0.2	0.900	195	1.11	1.33
C-090	1	<10	43	120	18	<2	<0.5	4	4	237	3.06	320	18	0.20	64	8.29	0.5	0.30	14	0.2	0.750	51	0.60	0.68
C-102	1	<10	52	120	14	<2	<0.5	3	3	308	2.14	338	8	0.22	38	7.56	1.0	0.29	14	0.2	0.450	70	1.04	1.61
C-106	1	<10	83	140	24	<2	<0.5	<1	5	207	8.74	1335	14	0.34	160	5.41	<0.5	0.11	14	8.0	5.000	23	0.27	1.31
C-120	2	<10	67	280	34	<2	<0.5	8	13	265	3.92	440	40	0.22	124	5.84	0.5	0.23	22	0.2	1.080	85	0.63	1.26
C-132	1	<10	79	360	20	<2	<0.5	12	33	359	3.33	498	68	0.59	87	7.45	1.0	0.09	24	0.2	0.420	63	0.49	1.86
C-151	1	<10	58	300	22	<2	<0.5	9	19	262	3.79	416	45	0.36	92	6.15	0.5	0.16	26	0.2	0.490	50	0.37	1.53
C-164	2	<10	70	220	24	<2	<0.5	10	14	303	4.88	405	30	0.42	119	6.91	0.5	0.16	22	0.2	0.820	40	0.31	0.85
C-168	1	<10	82	350	22	<2	<0.5	13	34	455	3.70	696	71	0.29	101	9.04	1.5	0.06	28	0.2	0.400	87	0.57	2.21
C-183	2	<10	72	180	22	<2	<0.5	9	6	239	5.77	534	12	0.36	137	6.94	0.5	0.16	18	0.2	1.240	32	0.35	1.96
C-194	4	<10	169	170	16	<2	<0.5	<1	9	141	19.75	4261	28	0.31	422	3.27	<0.5	0.87	18	0.2	6.425	62	0.74	0.66
C-218	1	<10	53	250	12	<2	<0.5	5	27	273	2.49	243	60	0.35	58	4.96	1.0	0.02	22	0.2	0.320	35	0.23	1.30
C-219	1	<10	68	220	16	<2	<0.5	6	40	238	3.00	889	86	0.54	68	4.44	1.0	0.09	22	0.2	1.300	31	0.17	1.13
C-237	1	<10	72	480	22	<2	<0.5	14	30	335	3.45	835	68	0.36	77	6.17	1.5	0.03	26	0.2	0.360	61	0.25	1.30
C-246	2	<10	103	430	10	<2	<0.5	5	2	211	4.16	586	6	0.20	153	6.36	0.5	0.24	14	0.2	1.290	48	0.64	1.30
C-249	2	<10	26	160	12	<2	<0.5	2	2	263	1.39	168	2	0.17	27	6.43	1.0	0.09	14	0.2	0.600	38	0.50	1.72
C-276	4	<10	33	160	12	<2	<0.5	1	2	219	1.86	274	3	0.17	39	6.88	1.0	0.07	14	0.2	0.610	34	0.47	1.64
C-277	1	<10	41	140	41	<2	<0.5	5	2	194	2.24	370	5	0.17	50	7.09	0.5	0.19	12	0.2	0.580	46	0.71	1.23
C-310	2	<10	76	190	18	<2	<0.5	4	5	263	3.56	535	11	0.36	75	7.65	0.5	0.34	14	0.2	0.760	72	0.61	1.00
C-316	2	<10	50	190	16	2	<0.5	6	3	193	3.46	346	5	0.23	74	8.65	1.0	0.17	14	0.2	0.540	33	0.35	1.42
C-328	2	<10	32	170	12	<2	<0.5	3	2	279	1.75	363	5	0.17	29	5.76	0.5	0.12	14	0.2	0.510	51	0.55	1.56
C-336	3	<10	267	420	14	<2	<0.5	<1	5	188	10.54	1803	10	0.38	574	5.87	<0.5	0.64	24	0.2	4.850	147	0.56	0.73
C-338	2	<10	82	150	12	<2	<0.5	<1	10	147	6.31	2834	29	0.23	151	3.88	<0.5	0.25	24	0.2	4.200	48	0.42	0.66
C-341	3	<10	65	400	16	2	<0.5	6	7	252	3.86	264	17	0.44	54	8.30	1.0	0.19	14	0.2	0.490	68	0.39	1.22
C-350	3	<10	53	260	14	<2	<0.5	4	4	292	2.51	328	11	0.36	37	7.90	1.0	0.40	12	0.2	0.470	105	0.77	1.20

Table 19 List of the Results of ICP Analysis(3)

Sample No.	Mo ppm	W ppm	Zn ppm	P ppm	Pb ppm	Bi ppm	Cd ppm	Co ppm	Ni ppm	Ba ppm	Fe %	Mn ppm	Cr ppm	Mg %	V ppm	Al %	Be ppm	Ca %	Cu ppm	Ag ppm	Ti %	Sr ppm	Na %	K %
C-355	2	<10	18	190	12	<2	<0.5	3	3	157	1.19	137	8	0.15	37	5.84	0.5	0.10	12	0.2	0.530	27	0.27	0.94
C-356	2	<10	43	150	22	<2	<0.5	2	3	145	2.21	595	5	0.13	56	4.41	0.5	0.13	12	0.2	1.630	44	0.30	0.77
C-374	3	<10	75	380	18	<2	<0.5	7	5	219	4.42	361	16	0.41	78	7.59	0.5	0.32	16	0.2	0.930	198	0.85	0.99
C-378	3	<10	70	260	128	<2	1.0	5	3	204	2.85	261	17	0.28	59	6.05	0.5	0.27	14	0.2	1.000	111	0.65	0.88
C-383	2	<10	55	240	16	<2	<0.5	7	3	229	2.46	359	11	0.24	51	5.70	1.0	0.29	12	0.2	0.890	113	0.72	0.81
C-390	1	<10	41	170	24	<2	<0.5	1	3	191	2.90	637	12	0.19	60	3.93	0.5	0.29	14	0.2	2.150	56	0.48	0.51
C-400	1	<10	42	120	62	<2	<0.5	2	2	269	1.31	238	7	0.12	34	3.53	<0.5	0.25	12	0.2	0.890	35	0.41	0.62
D- 10	2	<10	65	260	26	<2	<0.5	8	7	322	3.65	1056	11	0.65	100	8.10	1.0	0.36	26	0.2	0.800	82	0.56	2.31
D- 23	3	<10	83	250	18	<2	<0.5	11	12	304	4.68	939	28	0.59	156	7.12	0.5	0.43	24	0.2	1.130	89	0.94	1.95
D- 33	2	<10	155	400	16	<2	<0.5	14	8	313	7.60	1382	54	0.63	254	7.05	<0.5	0.69	30	0.2	1.150	125	0.89	0.94
D- 40	2	<10	66	310	24	2	<0.5	10	14	419	3.69	701	46	0.58	110	8.07	1.0	0.28	26	0.2	0.680	89	0.79	1.96
D- 42	2	<10	169	400	16	<2	<0.5	15	9	313	8.82	1587	53	0.67	296	7.42	<0.5	0.71	32	0.2	1.300	124	1.01	1.08
D- 54	1	<10	102	410	16	2	<0.5	15	17	220	8.81	912	105	0.58	306	6.62	<0.5	0.53	54	0.2	1.410	132	1.19	0.91
D- 69	2	<10	90	530	14	2	<0.5	16	9	172	9.92	1132	39	0.53	302	7.32	<0.5	2.09	42	0.2	1.600	171	0.99	0.87
D- 76	2	<10	63	320	8	<2	<0.5	13	13	138	5.93	754	44	0.34	185	6.46	<0.5	0.46	42	0.2	0.630	41	0.33	0.46
D- 84	1	<10	61	310	8	<2	<0.5	16	25	143	4.98	635	79	0.99	171	5.12	<0.5	1.13	32	0.2	1.010	122	0.99	0.50
D- 87	1	<10	37	220	10	<2	<0.5	12	33	198	2.57	408	74	0.97	86	5.09	<0.5	1.21	24	0.2	0.580	194	1.04	0.78
D-105	2	<10	28	180	12	<2	<0.5	4	3	324	1.76	597	5	0.19	25	7.16	1.0	0.12	14	0.2	0.680	42	0.66	2.02
D-125	2	<10	56	170	16	<2	<0.5	6	4	412	2.78	341	5	0.34	42	10.72	1.5	0.19	16	0.2	0.260	64	0.77	2.43
D-126	2	<10	71	240	18	<2	<0.5	7	5	515	3.53	652	12	0.44	82	8.51	1.0	0.68	20	0.2	0.500	129	1.51	2.01
D-136	1	<10	42	180	14	<2	<0.5	4	3	393	2.31	436	5	0.25	31	8.55	0.5	0.13	16	0.2	0.360	57	0.74	2.40
D-143	2	<10	82	370	20	<2	<0.5	9	7	476	4.24	762	18	0.67	121	8.67	<0.5	1.14	24	0.2	0.690	160	1.63	2.02
D-149	2	<10	124	420	20	2	<0.5	15	10	402	7.81	1227	44	1.04	290	7.46	<0.5	1.46	26	0.2	1.490	166	1.62	1.71
D-151	2	<10	53	200	16	<2	<0.5	5	5	441	2.65	524	6	0.27	37	9.19	0.5	0.17	16	0.2	0.290	62	0.87	2.57
D-152	1	<10	81	350	16	<2	<0.5	13	38	354	3.99	623	79	0.29	101	7.12	0.5	0.09	28	0.2	0.420	65	0.46	1.87
D-171	2	<10	101	360	20	<2	<0.5	16	29	472	5.89	892	63	0.54	199	8.71	<0.5	0.19	30	0.2	0.780	82	0.92	1.98
D-174	2	<10	88	460	18	<2	<0.5	12	31	352	4.70	457	68	0.36	116	7.37	0.5	0.20	30	0.2	0.420	77	0.61	1.79
D-186	2	<10	65	360	18	<2	<0.5	10	22	324	4.04	802	61	0.29	98	6.20	0.5	0.19	24	0.2	1.210	52	0.37	1.61
D-197	1	<10	76	410	18	<2	<0.5	16	36	402	3.88	699	80	0.57	105	8.00	0.5	0.23	32	0.2	0.470	115	0.49	1.93
D-211	1	<10	63	310	14	<2	<0.5	9	25	378	3.03	551	54	0.33	76	6.51	0.5	0.06	26	0.2	0.360	48	0.36	1.75
D-220	<1	<10	71	380	14	2	<0.5	13	25	283	3.90	527	67	0.41	118	7.04	<0.5	0.14	30	0.2	0.390	56	0.54	1.51
D-236	1	<10	60	250	14	<2	<0.5	6	18	229	3.22	709	43	0.26	78	4.43	<0.5	0.19	22	0.2	1.060	45	0.34	1.10
D-238	1	<10	58	230	14	<2	<0.5	8	26	218	3.04	582	69	0.30	74	4.12	0.5	0.16	22	0.2	0.930	41	0.29	1.02
D-247	<1	<10	55	240	10	<2	<0.5	5	19	236	1.85	395	44	0.15	49	4.07	0.5	0.03	18	0.2	0.280	24	0.13	1.12
D-256	<1	<10	75	320	14	<2	<0.5	8	25	322	3.23	371	58	0.36	75	6.61	1.0	0.06	22	0.2	0.520	36	0.22	1.61
D-263	<1	<10	43	180	10	2	<0.5	4	13	192	1.96	497	35	0.17	46	4.00	0.5	0.04	16	0.2	0.660	21	0.10	1.03
D-267	<1	<10	44	200	8	<2	<0.5	5	17	204	1.84	266	48	0.19	49	3.85	0.5	0.02	18	0.2	0.290	26	0.14	1.00
D-305	1	<10	65	280	4	2	<0.5	15	18	136	4.66	650	54	0.39	147	5.32	<0.5	0.32	60	0.2	0.380	39	0.28	0.64
D-321	<1	<10	70	250	10	<2	<0.5	5	19	371	2.37	325	53	0.22	86	6.00	1.0	0.07	22	0.2	0.550	47	0.18	1.71
D-325	<1	<10	40	190	8	<2	<0.5	6	14	272	1.96	258	43	0.17	58	4.46	0.5	0.08	20	0.2	0.360	32	0.18	1.11
D-331	<1	<10	81	290	10	2	<0.5	10	21	283	3.89	542	52	0.47	147	6.58	<0.5	0.56	40	0.2	0.720	101	0.59	1.47
D-333	1	<10	23	240	14	<2	<0.5	1	2	170	2.21	331	12	0.11	48	3.52	<0.5	0.24	12	0.2	1.560	173	0.51	0.43
D-338	1	<10	28	140	8	<2	<0.5	3	2	160	1.60	293	10	0.17	31	4.22	<0.5	0.19	10	0.2	1.020	89	0.43	0.62
D-343	1	<10	38	140	8	<2	<0.5	1	2	147	3.29	613	20	0.16	50	3.86	<0.5	0.25	10	0.2	2.510	78	0.40	0.44
D-349	<1	<10	34	180	10	<2	<0.5	2	3	212	1.79	242	15	0.24	46	5.41	0.5	0.06	12	0.2	1.090	40	0.24	1.30

Table 19 List of the Results of ICP Analysis(4)

Sample No.	Mo ppm	W ppm	Zn ppm	P ppm	Pb ppm	Bi ppm	Cd ppm	Co ppm	Ni ppm	Ba ppm	Fe %	Mn ppm	Cr ppm	Mg %	V ppm	Al %	Be ppm	Ca %	Cu ppm	Ag ppm	Ti %	Sr ppm	Na %	K %
D-350	1	<10	75	260	12	<2	<0.5	2	6	175	2.98	620	24	0.31	97	4.80	0.5	0.10	14	0.2	1.700	45	0.13	1.14
D-351	1	<10	37	130	10	<2	<0.5	<1	2	159	1.76	558	16	0.12	45	2.87	0.5	0.05	10	0.2	1.970	31	0.20	0.84
D-356	1	<10	42	200	8	<2	<0.5	1	2	208	1.98	176	9	0.23	39	5.36	0.5	0.07	10	0.2	1.160	32	0.48	1.17
D-361	1	<10	68	80	24	<2	<0.5	<1	4	95	8.59	2707	10	0.27	84	2.24	<0.5	0.08	22	0.2	5.076	19	0.22	0.42
D-362	<1	<10	60	70	14	<2	<0.5	3	4	117	5.52	1231	14	0.26	60	4.00	<0.5	0.32	14	0.2	2.210	52	0.43	0.49
D-371	1	<10	70	380	12	<2	<0.5	6	7	306	2.94	424	16	0.36	87	6.78	0.5	0.18	40	0.2	0.770	75	0.78	1.86
D-379	1	<10	39	140	8	<2	<0.5	1	2	306	2.20	312	6	0.22	43	7.14	0.5	0.07	12	0.2	0.840	52	0.59	1.89
D-380	1	<10	55	260	8	<2	<0.5	5	6	300	2.74	377	17	0.32	67	6.73	0.5	0.15	20	0.2	0.860	70	0.67	1.65
D-381	1	<10	79	350	8	<2	<0.5	5	7	314	3.83	516	41	0.42	108	6.62	<0.5	0.23	28	0.2	1.040	86	0.70	1.68
D-1001	<1	<10	45	200	10	<2	<0.5	3	24	212	2.06	467	50	0.27	48	3.96	<0.5	0.06	18	0.2	0.710	27	0.19	1.06
D-1002	<1	<10	52	180	8	4	<0.5	3	36	177	2.54	905	71	0.33	48	3.15	<0.5	0.10	16	0.2	1.290	20	0.15	0.89
D-1003	<1	<10	46	210	8	<2	<0.5	5	23	213	2.10	237	48	0.26	50	4.10	0.5	0.04	18	0.2	0.440	30	0.18	1.07
D-1004	<1	<10	51	270	8	<2	<0.5	5	16	209	2.32	266	42	0.22	47	3.93	<0.5	0.02	16	0.2	0.270	32	0.14	1.04
D-1005	<1	<10	76	270	4	<2	<0.5	17	27	194	5.58	591	08	0.67	180	5.91	<0.5	0.61	54	0.2	0.740	93	0.67	0.76
E-005	<1	<10	113	110	14	<2	<0.5	10	8	246	5.02	858	67	0.39	293	5.73	<0.5	0.27	16	0.2	0.980	62	0.82	1.04
E-009	<1	<10	161	200	18	<2	<0.5	5	5	317	6.31	1468	27	0.37	181	6.50	<0.5	0.60	16	0.2	1.180	113	1.14	1.33
E-010	1	<10	129	160	18	<2	<0.5	5	4	328	4.41	1066	15	0.26	130	7.06	<0.5	0.35	20	0.2	0.950	81	0.97	1.38
E-017	<1	<10	73	140	14	<2	<0.5	4	5	349	3.45	787	17	0.25	88	7.04	<0.5	0.35	14	0.2	0.850	83	1.22	1.43
E-034	1	<10	70	110	12	<2	<0.5	4	3	343	2.86	610	18	0.20	55	6.04	<0.5	0.24	12	0.2	0.440	72	1.04	1.32
E-041	1	<10	84	110	14	<2	<0.5	7	6	245	4.33	588	38	0.31	103	6.76	<0.5	0.13	20	0.2	0.550	36	0.32	1.04
E-043	1	<10	94	110	12	2	<0.5	4	3	360	4.34	912	17	0.22	94	6.57	<0.5	0.50	12	0.2	0.790	102	1.53	1.35
E-049	<1	<10	40	90	12	<2	<0.5	2	2	331	2.08	557	9	0.16	32	7.34	0.5	1.22	12	0.2	0.730	173	2.25	1.11
E-058	<1	<10	70	220	14	2	<0.5	9	8	313	4.39	712	32	0.40	111	7.07	<0.5	0.59	26	0.2	0.630	133	1.31	1.31
E-077	<1	<10	77	290	12	<2	<0.5	13	30	375	3.28	557	65	0.43	90	6.64	0.5	0.22	36	0.2	0.450	64	0.36	1.58
E-085	<1	<10	48	230	12	2	<0.5	5	18	210	1.80	250	43	0.18	49	3.99	0.5	0.02	20	0.2	0.280	28	0.15	1.05
E-095	<1	<10	73	160	24	<2	<0.5	8	7	212	6.09	619	27	0.39	143	6.35	2.5	0.16	24	0.2	1.450	32	0.25	1.71
E-108	<1	<10	39	300	10	<2	<0.5	9	18	430	2.83	403	45	0.30	86	5.69	1.5	0.15	42	0.2	0.310	55	0.33	1.23
E-120	<1	<10	102	300	18	2	<0.5	15	38	621	3.65	840	61	0.46	102	7.51	3.0	0.11	36	0.2	0.420	61	0.40	1.81
E-137	<1	<10	75	290	10	<2	<0.5	9	14	220	6.42	1691	75	0.35	180	5.95	2.0	0.80	42	0.2	2.840	130	0.84	0.53
E-145	<1	<10	73	260	12	<2	<0.5	7	27	399	2.72	357	60	0.43	91	7.38	2.0	0.08	30	0.2	0.440	62	0.54	1.75
E-155	<1	<10	61	250	18	<2	<0.5	8	18	245	2.33	406	48	0.17	61	5.62	1.5	0.04	22	0.2	0.420	19	0.11	1.27
E-163	<1	<10	22	110	10	<2	<0.5	2	8	146	1.07	90	26	0.10	35	2.89	0.5	0.02	14	0.2	0.290	19	0.08	0.72
E-167	<1	<10	31	140	10	<2	<0.5	5	11	172	1.37	107	32	0.22	40	3.31	1.0	0.03	12	0.2	0.300	24	0.17	0.83
E-170	<1	<10	42	150	10	<2	<0.5	4	11	185	1.69	506	33	0.19	46	3.50	1.0	0.04	12	0.2	0.680	21	0.11	0.94
E-174	<1	<10	35	140	8	<2	<0.5	5	14	180	1.51	111	37	0.25	44	3.82	1.0	0.03	14	0.2	0.290	21	0.12	0.90
E-184	<1	<10	59	210	10	<2	<0.5	8	22	279	2.59	166	60	0.38	74	6.28	2.5	0.02	18	0.2	0.410	58	0.33	1.49
E-192	<1	<10	7	60	6	<2	<0.5	1	2	66	0.41	49	10	0.04	15	1.24	0.5	0.02	8	0.2	0.300	14	0.14	0.25
E-197	<1	<10	20	260	12	<2	<0.5	2	3	59	0.65	50	23	0.04	16	1.24	0.5	0.03	10	0.2	0.280	13	0.04	0.26
E-198	<1	<10	22	120	8	<2	<0.5	3	7	117	1.12	152	24	0.12	28	2.41	0.5	0.02	12	0.2	0.330	19	0.10	0.58
E-200	<1	<10	72	240	12	<2	<0.5	9	23	370	2.66	426	53	0.38	80	6.24	2.0	0.16	24	0.2	0.530	54	0.32	1.50
E-218	2	<10	85	120	10	<2	0.5	<1	5	185	8.74	2523	13	0.30	152	4.31	2.0	0.87	18	0.2	5.487	67	0.95	1.67
E-225	<1	<10	50	160	14	2	<0.5	9	8	220	3.95	917	36	0.33	117	5.75	1.5	0.44	24	0.2	0.880	60	0.77	1.73
E-227	<1	<10	35	120	12	<2	<0.5	1	3	165	3.43	640	15	0.18	75	3.98	1.5	0.61	8	0.2	2.430	110	0.90	0.48
E-236	<1	<10	29	110	12	<2	<0.5	2	2	92	2.42	352	15	0.12	49	2.73	1.0	0.28	8	0.2	1.450	67	0.38	0.30
E-239	<1	<10	9	90	18	<2	<0.5	<1	1	126	0.98	208	11	0.04	25	1.56	0.5	0.03	6	0.2	0.780	24	0.10	0.24

Table 19 List of the Results of ICP Analysis(5)

Sample No.	Mo ppm	W ppm	Zn ppm	P ppm	Pb ppm	Bi ppm	Cd ppm	Co ppm	Ni ppm	Ba ppm	Fe %	Mn ppm	Cr ppm	Mg %	V ppm	Al %	Be ppm	Ca %	Cu ppm	Ag ppm	Ti %	Sr ppm	Na %	K %
E-244	<1	<10	23	100	26	<2	<0.5	<1	1	134	2.77	615	18	0.10	62	1.36	1.0	0.07	8	0.2	2.470	30	0.14	0.24
E-253	<1	<10	48	140	10	<2	<0.5	<1	2	111	3.95	751	13	0.17	52	2.54	2.0	0.30	6	0.2	3.610	115	0.38	0.17
E-254	<1	<10	32	170	12	<2	<0.5	1	3	144	2.02	209	36	0.24	56	3.74	1.0	0.22	8	0.2	1.330	52	0.31	0.40
E-258	<1	<10	43	150	16	<2	<0.5	6	6	468	3.26	646	31	0.27	106	5.44	1.5	0.54	12	0.2	1.240	95	1.10	1.17
E-261	<1	<10	37	130	12	2	<0.5	5	4	163	2.31	436	16	0.17	70	3.66	1.0	0.33	10	0.2	1.220	73	0.49	0.47
E-263	<1	<10	67	310	12	<2	<0.5	8	9	293	3.52	461	35	0.51	99	7.07	1.5	0.88	16	0.2	0.650	137	1.15	1.18
E-270	<1	<10	52	140	10	<2	<0.5	5	4	191	2.85	239	15	0.28	44	7.59	2.0	0.80	8	0.2	0.800	142	0.99	0.64
E-277	<1	<10	53	180	12	<2	<0.5	4	5	153	3.55	423	17	0.23	69	7.63	2.0	0.63	10	0.2	1.520	186	0.79	0.70
E-279	<1	<10	36	180	12	<2	<0.5	2	3	263	2.35	374	21	0.17	50	6.01	1.0	0.71	8	0.2	1.550	211	1.03	0.59
E-297	<1	<10	11	110	10	<2	<0.5	<1	2	358	0.90	94	9	0.11	15	5.04	0.5	0.80	8	0.2	0.360	184	1.38	0.78
E-298	<1	<10	34	220	10	<2	<0.5	1	3	295	1.81	293	27	0.15	40	5.64	1.0	0.67	8	0.2	1.240	220	1.09	0.62
E-299	<1	<10	66	220	22	<2	0.5	<1	7	211	5.87	1154	23	0.42	85	4.82	2.5	0.55	14	0.2	3.980	85	0.76	0.73
E-301	<1	<10	39	150	10	<2	<0.5	2	2	271	1.77	184	4	0.19	35	7.07	1.5	0.06	10	0.2	0.630	34	0.50	1.69
E-314	<1	<10	110	220	12	<2	<0.5	7	5	228	5.12	837	33	0.31	167	7.67	2.5	0.38	14	0.2	1.550	76	0.67	0.76
E-320	<1	<10	46	200	12	<2	<0.5	2	2	153	3.84	215	6	0.16	95	7.02	1.5	0.10	14	0.2	0.670	24	0.19	0.89
E-323	<1	<10	55	180	14	<2	<0.5	2	3	290	2.85	452	12	0.23	71	7.50	2.0	0.36	14	0.4	0.730	73	0.75	1.25
E-325	<1	<10	63	220	12	<2	<0.5	3	2	211	2.89	690	12	0.18	90	5.50	1.5	0.14	10	0.2	1.050	44	0.41	0.95
E-327	1	<10	74	230	10	<2	<0.5	2	2	197	4.57	1477	17	0.17	141	5.07	1.5	0.17	10	0.2	2.130	49	0.41	0.81
E-328	<1	<10	79	260	14	<2	<0.5	5	5	281	4.06	593	29	0.30	123	6.71	1.5	0.24	18	0.2	1.460	72	0.66	1.38
E-331	<1	<10	69	410	14	<2	<0.5	8	5	275	3.76	498	24	0.26	95	6.39	1.5	0.20	16	0.2	1.190	64	0.58	1.23

PART 5 CONCULUSION AND RECOMMENDATION

PART 5 CONCLUSION AND RECOMMENDATION

CHAPTER 1 SYNTHET REVIEW AND CONCLUSION

1-1 Characteristics of Geology and Mineralization at Bt.Raja Area

The geologic sequence of the Bt.Raja Area consists of the Mersip Limestone Member and its horizon of the S.Rawas Formation occuping the axial part of the synclinorium, and the Raja granites intruded into the Formation. The Mersip Limestone Member and its horizon are of the Upper and Middle of S.Rawas Formation, and are paleontologically Late Jurassic. This is also confirmed by the date through isotopic ratio. Raja granites are large intrusive body, intruded during the period of 60 ~ 50 Ma, and occupy the most axial part of the synclinorium mentioned above. The granites are divided into melanocratic alkalic diorite, including quartz monzonite, and pinkish leucocratic calc-alkali or calsic granite. The former is somewhat earlier than the latter.

The 20 mineral indications were investigated by means of geological, ground magnetic and geochemical surveys on their occurrence and related magnetic and geochemical anomalies. The synthetic interpretation indicates that the mineralization has essentially the features of a porphyry copper type deposit. From the occurrence of the mineral indications, it seems possible that the mineralization is related to the intrusion of Raja granites, and was emplaced 60~ 50 Ma and later.

Even though, the mineralization is large in scale, taking into account that it is porphyry copper type, it may be very low grade, less than 1/10 the grade of an ordinary workable porphyry copper deposit. It is insisted that a very low grade porphyry copper type mineralization has been emplaced in the Bt.Raja Area.

1-2 Characteristics of Geology and Mineralization at the S.Tuboh Area

The drilling survey conducted in the second phase unravelled the characteristics of geology and mineralization of the S.Tuboh Area, as summarized in Fig 44.

The mineralization is a high-grade Ag-Zn- Pb bearing skarn type deposit emplaced in the Mersip Limestone Member and its horizon of middle~ upper of

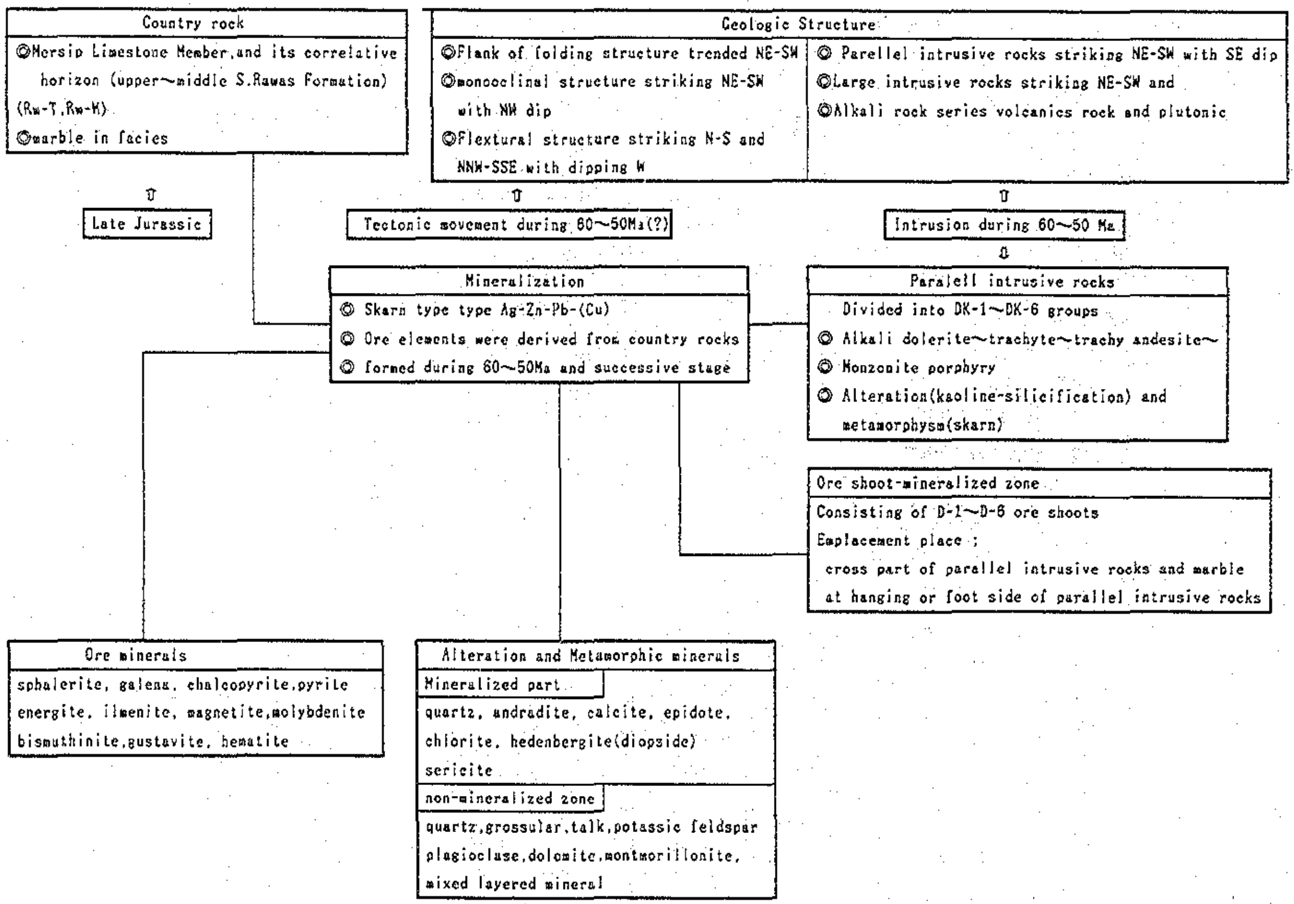


Fig.44 Synthesis Figure of Geologic and Mineralization Features, S.Tuboh Prospective Area

S.Rawas Formation. The bonanzas are embedded selectively at intersections of marble beds and parallel intrusions of alkalic intrusive rocks. The investigation revealed much information on the characteristics of mineralization such as origin of ore-forming elements, presences of silver mineral (gustavite) of Ag-Pb-Bi-S, distinction of skarn garnet between mineralized and barren parts etc. Fig.44 is a summerlized characteristics of the S.Tuboh mineralization at present.

1-3 Conclusion of the mineralizations of Bt.Raja and S.Tuboh Areas

(1) Bt.Raja Area

The mineralization in the area seemed to be a porphyry copper deposit, with expected large amounts of ore reserve. The survey through the second phases has not reached inside of Raja granites, and are enough to evaluate the concept. However the initial phase survey result is negative on the possibility of mineralization emplacement inside the granites. In addition, ore grade of the mineralization is presumed to be very low, less than 1/10 of ordinary porphyry copper deposit considering exisisting assay data. Therefore, it is concluded that the mineralization in the Bt.Raja Area is not encouraging for future exploration, even though the indications of a porphry copper type deposit have been found.

(2) S.Tuboh Area

The drilling survey has discovered 4 "ore shoots" D1～D4, and 2 highly-possible ore shoots D-5, D-6. Among them, D-2 and D-3 are parallel ore shoots, 50m apart in above and below, and with promising ore shoots expected to extend to their strike side and dip side. Consequently, it is hoped that as each ore shoot extends more, new parallel ore shoots will be discovered and large bonanzas will be emplaced at places where ore shoots cross or join each other. Moreover, silver and zinc contents in these ore shoots are consistently high in grade at most ore zones in the drill holes.

It is concluded that the S.Tuboh Area has good potential of high-grade ore shoots and is promising area for further survey.

CHAPTER 2 RECOMMENDATION FOR THIRD PHASE SURVEY

It is desirable to explore with aiming at Ag-Zn-Pb ore mineral bearing skarn deposits in S.Tuboh Area for the third phase survey. Striking and dipping extention areas of the high grade skarn type deposits in S.Tuboh area, particularly high grade ore deposit zones of D-2 and D-3 at the southeast part of the area, are very promising area for the future exploration.

Namely the third phase survey unravels the emplacement condition of the ore shoots, namely strike-side extension by 70m～100m interval, and deep-side extention by 250m in depth at least and their ore grades, targeting the two ore zones. For the purpose, it is recommendable that drillings are made plan to penetrate from southeast to northwest, namely hanging wall side to foot wall side of the ore zone, because the ore zone structurally strike N45° ～50° E with 65° ～75° SE.

SUPPLEMENTARY NOTES

Note-1 Whole Rock Analysis

Twelve rock samples consisting of 10 samples from the Bt.Raja area and 2 samples from the S.Tuboh area were analyzed. The 10 samples of the Bt.Raja area consist of 7 samples of igneous rock, 2 samples of hornfels and a sample of skarn.

Analysis results are listed in Table 20. Norm calculation results of 7 sample of Bt.Raja area and 2 samples of S.Tuboh are also shown in the Table 21.

The $SiO_2 \cdot Na_2+K_2O$ diagram plotted with the values from this anlysis,data of the Bt.Raya area, and of the initial phase survey are shown in Fig.45.

The Bt.Raja and S.Tuboh igneous rocks are characterized by generally high alkali. Furthermore, alkaline series rocks are distinguishable on the $SiO_2 \cdot Na_2+K_2O$ diagram ※ , and many rocks exist the around boundary between alkali rock series and non-alkali rock series. Nevertheless calcic rocks plotted in an area away from the boundary, seem to be co-exist. On average, these rocks are in the alkali-calc rock series.

The igneous rocks (10 samples) in the S.Tuboh area range within the alkali to alkali-calc rock serieses without exception, and it is pointed out that the intrusive rocks are mostly of alkali rock series.

On the other hand, alkali rock series and calcic rock series co-exist in the Bt.Raja area. Of the Bt.Raja granite, diorite and resembling rock are close to the alkali rock series, while granite,granodiorite and leucocratic rock are of the calcic rock series. If the intrusive rocks of the Bt.Raja area were be derived from the same magma, more-differentiated and less-differentiated intrusive rocks would co-exist in the area. According to the general tendency of magma differentiation, granite and granodiorite are at a later stage, and diorite is at an early stage of the differntiation.

The concept is consistent with the assumption that the diorite is an earlier intrusion than the granite and granodiorite. The magma could be primarily of alkali rock series or close to alkali rock series.

※It is questionable whether the classification is applicable for plutonic rock.

Since there is no other suitable method, the classification was applied.

Table 20 Whole Rock Composition of the Igneous Rock

No.	Sample No.	SiO_2%	Al_2O_3%	Fe_2O_3%	FeO %	MgO %	CaO %	Na_2O%	K_2O %	TiO_2%	P_2O_5%	MnO %	BaOppm	LOI%	Locality
1	AR-75	67.09	14.29	1.85	2.34	1.98	3.64	2.50	2.45	0.38	0.03	0.12	750	1.77	Bt. Raja
2	AR-126	70.32	14.40	0.45	1.19	0.65	2.38	4.13	4.61	0.28	0.02	0.06	400	0.51	Bt. Raja
3	BR-9	54.43	16.82	2.39	6.28	3.38	6.56	4.70	1.59	1.00	0.22	0.19	200	<0.01	Bt. Raja
4	BR-25	55.95	16.51	1.81	6.41	5.89	2.76	5.34	0.74	0.76	0.08	0.11	50	0.91	Bt. Raja
5	BR-48	56.91	21.76	0.36	5.81	2.40	1.62	1.45	4.50	0.68	0.05	0.22	500	1.76	Bt. Raja
6	BR-51	66.08	15.02	1.51	1.79	0.85	2.21	4.29	4.14	0.39	<0.01	0.13	350	1.05	Bt. Raja
7	BR-61	72.97	13.14	0.81	0.83	0.45	0.93	3.38	5.22	0.23	<0.01	0.04	350	0.85	Bt. Raja
8	BR-62	67.70	14.92	2.46	1.00	0.77	2.15	4.44	4.24	0.39	<0.01	0.09	450	0.56	Bt. Raja
9	BR-69	66.66	15.27	1.45	2.07	0.92	2.27	4.62	3.67	0.39	0.07	0.10	350	1.09	Bt. Raja
10	BR-86	60.35	16.10	1.53	3.86	2.02	4.25	4.49	3.05	0.77	0.21	0.11	300	1.59	Bt. Raja
11	61-ST-1	44.13	18.01	5.57	5.69	5.76	9.87	3.21	1.10	1.00	0.18	0.14	200	1.26	S. Tuboh
12	61-ST-2	50.35	16.34	1.59	6.25	6.49	8.51	3.10	1.62	0.64	0.18	0.16	300	2.14	MJI-7Drill

Table 21 Normative Composition of the Igneous Rocks

No.	SampleNo.	Q	C	or	ab	an	Ne	Di			Hy		Ol		Mt	Hm	Il	Tn	Ap
								wo	en	fs	en	fs	fo	fa					
1	AR-126	22.97	0.00	27.25	34.93	7.15	0.00	1.89	0.97	0.88	0.65	0.59	0.00	0.00	0.65	0.00	0.53	0.00	0.05
2	BR-9	1.17	0.00	9.40	39.75	20.11	0.00	4.59	2.27	2.23	6.14	6.03	0.00	0.00	3.46	0.00	1.90	0.00	0.52
3	BR-51	20.88	0.00	24.47	36.28	9.51	0.00	0.58	0.32	0.24	1.80	1.39	0.00	0.00	2.19	0.00	0.74	0.00	0.02
4	BR-61	30.46	0.26	30.85	28.58	4.55	0.00	0.00	0.00	0.00	1.12	0.55	0.00	0.00	1.17	0.00	0.44	0.00	0.02
5	BR-62	20.45	0.00	25.06	37.55	8.27	0.00	0.97	0.84	0.00	1.08	0.00	0.00	0.00	2.39	0.81	0.74	0.00	0.02
6	BR-69	18.90	0.00	21.69	39.07	10.10	0.00	0.30	0.15	0.14	2.14	2.01	0.00	0.00	2.10	0.00	0.74	0.00	0.17
7	BR-86	9.96	0.00	18.03	37.97	14.78	0.00	2.06	1.04	0.98	3.99	3.78	0.00	0.00	2.22	0.00	1.46	0.00	0.50
8	61-ST-1	0.00	0.00	6.50	20.77	31.49	3.45	6.80	4.76	1.48	0.00	0.00	6.72	2.30	8.07	0.00	1.90	0.00	0.43
9	61-ST-2	0.00	0.00	9.57	26.22	25.89	0.00	6.33	3.79	2.21	7.11	4.14	3.69	2.36	2.30	0.00	1.22	0.00	0.43

Abbreviation

Q : Quartz	an : Anorthite	fs : Ferrosilite	Mt : Magnetite
C : Corundum	Ne : Nepheline	Hy : Hypersthene	Il : Ilmenite
or : Orthoclase	Di : Diopside	Ol : Olivine	Tn : Titanite
ab : Albite	wo : Wollastonite	fo : Forsterite	Ap : Apatite
	en : Enstatite	fa : Fayalite	

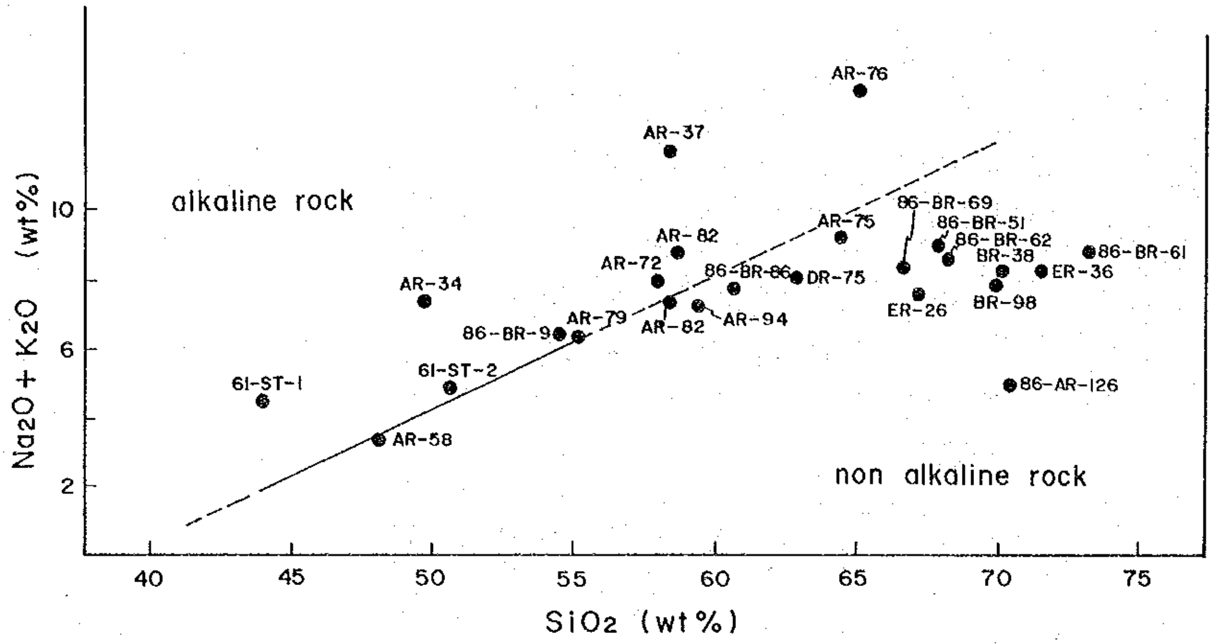


Fig.45 SiO_2 - (Na_2O + K_2O) Diagram (1)

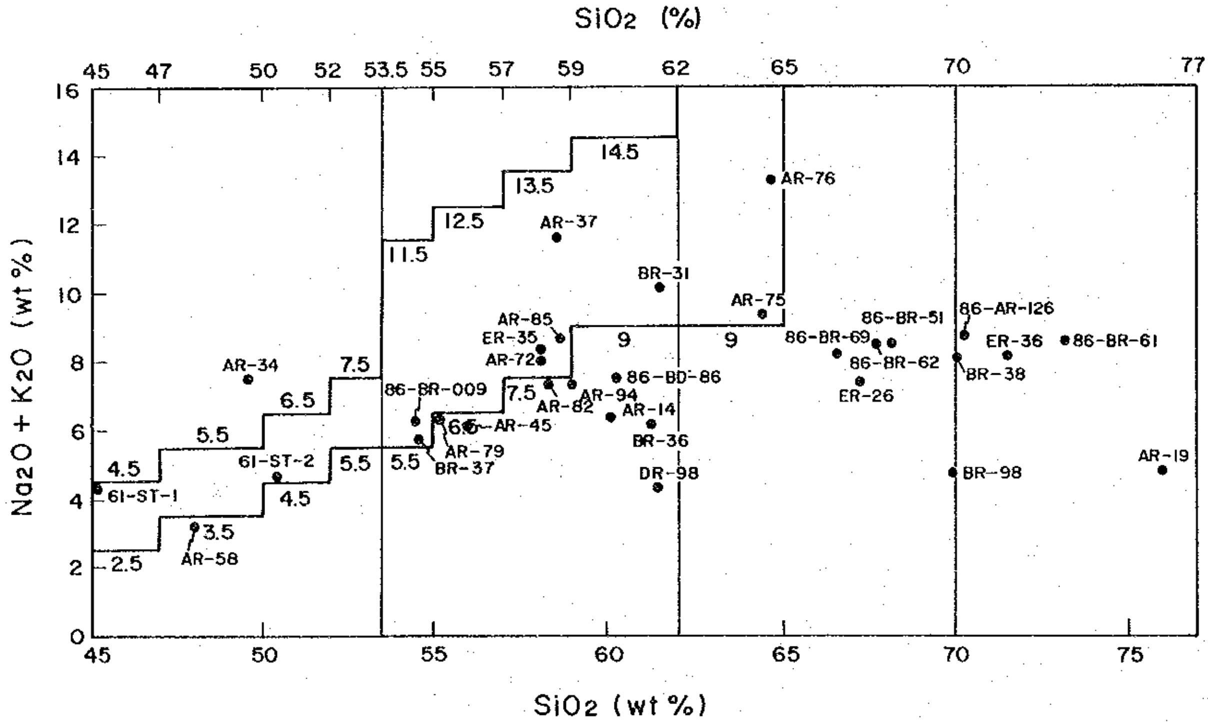


Fig.46 SiO_2 - (Na_2O + K_2O) Diagram (2)

However, the concept is inconsistent with the intrusive rocks of the S. Tuboh area because it is supposed that early differention of alkali rock series (monzonite, alkali gabbro, alkali dolerite,trachyte and so on) took place at Bt.Raja and in the southeast area at the time of the Bt.Raja intrusion. It may be inferred that the source magma of theRaja granites branched to make several magma reservoirs, and those respective magma reservoirs were differentiated under different physico-chemical conditions to make different rock series. Thus Raja granite and S.Tuboh intrusivs were derived from different magma reservoirs, and are composed of respectively different rock series.

On the basis of the results of the whole rock analysis, the classification of the granites in Bt.Raja and intrusive rcks in S.Tuboh are shown in Table 22 , and figure of $SiO_2 \cdot Na_2O+K_2O$ is shown in Fig. 46.

Table 22 Classification of the Igneous Rocks in Bt.Raja Detailed Survey Area and S.Tuboh Prospective Area by Whole Rock Analysis

		High ←— Alkali —→ Low
$SiO_2 \cdot Na_2O + K_2O$ (1)	Alkalic	61-ST-1.61-ST-2.BR-9.(**AR-34.37.BR-31.AR-85.ER-35.AR-72.AR-79.82)
	Non-alkalic	BR-86.69.51.62.61.AR-126.(**AR-58.45.BR-37.AR-75.94.DR-75.AR-26.14.ER-26.DR-98.BR-38.98.ER-36.AR-19)
Alkali-calc index	Alkali	61-ST-1.(**AR-37.34.76)
	Alkali-calc	BR-9.61-st-2.(**BR-31.AR-85.ER-35.AR-72.79.82.58.45.BR-37.AR-75.94.DR-75.AR-26)
	Calc-alkali	BR-86.59.51.(**AR-14.DR-36)
	Calcic	BR-62.61.AR-126.(**ER-26.BR-38.98.ER-36.AR-19)
$SiO_2 \cdot Na_2O + K_2O$ (2)	Basaltic (SiO_2<53.5%)	
	High alkali	(**AR-34)
	Low alkali	61-ST-1.61-ST-2
	Non-alkali	(**AR-58)
	Intermidate (53.5%≤SiO_2≤62%)	
	Phonolitic	----------
	Trachytic・Trachy andesitic	BR-9.(**AR-37.BR-31.AR-85.ER-35.AR-72.BR-37)
	Non-alkali andesitic	BR-86.(**AR-94.82.14.45.79.BR-36.DR-98)
	Trachytic ($Na_2O + K_2O$≥9%) (62%≤SiO_2≤65%)	(**AR-76.75)
	Dacitic ($Na_2O + K_2O$<9%) (62%<SiO_2≤70%) ($Na_2O + K_2O$<16%) (65%<SiO_2≤70%)	BR-51.69.62.(**ER-26.BR-98)
	Rhyolitic (70%<SiO_2)	AR-126.BR-61.(**ER-36.BR-38.AR-19)

Note-2 Age dating

The radiometric age determination results by K-Ar method on 2 samples from Bt.Raja area and 2 samples from S.Tuboh area are as follws ;

AR-126	Bt.Raja	Granite	Calcic rock	55.5± 2.8 Ma
BR- 9	Bt.Raja	Diorite	Alkali-Calc rock	57.8± 2.9 Ma
61-ST-1	S.Tuboh	Gabbro	Alkali rock	51.7± 2.7 Ma
61-ST-2	S.Tuboh(MJI-7)	Dolerite	Alkali-Calc rock	51.9± 2.6 Ma

The K/Ar dating results of the Bt.Raja and S.Tuboh areas and vicinities as determined by the initial phase survey is as follows :

85-AR-14	R.Rawas•R.Suban	Granite	Calc-Alkali rock	51.9± 2.6 Ma
85-BR-98	Bt.Raja	Granite	Calc-Alkali rock	54.1± 2.7 Ma
85-AR-76	S.Tuboh	Quartz-monzonite	Alkali-Calc rock	40.1± 2.0 Ma

Individually, they appear to be grouped into several ages, but when the deviations values are considered they fall into an appropriate range as shown in Fig. 47

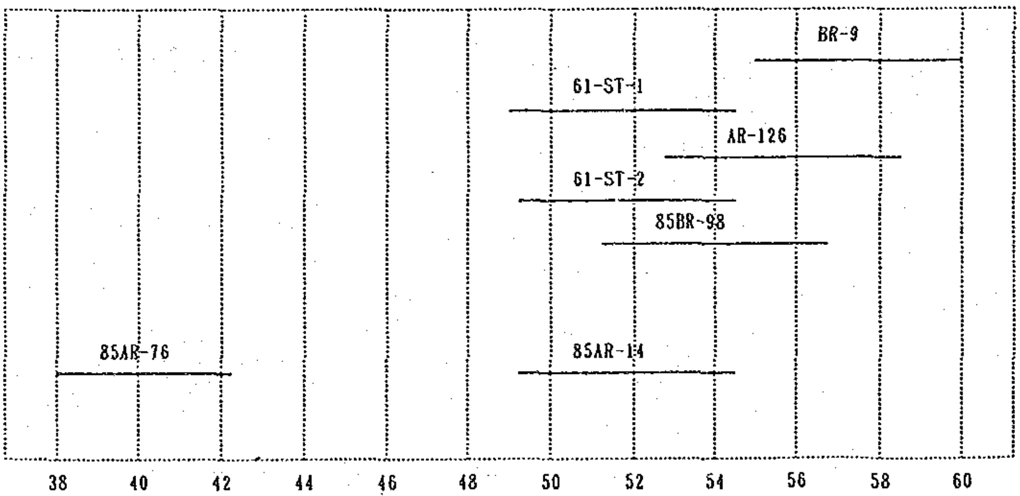


Fig.47 Radiometric Age Range of Rocks, Considering Measure-Error

In accordance with the figure, 85AR-76 is considerably younger than other sameles, showing a significant age difference, and the other 6 samples are almost the same ages, although BR-9 is slightly older. Of the 5 samples, 61-ST-1, 61-ST-2, 85AR-14, 85-BR-98 and AR-126 have undergone some mineralization, and they might be similar in age considering the mineralization effect. 85AR-76 is presumed to intrude into the series of igneous activity of 61-ST-1 on the basis of location and continuity with each other, but the former is somewhat younger than the latter because the former is coarser in grain than the latter(61-ST-1 and 61-ST-2) and intruded into the latter. On the other hand, the former was presumably subject to rejuvenation of its age upon consideration of the heat-effects by mineralization and post-intrusion.

Consequently, with consideration also of the interpretation by whole rock analysis (Note-1), most igneous rocks distributed in the Bt.Raja and S.Tuboh areas intruded during the same activity but they presumably have slight fiffernt age in accordance with magmatic differentiation.

Note-3 Microscopic Observation by Thin Section

(1) Bt.Raja area

Sixteen thin sections were observed from the Bt.Raja area, and among them, 9 sections of igneous rock are described . (Table 23).

[AR-43] : The sample was taken at the confluence of R.Tamian and R.Rawas. and is of the marginal part of the intrusive rock distributed along R.Rawas from southwest of Pulaukidak to downstream of R.Suban. Potassic-feldspar is probably embedded in a groundmass, but this is not certain. However, the rock is identified as alkalic monzonite porphyry, owing to rich sodium content. A biotite granite occurs to the south and west from the sample location, and a mostly alkalic monzonite or quartz monzonite in south Sumatra is reported from the northeast area along R.Rawas.

[AR-56] : Two outcrops of granitic intrusions are known, extending in a NNW-SSE downstream of R.Seri. The mineral indication No. 17 consisting of pyrite and pyrrhotite and geochemical anomaly No.17 are in contact with the intrusive rock.

Table 23 Microscopic Observation of Rock Thin Sections in Bt.Raja Detailed Survey Area

Sample	Locality	Rock	Phenocryst, Mineral Chip, Granitic Rock										Groundmass, Matrix												Altered, Minerals, etc.													Remarkes
No.		Name	Q	Af	Pl	Bi	Ho	Au	Hy	Ol	Op	Mf	Q	Af	Pl	Bi	Ho	Cx	Ox	Ol	Mf	Op	G	Cl	Q	Ch	Se	Ep	C	K	Ga	Sf	Ac	Ho	Sp	He	Px	
AR-35	Bt.Raja	Sk																							○	▲					◎		▲					
AR-43	Bt.Raja	Qmp			○		○		○			△	△	○	◎	△					△	△					▲	▲	▲									Na-rich
AR-56	Bt.Raja	Gr	○	○	○	△	△				△															▲	△	▲										Acc.: ▲
AR-83	Bt.Raja	Sk				○																			▲	▲	△	△	▲		○	△	△	△	▲	▲	◎1	1)Diopside, Af.: ◎
AR-126	Bt.Raja	Gr	○	○	○		△				△															△	△											Por., Acc., Mt.: ▲
BR-3	Bt.Raja	Di	△		◎	△		○			△															▲												Fresh Acc.: ▲, Mt. : △
BR-9	Bt.Raja	Di	▲		◎			○	○		△																											Fresh Acc.: ▲
BR-16	Bt.Raja	Tuff	△		○		△				△		△		△		△				△	△			△				△				△					Fragment(An.:○), Tourmaline : △
BR-23	Bt.RAja	Dp			◎		○	○							○		△	△				△				▲	△	△					○					Mt. : ▲
BR-25	Bt.Raja	Mudyss			○						△		△		△	△						△		◎	△	△			△				△					Hornfelsic, C-Ch-Ac-q Vein
BR-33-2	Bt.Raja	Slate													△							△		△			△	△	△								○1	Skarnization, 1)Diopside, Prehnite : △?
BR-51	Bt.Raja	Gr	○	○	○	△	▲				△															△	▲	△										Graphic, Acc., Mt. : ▲
BR-61	Bt.Raja	Gr	○	△	◎	△					△															△	△	△										
BR-62	Bt.Raja	Gd or To	○	○	?	◎	△				△															▲	▲											Por., Acc. : ▲, Mt. : △, fine~medium grain
BR-69	Bt.Raja	To	○	△	◎	△	△				△															▲	▲											Acc., Mt.: ▲, fine grain
BR-86	Bt.RAja	To	○	△	◎	△	△				△															△	△	▲										Poikilitic, Ac., Mt.: ▲, fine grain

Abbreviation

Gr : Granite
Di : Diorite
Dp : Diorite porphyry
Gd : Granodiorite
To : Tonalite
Sk : Skarn(or Skarnized rock)
Gb : Gabbro
Dol: Dolerite
Tr-An : Trachy-Andesite
An : Andesite
Qmp: Quartz monzonite
Tr-Dol: Trachy-Dolerite
Mph: Monzonite pophyry
Bs-An: Basaltic-Trachy andesite

Q : Quartz
Af : Kali-feldsper
Pl : Plagioclase
Bi : Biotite
Ho : Hornblende
Au : Augite
Hy : Hypersthene
Ol : Olivine
Op : Opaque mineral
Maf: Mafic mineral
G : Glass
Cl : Clay mineral

Ch : Chlorite
Se : Sericite
Ep : Epidote
C : Calcite
K : Kaoline
Ga : Garnet
Sf : Sulfide minerals
Ac : Actinolite
Sp : Sphalerite
He : Hematite
Px : Pyroxene group minerals
Ta : Talc
Mt : Magnetite

◎ : Abundant
○ : Common
△ : A few
▲ : Rare

A pinkish feldspar is predominantly visible in a finely piebald rock. It is composed of an equivolume of quartz, potassic feldspar and plagioclase, and mafic minerals of biotite and hornblende in equigranular texture, with a small amount of accessory sericite and chlorite. The rock is identified as granite from the composition of rock-forming minerals and its texture.

[AR-126] : The sample was taken from an exposure at the S.Padang mineral indication(magnetite boulder zone). The rock has been dated as 55.7 ± 2.8 Ma by the K-Ar method as mentioned before. It resembles AR-56 in appearance, and has the same mineral composition as AR-56. A small amount of chlorite and sericite occurs as accessories, showing slight alteration. It is called granite, in accrod with the same reason as AR-56.

[BR-3],[BR-9] : The samples were taken from a ridge dividing flow area R.Seri and R.Pangi at the southwest end of Bt.Raja. The localities were separated by 1km. BR-9 has been dated as 57.8 ± 2.9 Ma by the K-Ar method. It plots in the slightly alkalic region on the $SiO_2 \cdot Na_2O + K_2O$ figure, and also in 51～56 of the alkali calc index. However, pyroxene is not particularly a sort of alkalic rock, and no alkalic hornblende occurs. Its texture is equigranular holocrystalline. BR-3 has undergone considerable alteration, and is a dark black rock with sporadic concentrations of pyrrhotite and chalcopyrite. An aggregate of fine-grained secondary biotite occurs clearly trending like veins. Both rocks are named diorite, on the basis of their composition of rock-forming minerals and chemical component.

[BR-23] : The sample was collected from boulders distrinuted extensively as rock in a location west of Bt.Raja. It has undergone considerabe mineralized alteration associating with dots of pyrrhotite, and resembles to BR-3 in rock facies. It is porphyritic rock composed of phenocrysts of pyroxene, hornblende and plagioclase, and is aligned with BR-3 and BR-9.

[BR-51] : The rock is situated northeast of Bt.Raja peak, and in the marginal part of the Raja rock body. It is pinkish in appearance, looks like AR-56 and AR-126, but is finer in grain than either comparing both. It consists of an equivolume of quartz, potassic feldspar and plagioclase, with a little hornblende and a few of biotites. The rock is identified as granite from the existense of graphic texture and rock-forming minerals.

[BR-61, BR-62, BR-69, BR-86] : The 4 samples were taken in an area from the northeast marginal part to inside the Raja granites. BR- 61 is clearly different from the other three in appearance. It is pinkish porphyritic rock, while the others are dark grayish fine grained rock.

BR-61 is composed of plagioclase > quartz > potassic feldspar, with accessory biotite, and is regarded as granodiorite, but granite based on chemical composition. BR-62, BR-69 and BR-86 vary from felsic to mafic in order, namely BR-62 is granodiorite or tonalite, and BR-69 and BR-86 are tonalite.

(2) S. Tuboh area

The petrographic observation was conducted on the rock collected from ground surface and drill cores, as shown in Table 24.

Of a total 16 samples, 11 samples are igneous rocks, and a small scale intrusive rock intruded into the marble is petrologic heart of the observation in the area.

[61-ST-1, 61-ST-4] : The samples were taken from intrusive rock extending southwest of the S.Tuboh area. They are a part of the" quartz monzonite" the initial phase survey in their occurrence, and are dark coloured medium~fine grained holocrystalline rock. Their constituents are plagioclase > common pyroxene > hornblende - biotite, and they are identified as (alkali) gabbro in accord with their rock-forming mineral, constitutions, low content of SiO_2 and position on the $SiO_2 \cdot Na_2O+K_2O$ figure of ST-61-1.

[61-ST-2] : The rock occurs in the foot wall of the deep mineralized zone of MJI-7, and is correlative with DK-3. It is dark, black, fine-grained rock and has been dated as 51.9 ± 2.6 Ma by the K-Ar method. The whole rock analysis indicates that it is weak alkaline basalt and is close to 61-ST-1. Plagiclase and pyroxene are embedded in a sub-ophitic groundmass without phenocryst. The rock is regarded as alkalic basalt or alkalic dolerite on the basis of the facts that the plagioclase is albite and a small amount of potassic feldspar occur in the groundmass. It is called alkalic dolerite in the report.

[61-ST-7] : This rock belongs to DK-2, namely the intrusive rock in contact with the shallow ore zone of MJI-7 and MJI-8, and the ore zone of MJI-6. The upper part of the rock is 61-ST-6 composed of quartz-epidote-chlorite-calcite, and a farther upper part, 61-ST-5 is skarn (quartz-andradite).

Table 24 Microscopic Observation of Rock Thin Sections in S.Tuboh Prospective Area

Sample No.	Locality	Rock Name	Phenocryst, Mineral Chip, Granitic Rock										Groundmass, Matrix												Altered, Minerals, etc.															Remarkes (Rock unit)
			Q	Af	Pl	Bi	Ho	Au	Hy	Ol	Op	Mf	Q	Af	Pl	Bi	Ho	Cx	Ox	Ol	Mf	Op	G	Cl	Q	Ch	Se	Ep	C	K	Ga	Sf	Ac	Ho	Sp	He	Op	Px	Ta	
61-ST-1	S.Tuboh	Ga			◎	△	△	○			△															△	?	△												Surface
61-ST-2	MJI-7	Alkali-Dol			?							?	△	?	○	△	○	?				△			△	△	△													(Dk-3)
61-ST-3	S.Larang	Slate	△	?	?						△	?	△									△		◎	▲	△	?													Surface
61-ST-4	S.Tuboh	Ga			◎	△	?	○	△		△															△	▲													Surface
61-ST-5	MJI-7	Sk																							△	▲			△								▲	△		(D-2)
61-ST-6	MJI-7	Sk																							○	△		◎	○								△			(D-2)
61-ST-7	MJI-7	Tr-An			○						△	?	△	?	◎		△					△			▲	?			△				△							(Dk-2)
61-ST-38	MJI-8	Sk																							△	▲			○		○							△		(D-2)
61-ST-43	MJI-5	Alt-Tr-An			○							△		?	○	△					△	△			○	△			△											(Dk-1)
61-ST-47	MJI-6	Tr-An			○							?		?	○	△					△	△			△	△	▲		△											(Dk-2)
61-ST-58	MJI-6	Sk																							△	△			△		◎		▲				△	△		(D-2)
61-ST-60	MJI-3	Alt-Bs Lava			○							?	△		?		△					△				△	?		○				△						○	
61-ST-65	MJI-10	Qmp		△	△								○	○	○			△				△					▲		▲											
61-ST-68	MJI- 9	Tr-Dol			△							?			◎						△	△			○	?	△		○								△			(Dk-6 (u)) Na rich feldspar
61-ST-70	MJI- 9	Mph			○			△			△			○	○	△		△				△			○	△	▲	▲									△			(Dk-6 (L)) Na rich feldspar
61-ST-71	MJI- 9	Bs-An			○							△			◎						△	△			○	△	△		○											(Dk-6 (L)) Na rich feldspar

Abbreviation

Gr : Granite
Di : Diorite
Dp : Diorite porphyry
Gd : Granodiorite
To : Tonalite
Sk : Skarn(or Skarnized rock)
Gb : Gabbro
Dol: Dolerite
Tr-An : Trachy-Andesite
An : Andesite
Qmp: Quartz monzonite
Tr-Dol: Trachy-Dolerite
Mph: Monzonite pophyry
Bs-An: Basaltic-Trachy andesite

Q : Quartz
Af : Kali-feldsper
Pl : Plagioclase
Bi : Biotite
Ho : Hornblende
Au : Augite
Hy : Hypersthene
Ol : Olivine
Op : Opaque mineral
Maf: Mafic mineral
G : Glass
Cl : Clay mineral

Ch : Chlorite
Se : Sericite
Ep : Epidote
C : Calcite
K : Kaoline
Ga : Garnet
Sf : Sulfide minerals
Ac : Actinolite
Sp : Sphalerite
He : Hematite
Px : Pyroxene group minerals
Ta : Talc
Mt : Magnetite

◎ : Abundant
○ : Common
△ : A few
▲ : Rare

Only phenocrysts of plagioclase are observable by microscopic, but plagioclase > quartz > potassic feldspar are detected by X-ray diffractive analysis. It is identified as trachy andesite based on the presence of trachytic texture and quartz.

[61-ST-43] : It is correlative with DK-1, and is megascopically pale reddish brown or pale-orange coloured altered rock. A large number of secondary quartz occur as alteration products. The plagioclase is albite. It seems to be dacite, but may be close to 61-ST-7.

[61-ST-47] : It is a member of DK-2. Phenocrysts of only plagioclase are embedded in a groundmass of plagioclase, and a small amount of quartz, biotite and potassic feldspar(?). Its ground mass does not shows trachytic texture, but it has a close relationship with 61-ST-7, considering the result of the X-ray diffractive analysis.

[61-ST-60] : It is mafic lava found commonly in the deep part of the holes. X-ray diffractive analysis has detected equal volumes of epidote and talc in the rock.

[61-ST-65] : The sample is a part of the quartz monzonite occurring in the shallow part of MJI-10. Megascopically it looks somewhat decoloured, but is microscopically fresh rock. A small amount of phenocrysts of plagioclase and potassic feldspar lie in a ground mass of equal volumes of quartz, potassic feldspar and plagioclase. It is named quartz monzonite porphyry, in accord with the phenocrysts and the assemblage of rock-forming minerals.

It is taken into consideration that the large intrusive body of the S.Tuboh area is heterogeneous rock, since there are many rock facies of quartz monzonite, quartz monzonite porphyry, and (alkali) gabbro in spite of it is an intrusive rock.

[61-ST-68, 61-ST-70, and 61-ST-71] : 61-ST-68 is present in the upper part, and 61-ST-70 and ST-61-71 occur in the lower part of intercalated ore zone and cave at shallow depth in MJI-9, as if they are two intrusive bodies. All rocks are not megascopically different, and are grayish green volcanic rock having trachytic texture with plagioclase. Cognettic coarse-holocrystalline or poly-phenocryst xenoliths are sometimes contained in these rocks. The plagioclase is sodium rich and is in the range of albite to oligoclase. The rock is so-called basaltic andesite, but individually, 61-ST-68 is called trachy dolerite, 61-ST-70 is monzonite porphyry and 61-ST-71 is trachy-basaltic andesite.

The result of the microscopic observation is shown in Table 25.

Table 25 Summary of Microscopic Observation of Rock(Bt. Raja Detaild Survey Area and S. Tuboh Prospective Area)

Item of classification	Classification		
	Leucocratic	Intermediate	Melanocratic
Color tone (microscopic)	AR-56, AR-126 Br-51, BR-61 ST-43 (alteration)	AR-43,	BR-3, BR-9, BR-62, BR-69, BR-86 ST-1, ST-2, ST-4, ST-7, ST-47, ST-60, ST-65, ST-68, ST-70, ST-71
	Plutonic	Intermediate	Volcanic
Rock facies (microscopic))	AR-43, AR-56, AR-126 BR-3, BR-9, BR-23 BR-51, BR-61, BR-62, BR-69, BR-86 ST-1, ST-4, ST-65	ST-70	ST-2, ST-7, ST-43 ST-47, ST-60, ST-68 ST-71
	Felsic	Intermediate	Mafic
Classification of felsic-mafic (microscopic & whole rock analysis)	AR-43, AR-56, AR-126 BR-51, BR-61, BR-62 BR-69 ST-43 (alteration)	BR-3, BR-9, BR-23, BR-86 ST-65, ST-70 ST-7, ST-47 ST-71	ST-1, ST-2, ST-4, ST-60 ST-68

Note-4 X-ray Diffractive Analysis

(1) Bt.Raja area

The results of the X-ray diffractive analysis of the samples of the Bt.Raja area are shown in Table 26.

The three samples of AR-24, 25, 26 were taken from clay veins trending NW-SE north of R.Suban. The clay veins are thought to be related to the S.Suban mineral indication, but it cannot confirmed by only the result of the analysis. As mentioned later, a chalcopyrite is observed through microscopic test of polished specimens. The hornblende detected is actinolite, and it could have a relation to skarn mineralization. However it is definitely not an extention of the S.Suban indication, upon comparison with AR-35 and AR-

Table 26 X-ray Diffractive Analysis of Samples in Bt.Raja Detailed Survey Area

No.	Sample No	Py	Mt	He	Go	Lep	An	Gr	Ca	Am	Px	Wo	Ep	M	Ch	Ta	Se	K	Q	Pl	Kf	Cp	Ga	Remarks
1	AR-24	△							△				△		◎				○					
2	AR-25	▲											△				△	△	◎		△			
3	AR-26									○[1]					○		△			◎				[1]Actinolite
4	AR-35						◎								?				△					
5	AR-61													○			▲	△	○		○			
6	AR-75							◎				◎								△	△			
7	AR-76																▲	?	◎					
8	AR-91						◎			△					?	△								
9	AR-104	○												△	?		△		◎		▲			
10	AR-114	△															◎[1]		○					[1]$2M_1$
11	BR-5																△	△[1]	◎					[1]Kaolinite
12	BR-18				◎												◎	△						
13	BR-62			?	◎	?				?								?						
14	BR-64	△											?	△	?		△	?	◎	○	○			
15	BR-67	○															○[1]		◎			▲	▲	[1]$2M_1$
16	BR-74		○	△	◎	?	△				?								?					
17	BR-79			△	◎		△												?					
18	BR-84			◎[1]							?								○					[1]Specularite
19	BR-87									○[1]					?		▲		○	◎				[1]Actinolite

Abbreviation

Py : pyrite
Lep : lepidochrosite
Am : amphibole
Ch : chlorite
Q : quartz
Cp : chlcopyrite

Mt : magnetite
An : andradite
Wo : wollastonite
Ta : talc
Pl : plagioclese
Ga : galena

He : hematite
Gr : grossular
Ep : epidote
Se : sericite
Kf : kalifeldsper

Go : goethite
Ca : calcite
M : montomorillonite
K : kaoline
Px : pyroxene

◎ : Abundant

○ : Common

△ : A few

▲ : Rare

91 of the Suban indication.

Samples of AR-61and 75 taken from R.Tandoi, a tributary of R.Seri, and AR-75 taken south of the former two were thought to have a relation to the hematite-pyrite boulder zone extending along R.Tandui. SR-61 consists of quartz-potassic feldspar-montmorillonite-kaoline, AR-76 is composed of grossular-wollastonite-potassic feldspar-plagioclase, and AR-76 contains only quartz. The alteration-metamorphism is not related to mineralization.

A-104 is pyrite disseminated argillized slate occurring at the south side of R.Rawas and downstream of R.Pengan, and was taken from near the S. Suban mineralized indication. The sample consists mainly of quartz and pyrite, but presence of a small amount of sercite-montmorillonite-chlorite makes the rock look argillic.

AR-119 is from a pyrite-clay vein occurring at the Padan mineral indication (NO.11), and it is worth noting that it predominant of sercite.

BR-5 was taken for the reasons that it was de-coloured and an argillized phyllite at the margin of 〃diorite〃, but it has merely undergone quartz-kaoline-sericite alteration. BR-18 consists of goethite-sericite-kaoline, and is a product of weathering.

BR-62B, BR-74, BR-79, BR-84 and BR-87 are related to the mineral indication (No.6) at the midstream of R.Menalu. It consists of goethite-hematite-magnetite-pyrite-quartz and andradite, showing representative mineral assemblage of the Bt.Raya mineralization.

BR-64 and BR-67 were taken from the No.12 mineralized indication. BR-64 is granodiorite + quartz-pyrite in visible appearance. Potassic feldspar and plagioclase detected by X-ray diffractive analysis are components of granodiorite. BR-67 is of quartz-pyrite-galena-sphalerite in fine veins, and quartz, sericite, pyrite and a small amount of chalcopyrite and galena were detected from the sample. The assemblage is not different by visible observation, but it is worth noting that sericite is a main mineral of the alteration.

As mentioned above, although the Bt.Raja area is very extensive, and mineralization features are individually difference depending on the indication, the features of mineralization are generalized as :

① Andradite has clearly a tendency to associate with mineralization, while grossular appears to occur in barren skarn.

② Predominant sericitization occurs in magnetite-hematite mineralization, and presumably indicates sulphides of Mo, Cu, Pb, Zn and so on, at depth.

③ Potassic feldspar and plagioclase are of minerals in original rock or host rock.

(2) S.Tuboh area

Twenty seven samples from S.Tuboh area were analysed by X-ray diffraction analyser, and the result is shown in Table 27 The main non ore minerals detected are qartz, calcite, garnet, plagioclase, potash feldspar, kaolin mineral, chlorite, epidote and pyroxene.

61-ST-5 and 61-ST-6 are samples from the skarn zone continuing from the shallow ore zone of MJI-7, and the constitutent minerals of the skarn zone are andradite-quartz, quartz-epidote-calcite-chlorite. 61-ST-30 from the skarn zone accompanied by the deep ore zone of MJI-7 consists of mainly andradite. The andradite is detected usually from the ore zone..

To the contrary, grossular is detected from the argillaceous part in DK-1 of 61-ST-42 taken from the shallow part of MJI-5. The garnet zone in slumping structure of 61-ST-43 collected from MJI-5, and the garnet zone of 61-ST-62 occurred in the deep part of MJI-3. These parts are not accompanied by a mineralized zone.

From these facts, the following garnets occur in common ;

mineralized part -------- andradite

non-mineralized part ------ grossular

X-ray diffractive analysis on 11 intrusive rock samples detected assembleges of quartz-plagioclase and plagioclase-potash feldspar-quartz. 61-ST-48 and 61-ST-59 contain particularly kaolin. These intrusive rock bodies are not accompanied by a mineralized zone, and it presumably have mutual relationship with the occurrence of the kaolin. Quartz is a product of the alteration

It is noticeable that 61-ST-6, basalt lava which occurred continuously throughout all drill holes contained both chlorite and talc. The tuffaceous thin beds and the tuffaceous fragment of upper and lower horizons of the lava

Table 27 X-ray Diffractive Analysis of Samples in S.Tuboh Prospective Area

No.	Sample No	Drilling No	Cp	Ga	Sp	Py	Asp	Mt	He	Il	An	Gr	Ca	Do	Am	Px	Ep	M	Mix	Ch	Ta	Se	K	Q	Kf	Pl	Remarks
1	61-ST-5	MJI-7									◎		?			△[1]				▲				◎			[1]Dp(p)
2	61-ST-6	MJI-7				▲					?		○	?			○			○		△		◎			
3	61-ST-7	MJI-7				▲									?					△		▲		○	△	◎	
4	61-ST-10	MJI-7			△						◎						△							△			
5	61-ST-12	MJI-7			○						○		◎				?							△			
6	61-ST-13	MJI-7	?		△						?		△	?			○	△	?	△				△			
7	61-ST-21	MJI-7		△	◎						○													○			
8	61-ST-30	MJI-7				?	○	?			○		△					?						△			
9	61-ST-38	MJI-8	?		?	?					△		○		△	○[1]								○			[1]Hd
10	61-ST-41-2	MJI-8		△	◎						△		△				?							△			
11	61-ST-42	MJI-5				△						△	○				△		?	?				◎			
12	61-ST-46	MJI-5										○	○							△		▲		○	△	△	
13	61-ST-47	MJI-5											▲		▲					▲		▲		△	△	◎	
14	61-ST-48	MJI-6				△							○						?			▲	○	◎			
15	61-ST-49	MJI-6				△							△						△	△		▲	?	◎	△		
16	61-ST-51	MJI-6	△		△	△			?	?			◎			○[1]				▲	?	▲		○			[1]Hd
17	61-ST-52	MJI-6							?				△	△			△	?						◎	△		
18	61-ST-56	MJI-6	△		△						○		△		?	△[1]		?		△				○			[1]Hd
19	61-ST-59	MJI-3				△							△	?			▲					▲	○	◎			
20	61-ST-60	MJI-3				△							△	△	△					○	○			△			
21	61-ST-62	MJI-3				△						○	◎									△			?		
22	61-ST-64	MJI-2		△	○						△													○			
23	61-St-67	MJI-9			?	△							▲									△	○	◎			
24	61-ST-68	MJI-9				△							△							?		△	?	○		○	
25	61-ST-70	MJI-9				△							△				△[1]			△		?		△	○	○	[1]Augite
26	61-ST-71	MJI-9				▲							△							△		▲		○		○	
27	61-ST-72	MJI-9				▲							△							△		▲		◎			

Abbreviation

Py : pyrite
Lep: lepidochrosite
Am : amphibole
Ch : chlorite
Q : quartz
Cp : chlcopyrite
Il : ilmenite

Mt : magnetite
An : andradite
Wo : wollastonite
Ta : talc
Pl : plagioclese
Ga : galena
Do : dolomite

He : hematite
Gr : grossular
Ep : epidote
Se : sericite
Kf : kali-feldspar
Sp : Sphalerite
Mix: Mixed layer mineral

Go : goethite
Ca : calcite
M : montomorillonite
K : kaoline
Px : pyroxene
Asp: Arsenopyrite
Dp : Diopsde
Hd : Hedenbergite

◎ : Abundant
○ : Common
△ : A few
▲ : Rare

also contain chlorite and talc, suggesting that they are the same material of basaltic lava.

Note-5 $^{87}Sr/^{86}Sr$ Ratio Analysis

The mineralization of the S.Tuboh area supposed from $^{87}Sr/^{86}Sr$ ratio analysis is mentioned in Part 3. Thus explanation of the samples used and basic data of the assay was described as follows ;

(1) Interpretation of strontium isotope data

a.] Igneous rock and sedimentary rocks

① 61-ST-4

The rock links to the alkali gabbro of 61-ST-1 identified by microscopic observation and dated as 51± 2.7Ma, It has been intruded by the quartz monzonite dated as 40.1± 2.0Ma by K-Ar method.

Although data of Rb are lacking, the $^{87}Sr/^{86}Sr$ value of the rock obtained from K/Ar data is 0.70451, and the value is almost regarded as the value of initial strontium isotopic ratio, and entirely coincide with a average value of a igneous rock occurred at Oceanic Island and Island arc.

② 61-ST-3

The rock is sericite-chlorite-tuffaceous phyllitic slate.

Tuffaceous sandstone and basalt lava occur near the rock. They are correlative with Rw-L～Rw-T.

The value of the rock is extremely high, being correlative with the isotopic property of old continental sial(0.72± 0.01). The rock was presumably derived from clastics consisting of rocks of old continental crust.

③ 61-ST-8

The sample was taken from the pure limestone part of the Mersip Limestone Member, and is dark greyish rock with a small number of segregated calcite vein. The value obtained is 0.70691, and it is equivalent to the initial strontium isotopic ratio, taking very low values of Rb/Sr in carbonates into consideration. It is presumed that the value is the isotopic ratio of sea water at sedimentation time of the rock. Its meaning is discussed later.

④ 61-ST-5,6,7

The rocks are skarn and skarnized intrusive rock of shallow ore part of MJI-7. It is discussed later.

b.】 Age of the Mersip Limestone Member and associated beds. It is pointed out that the $^{87}Sr/^{86}Sr$ ratio of a limestone is the strontium isotopic ratio of sea water at its sedimentation time. Fig 48, the compiled values through Phaneorozoic time by Burke et al(1982) is adopted in order to settle the strontium isotopic ratio (0.70691) level. The figure reveals that coincident point of the isotopic ratio value of sea water and the value of the Mersip Limestone Member indicates Late Jurassic or Late Permian.

The S.Rawas Formation is correlative with Jurassic to Cretaceous by way of paleontologic information, as mentioned in the initial phase survey.

In accordance with this data, the Mersip Limestone Member of middle～upper S.Rawas Formation is correlative with the late Jurassic. It is also consistent with the age on the basis of strontium isotopic ratio. Namely, the Mersip Limestone Member is defined as upper Jurassic in age, and its scientific age is around 150～170 Ma.

c.】 Skarnization

All data obtained is schematically shown in Fig 49.

The relationship among these values indicates following important concept ;

The first of all, these strontium isotopic values of garnet skarn(61-ST-5) and epidote skarn(61-ST-6) have significantly different with that of intrusive rocks (61-ST-4) regarded as "ore bringer", but these values are consistent with nearly the value of the Mesip Limestone Member.

The fact insists that the Sr contained in the skarn, namely the essential Sr content in ore-forming fluid took part in the skarnitization, is of Mersip Limestone origin, doing not derived from intrusive rock(or magma).

On the other hand, the value of slightly altered intrusive rock(61-ST-7)

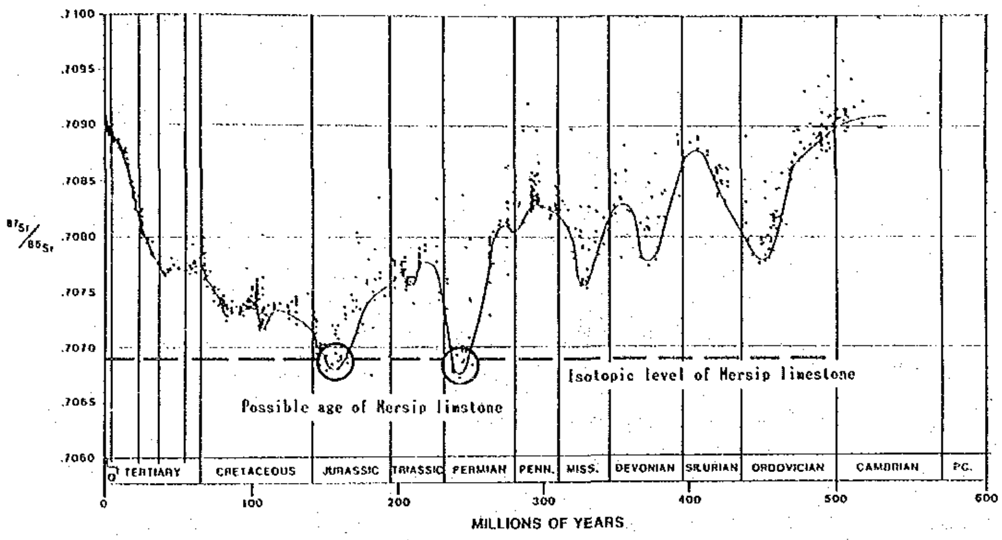


Figure 1. Plot of $^{87}Sr/^{86}Sr$ age for 744 of 786 marine samples. $^{87}Sr/^{86}Sr$ values for the 42 modern marine samples (Table 1) are not shown. Modern values, however, were accounted for in drawing band and line. For any given time, correct seawater ratio probably lies within band. Line represents our best estimate of seawater ratio versus time. Pre-Cenozoic ages are based on van Eysinga (1975). Cenozoic ages are based on time scale provided by L. B. Gibson (1980, personal commun.). Pliocene-Pleistocene boundary is at 1.62 m.y. B.P., and Tertiary stage boundaries are at 5.0, 23.5, 37.0, and 53.5 m.y. B.P. (Burke et al., 1982)

Fig.48 Strontium Isotopic Age Curve for Phanerozoic Sea Water (Burke et al 1982)

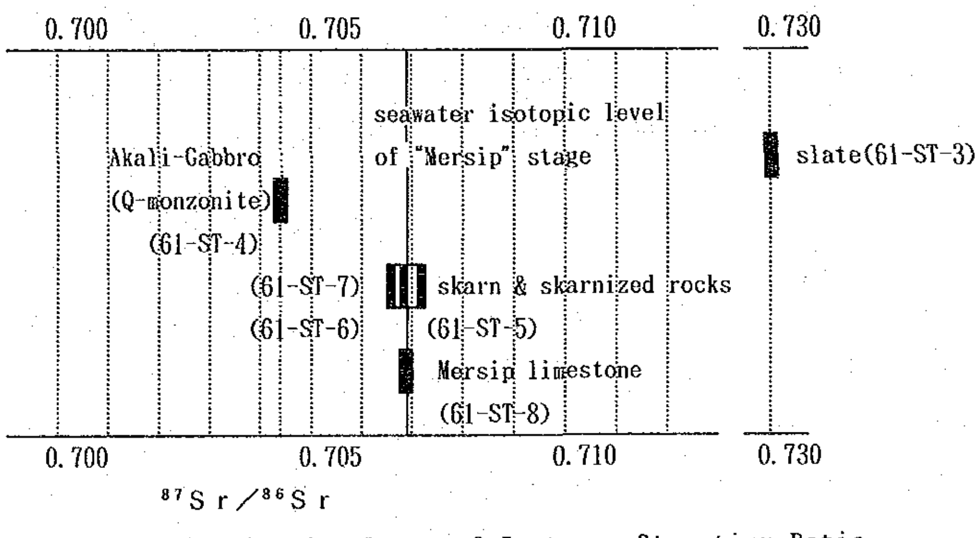


Fig.49 Distribution Range of Isotrope Strontium Ratio of the Samples

is in the middle of those of limestone and "ore bringer". It indicates probably that Sr contained in the intrusive rock (origin rock) may have a similar isotopic ratio as the ore bringer, thus the ratio took some part in the skarn, under the conditions of weak skarnization or mineralization.

If 61-ST-6 is of the same intrusive rock origin, the difference of the isotopic ratio value between the rock and 61-ST-7 depends presumably on intensity-grade of skarnization(replacement) by ore-forming fluid contained limestone-origin Sr.

A garnet skarn(mostly consisting of equivalent volume of quartz and andradite) is hardly distinguished its original rock, but taking into rich content in andradite and some content of diopside into consideration, it could be limestone origin. The rock contains slightly high ratio of $^{87}Sr/^{86}Sr$ comparing the limestone, and it is possibly pelitic(slaty) limestone in its origin.

Sample No.	$^{87}Sr/^{86}Sr$ ratio	Total Sr(ppm)
61-ST-3	0.73042 ± 0.00008	14
61-ST-4	0.70451 ± 0.00005	360
61-ST-5	0.70721 ± 0.00005	12
61-ST-6	0.70670 ± 0.00007	1000
61-St-7	0.70588 ± 0.00007	200
61-ST-8	0.70691 ± 0.00008	250

d. Origin of metals

The above data indicates that Sr has been derived from Mersip Limestone Member and its related bed. It is unnatural that Sr has come from Mersip Limestone Member and its related bed, but other metallic elements have been derived from magma or intrusive rock. Thus Sr and metallic elements both have derived from Mersip Limestone Member and its related bed.

Note-6 Chemical Analysis of Ore

(1)Bt.Raja area

Assay results of ore and mineralized rock collected in the Bt.Raja area are listed in Table 28 .

AR-15, AR-112, AR-114, AR-123 were taken at the Padan mineral indication (No.11), and pyrolusite is observed by microscopic observation in AR-123. Other samples constist of magnetite and hematite. It is worth noted that some sample contain considerably high silver.

BR-24,BR-34,and BR-35 are from F Sector. Pyrrhotite and pyrite are recognized in BR-24 through microscopic observation. These samples are generally low grade, indicating grades of No18, 19, 20 of F sector.

BR-41, BR-65, and BR-84 were collected from the No. 6 mineral indication, and BR-67 represents the No.12 mineral indication. It is a low grade sulphide mineralized zone, but it contains a rather high silver content. Although molybdenite is visibly observable, but its grade is very low, owing to its sporadic distribution.

Results of other samples also correspond with the grade of the related mineralized indications observed, as shown in the Table 29

(2) S.Tuboh area

The results are mentioned in Part 3. The samples of ground surface have a tendency of Pb>Zn, suggesting sporadic distribution of Pb in the mineralization.

Assay rersults are shown in Table 29.

Note-7 Results of Microscopic Observation (Polished Ore Specimen)

(1) Bt.Raja area

The ores in the Bt.Raja area are grouped into the following three mineral assemblages, based on visible classification as mentioned in Part 2 :

(i) magnetite-(hematite) massive ore

(ii) quartz-molybdenite-pyrite-chalcopyrite-sphalerite-galena veinlets-network ore

(iii) pyrite, magnetite, chalcopyrite-pyrrhotite disseminated ore

Table 28 Element Analysis of res in Bt. Raja Detailed Survey Area

Sample No.	Cu%	Mo%	Pb%	Zn%	Co%	Fe total%	Ag g/t	Au g/t
AR-15	<0.01	<0.001	<0.01	0.02	0.005	67.33	3.3	<0.07
AR-24	0.10	<0.001	<0.01	0.01	0.010	16.91	1.7	0.07
AR-55	<0.01	<0.001	<0.01	0.01	0.001	4.84	o.5	<0.07
AR-76	0.05	<0.001	<0.01	0.01	0.001	4.75	8.5	<0.07
AR-104	<0.01	<0.001	<0.01	<0.01	0.002	6.29	1.3	0.07
AR-112	0.03	<0.001	<0.01	0.04	0.007	64.97	15.0	<0.07
AR-114	<0.01	<0.001	<0.01	<0.01	0.009	26.54	2.3	<0.07
AR-123	0.05	<0.001	0.04	0.02	0.031	1.46	28.5	<0.07
BR-3	0.04	<0.001	<0.01	<0.01	0.004	8.22	1.0	0.07
BR-24	0.04	0.002	<0.01	<0.01	0.006	6.65	1.7	0.07
BR-34	0.03	<0.001	<0.01	0.56	0.003	7.25	2.8	0.07
BR-35	0.01	<0.001	<0.01	0.01	0.004	6.16	2.3	<0.07
BR-41	<0.01	0.001	<0.01	<0.01	<0.001	1.38	<0.3	<0.07
BR-65	<0.01	0.002	<0.01	0.01	<0.001	3.17	0.5	<0.07
BR-67	0.16	<0.001	0.15	0.04	<0.001	8.51	23.0	0.17
BR-84	0.01	<0.001	0.02	0.05	0.004	66.35	6.5	0.51

Table 29 Element Analysis of Ores in S.Tuboh Prospective Area

No.	Sample No.	Drilling No.	Depth (m)	Wd (cm)	Au g/t	Ag g/t	Cu %	Pb %	Zn %	Co %	Mo %
1	MJI-2-1	MJI-2	12.90～13.30	40	0.14	72.5	0.77	0.52	9.20	0.017	0.001
2	MJI-2-2	MJI-2	39.17～39.50	33	0.14	58.0	0.06	0.23	6.72	0.012	0.002
3	MJI-6-1	MJI-6	128.70～129.50	80	0.07	36.0	1.15	0.06	1.99	0.022	<0.001
4	MJI-6-2	MJI-6	129.50～130.50	100	<0.07	11.5	0.01	0.04	0.03	0.004	<0.001
5	MJI-6-3	MJI-6	130.50～131.50	100	0.96	205.0	0.03	0.79	0.02	0.008	<0.001
6	MJI-6-4	MJI-6	131.50～131.80	30	<0.07	9.5	0.02	0.03	0.07	0.005	<0.001
7	MJI-6-5	MJI-6	131.80～132.80	100	0.75	280.0	6.10	0.54	11.30	0.053	<0.001
8	MJI-6-6	MJI-6	132.80～133.28	48	0.07	132.0	4.49	0.15	17.90	0.051	<0.001
9	MJI-7-1	MJI-7	44.20～45.20	100	0.21	790.0	0.20	2.87	14.60	0.024	<0.001
10	MJI-7-2	MJI-7	45.20～46.20	100	0.14	420.0	0.46	1.45	32.50	0.051	0.001
11	MJI-7-3	MJI-7	46.20～46.60	40	<0.07	77.0	0.07	0.27	3.84	0.009	<0.001
12	MJI-7-4	MJI-7	46.60～47.05	45	<0.07	7.0	<0.01	0.03	0.34	0.004	0.001
13	MJI-7-5	MJI-7	47.05～47.92	87	<0.07	88.0	0.05	0.98	6.94	0.015	<0.001
14	MJI-7-6	MJI-7	52.93～53.35	42	<0.07	138.0	0.84	0.61	6.01	0.012	<0.001
15	MJI-7-7	MJI-7	53.35～54.35	100	0.14	355.0	4.73	10.60	13.60	0.020	0.001
16	MJI-7-8	MJI-7	54.35～54.95	60	<0.07	200.0	0.12	2.03	10.90	0.021	<0.001
17	MJI-7-9	MJI-7	54.95～55.22	27	<0.07	11.0	0.01	0.11	0.33	0.002	<0.001
18	MJI-7-10	MJI-7	55.22～56.20	98	0.14	114.0	0.21	0.87	7.81	0.016	<0.001
19	MJI-7-11	MJI-7	134.98～135.18	20	0.07	285.0	1.74	15.80	19.90	0.021	<0.001
20	MJI-7-12	MJI-7	136.94～137.24	30	0.07	202.5	0.08	1.31	3.65	0.008	<0.001
21	MJI-7-13	MJI-7	138.30～138.55	25	0.07	35.0	0.01	0.22	0.94	0.004	0.001
22	MJI-8-1	MJI-8	63.85～64.11	26	0.07	50.0	0.35	0.24	2.66	0.016	0.002
23	MJI-8-2	MJI-8	64.11～65.11	100	0.07	265.0	1.51	2.22	26.50	0.046	<0.001
24	MJI-8-3	MJI-8	65.11～65.73	62	0.07	176.0	2.61	1.87	30.10	0.054	0.001
25	MJI-8-4	MJI-8	126.25～126.37	12	0.07	158.0	0.42	20.00	18.00	0.026	<0.001
26	MJI-8-5	MJI-8	133.14～134.00	86	0.07	520.0	0.84	17.40	21.90	0.029	<0.001
27	MJI-9-1	MJI-9	41.85～42.05	20	0.07	97.0	0.03	0.41	16.30	0.034	0.001

Table 30 shows microscopic observation results on the polished ores.

AR-15, AR-112, AR-114 and AR-123 were sampled from Padan mineral indication. AR-15 and AR-112 consist of a magnetite-hematite assemblage, and is consistent with that of the surface mineralization.

AR-114 and AR-123 are pyrite-clay vein occurring at the old tunnel at 3m～5m under a magnet-hematite boulder zone. The clays were detected as sericite and quartz by means of X-ray diffraction analysis, but the positional relationship between the clay zone and the boulder zone is unclear.

AR-123 contains a black manganese mineral,identified by microscopic observation.

Consequently, the Padan mineral indication is chracterized by following mineral occurrence ;

Iron oxide : Magnetite-hematite ores are mostly scattered as boulders, and manganese oxide at outer zone of the ores with quartz.

Iron sulphide : Sericite-quartz-pyrite ores are emplaced 3m～5m below of surface. The relation of the "ore"and the surface"ore" is not clear.

AR-83 of the S.Suban mineral indication contains a dominant amount of pyrite and limonite. The first phase survey confirmed that assemblage of the ore(85-AR-137) was magnetite-andradite, accompanying cuprite, hematite, and quartz by detection through X-ray diffractive analysis. AR-83 was taken from outer mineralization part of the 85-Ar-137. Thus the mineral assemblage of the S.Suban indication is divisible into two assemblage as follows ;

Iron oxide + andradite : [+] copper oxide (primary ore may be copper sulphide?)

Iron sulphide + andradite : [+] limonite

AR-60 was taken at hematite boulder zone, extending along R.Tandui, the north tributary of R.Seri, southeast end of E sector. Hematite and pyrite are visible, and chalcocite, covellin and ilmenite(?) are observed microscopically. The pyrite probably contained a very small amount of copper. The copper may be dissolved by meteoric water, and enriched as secondary minerals such as chalcocite and coveline. However a copper

Table 30 Microscopic Observation of Polished Ore specimens in Bt.Raja

Detailed Survey Area

No	Sample No.	Locality	Minerals												Remarks
			Cp	Cc	Cv	Ga	Mn	Py	Po	Mar	Mt	He	Li	Gn	
1	AR-15	S. Padan									◎	◎[1]		△	[1]Lattice structure
2	AR-60	S. Seri		▲	▲			◎				◎[1]		△	[1]Lattice structure
3	AR-83	S. Suban						△					△	◎	
4	AR-112	S. Padang									◎	◎[1]		△	[1]Lattice structure
5	AR-114	S. Padang						◎						△	
6	AR-123	S. Padang					◎[1]							△	[1]Pyrolusite(?)
7	BR-3	S. Pangi	△					△	○					◎	Disseminated in diorite
8	BR-24	S. Tamulun	△						△					◎	
9	BR-26	S. Tamulun	△					△	△					◎	
10	BR-67	S. Menalu	△		▲	△		○		△				◎	Gn consists of Se.-Ch.
11	BR-84	S. Betung										[1]◎	△	◎	[1]Specularite
12	BR-92	S. Padang						△				△		◎	Q-vein

Abbreviation

Mn : Mn mineral	Gn : Gangue	Py : Pyrite	
Po : Pyrrhotite	Cp : Chalcopyrite	Ma : Marcasite	◎ : Abundant
Cc : Chalcocite	Mt : Magnetite	Il : Ilmenite	○ : Common
Cv : Covelline	He : Hematite		△ : A few
Ga : Galena	Li : Limonite		▲ : Rare

anomalous area was not discovered by geochemical survey in the sector. Ilmenite commonly accompanies in ore in this area as well as orein the S.Tuboh area.

BR-3 is pyrrhotite disseminated ore embedded in silicified(?) dioritic rock. The ores are found as a large amount boulders. Chalcopyrites is observed through the microscope, but the ore is very low in Cu grade with only slightly higher grade comparing Co, Ag, Zn, and Pb at Ec-1 and Ec-2 (anomalies anomalous area). Therefore, copper mineral may not occur commonly in the area, despite copper ores being recognized in the sample.

BR-24 and BR-26 were taken at the pyrrhotite-pyrite bearing mineralized indication (No.20), coinciding it location with the Fc-2 anomalous zone. In the sample, chalcopyrite was detected by microscopic observation, and Fc-2 located ajacent the indication is Mo-Co-Au-Cu-Zn anomalous zone.

BR-67 was collected from the No.12 mineralized indication at upperstream of R.Menalu, and BR-84 from No.6 mineral indication downstream of the river. Description of microscopic observation is consistent with the results of visual observation on these samples. The former sample is of a mineralized indication of pyrite-molybdenite-galena-zincblende-chalcopyrite-quartz fine vein or network, and the result of microscopic observation is reasonable, considering sporadic distribution of these minerals. There is geochemical anomalous area of Au-Ag-Cu-Pb-Zn, covering the latter sample area.

BR-92 is a reddish brown boulder in the vicinity of S.Padan mineral indication(No.11).

(1) S.Tuboh area

As shown in Table 31,mineral assemblage in S.Tuboh mineralization areasfollows;

pyrite
sphalerite-galena-chalcopyrite — pyrite-pyrrhotite
pyrite-arsenopyrite

Molybdenite occurs occasionally in 61-ST-53, 61-ST-55(MJI-6). The molybdenite is megascopically observed in 61-ST-53, as described in Part 2 Chapter 2, and also the button-shaped molybdenite and pyrite are scattered in the quartz vein.

A bismuthinite seems to be in the molybdenite of 61-ST-69(MJI-10), but it

Table 31 Microscopic Observation of Polished Ore Specimens in S.Tuboh Prospective Area

No	Sample No.	Drill-ing No.	Depth (m)	Minerals Cp	Ga	Sp	Mb	Py	Po	Asp	Mar	Mt	He	Il	Li	Gn	Remarks
1	ST-9	MJI-7	44.13	△	△	◎			▲				△		?	◎	
2	ST-11	MJI-7	45.57	△	▲	◎			▲				▲		?	▲	
3	ST-15	MJI-7	47.76	△	△	◎							▲			◎	
4	ST-17	MJI-7	53.23	△	▲	○			▲	▲			○			○	
5	ST-18	MJI-7	53.41	△	▲	○		◎	▲	▲	△		▲	○		△	
6	ST-19	MJI-7	53.79	○	○	○		○						△		△	
7	ST-21	MJI-7	54.35	▲	△	◎							△		?	◎	
8	ST-23	MJI-7	54.65	△	○	◎										◎	
9	ST-25	MJI-7	55.70	△	△	◎	?	△	▲				△		?	△	
10	ST-27	MJI-7	135.10	○	○	◎		△		○						△	
11	ST-33	MJI-8	63.87	△	▲	△		△								◎	
12	ST-34	MJI-8	64.20	○	▲	◎		△	△							△	
13	ST-35	MJI-8	64.76	△	△	◎		△			△					△	
14	ST-36	MJI-8	65.27	○	△	◎		△			▲					△	
15	ST-37	MJI-8	65.49	○	△	◎	?	△								◎	
16	ST-41-1	MJI-8	133.14	△	○	◎										○	
17	ST-51	MJI-6	128.94	○	?	○		○				△	△			○	
18	ST-53	MJI-6	131.30				△	△								◎	Bi-(?)
19	ST-55	MJI-6	131.63	○	▲	○	▲	△						△		△	
20	ST-56	MJI-6	132.96	○	▲	◎		△	△				△			△	
21	ST-63	MJI-2	13.06		▲	△		▲					△		△	◎	
22	ST-64	MJI-2	39.31		△	◎		▲								○	
23	ST-69	MJI-9	41.90	△	△	○	?	△								◎	Bi-(?)

Abbreviation

Mb	: Molybdenite	Gn	: Gangue	Py	: Pyrite		
Po	: Pyrrhotite	Cp	: Chalcopyrite	Mar	: Marcasite	◎	: Abundant
Asp	: Arsenopyrite	Mt	: Magnetite	Il	: Ilmenite	○	: Common
Cv	: Covelline	He	: Hematite	Bi	: Bismuth	△	: A few
Ga	: Galena	Li	: Limonite		-mineral	▲	: Rare

is not microscopically identified because of very minute grain.

61-ST-18 and 61-ST-19 collected from the shallow ore zone(D-2) of MJI-7, and 61-ST-55(D-2) of MJI-6 are accompanied by ilmenite, associated with pyrite. Magnetite co-exists with pyrite in 61-ST-51(D-2).

Arsenopyrite is found in 61-ST-17,61-ST-18 and 61-ST-27 (MJI-7). Most arsenopyrites form idiomorphic.

As for the other mineral, marcacite occurs in three samples and hematite in ten samples. They occur commonly with pyrite, or as veinlet, and hematite bearing veinlets occur along the cleavage of gangue minerals. Both minerals are also supergene products.

A exsolution texture occurs commonly. Chalcopyrite dots and lamellae are included in sphalerite with exsolution texture, and some galena and pyrrhotite also exist with sphalerite, showing exsolution texture.

Note-8 EPMA Analysis on Ores of S.Tuboh Area

The following samples were chosen for electron probe microscopic analysis(EPMA)

sample No.	drill No.	depth sampled	Remarks
61-ST-11	MJI-7	47.57m	D-2 upper, Sp-Gn-Cp-Gt massive ore
61-ST-19	MJI-7	53.79m	D-2 upper, Sp-Cp-Gn ore
61-ST-27	MJI-7	135.10m	D-3 Sp-Gn-Cp ore
61-ST-34	MJI-8	64.20m	D-2 upper, Sp-Gn-Cp-Gt-Hd ore
61-ST-55	MJI-6	131.95m	D-2 (lower?)Cp- Sp-Bn-Cc-Hd-Gt ore

EPMA analysis was done for the aim at studying behavior of silver and detecting a silver bearing mineral in the ore of the S.Tuboh area. After polishing the 5 samples, and treating their polished surfaces, ore minerals, their paragenesis and grain size were roughly detected by microscop. Through the preparation work, points target were markedin a mineral, and the minerals were assayed by EPMA.

The analysis was conducted in two steps. First, the content grade and minerals of silver were detected at silver-distributed and high-silver concentrating parts. The assay result reveals following facts ;

① Silver is contained in two kinds of mineral, namely(i)galena and (ii) Ag-Pb-Bi-S mineral.

② Common coarse-grained galenas existed usually contain a few silver.

③ Silver containg galena has a tendency to occur in contact with a fine grained chalcopyrite or sphalerite.

It is pointed out that low-graded lead ores has a tendency with silver in galena contained in galena, and the Ag-Pb-Bi-S mineral has been detected.

For the second step, 6 favorable points were selected for analysis of silver bearing minerals,by means of EPMA as shown in Table 32.

Among the samples, 61-ST-27 (a part of MJI-7-11) contains 15.80% of Pb, but Ag content in galena is below a detective limit. 61-ST-19 (MJI-7-7, Pb=10.60%) has the same tendency as the case of 61-ST-27. Consequently, the high grade of silver in MJI-7-7 and MJI-7-11 are presumably attributed to the Ag-Pb-Bi-S mineral, not galena.

On the contrary, from samples of low-grade in Pb, namely 61-ST-55(MJI-6-5, Pb=0.54%, Ag=280g/t), 61-ST-11(MJI-7-2, Pb=1.45%, Ag=420g/t) and 61-ST-34(MJI-8-2, Pb=2.22%, Ag=265g/t), silver bearing galena and Ag-Pb-Bi-S mineral have been detected, and it was unravelled that silver existed in the both mineral.

Gustavite (P-1-b (61-ST-55)) is a Ag_2S-Bi_2S_3-Pb_2S_2 mineral, and T.Mariko (1981) described the mineral as a solid-solution mineral with gustavite ($PbAgBi_3S_6$) and lillianite($Pb_3Bi_2S_6$), studying a ore produced from Nakatatsu Mine, Japan. For example, Fig. 50 shows a ternary diagram of Ag_2S-Bi_2S_3-Pb_2S_2 plotted Ag-Bi-Pb-S mineral of Nakatatsu Mine, adapted from T.Mariko (1981), and the gustavite of S.Tuboh is plotted in the figure.

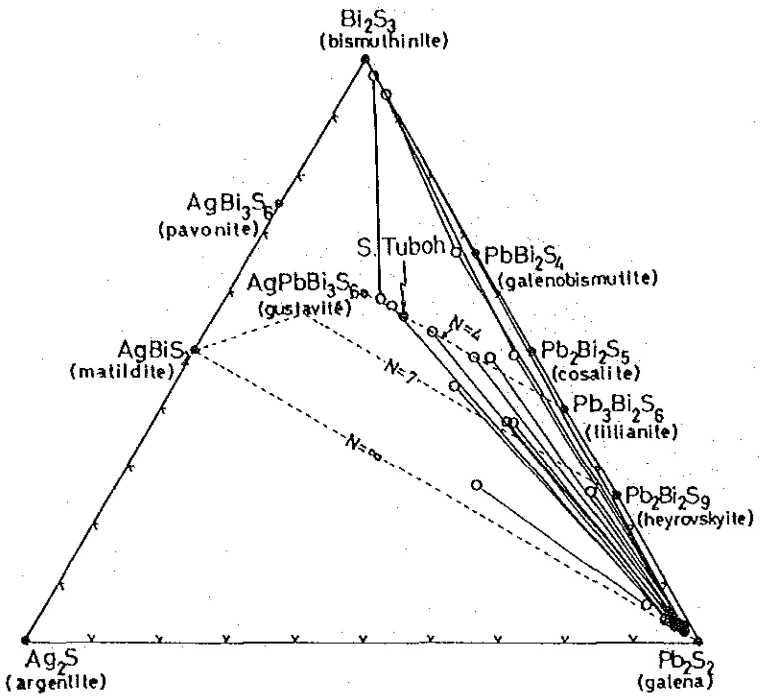


Fig.50 Bi_2S_3-Ag_2S-Pb_2S_2 Triangle showing the Compositional Variation of the Nakatatsu and S.Tuboh Ag-Bi-Pb-S Minerals (Adopted Mariko 1981)

Table 32 Electron Probe Micro Analysis of Ores in S.Tuboh Prosoective Area

sampl No.	Anal.p	mineral	Ag	Bi	Pb	Te	Se	Cu	S	total
61-ST-55	P-1-a	Galena	1.30	3.60	81.31	0.13	0.00	0.04	13.12	99.50
61-ST-55	P-1-a	Gustavite	9.03	55.20	20.31	0.12	0.00	0.00	16.75	100.41
61-ST-55	P-1-a	Galena	1.49	3.57	81.51	0.15	0.00	0.60	13.34	100.66
61-ST-55	P-1-a	Galena	1.78	3.80	81.61	0.14	0.00	0.02	13.90	101.25
61-ST-55	P-1-a	Galena	0.00	0.05	87.39	0.08	0.00	0.04	13.38	100.95
61-ST-55	P-1-2	Galena	0.00	0.14	87.18	0.05	0.00	0.19	13.24	100.80

unit : %

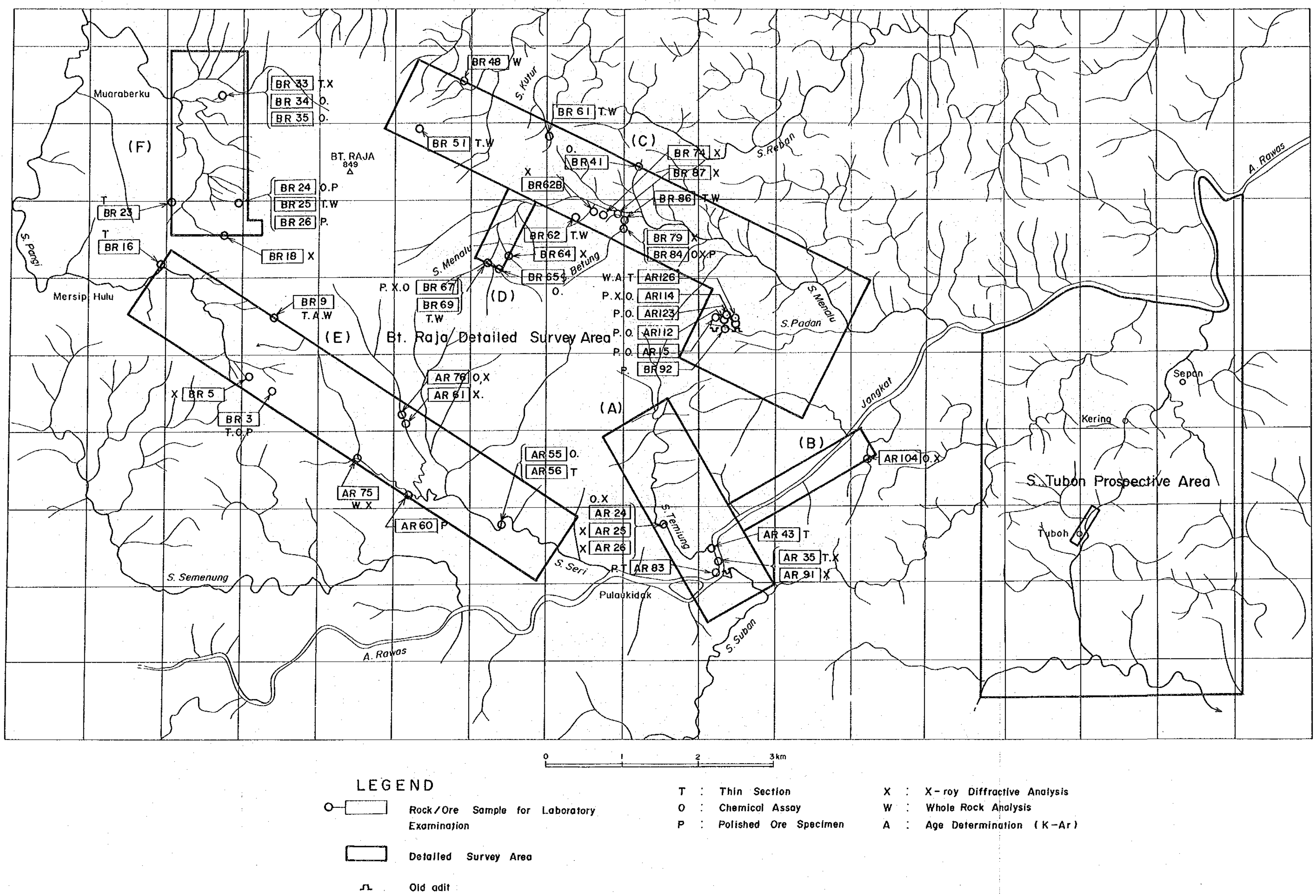


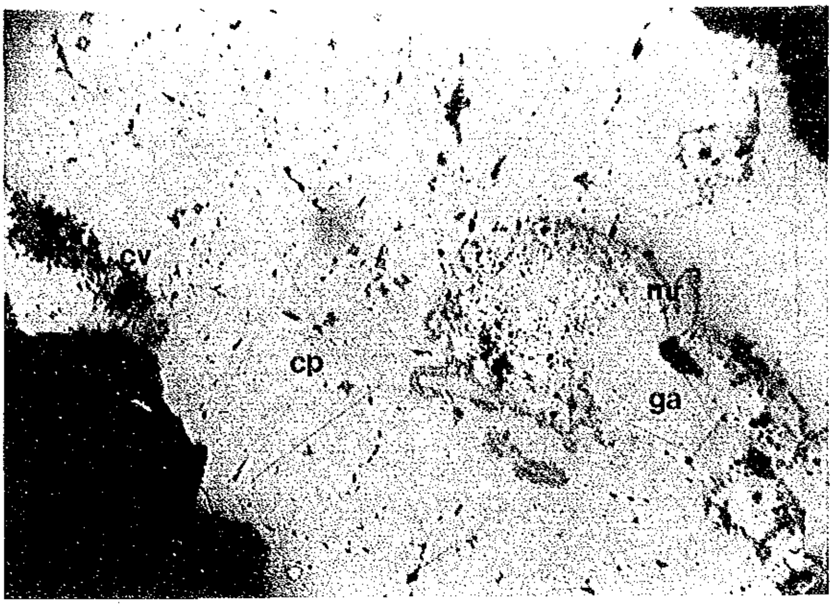
Fig.51 Locality Map of Rock Samples for Laboratory Analysis in Bt.Raja Survey Area

REFFERNCES

REFFERENCES

1. Burke,W.H., Denison,R.E., Hetherington,E.A., Koeprick,R.B.,Nelson,H.F., Otto,J.B.(1982) : Variation of seawater $^{87}Sr/^{86}Sr$ throughout Phanerozoic Time, Geology 10, 516～519
2. Kojima,M., Saitoh,T. (editted) (1978) : Age determination, Geoscience (in Japanese), Iwanami, Vol.6, 115～155
3. Mariko, T (1981) : Silver distribution and silver-bearing mineral in the Nakayama and Hitokata of the Nakatatsu mine, Fukui Prefecture, Japan. in Japanese), Mining Geology Special Issue No.10, 159～174
4. Miyashiro,A., Kushiro,I.(1977) : Classification and property of rocks, (in Japanese), Petrology (II), Kyouritsu Zensho, 10～92
5. Peterman,Z.E., Hedge,C.E., Tourtelet,H.A.(1970) : Isotopic composition of Strontium in seawater throughout Phanerozoic time, Geoch. Cosmoch. Acta, 34, 105～120

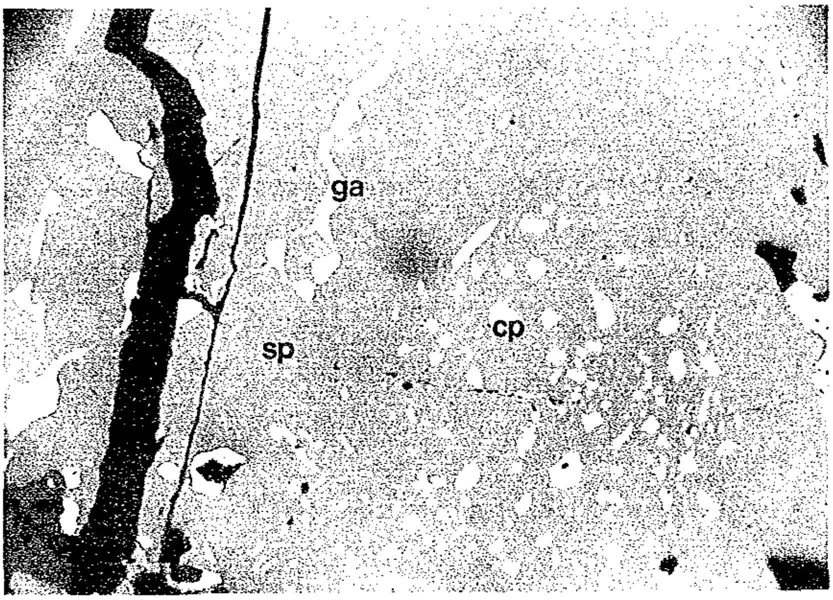
PHOTOGRAPH



(×150)

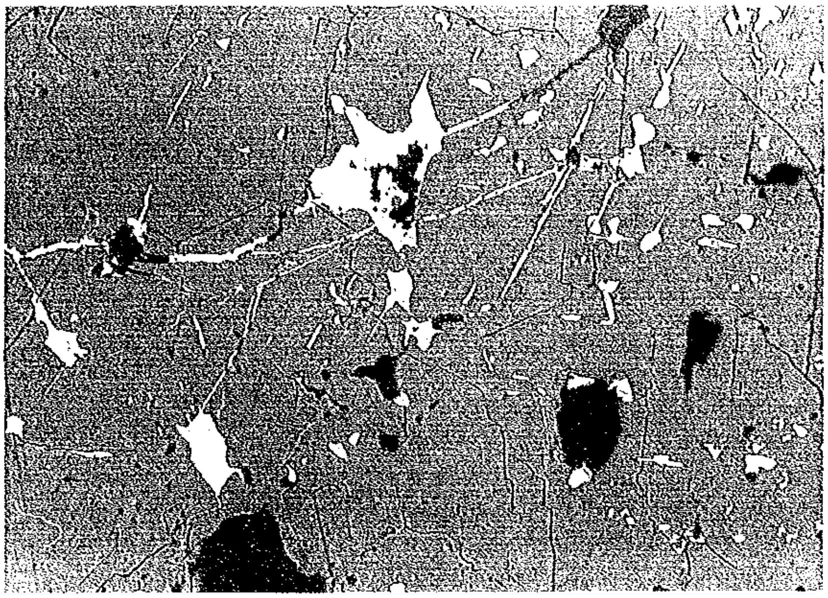
① BR-67(Bt.Raja Area) : Galena(ga) surrounded by fine-grained marcasite(mr) in chalcopyrite(cp). Covellite occurs in chalcopyrite, forming like veinlet.

The ore specimen was taken from typical pyrite-chalcopyrite-molybdenite-galena-sphalerite disseminated ore in quartz vein, in Bt.Raja Area.



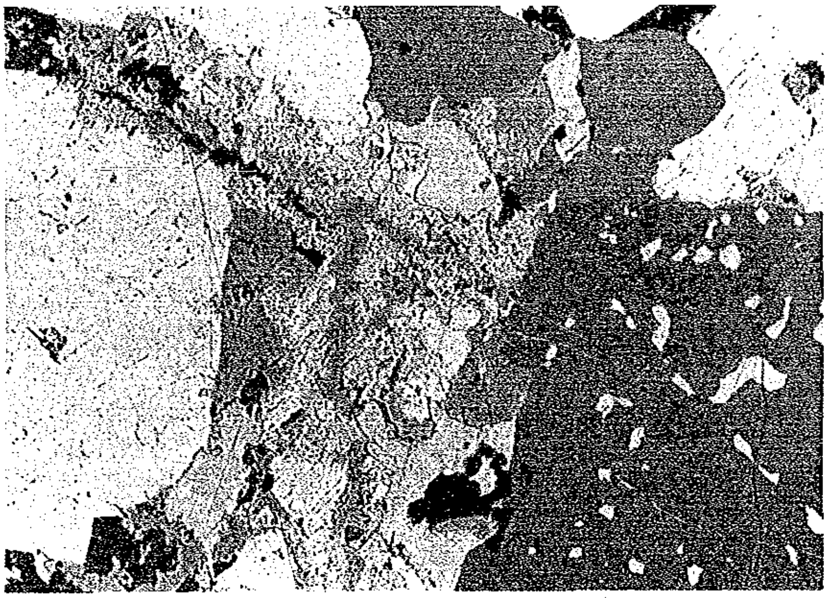
(×150)

② 61-ST-21(Bt.Tuboh Area) : Exsolution texture occured commonly in the ore. Ex solution-grains of chalcopyrite(cp) in sphalerite, and veinlet-formed galena(ga)



(×100)

③ 61-ST-11(MJI-7 S.Tuboh Area) : Exsolution texture of silver beaing galena (greyish white) and chalcopyrite(cream yellow) in sphalerite(grey).
Galena occured at center part of the photo contains 1.80% of silver.



(×400)

④ 61-ST-55(MJI-6, S.Tuboh Area) : Silver bearing galena (greyish blue) and gustavite in contact with pyrite and sphalerite. Galena has a tendency to contact with other ores, and a large amount of coarse-grained galenas usually contain poor silver. Silver is contained 1.49% in galena, on the contrary 9.03% in gustavite.