CHAPTER 3 GEOCHEMICAL SURVEY

3-1 Outline

For the geochemical survey on soil, the survey area was divided into geophysical survey area (Pagar Gunung mineralized zone area, 1.2 km x 1.2 km) and outside area of geophysical survey (Pagar Gunung – Patahajang area). The sampling method and number of samples for each area are shown below.

	Number of samples	Sampling method
Geophysical survey area (Pagar Gunung)	229	At 50 m intervals along geophysical measurement lines (9 lines x 1.2 km/line, measurement line interval 150 m)
Outside area of geophysical survey area (Pagar Gunung petahahang)	198	Sampling density of 7 samples/km

The samples were collected from the horizon B and the analysis was made of 5 path – finder elements, namely gold, silver, copper, lead and zinc.

3-2 Geophysical Survey Area

3-2-1 Correlation among Path-finder Elements

As shown in the following table, the correlation between copper-gold and copper-silver is poor, but the correlation among other elements, especially among silver, lead and zinc is very good. (Table IV-2)

Table IV-2 Correlative Coefficiency of Path-finder Elements (Au, Ag, Cu, Pb, Zn) through Geochemical Survey in Pagar Gunung Area

	Ag	Cu	Pb	Zn
Au	0.550666	0.192713	0.562439	0.512393
Ag		0.120403	0.622877	0.321714
Cu			0.335302	0.718206
Pb				0.752058

(Population 229)

3-2-2 Anomalous Areas

The maximum and minimum values, mean value (M), standard deviation (S.D.), threshold value (I) (M + S.D.) and threshold value (II) (M + S.D.) obtained by statistical processing are as follows. (Table IV-3) copper, lead and zinc are distributed in an overlapping region. (Fig. IV-4) This range consisting of Sedimentary rock Pyroclastic rock Member (Pagar Gunung mineralized zone emplacement horizon) is a noteworthy anomalous area where the exlistance of mineralization is expected judging from the existence of intrusive rock of quartz diorite and also the existence of Barute zinc deposit outcrop.

Grade 2 anomalous areas of gold and silver are distributed in the Mandagang mountain and along the Saladi River in the Simpang Pining village. Especially in the center of the Saladi river gold and silver anomalous areas, the quartz diorite intrusive rock exists. This gold and silver anomalous areas have the possibility of a dispersion halo due to the intrusion of the quartz diorite. Under the extensive gold and silver anomalous areas distributed in the Mandagang hill consisting of limestone, it is possible that concealed intrusive rock of quartz diorite exists and it is also thinkable that a contact metasomatic deposit is concealed (Fig. IV-4).

Table IV-5 Anomalous Value of Path-finder Elements (Au, Ag, Cu, Pb, Zn) through Geochemical Survey in Pagar Gunung-Patahajang Area

Element	Max.	Min.	Mean, M	S.D.	M + S.D.	M + 2 x S.D.
Au (ppb)	270	1	11	0.5884	175	
Ag (ppm)	3.9	0.1	0.25	0.4430	1.98	
Cu (ppm)	660	15	58	0.2634	195	359
Pb (ppm)	3,000	1	26	0.5395	313	1,084
Zn (ppm)	4,700	28	198	0.3593	627	1,436

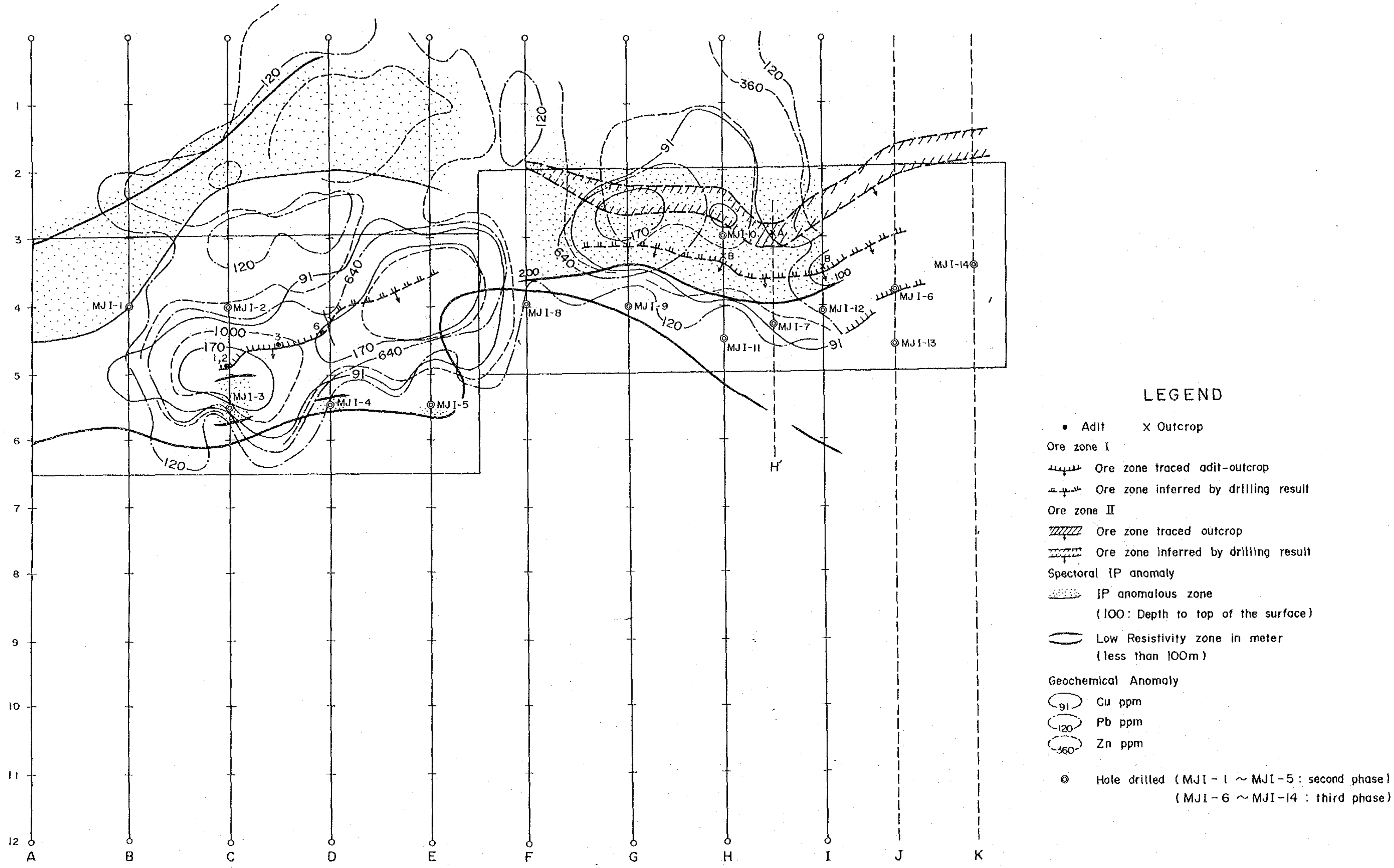


Fig. IV-3 Distribution of Geochemical Anomaly areasin Pagar Gunung Area

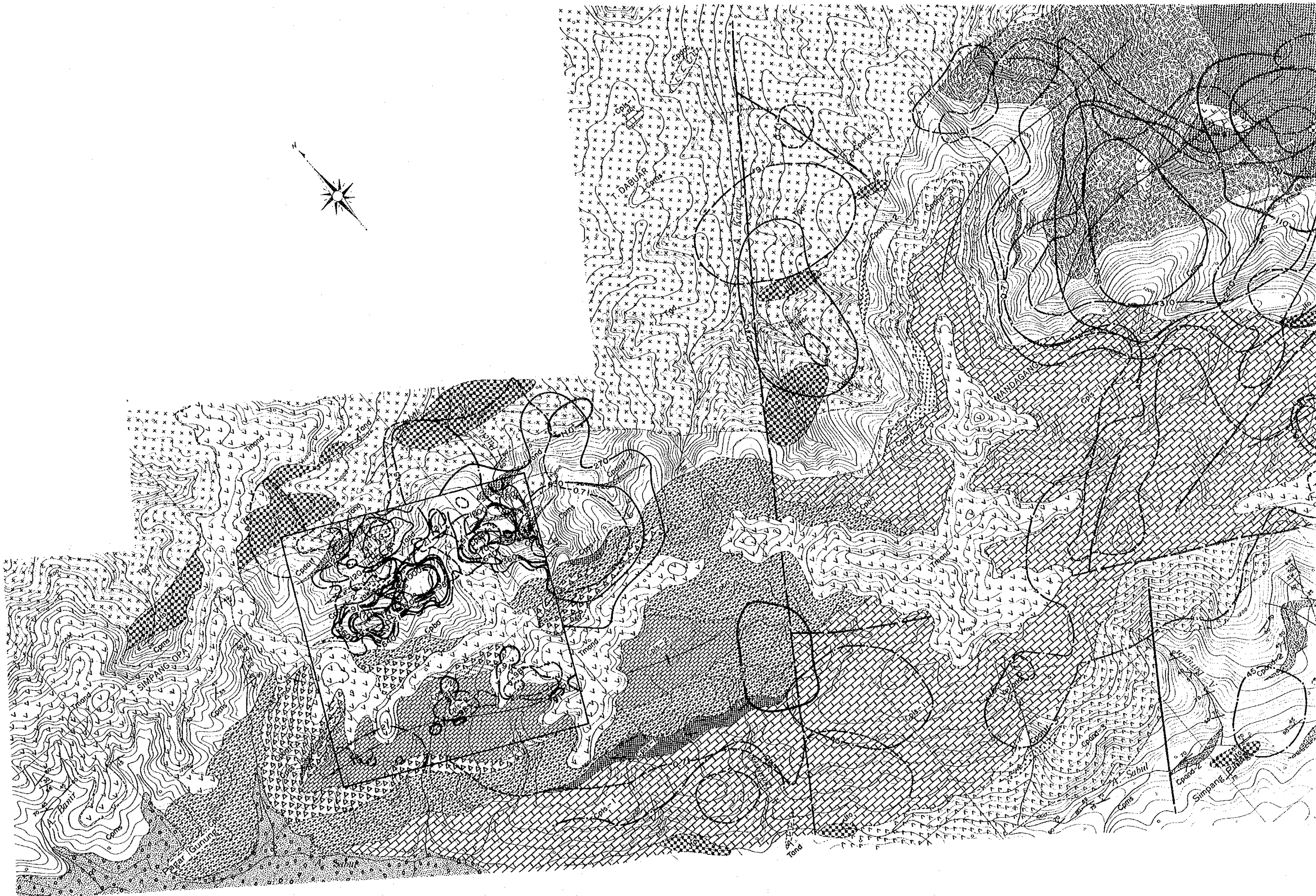


Fig. IV-4 Distribu

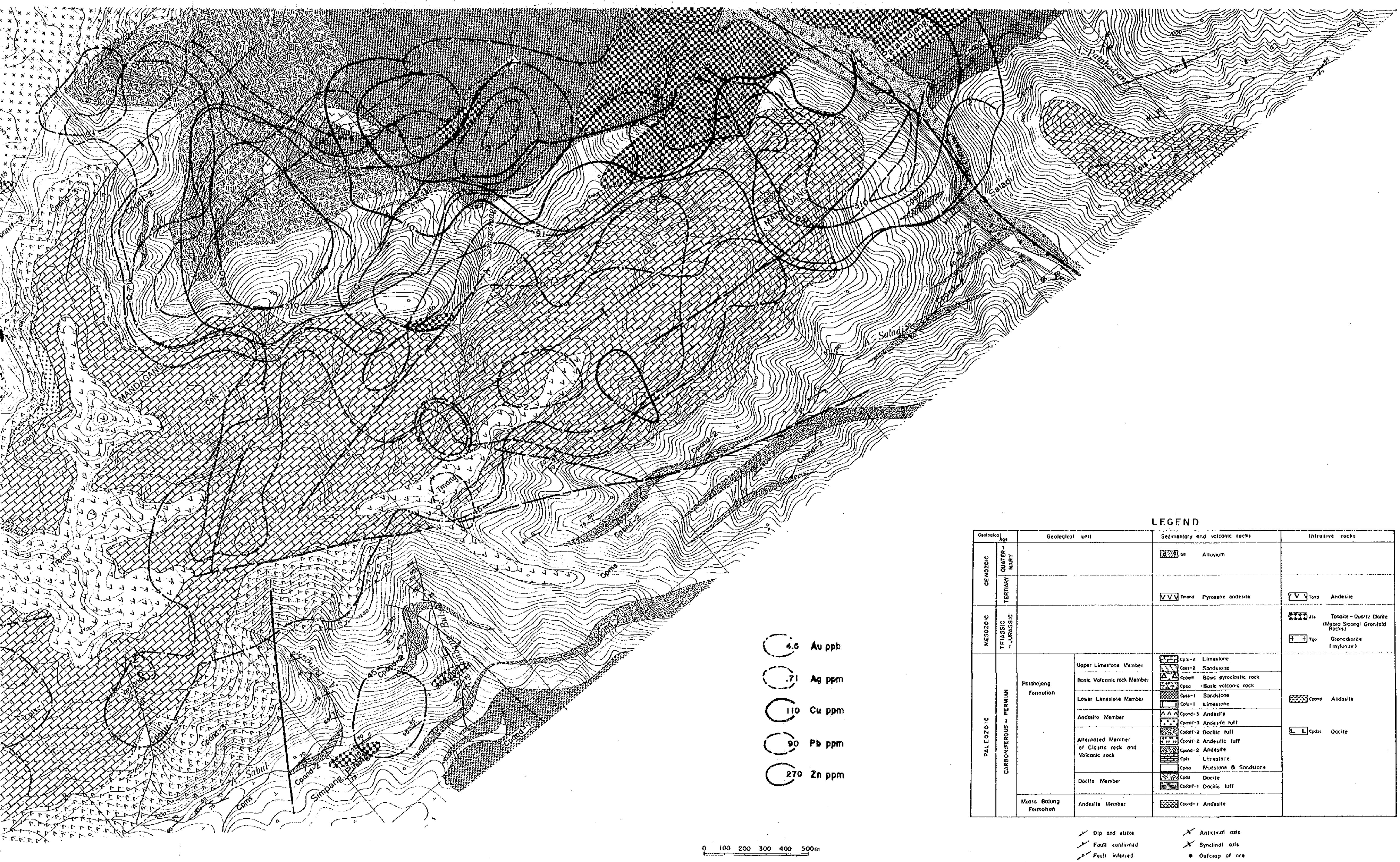


Fig. IV-4 Distribution of Geochemical Anomaly Areas in Pagar Gunung-Patahajang Area

CHAPTER 4 GEOPHYSICAL SURVEY (SIP METHOD)

4-1 Outline of Survey

Geophysical surve (spectrual IP method) was conducted on the Pagar Gunung mineralized zone to clarify the conditions under the deposit and extension of the mineralization zone.

The spectral IP method is a new prospecting method to measure continuously the IP phenomena in a wide frequency range (0.1 – 100 Hz) and makes it possible to determine the types of minerals and rocks with the spectral characteristics of the obtained magnitude (signal strength) and phase difference and to improve the exploration depth by eliminating the electromagnetic coupling effect.

The survey was made at 150 m intervals on the measurement line of 1.2 km using 9 measurement lines (total length 11 km) (Fig. IV-9) and the measurement was made at the electrode interval a = 100 m and with dipole/dipole electrode configuration.

As the measuring instrument, American company Zonge's GDP-12/2G system was used. This makes it possible to measure the magnitude and phase difference with 18 frequencies within the range of 0.125 – 88 Hz.

The data after calibration and topographic correction of the apparent resistivity are shown in the following diagrams.

(1) *Cole-Cole* diagram, spectral map of phase difference and magnitude

(2) Frequency effect and apparent resistivity pseudo section and plan

(3) Phase difference (each frequency) and three-point decoupled phase difference pseudo section

Physied properties measurement was made on 29 samples and a simulated model calculation was made on 2 major places.

4-2 Survey Results

The following anomalies were found (Figs. IV-9).

(1) Around No. 5 – No. 6 on C.D.E. measurement lines

(2) Around No. 3 – No. 4 on A – I measurement lines

It seems that the anomalies on the C.D.E. measurement lines originated from 2 anomalous sources. From the similarity of the anomaly patterns, it is considered that the anomalies (1) and (2) are the anomalous zones which are continuous in the east-west direction.

The anomalous zone (1) seems to be caused by the mineralization which is slightly inclined toward south from the shallow place to the depth of 150 m – 200 m, and the frequency effect of the anomalous zone (0.125 – 1 Hz) is rather low at 2 – 3% except No. 6 – No. 7 on the C line (4 – 5%). According to the spectral information, the spectral characteristic of phase difference of the anomalous zone on the C line tends to decrease in the low frequency range (harmonics of 0.125 Hz), as the frequency increases, but the phase difference spectrum of the anomalous zone on the D.E lines indicates a flat characteristic.

The anomalous zone (2) on all the measurement lines is caused by the mineralization which is shallow near the northorn end and is gradually inclined toward the south and the center of the mineralization zone seems to be in the neighborhood of the measuring points No. 3 and No. 4.

The drilling was conducted for the 2 eastwest-continuous anomalous zones (1) and (2) described in 4-2. On the C, D and E measurement lines, the boring was conducted between the measuring points No. 5 and No. 6 for the anomalous zone (1) and for the anomalous zone (2) the boring was conducted mainly around the measuring point No. 4. As a result, it was found that the anomalous zones on the measurement lines almost corresponded to the mineralized zones.

The anomaly of (1) seems to have reflected the weak pyrite mineralized zone which is distributed at the depth of approximately 200 m – 250 m from the ground surface. The C and D lines have some lead and zinc mineralization zone, but the anomaly due to this seems to be small.

The frequency effect is 4 – 5% on the C line but generally weak at 2 – 3% and this fact corresponds to the drilling result. The apparent resistivity shows a tendency that the anomaly of the frequency effect on the C line corresponds to the low apparent resistivity zone and the phase difference spectrum of the anomaly on the C line tends to decrease in the low frequency area (harmonics of 0.125 Hz), and for this reason, it was expected that strong pyrite mineralization dissemination zone and massive, banded mineralization zone might exist, but no such result as to prove such characteristics was found by the boring MJI-3.

The anomalous zone (2) has its center near the measuring points No. 3 – No. 4 on each measurement line and from the pattern of anomaly, it was considered to be a mineralization zone which was continuous in almost an eastwest direction.

The anomalous value of the frequency effect is high at 3 – 9% and generally stronger pyrite dissemination zone, baneded pyrite, galena and sphalerite than those obtained for (1) are grasped and the geophysical data seem to reflect them.

In the apparent resistivity, the anomaly of the frequency effect on the I line is in agreement with the low apparent resistivity zone, and the drilling result (MJI-12) shows the massive, banded mineralization zone.

The boring MJI-10 on the H line was conducted in the anomalous zone of the frequency effect but not in the low apparent resistivity zone and showed a weak pyrite dissemination zone. This resistivity anomaly reflects well the condition of the mineralization zone.

The phase difference spectrum shows a large phase difference in the low frequency range and as the frequency increases, some tend to decrease (anomaly on F line) and others show almost flat characteristic (anomaly on other lines).

On the F line, the anomaly of the frequency effect is in agreement with the low aparrent resistivity and also the boring showed a strong pyrite dissemination zone and the spectral characteristic seems to reflect the condition of the mineralized zone.

On the I line, the resistivity is low and the boring showed the massive banded mineralized zone, but the phase difference spectrum showed a flat characteristic. At one point between the measuring points No. 3 and No. 4 a very sharp decrease in phase difference was found. This is called negative electromagnetic coupling phenomenon and often occurs when the low resistivity zone exists locally.

The boring also showed bancded galena and sphalerite mineralization at the shallow part and it may be the indication related to this.

The frequency effect of the anomalous zone (0.125 – 1 Hz) is high at 3 – 9%. According to the spectral information, the phase difference spectrum of the anomalous zone on the F line tends to decrease in the low frequency range (0.125 Hz harmonics) as the frequency increases, but in the anomalous zone on the other measurement lines, almost flat characteristic is exhibited in the low frequency range (harmonics of 0.125 Hz). A very sharp decrease in phase difference was shown at one point between the measuring points No. 3 – No. 4 on the I line.

4-3 Relationship between Geophysical Survey Anomaly and Boring Survey Result

For the anomaly found by the geophysical survey, boring was made, 5 holes in the 2nd year and 5 holes in the 3rd year totaling 10 holes.

They are MJI-1 (B measurement line), MJI-2 and MJI-3 (C line), MJI-4 (D line), MJI-5 (E line), MJI-8 (F line), MJI-9 (G line), MJI-10 and MJI-11 (H line) and MJI-12 (I line).

The following will discuss the relationship between the results and the geophysical survey data. The geophysical survey data are shown in the diagrams described in 4-1, and of them, the frequency effect (P.F.E. 0.125 – 1 Hz) and apparent resistivity (0.125 Ha) pseudo section and phase difference spectrum diagram were mainly used to investigate the relationship between geophysical survey data and the mineralization zones found by a boring survey. Figs. IV-9 show the frequency effect, apparent resistivity and mineralization zones of the measurement lines B, C, D, E, F, G, H and I.

In the mineralization zones, pyrite and pyrrhotite dissemination zones are widely distributed and partially massive, banded pyrite, pyrrhotite, banded pyrite, pyrrhotite, banded galena and sphalerite are embedded.

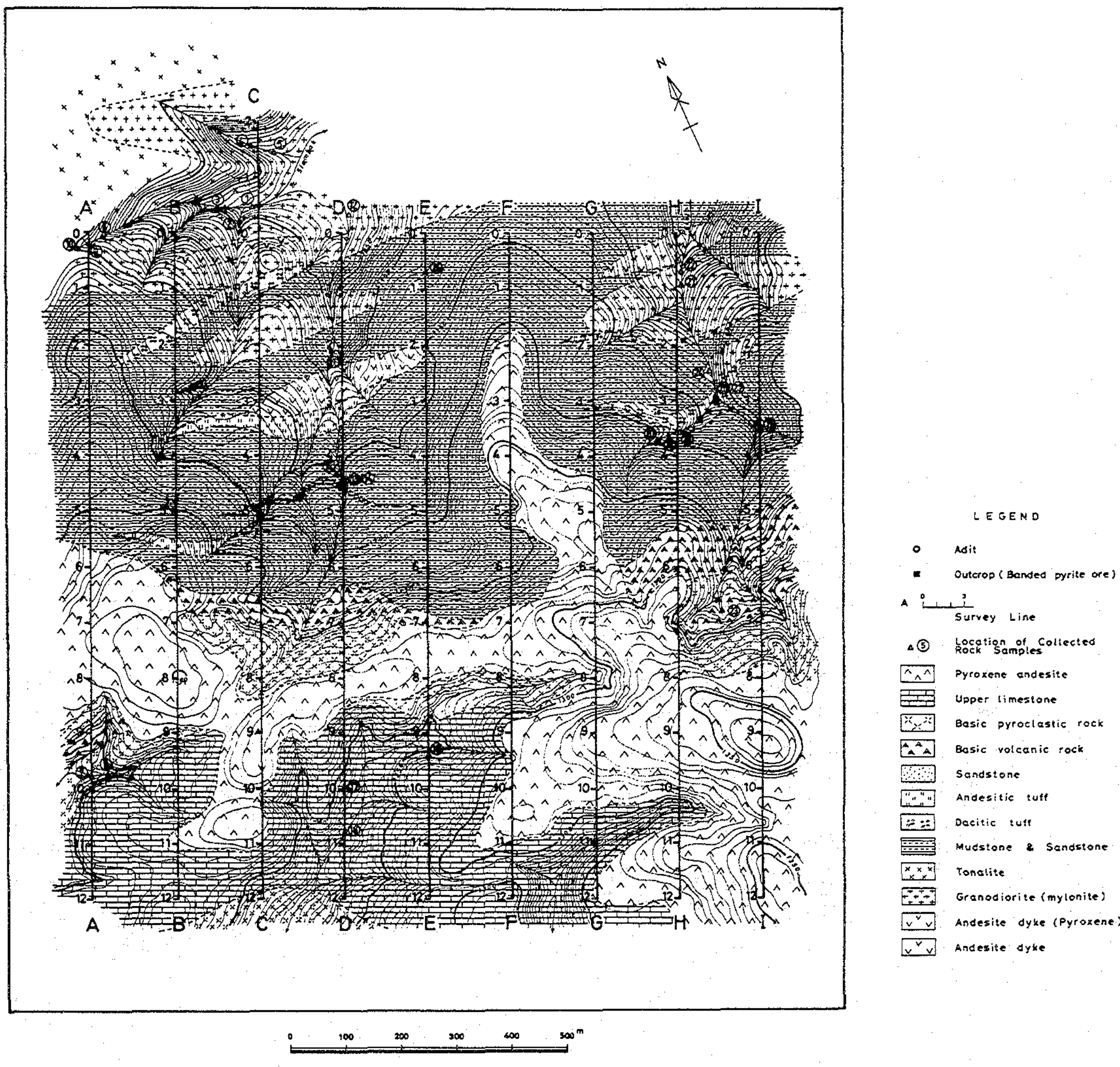


Fig. IV-5 Location Map of Spectral IP Survey Lines

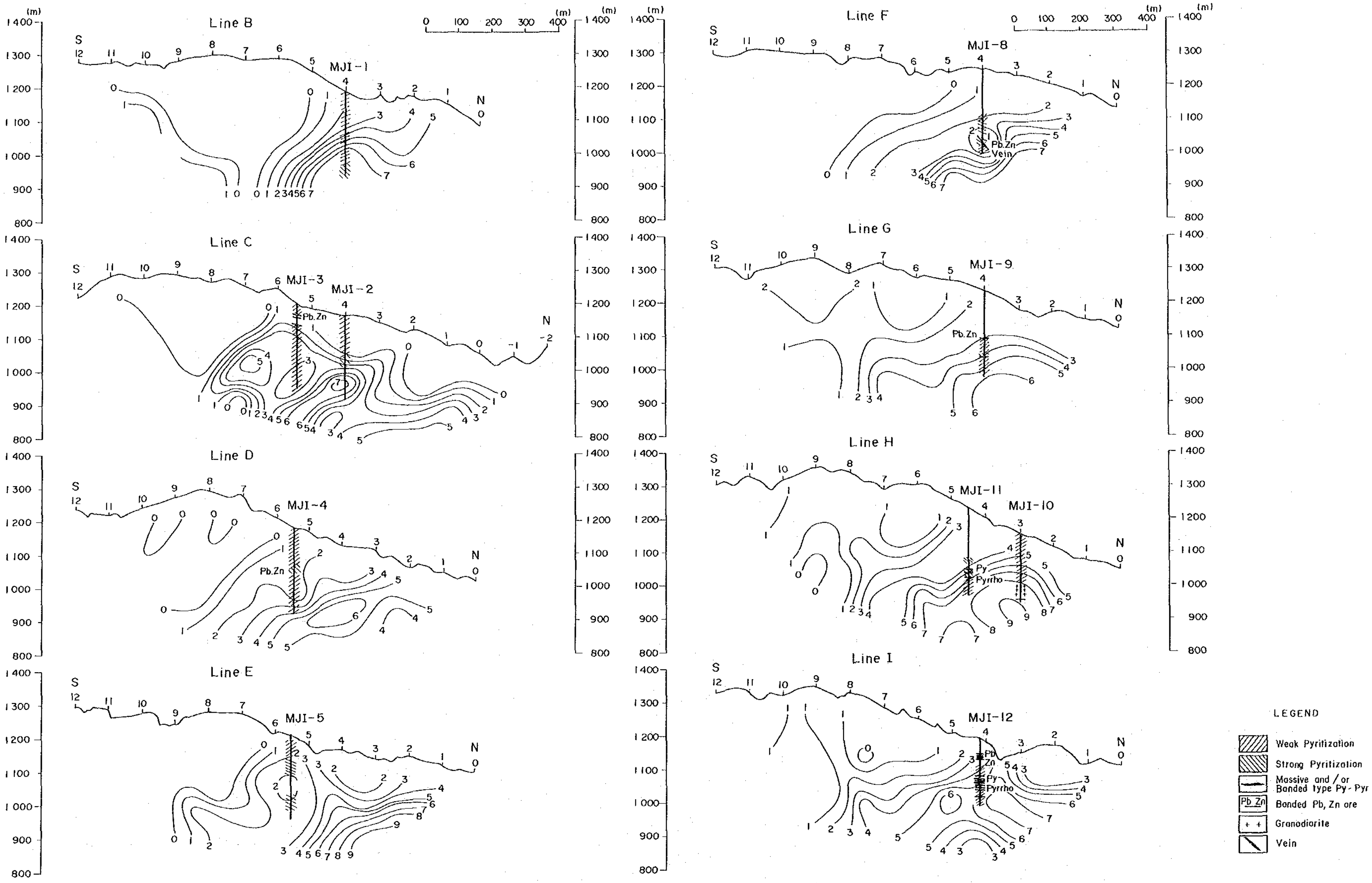


Fig. IV-6 Spectral IP Pseudo-Section Percent Frequency Effect (0.125-1.0 Hz) (F, G, H, I lines)

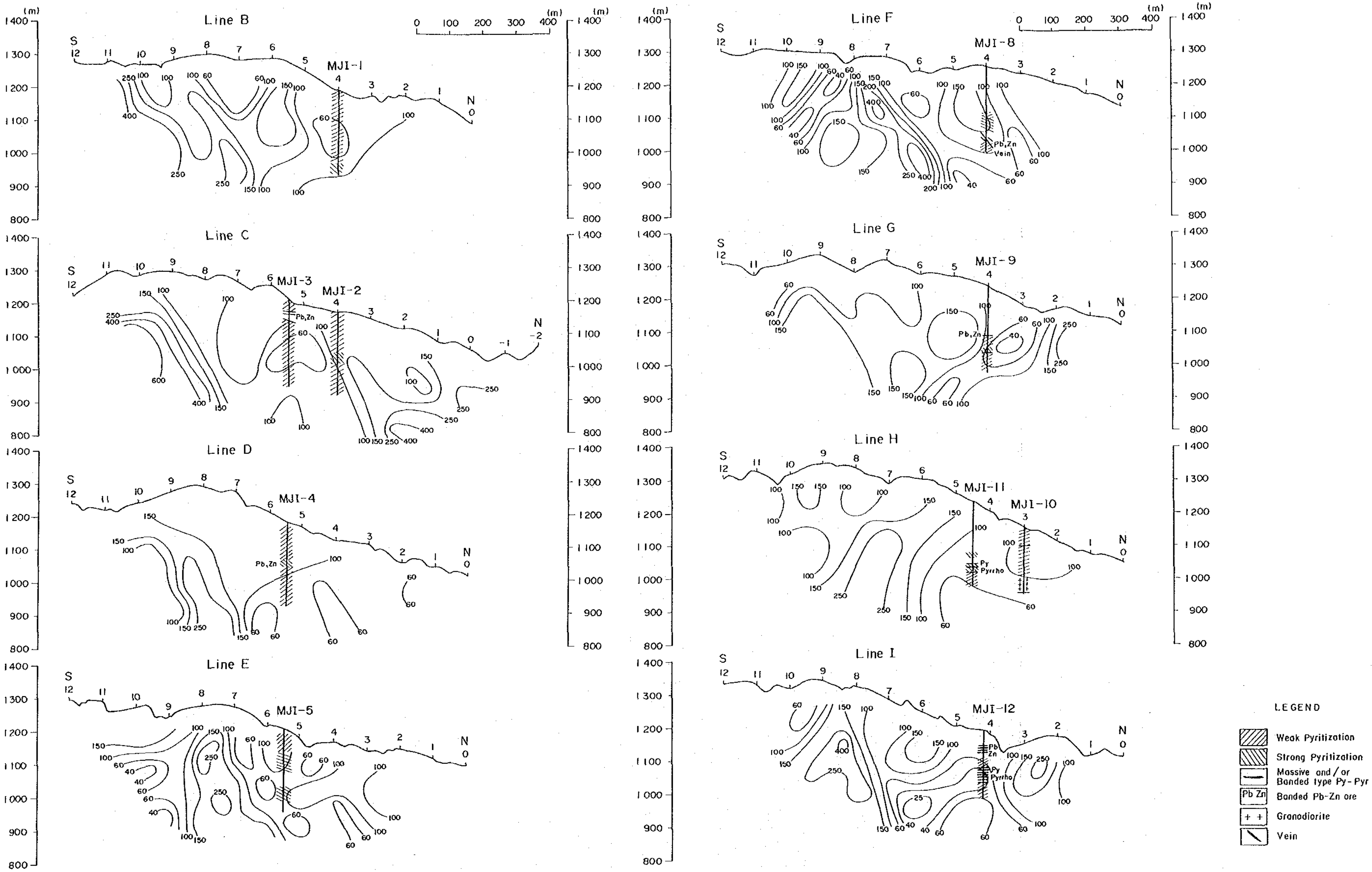


Fig. IV-7 Spectral IP Pseudo-Section Apparent Resistivity (0.125 Hz) (F, G, H, I Lines)

CHAPTER 5 DRILLING SURVEY

5-1 Outline

5-1-1 Objective and Location

In order to confirm the storage condition, continuity and minerals of the Pagar Gunung silver-lead-zinc mineralization whose storage range was clarified by the geological survey, geolchemical survey and geophysical survey (SIP method) and the banded and bedded pyrites mineralization zone under it, a boring survey was conducted. The boring locations are shown in Fig.

5-1-2 Survey Period and Survey Amount

The boring survey was conducted from the later half of the 2nd year through the 3rd year. Each drilling period and drilling depth are shown in Table IV-6.

Table IV-6 Drilling Holes Performed at Pagar Gunung Area

Hole No.	Drill length	Dip	Surface soil (m)	Core length (m)	C.R.
Second Phase					
MJI-1	200.50	-90°	10.00	177.80	93.3
MJI-2	250.20	-90°	9.00	195.65	81.1
MJI-3	250.30	-90°	17.00	210.70	90.3
MJI-4	250.20	-90°	7.00	185.95	76.5
MJI-5	250.10	-90°	12.00	212.00	89.0
Total	1,201.30		(55.00)	(982.10)	(85.7)
Third Phase					
MJI-6	250.30	-90°	9.00	221.90	92.0
MJI-7	200.40	-90°	12.00	169.20	89.8
MJI-8	250.50	-90°	16.00	215.50	91.9
MJI-9	250.50	-90°	8.00	219.45	90.5
MJI-10	200.50	-90°	7.00	167.45	86.5
MJI-11	250.20	-90°	13.30	183.50	77.5
MJI-12	200.30	-90°	5.00	168.60	86.3
MJI-13	250.50	-90°	9.00	208.30	86.3
MJI-14	250.70	-90°	21.00	202.60	88.2
Total	2,103.90		(100.30)	(1,756.50)	87.7
The Total	3,305.20		(155.30)	(273.60)	(86.9)

C.R: Core Recovery

5-2 Geology

The drilling survey clarified in detail as shown in Fig. IV-2 and following table the relattions among the facies of the Patahajang Formation, Sedimentary Rock and Volcanic Rock Member embedding the Pagar Gunung mineralized zone and the upper Basic Volcanic Rock Member and limestone Member, as follows (Fig. IV-9, IV-10).

Basic Volcanic Rock Member		
Lower limestone Member		~~~~~~~~Thrust
Sedimentary Rock and Pyroclastic Rock Member		
Shale-Calcareous Shale Facies	(I)	(MZ I')
Sandstone-shale Facies	(II)	Argillaceous Rock Facies
Shale-Tuff Facies	(II)	
Calcareous Rock-Shale Facies	(IV)	(MZ I)
Siliceous Rock-Tuff Facies	(V)	Siliceous Rock and Pyroclastic Rock Faciesck F
Banded Shale (slate Facies	(VI)	(MZ II)
Siliceous Rock Slate-Tuff Facies	(VII)	(MZ III)

(MZ = Mineralized Zone)

The Basic Volcanic Rock Member (and Lower Limestone Member) is in contact with the Sedimentary Rock and Pyroclastic Rock Member through a fault. This fault is infered to be a thrust fault and it is highly possible that the Basic Volcanic Rock Member is allochthonous rock.

The Sedimentary Rock and Pyroclastic Rock Member is roughly divided into the upper Argillaseous Rock Predominency Facies and the lower Siliceous Rock Predominance Facies.

The Argillaceous Rock Predominance Facies, mainly consists of shale and sandstone and intercalates calcareous bed (calcareous shale calcarcous conglomeratic shale calcareous sandstone) in it. The drilling survey confirmed two calcareous rock beds and silver bearing lead and zinc mineralized zones are embedded in each of them.

The siliceous rock Predominancy facies consists of the fine-grained siliceous slate, slate and dacitic – andesitic tuff alternation of strata. Catacrastic deformation is remarkable and schistosity and catacrastic cleavage are caused and the rock is semischist and cataclasite like rock. In this facies, too, the calcareous rocks (calcareous siliceous slate, calcareous sandstone) are intercalated and many of them are altered into skarn and are accompanied by epidote, garnet and banded pyrrhotite and pyrite deposits. In the northern part of the survey area, muscovite grandiorite is distributed and was confirmed by the drilling MJI-10. It shows banded structure and is changed into mylonite. The drilling MJI-10 captured quartz diorite intruded in the mylonite.

from 10° to 70°S. But on the average they have homoclinal structure with the average dip of 30°S. Normal faults after deposit formation are recognized cutting through the deposits, and their strike and dip are N30° – 50°W 70°S.

5-3 *Mineralized Zone*

The chemical analysis results of the deposits found by the drilling survey (14 holes) are *shown in Table IV-7. These deposits were zoned as follows on the basis of the geology and* minerals and also in conformity with the deposit horizons by outcrop clarified by the geological survey. (Fig. IV-11 and Table IV-7)

Mineralization I' (new deposit outcrop)
Mineralization I (silver bearing lead-zinc deposit: Pagar Gunung east deposit – west deposit)
Mineralization II (banded pyrites deposit) Consisting of 6 deposits.

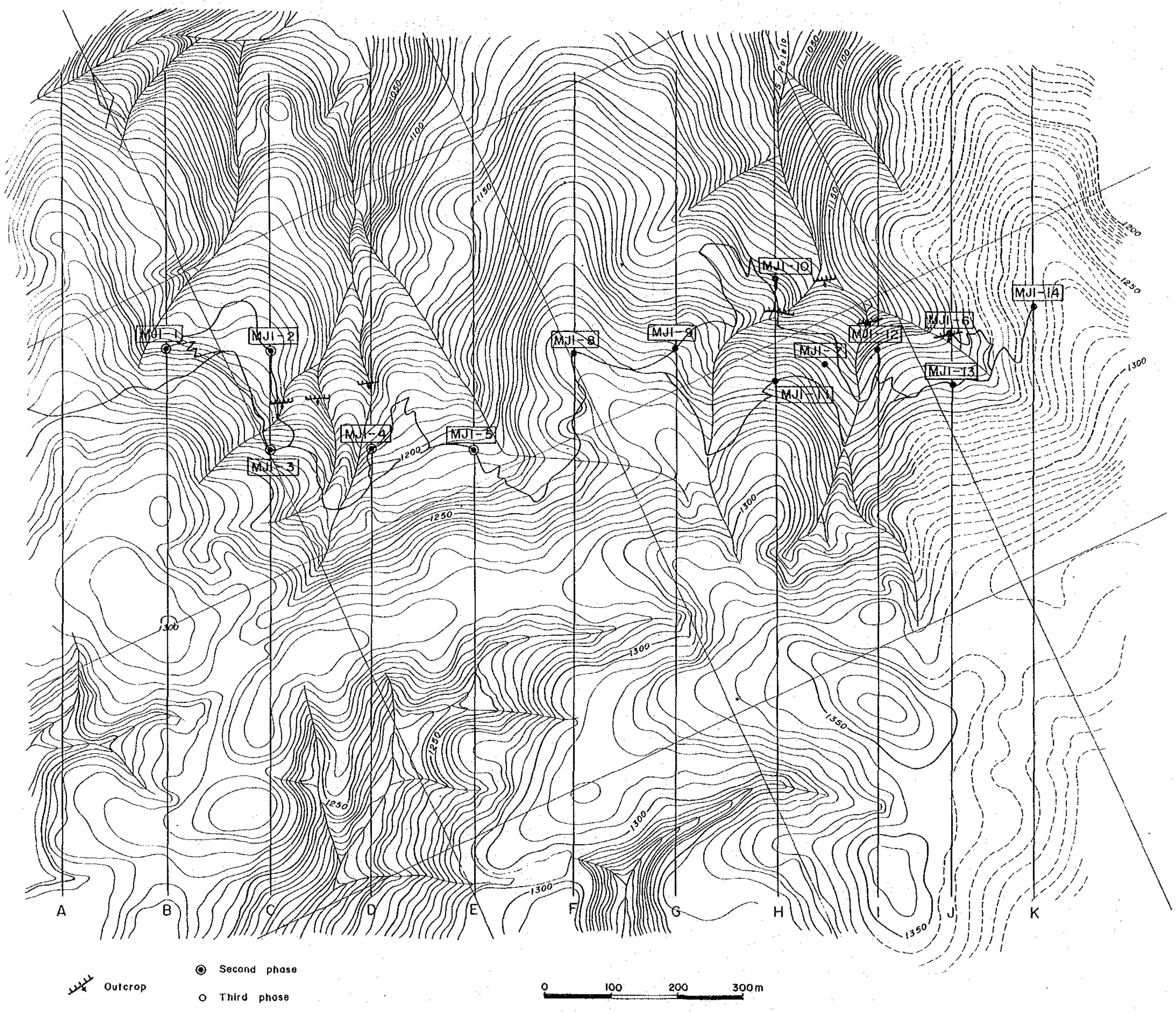


Fig. IV-8 Location Map of Drill Holes in Pagar Gunung Area

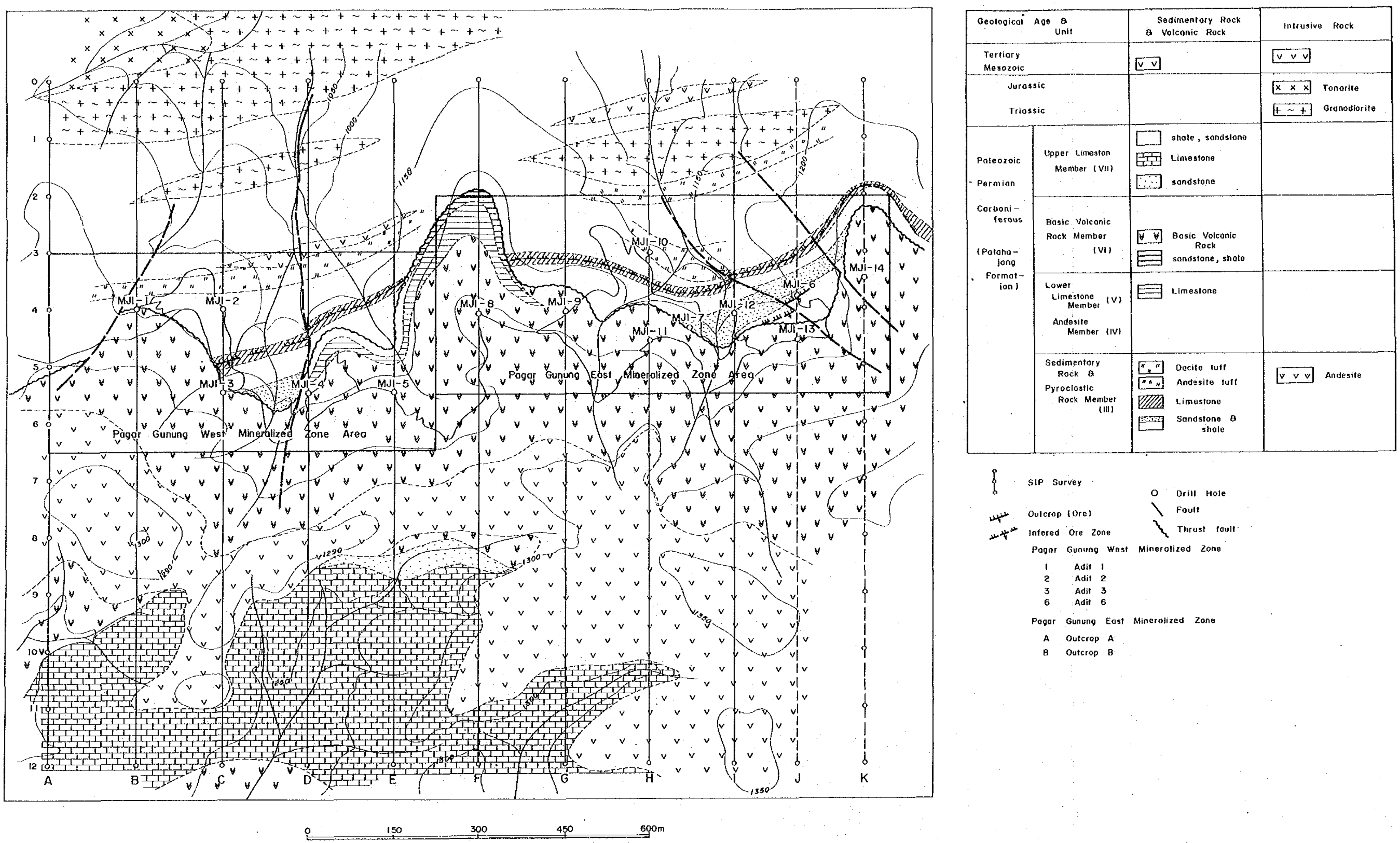


Fig. IV-9 Geological Map of Pagar Gunung Area

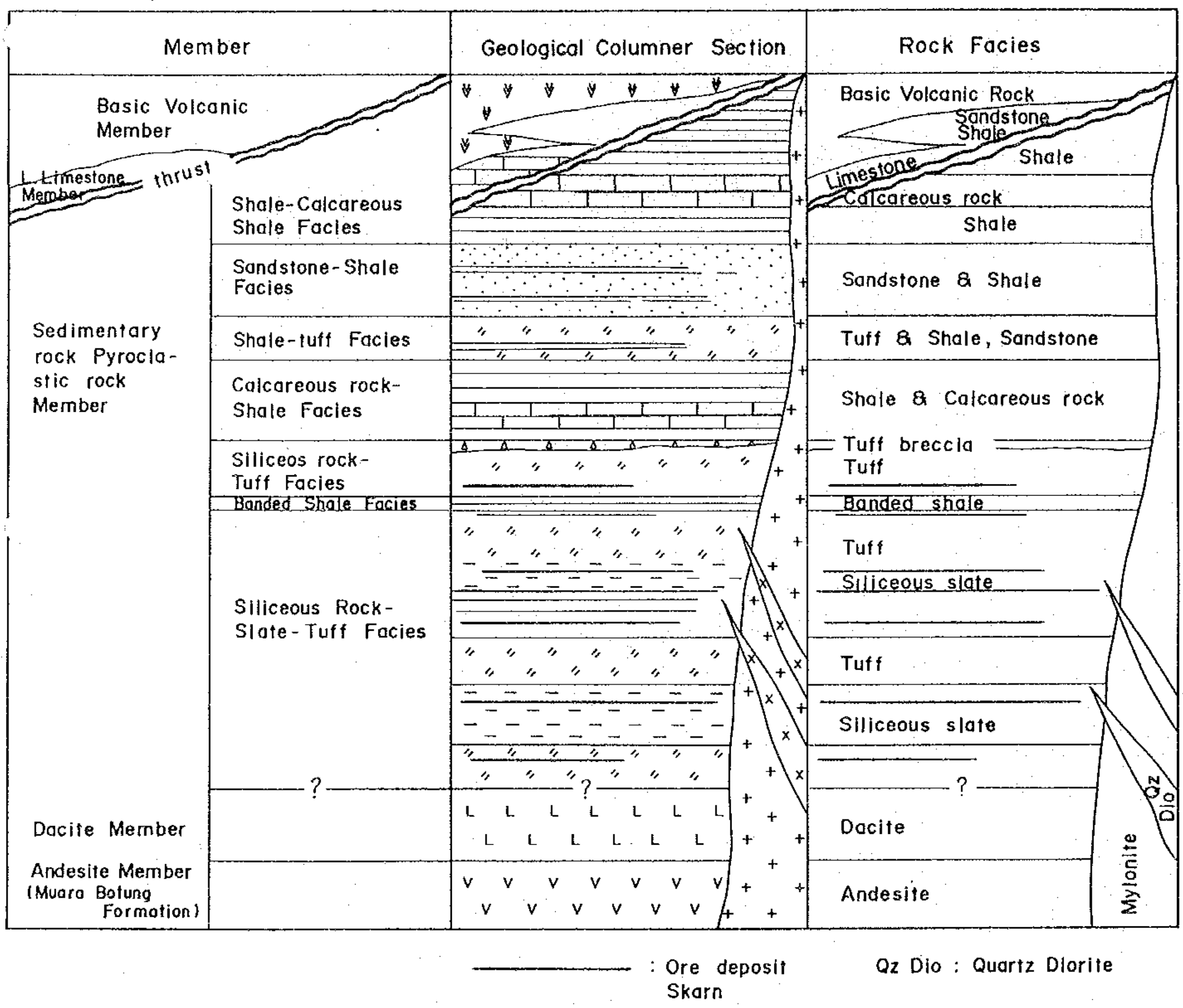


Fig. IV-10 Generalized Stratigraphy of Pagar Gunung Area

Mineralization III (Massive dissemination pyrite deposit)

The Mineralization Zone I' and Mineralization Zone I consist of silver-bearing (chalcopyrite) galena-sphalerite deposits with calcareous rock/calecareous conglomeratic shale of argillaceous Rock-Predominance Facies as the country rock and being accompanied by epidote, clinopyroxene and calcite skarn. The Mineralized Zone I was traced 1,200 m east and weat with alternating with rich and poor part.

The shoot (MJI-9, MJI-12) is strongly green-skarnized and the ore grade is Ag 60 g/t – 200 g/t, Cu 0.5% – 1.0% and Pb + Zn 10%, but in the poor ore portion (MJI-14), dissemination or film-like galena and sphalerite are caused along the bedding at the portion which undergo sericitization and there is almost no accompanying of green skarn and the ore grade is silver 20 g/t or less and lead + zinc 2.0% – 3.0%. The deposit is considered to be a skarn type deposit which selectively replaced the calcareous rock.

The Mineralization Zone II is also the metasomatic calcareous rock, part of Siliceous Rock Prodominantce Facies embeding in a bedded and banded form. At the eastern area many mineralized Sub-Zone are recognized and the thickness of the unit deposit increases. That is, the drilling MJI-12 captured the largest number of moneralized sub-zone and as shown in Fig. IV-11, roughly six mineralized sub-zones are counted, and the drilling MJI-14 found the emplacement of a deposit with the width of 9.00 m. The deposit has the paragenesis of pyrrhotite-pyrite in the skarn consisting of epidote, garnet and calcite (some amount of clinopyroxene) and is partially accompanied by sphalerite. The upper horizon deposit contains the more the sphalerite. (Fig. IV–12) The Zinc grade exceeds 6% in some part (MJI-9), but on the average it is about 1.00% – 0.30%. The lowest mineralized sub-zone (II-5~6) contains only a small amount of lead and zinc.

5-4 Characteristics of Deposit

(1) The Pagar Gunung mineralization zone is a skarn type deposit being accompanied by the skarn minerals such as epidote, clinopyroxene and garnet, and it is divided into 2 types as shown in following table in accordance with the facies of the country rock.

	Host rock	Ore mineral	Skarn mineral
Lead zinc deposit type	Argillaceous Rock Predominance Facies	Sph ≥ gal > Cp·Py ≫ Aspy	epidote (pistacite) clinopyroxene
Pyrites deposit type	Siliceous Rock Predominance Facies	Pyrrh ≥ Py ≫ Spy	Epidote, garnet (grandite series) (clinopyroxene)

The mineralized zone belonging to the lead-zinc deposit type is Mineralization Zone I' and Mineralization Zone I, and the deposit belonging to the pyrites deposit type is Mineralization Zone II, III.

(2) The Mineralized Zone I belonging to the lead-zinc type replaces selectively the calcareous shale, including calcareous pebbles or nodules. The ore shoot is accompanied by skarn minerals but the poor ore portion has almost no content of the skarn minerals and has undergone serictization along the bedding and film-like or dissemination ore minerals (sphalerite, galena, pyrite) are embedded.

(3) In the Mineralized Zone II belonging to the pyrites deposit type, skarns mainly consisting of epidote and garnet are recognized in bedded or banded form and also the pyrrhotite or pyrite is recognized with the partial paragenesis of sphalterite.

Even if there is no mineralization accompanied by the ore minerals, epidote skarn exists and generally in the upper and lower tuffs, spotty epidotes or epidote veinlets exist and for this reason, it is considered that this zone is widely affected by the mineralization.

(4) The deposits in the Pagar Gunung, especially the lead zinc deposits selectively replaced the calcareous rock and received stratabound control. The Mineralized Zone I' found by the drilling survey is embedded, like the Mineralized Zone I in calcareous rock (calecareous conglomeratic shale) of argillaceous rock predominancy facies, and therefore, the survey and prostecting of the lead-zinc deposits should be focused on the calcareous rock bed in the argillaceou rock predominanc facies. Since the deposit found by the drilling MJI-13 shows a good content of gold, silver, copper, lead and zinc, the prospecting of east-west extension is interesting.

(5) For the Pagar Gunung deposit clarified by the drilling survey, the possible ore reserve of about 800,000 t, mean true deposit width (thickness) 0.88 m, Ag 68 g/t, Cu 0.45%, Pb 1.20%, Zn 4.60% can be calculated.

Table IV-7 Chemical Assay Result Summary of Each Mineralized Zone

Drilling Number		Depth (m)	Assay Result Wd cm	Au g/t	Ag g/t	Cu %	Pb %	Zn %	Core recovery %	Remarks
Mineralized Zone I'										
	MJI-13	23.10 ~ 24.20	110	0.41	195	1.25	1.31	9.85	100	py-gal-cp sph ore in calcareous shale
	MJI-14	36.40 ~ 36.45	5		92	0.24	5.51	1.26	100	drag ore of cp-gal-sph-py in thrust fault
		38.30 ~ 38.50	20	1.63	94	0.90	6.48	3.84	100	ditto
		39.10 ~ 39.80	70		32	0.11	2.24	1.30	(slime)	py-gal-sph-(cp) ore in fault
Mineralized Zone I										
	MJI-3	53.70 ~ 54.30	60	<0.1	62.0	0.14	3.44	1.29	50	gal-sph-cp ore in shear zone
		59.50 ~ 60.00	50	<0.1	34.0	0.29	0.90	0.85	92	ditto
	MJI-4	116.50 ~ 118.40	190	<0.1	4.5	0.93	0.71	1.50	68	gal-sph-cp massive ore in shear zone
		122.00 ~ 122.60	60	<0.1	42.0	0.30	2.50	4.48	100	ditto
		123.90 ~ 124.80	90	<0.1	47.0	0.21	0.80	1.53	78	ditto
	MJI-5	190.40 ~ 192.60	220	<0.1	27.7	0.28	0.17	3.73	95	ga-sph-cp banded, diss ore in calcarcous shale
	MJI-6	38.60 ~ 38.90	30		6.2	0.05	0.89	0.77	100	gal-sph-py diss with calcite vein-let. (calcareous shale)
		61.70 ~ 62.80	110		20.3	0.08	1.60	[illegible]	100	gal-sph-pyrrh-py diss in weak skarn zone
		64.15 ~ 64.35	20		37.2	0.11	0.89	1.70	100	gal-sph-pyrrh diss (cp veinlet)
	MJI-7	77.10 ~ 77.30	20	0.23	1.9	0.03	0.11	3.65	100	sph-py [illegible] in epidote skarn
		88.70 ~ 88.80	10		[illegible]	0.01	1.42	1.44	100	ditto
	MJI-9	149.40 ~ 149.60	20		[illegible]	0.10	0.04	12.30	100	sph veinlet in green skarn
		150.40 ~ 151.40	100		164.6	0.82	1.69	7.52	100	cp-gal-sph bended ore in green cal skarn
	MJI-12	49.60 ~ 49.90	30		34.0	0.13	3.02	3.97	100	py-sph veinlet in epidote skarn
		51.60 ~ 51.80	20		20.0	0.06	0.90	1.43	100	gal-sph-diss in epidote skarn
		52.10 ~ 52.60	50		27.0	0.09	1.20	2.22	100	gal-sph diss in epidote skarn
		72.30 ~ 73.30	100		1.2	0.04	<0.01	0.53	100	sph diss in green skarn
		75.10 ~ 76.10	100		23.9	0.48	0.03	7.56	100	(gal)-cp-sph bended ore in green skarn
	MJI-13	66.80 ~ 67.00	20		8.5	0.25	0.02	0.11	100	py massive ore in calcareous shale
		86.30 ~ 86.75	45	0.41	94.0	1.07	0.39	2.70	100	cp-sph veinlet and diss in calcareous sh
		95.10 ~ 95.30	20		15.5	0.16	0.06	0.65	100	py-pyrrh-sph banded ore in green skarn
		96.35 ~ 97.20	85		7.5	0.05	0.02	0.68	100	py-pyrrh banded ore in sil shale
		100.10 ~ 100.45	35	<0.1	28.0	0.68	<0.01	1.74	100	cp-sph ore in (epd) calcareous
		102.20 ~ 102.40	20		3.3	0.06	<0.01	0.08	100	sph-py veinlets in green skarn
	MJI-14	141.65 ~ 142.35	70		12.0	0.04	1.59	1.47	100	py-gal-sph diss in calcareous shale
Mineralized Zone II										
II-1	MJI-6	77.80 ~ 78.30	50		5.6	0.02	0.22	0.35	100	banded py ore
		98.15 ~ 98.95	80		8.1	0.03	0.27	0.49	100	network of py-(gal-sph) veinlet in epido te sharn
	MJI-12	108.35 ~ 108.75	40		4.0	0.04	0.20	0.58	100	(gal-sph)-pyrrh banded ore in epidote skarn
	MJI-13	114.10 ~ 114.40	30		3.9	0.13	<0.01	0.17	100	pyrrh-py banded ore in epidote skarn
II-2	MJI-5	241.40 ~ 242.20	80	<0.1	13.0	0.05	0.60	2.03	100	gal-sph-
	MJI-12	120.50 ~ 120.85	35	0.10	11.4	0.03	0.96	0.78	100	gal-sph-pyrrh banded ore in green skarn
II-3	MJI-7	131.50 ~ 132.00	50		1.9	0.05	<0.01	0.04	100	py-pyrrh banded ore in epidote skarn
		132.45 ~ 132.85	40		1.9	0.05	<0.01	0.21	100	py-pyrrh banded ore in epidote skarn
	MJI-8	215.05 ~ 215.30	25		1.9	0.01	0.01	0.24	100	(gal-sph)-py banded ore in epidote skarn
	MJI-9	191.50 ~ 192.05	55		1.7	0.02	0.02	0.04	100	pyrrh-banded ore in epidote skarn
	MJI-10	54.30 ~ 54.75	45		14.7	0.02	0.11	0.14	100	massive-diss py ore in epidote skarn
	MJI-11	184.00 ~ 184.10	10	<0.1	12.5	0.07	0.11	1.39	100	sph-pyrrh banded ore in epidote skarn
		185.20 ~ 186.70	150		0.7	0.04	<0.01	0.23	100	(sph)-pyrrt banded ore in epidote skarn
	MJI-12	126.85 ~ 127.25	40	<0.1	2.6	0.08	0.01	0.12	100	(sph)-pytth-py ore in epidote skarn
II-4	MJI-7	140.05 ~ 140.70	65	<0.1	3.1	0.05	0.14	0.24	100	py-pyrrh banded ore in epidote skarn
	MJI-8	237.20 ~ 237.40	20		1.9	<0.01	0.01	1.22	100	(sph)-py-banded ore in epidote skarn
	MJI-11	192.55 ~ 192.95	40		1.9	0.05	0.01	0.05	100	pyrrh banded ore in epidote skarn
		194.60 ~ 194.75	15		1.2	0.08	<0.01	0.06	100	pyrrh banded ore in epidote skarn
		195.15 ~ 195.40	25	<0.1	0.9	0.05	<0.01	6.94	100	sph-pyrrh banded ore in epidote skarn
		195.70 ~ 195.80	10		1.1	0.05	0.01	0.02	100	pyrrh banded ore in epidote skarn
	MJI-12	130.05 ~ 130.55	50		1.7	0.03	0.07	0.17	100	(gal-sph) pyrrh ore in epidote skarn
II-5	MJI-6	127.20 ~ 127.80	60		16.4	0.06	0.23	0.34	100	(gal-sph) py-pyrrh banded ore in green skarn
	MJI-11	203.70 ~ 204.00	30		0.9	0.04	<0.01	0.06	100	pyrrh banded ore in epidote skarn
		205.35 ~ 206.55	120		4.4	0.04	0.04	0.09	100	pyrrh banded ore in epidote skarn
		207.50 ~ 208.60	110		1.1	0.03	0.02	0.03	100	pyrrh banded ore in epidote skarn
		209.90 ~ 210.30	40		0.7	0.03	<0.01	0.01	100	pyrrh-py banded ore in epidote skarn
	MJI-12	136.30 ~ 136.80	50		0.9	0.03	<0.01	0.01	100	pyrrh-py banded ore in (garnet) epidote skarn
		138.60 ~ 138.75	15		0.7	0.01	0.02	0.03	100	py diss in epidote skarn
		139.20 ~ 140.90	170		1.1	0.03	<0.01	0.01	100	(pyrrh)-py diss in epidote skarn
		141.35 ~ 143.00	165		3.1	0.04	0.01	0.04	100	(pyrrh)-py diss in epidote skarn
		143.50 ~ 145.00	150		5.5	0.03	0.07	0.18	100	(sph)-py-(pyrrh) bended ore in epidote skarn
II-6	MJI-6	163.80 ~ 166.85	305		1.6	0.10	<0.01	0.01	100	pyrrh-py massive ~ banded ore in epidote skarn
		169.70 ~ 175.70	600		1.4	0.12	<0.01	0.02	100	py-pyrrh massive ~ banded ore in epidote skarn
	MJI-12	172.35 ~ 175.65	330		1.2	0.14	<0.01	<0.01	100	py-pyrrh massive ~ banded ore in epidote skarn
	MJI-13	195.40 ~ 196.70	130		3.5	0.08	<0.01	0.01	100	py-pyrrh massive ~ banded ore in epidote skarn
	MJI-14	215.50 ~ 224.50	900	<0.1	4.4	0.12	0.02	0.01	100	py-pyrrh massive ~ banded ore in epidote skarn
Mineralized Zone III										
	MJI-10	189.80 ~ 190.40	60		0.5	<0.01	0.01	0.03	100	massive ~ diss py ore (sericitization)
Vein	MJI-9	235.60 ~ 235.65	5		6.5	0.03	0.10	0.90	100	sph-py-pyrrh ore
	MJI-14	192.10 ~ 192.15	5	1.51	450.0	2.15	11.70	6.10	100	cp-gal-sph ore (very coarse grain)

(Note, gal: galena Sph: sphalerite cp: chalcopyrite Pyrrh: Pyrrhotite
py: pyrite diss: dissemination

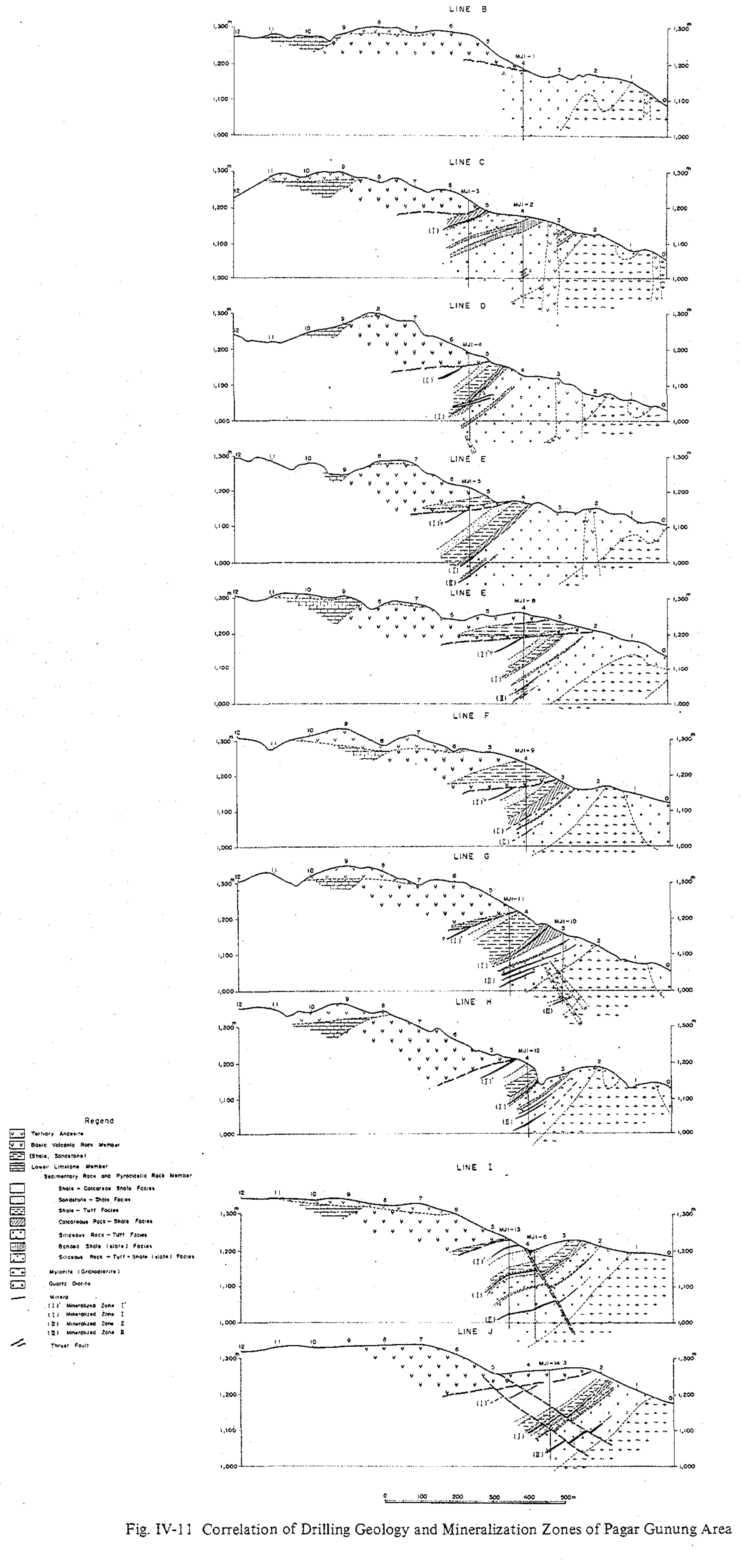


Fig. IV-11 Correlation of Drilling Geology and Mineralization Zones of Pagar Gunung Area

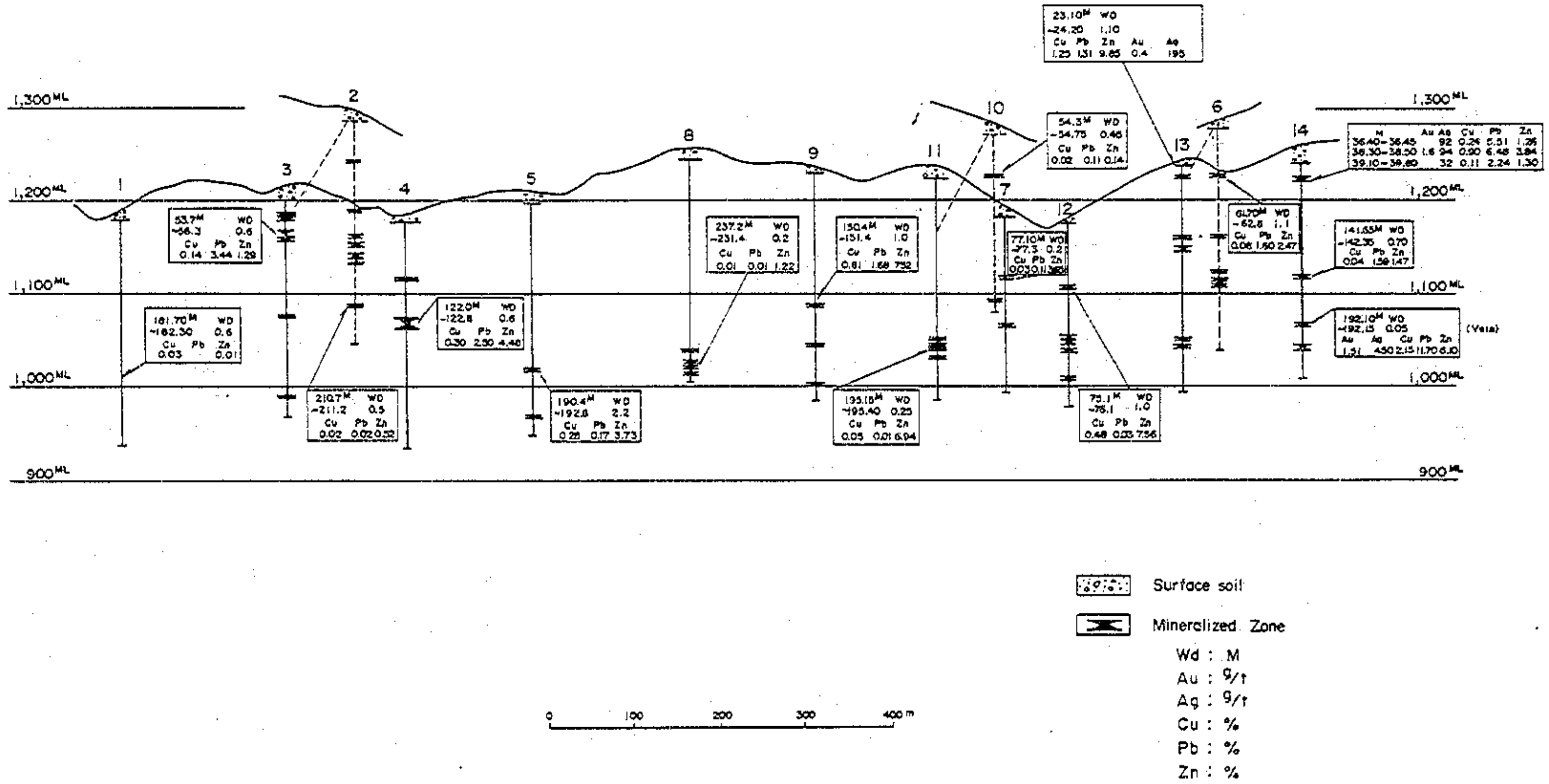


Fig. IV-12 Chemical Assay Result of Mineralization Zone, Pagar Gunung Area

PART V

PASAMAN AREA

CHAPTER 1 GEOLOGY

1-1 General Geology

The geology of the study area is made up of the Cretaceous Woyla Group consisting of pelitic schist (or pelitic slate, phyllite), green schist and limestone, and ultrabasic rock, mainly hartzburgite and small exposure of dunite. The area is interpreted that Woyla Group sedimented along marginal basin spreaded and at Cretaceous age, and the ultrabasic rock was accreted into Woyla Group from mantle as ophiolite.

Quaternary pyroclastic sediment of Talmak volcano is distributed at extreme southeast part of the survey area.

The generalized stratigraphy, igneous activity and tectonics is shown in Fig. V-1.

1-2 Woyla Group

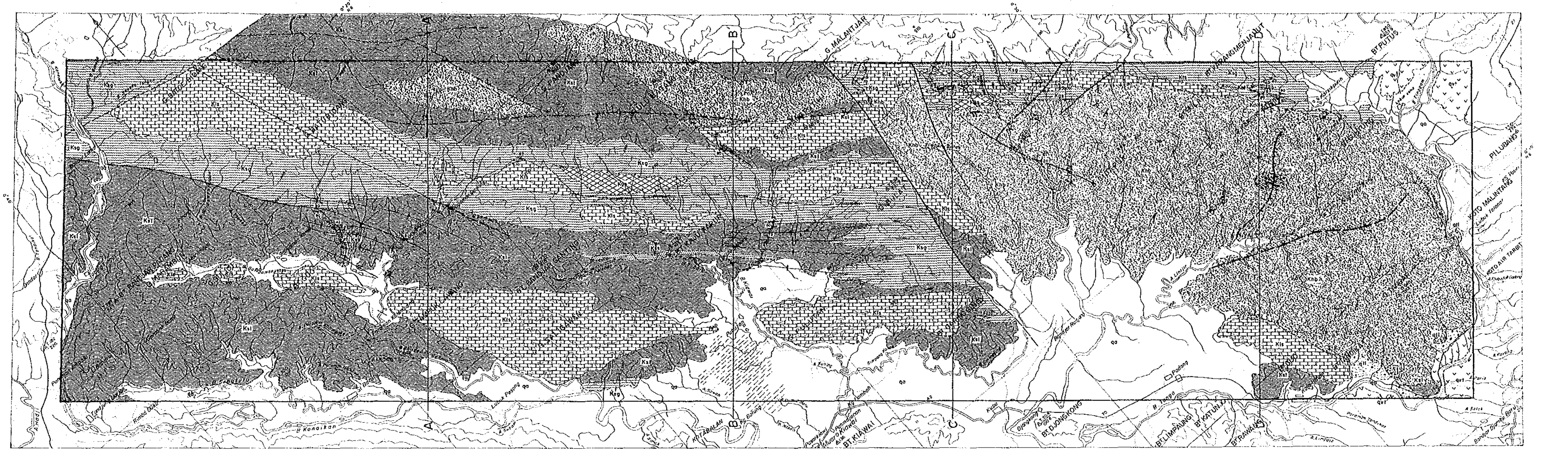
Pelitic Schist of northern area (Sarigawan River area) is low metamorphosed schist is distributed at the south area which ultrabeic rock is emplaced. Green schist and massive green rock contains chlorite, epidote and actinolite as metamorphosed mineral.

Irregular shaped limestone and green schist is upper horizone of Woyla Group, and pelitic schist is lower horizone of the Woyla Group. They strike generally N 70°W, dip 70°NE or SW, showing reapeted folding.

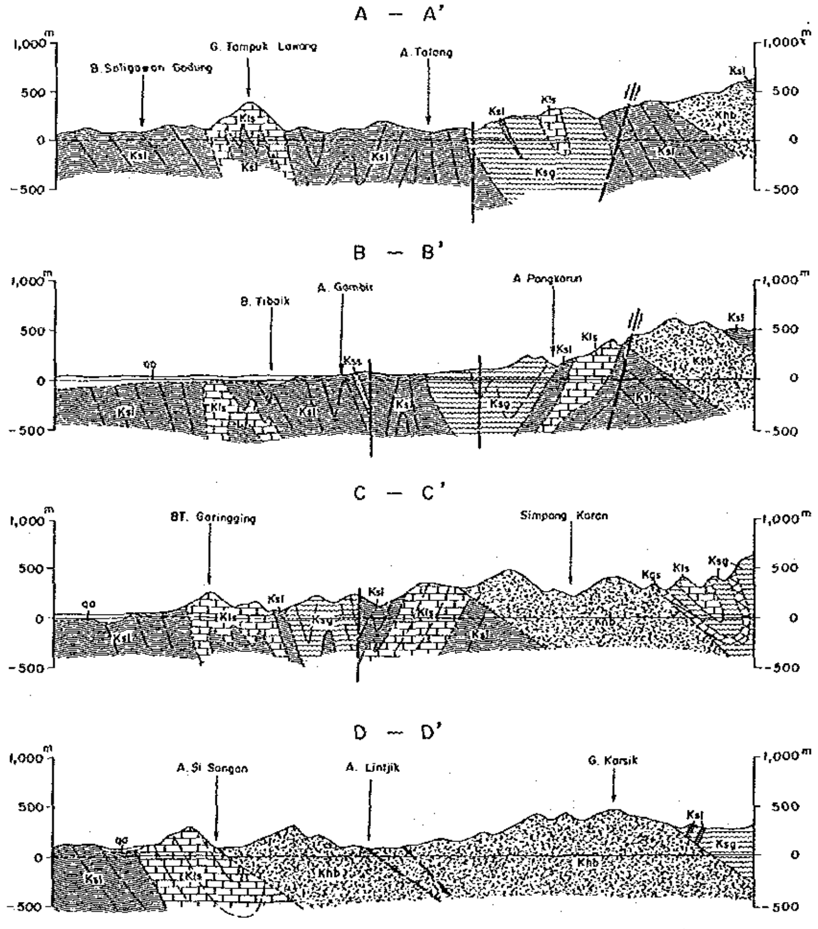
1-3 Ultrabsic Rock

Ultrabasic rock distributed in the southpart of the survey area is 5 km in the width extending 8 km, centering Lintjik River. Another two small lenticular ultrabasic rock of about one km in widthat upper reached the Sligawan river and Simpan Koroh River.

Most ultrabasic rock is hurtzburgite consisting of 70% – 90% olivine, 10% – 30% orthopyroxene and small amount of clinopyroxene (5%). Dunite consisting mostly of olivine occupies a small part. Brecciated shear zone is observable at Lintjik river area situating center of the ultrabasic rock body.



PROFILE



LEGEND

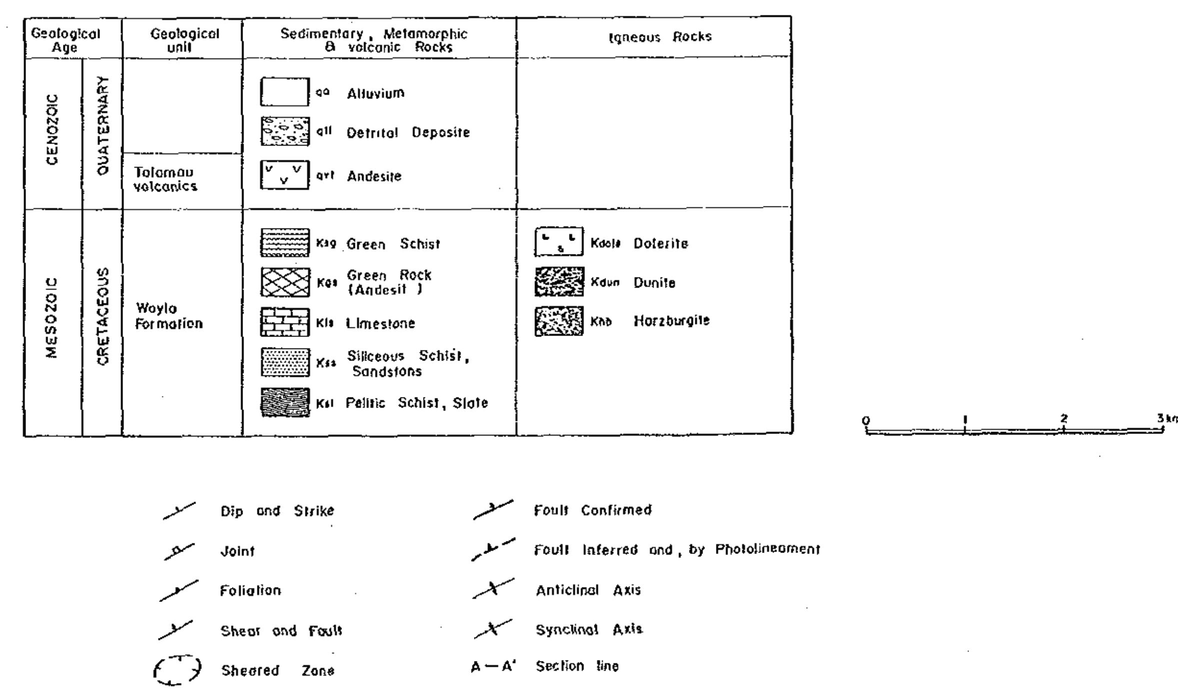


Fig. V-1 Geological Map of Pasaman Area

CHPATER 2 CHEMISTRY OF ULTRABASIC ROCK

2-1 Chemical Composition of Ultrabasic Rock

A whole rock chemical analysis was carried out on 15 samples of fresh ultrabasic rock under even distriribution of the body in order to examine their chemical composition. The breakdown is 13 incidented of hartzburgite, 1 of dunite and 1 of dolerite. (Table V-1, 2). Table V-2 is recalculated, after extracting igneous loss and included nickel and chrorite as oxide.

As refering assay data of hurtzburgite and dunite of New Caledonia and USGS standard (Coleman 1977), Pasaman hartzburgite and dunite are similar to the rock of New Caledonia and USGS Standard.

2-2 Chemical Composition of Rock Forming Minerals in the Ultrabasic Rock

Analysis using an electron probe micro analyser was carried out to detect the chemical composition rock forming minerals of the ultrabasic rock (hartzburgite and dunite) in the Pasaman Area, namely olivine, orthopyroxene, elionpyroxene and chrome mineral (Table V-3, V-4, V-5, V-6)

(a) Olivine
Olivine included in hartzburgite is $Fo_{91\ 92}$, and found in dunite Fo_{94}. The latter abounds in slight rich forsterite than the former.

(b) Orthopyroxene and Clinopyroxene
Orthopyroxene compórment $EN_{91}\sim_{92}$, clinopyroxene En_{49}, Wo_{47}, Fs_{4}, Partition of iron and magnesia can be used to determined forming temperature of the rock as geothermomater. According to the calculation, the partition value ($k \frac{Opx\text{-}Cpx}{Fe\text{-}Mg}$) ranges from 1.22 to 1.60. The value is recalculated from 750° to 650° celsius degree in temperature. The temperature is practically same for hurtzbergite accreted in tectonic zones throughout the world.

(c) Chromeum mineral
The result of analysis of the nine chromeum minerals (a mineral from dunite, eight minerals from hartzburgite), a mineral in dunite contains 51% of Cr_2O_3 and 17% of Al_2O_3 regarded as chromite, two minerals in hartzburgite Cr_2O_3 47% – 48% and Al_2O_3 19% – 20% regarded as mineral closed to chromite, but six minerals in hartzburgite contain Cr_2O_3 40% – 27% and Al_2O_3 20% – 40%, namely chromum spinel. There is vanagium (25 ppm – 75 ppm) and cobalt (79 ppm – 97 ppm) in the hartzburgite.

Table V-1 Chemical Composition of Pasaman Ultrabasic Rock (A)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Sample No.	BR-38	BR-74	BR-76	DR-36	DR-40	DR-41	DR-45	DR-50	DR-54	ER-61	ER-67	ER-111	ER-107	DR-57	FR-101
Location	S.Kanon	Branch of A.Lintjik	Branch of A.Lintjik	Branch of A.Lintjik	Branch of A.Lintjik	A.Lintjik	G.Tangar	Branch of A.Lintjik	G.Tangar	B.Pasaman	Branch of B.Pasaman	A.Lumpatan	S.Sangan	Branch of A.Lintjik	A.Karata putih
Rock Name	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Dunite	Dolerite
SiO_2 %	43.54	42.76	41.83	42.45	43.01	43.49	41.68	40.75	42.25	42.24	42.34	43.01	42.93	36.95	50.76
TiO_2 %	0.01	0.01	0.05	0.01	0.02	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.01	0.08	0.35
Al_2O_3 %	0.89	0.11	0.40	0.22	0.80	1.05	0.10	0.40	0.13	0.93	0.67	0.58	0.97	0.03	10.31
Fe_2O_3 %	0.99	1.91	1.38	0.94	0.74	0.78	1.63	1.54	1.62	0.82	0.92	0.86	1.87	2.50	3.71
FeO %	6.77	5.76	6.41	6.98	6.77	6.34	6.19	6.19	6.05	7.20	6.62	6.62	6.05	3.38	6.41
MnO %	0.15	0.13	0.13	0.15	0.14	0.14	0.14	0.17	0.14	0.16	0.13	0.13	0.13	0.08	0.18
MgO %	39.91	42.82	42.16	41.92	40.34	37.84	39.66	40.11	40.66	38.88	37.97	39.53	37.08	43.97	9.26
CaO %	1.21	0.82	0.87	0.85	1.37	2.17	0.97	2.16	0.73	2.36	1.75	0.99	2.19	0.23	10.55
Na_2O %	0.11	0.03	0.03	0.02	0.02	0.43	0.01	0.02	0.02	0.09	0.30	0.01	0.10	0.03	1.37
K_2O %	0.02	0.02	0.03	0.02	0.02	0.01	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.03	3.30
P_2O_5 %	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.33
BaO %	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.07
LOI %	3.19	4.72	3.96	2.38	2.83	3.72	5.44	5.07	4.64	2.94	3.98	2.22	4.25	10.85	2.26
Total	96.82	99.12	97.29	95.97	96.09	96.01	95.88	96.48	96.31	95.7	94.74	94.01	95.63	98.17	98.86
Cr ppm	1280	1220	1440	1140	1920	3400	1080	2000	1260	2900	1840	1560	3200	345	560
Ni ppm	1930	1950	2000	2050	1900	1720	1950	1880	1780	1900	1830	1800	1650	2300	143
V ppm	75	50	50	50	25	50	25	50	25	75	25	25	75	25	325
Co ppm	96	92	90	97	88	80	93	87	79	85	80	80	82	86	18
Pt ppb	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Pd ppb	<10	<10	<10	<10	<10	<10	10	<10	<10	10	<10	<10	10	<10	10
Au ppb	5	75	20	230	55	35	25	15	550	550	30	750	55	1050	5
MgO/MgO+FeO	0.85	0.88	0.87	0.86	0.86	0.86	0.87	0.87	0.87	0.84	0.85	0.86	0.86	0.93	0.59

Table V-2 Chemical Composition of Pasaman Ultrabasic Rock (B)

	1	2	3	4	5	6	7	8	9	10	11	12	13		(1)	(2)	14	(1)
Sample No.	BR-38	BR-74	BR-76	DR-36	DR-40	DR-41	DR-45	DR-50	DR-54	ER-61	ER-67	ER-111	FR-107	Average	USGS	New-Caledonia	DR-57	USGS
Location	S.Kanan	Branch of A.Lintjik	Branch of A.Lintjik	Branch of A.Lintjik	Branch of A.Lintjik	A.Lintjik	G.Tangar	Branch of A.Lintjik	G.Tangar	B.Pasaman	Branch of B.Pasaman	A.Lampatan	S.Sangan				Branch of A.Lintjik	
Rock Name	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Dunite	Dunite
SiO_2 1/1	46.30	45.11	44.62	45.16	45.88	46.77	45.89	44.34	45.90	45.23	46.41	46.64	46.65	45.76	44.0	43.9	42.17	4.05
TiO_2 1/1	0.01	0.01	0.05	0.01	0.02	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.01	0.02	0.016	0.07	0.09	0.013
Al_2O_3 1/1	0.95	0.12	0.43	0.23	0.85	1.33	0.11	0.44	0.14	1.00	0.73	0.63	1.05	0.61	0.78	1.1	0.03	0.24
Fe_2O_3 1/1	1.05	2.01	1.47	1.00	0.79	0.84	1.79	1.68	1.76	0.88	1.01	0.93	2.03	1.33	3.00	1.3	2.85	1.21
FeO 1/1	7.20	6.08	6.84	7.43	7.22	6.82	6.82	6.73	6.57	7.71	7.26	7.18	6.57	6.96	5.50	6.8	3.86	7.23
MnO 1/1	0.16	0.14	0.14	0.16	0.15	0.15	0.15	0.18	0.15	0.17	0.14	0.14	0.14	0.15	0.13	0.01	0.09	0.11
MgO 1/1	42.44	45.17	44.97	44.60	43.03	40.70	43.67	43.64	44.17	41.63	41.67	42.86	40.29	42.99	45.3	45.2	50.18	49.80
CaO 1/1	1.29	0.86	0.93	0.90	1.46	2.33	1.07	2.35	0.79	2.53	1.92	1.07	2.38	1.53	0.5	0.59	0.26	0.15
Na_2O 1/1	0.12	0.03	0.03	0.02	0.02	0.41	0.01	0.02	0.02	0.10	0.33	0.01	0.11	0.10	0.006	0.13	0.03	0.007
K_2O 1/1	0.02	0.02	0.03	0.02	0.02	0.01	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.004	0.01	0.03	0.0012
Cr_2O_3 1/1	0.20	0.19	0.22	0.18	0.30	0.54	0.18	0.32	0.20	0.45	0.30	0.25	0.51	0.30	0.42	0.41	0.33	0.58
NiO 1/1	0.27	0.26	0.27	0.28	0.26	0.24	0.28	0.26	0.25	0.26	0.25	0.25	0.23	0.26	0.31	0.54	0.06	0.29
Total 1/1	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
MgO/MgO+FeO	0.85	0.88	0.87	0.86	0.86	0.86	0.86	0.87	0.87	0.84	0.85	0.86	0.86	0.86	0.89	0.87	0.93	0.87

LOI: Deleted from analysis and then normalized

(1) Cazadero, Pecli U.S.G.S. standard from Coleman 1977.

(2) New Caledonia 4 Harzburgite, Rodgers (1975) from Coleman 1977.

Harzb.: Harzburgite

Table V-3 Chemical Composition of Olivine in Pasaman Ultrabasic Rock

Element \ Sample No.	DR-36		DR-40		DR-50		ER-111		DR-57	
SiO_2	40.84%	40.94%	40.66%	40.52%	40.78%	40.76%	40.69%	40.99%	41.72%	41.38%
Al_2O_3	0.02	0.00	0.01	0.02		0.01				0.00
TiO_2	0.00	0.01			0.00	0.04	0.01		0.03	0.00
FeO	8.70	8.45	8.81	8.97	8.06	8.36	7.79	8.12	6.13	6.10
MnO	0.13	0.16	0.07	0.14	0.16	0.18	0.14	0.12	0.05	0.11
MgO	50.11	50.41	50.39	50.39	50.74	50.80	50.57	50.49	52.84	52.02
CaO	0.03	0.02		0.03	0.00		0.01	0.01	0.08	0.10
Na_2O		0.00		0.02	0.01		0.01	0.00	0.00	0.00
K_2O	0.00		0.00	0.00	0.00	0.01				
NiO	0.37	0.33	0.42	0.44	0.45	0.47	0.37	0.43	0.44	0.43
Cr_2O_3			0.00	0.02	0.00	0.00		0.01	0.06	0.01
V_2O_3		0.00	0.02	0.01			0.03	0.00		
Total	100.20	100.32	100.40	100.56	100.19	100.64	99.63	100.17	101.36	100.17
Oxygen =	4									
Si	0.995	0.995	0.990	0.987	0.992	0.989	0.994	0.997	0.994	0.997
Al	0.001	0.000	0.000	0.001		0.000				0.000
Ti	0.000	0.000			0.000	0.001	0.000		0.000	0.000
Fe	0.177	0.172	0.179	0.183	0.164	0.170	0.159	0.165	0.122	0.123
Mn	0.003	0.003	0.001	0.003	0.003	0.004	0.003	0.003	0.001	0.002
Mg	1.821	1.827	1.829	1.829	1.840	1.837	1.841	1.830	1.876	1.869
Ca	0.001	0.001		0.001	0.000		0.000	0.000	0.002	0.003
Na		0.000		0.001	0.000		0.000	0.000	0.000	0.000
K	0.000		0.000	0.000	0.000	0.000				
Ni	0.007	0.006	0.008	0.009	0.009	0.009	0.007	0.008	0.008	0.008
Cr			0.000	0.000	0.000	0.000		0.000	0.001	0.000
V		0.000	0.000	0.000			0.001	0.000		
Total	3.004	3.005	3.010	3.013	3.008	3.010	3.006	3.003	3.005	3.003
Fe/Fe+Mg	0.089	0.086	0.089	0.091	0.082	0.084	0.080	0.083	0.061	0.062
Forsterite content	91	91	91	91	92	92	92	92	94	94

Table V-4 Chemical Composition of Orthopyroxene in Pasaman Ultrabasic Rock

Element \ Sample No.	DR-36				DR-40		DR-50		ER-111	
SiO_2	53.90%	52.12%	54.45%	54.17%	54.39%	53.96%	54.22%	54.18%	54.22%	54.02%
Al_2O_3	2.00	1.70	1.80	2.02	1.72	2.00	2.30	2.37	1.97	2.58
TiO_2	0.04	0.04	0.03	0.01	0.06	0.04	0.05	0.07	0.08	0.05
FeO	2.39	2.23	1.96	2.19	1.82	1.95	2.18	2.13	2.12	2.02
MnO	0.10	0.05	0.11	0.11	0.09	0.08	0.09	0.07	0.09	0.10
MgO	17.69	19.85	17.49	17.58	17.78	17.75	17.80	17.49	17.63	18.75
CaO	23.51	20.68	24.37	24.09	24.62	24.36	23.55	24.16	24.17	23.02
Na_2O	0.23	0.20	0.19	0.21	0.08	0.10	0.01	0.04	0.10	0.12
K_2O	0.01		0.01	0.00		0.01			0.03	0.01
NiO	0.08		0.05	0.03	0.01	0.01	0.10	0.10	0.05	0.05
Cr_2O_3	0.83	0.77	0.76	0.86	0.38	0.52	0.51	0.58	0.66	0.98
V_2O_3	0.02	0.00	0.05	0.02	0.01	0.05	0.02	0.02	0.03	0.02
Total	100.79	97.64	101.27	101.29	100.96	100.81	100.84	101.21	101.14	101.73
Oxygen =	6									
Si	1.944	1.929	1.953	1.945	1.955	1.944	1.948	1.943	1.948	1.924
Al	0.085	0.074	0.076	0.085	0.073	0.085	0.097	0.100	0.083	0.108
Ti	0.001	0.001	0.001	0.000	0.002	0.001	0.001	0.002	0.002	0.001
Fe	0.072	0.069	0.059	0.066	0.055	0.059	0.065	0.064	0.064	0.060
Mn	0.003	0.001	0.003	0.003	0.003	0.002	0.003	0.002	0.003	0.003
Mg	0.951	1.095	0.936	0.941	0.953	0.953	0.954	0.935	0.944	0.996
Ca	0.909	0.820	0.937	0.927	0.948	0.940	0.907	0.929	0.930	0.878
Na	0.016	0.014	0.013	0.015	0.006	0.007	0.001	0.003	0.007	0.008
K	0.001		0.000	0.000		0.001			0.001	0.001
Ni	0.002		0.001	0.001	0.000	0.000	0.003	0.003	0.001	0.001
Cr	0.024	0.022	0.021	0.025	0.011	0.015	0.015	0.016	0.019	0.028
V	0.000	0.000	0.001	0.001	0.000	0.001	0.000	0.000	0.001	0.001
Total	4.008	4.028	4.003	4.007	4.005	4.008	3.994	3.998	4.003	4.010
Fe/Fe+Mg	0.070	0.059	0.059	0.065	0.054	0.058	0.064	0.064	0.063	0.057

Table V-5 Chemical Composition of Clinopyroxene in Pasaman Ultrabasic Rock

Sample No. / Element	DR-36		DR-40		DR-50		ER-111	
	%	%	%	%	%	%	%	%
SiO_2	56.50	56.26	55.84	56.45	56.13	56.52	56.53	56.66
Al_2O_3	1.95	1.91	2.38	1.89	2.20	2.32	2.38	2.57
TiO_2	0.01	0.00	0.00	0.05	0.02	0.03	0.01	0.05
FeO	5.71	5.54	5.59	5.61	5.56	5.84	5.62	5.35
MnO	0.19	0.17	0.09	0.14	0.13	0.11	0.13	0.18
MgO	34.40	34.24	34.17	34.51	34.46	34.55	34.74	34.27
CaO	0.74	0.65	0.49	0.41	0.63	0.51	0.55	1.39
Na_2O	0.02	0.03	0.01	0.00	0.02	0.00	0.02	
K_2O	0.01			0.00	0.01	0.02	0.02	0.01
NiO	0.13	0.08	0.12	0.08	0.03	0.10	0.11	0.10
Cr_2O_3	0.76	0.72	0.48	0.33	0.44	0.31	0.59	0.73
V_2O_3	0.04	0.00	0.00	0.02	0.05			0.03
Total	100.46	99.61	99.16	99.49	99.67	100.29	100.70	101.34
Oxygen =	6							
Si	1.942	1.947	1.939	1.952	1.940	1.942	1.935	1.930
Al	0.079	0.078	0.097	0.077	0.090	0.094	0.096	0.103
Ti	0.000	0.000	0.000	0.001	0.001	0.001	0.000	0.001
Fe	0.164	0.160	0.162	0.162	0.161	0.168	0.161	0.152
Mn	0.006	0.005	0.003	0.004	0.004	0.003	0.004	0.005
Mg	1.763	1.766	1.769	1.779	1.775	1.769	1.773	1.740
Ca	0.027	0.024	0.018	0.015	0.023	0.019	0.020	0.051
Na	0.001	0.002	0.001	0.000	0.001	0.000	0.001	
K	0.000			0.000	0.000	0.001	0.001	0.000
Ni	0.004	0.002	0.003	0.002	0.001	0.003	0.003	0.003
Cr	0.021	0.020	0.013	0.009	0.012	0.008	0.016	0.020
V	0.001	0.000	0.000	0.001	0.001			0.001
Total	4.008	4.005	4.006	4.003	4.009	4.007	4.010	4.007
Fe/Fe + Ms	0.085	0.083	0.084	0.084	0.083	0.087	0.083	0.081
K $\frac{opx\text{-}cpx}{FE - Mg}$	1.22	1.44	1.60	1.48	1.32	1.39	1.35	1.45
Temperature C°	815	710	650	690	760	730	750	700
	760		675		745		725	

Table V-6 Chemical Composition of Chrome Mineral in Pasaman Ultrabasic Rock

Sample No. / Element	DR-36		DR-40		DR-50		ER-111		DR-57		DR-41		DR-45		FR-105		DR-54	
SiO_2	0.05	0.04	0.04	0.05	0.07	0.11	0.05	0.05	0.04	0.05	0.07	0.04	0.11	0.08	0.02	0.03	0.06	0.05
Al_2O_3	27.23	22.82	36.62	36.58	41.24	35.94	30.22	30.05	17.72	17.83	33.18	35.19	19.21	18.80	30.53	32.01	20.61	20.59
TiO_2	0.08	0.06	0.06	0.03		0.02	0.09	0.06	0.14	0.16		0.09	0.06	0.08	0.04	0.05	0.08	0.09
Feo	19.10	19.98	15.60	15.27	15.36	16.10	16.07	15.82	15.80	15.72	15.85	15.68	22.23	21.30	15.51	15.45	18.70	18.09
MnO	0.19	0.26	0.18	0.14	0.18	0.19	0.14	0.17	0.31	0.22	0.18	0.19	0.36	0.34	0.18	0.16	0.28	0.24
MgO	13.17	11.66	15.25	15.22	15.42	14.92	14.43	14.36	13.81	14.11	14.81	15.13	9.21	9.57	14.32	14.54	11.66	11.64
CaO		0.02		0.00	0.04		0.00	0.00		0.02	0.02		0.02	0.01		0.01	0.01	0.00
Na_2O	0.02	0.00	0.01			0.00	0.00	0.04			0.01	0.03	0.01			0.00	0.00	
K_2O	0.01	0.01		0.01	0.02	0.02	0.00		0.00			0.01	0.01	0.02		0.01		0.01
NiO	0.10	0.06	0.19	0.18	0.10	0.12	0.10	0.09	0.09	0.14	0.21	0.28	0.14	0.15	0.17	0.15	0.17	0.18
Cr_2O_3	39.63	44.07	31.91	32.37	27.17	32.43	38.12	39.48	51.63	51.69	35.11	33.61	47.04	48.52	38.60	37.75	47.87	47.72
V_2O_3	0.27	0.26	0.17	0.17	0.20	0.18	0.18	0.15	0.13	0.14	0.14	0.22	0.31	0.32	0.16	0.15	0.24	0.27
Total	99.85	99.22	100.04	100.02	99.80	100.03	99.41	100.27	99.68	100.10	99.58	100.46	98.70	99.19	99.53	100.32	99.66	98.89
Oxygen =	4												4					
Si	0.001	0.001	0.001	0.001	0.002	0.003	0.001	0.001	0.001	0.002	0.002	0.001	0.004	0.003	0.001	0.001	0.002	0.002
Al	0.976	0.844	1.241	1.239	1.373	1.224	1.061	1.048	0.657	0.657	1.148	1.197	0.735	0.715	1.069	1.105	0.764	0.768
Ti	0.002	0.001	0.001	0.001		0.000	0.002	0.001	0.003	0.004		0.002	0.001	0.002	0.001	0.001	0.002	0.002
Fe	0.486	0.524	0.375	0.367	0.363	0.389	0.401	0.391	0.416	0.411	0.389	0.378	0.604	0.575	0.385	0.378	0.492	0.479
Mn	0.005	0.007	0.004	0.003	0.004	0.005	0.004	0.004	0.008	0.006	0.005	0.005	0.010	0.009	0.005	0.004	0.007	0.007
Mg	0.597	0.545	0.654	0.653	0.649	0.643	0.641	0.633	0.648	0.658	0.648	0.651	0.446	0.460	0.634	0.635	0.547	0.549
Ca		0.001		0.000	0.001		0.000	0.000		0.001	0.001		0.001	0.000		0.000	0.000	0.000
Na	0.001	0.000	0.001			0.000	0.000	0.002			0.001	0.002	0.001			0.000	0.000	
K	0.000	0.000		0.000	0.001	0.001	0.000		0.000			0.000	0.000	0.001		0.000		0.000
Ni	0.002	0.001	0.004	0.004	0.002	0.003	0.002	0.002	0.002	0.004	0.005	0.006	0.004	0.004	0.004	0.004	0.004	0.005
Cr	0.953	1.093	0.726	0.736	0.607	0.741	0.898	0.923	1.284	1.279	0.815	0.767	1.207	1.238	0.907	0.874	1.191	1.194
V	0.006	0.007	0.004	0.004	0.005	0.004	0.004	0.003	0.003	0.004	0.003	0.005	0.008	0.008	0.004	0.004	0.006	0.007
Total	3.030	3.026	3.012	3.009	3.006	3.012	3.015	3.011	3.023	3.025	3.015	3.014	3.020	3.015	3.009	3.007	3.016	3.012
Fe/Fe + Mg	0.449	0.490	0.365	0.360	0.359	0.377	0.384	0.382	0.391	0.385	0.375	0.367	0.575	0.555	0.378	0.373	0.474	0.466

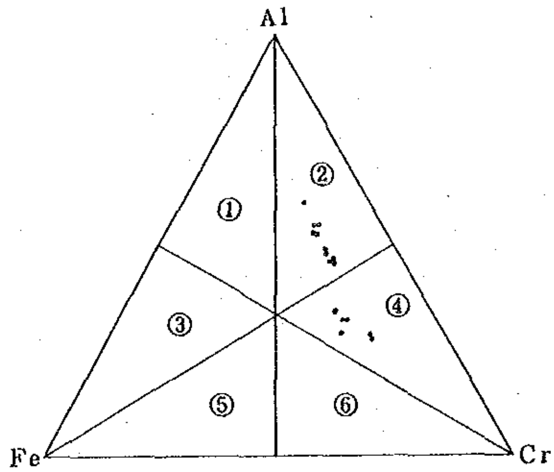
CHAPTER 3 MINERALIZATION AND ULTRABASIC ROCK

Ultrabasic rock of Pasaman area consists mainly of hartzburgite and a small distribution of dunite. The ultrabasic rock could be similar to ultrabasic rock distributing at tectonic zone of the world, based of compositions of olivine, clinopyroxene and orthopyroxene, and its forming temperature (650° – 750°) calculating from partition value of Mg and Fe of clinopyroxene and orthopyroxene. The ultrabasic rock was accreted from mantle, when marginal sea was closed at late Cretaceous age.

Chrome mineral associating in dunite contains Cr_2O_3 50%, but chrome minerals in hartzburgite have Cr_2O_3 27% 44%, Al_2O_3, and are called chrome spinel (Fig. V-2)

Though the ultrabasic rock bears chrome mineral as accessory mineral, it is a few possibility to develope to economical chromite ore deposit, under the consideration of grade of the mineral and hartzburgite dominant ultrabasic rock.

It is very useful to trace % dunite distribution in ultrabasic rock for survey of chromitite at Pasaman area.



① Ferrian Spinel
② Chromian Spinel
③ Alminian Magnetite
④ Alminian Chromite
⑤ Chromian Magnetite
⑥ Ferrian Chromite

Fig. V-2 Composition Diagram of Chrome Mineral in the Hartzburgite of Pasaman Area

PART VI

CONCLUSION AND RECOMMENDATION FUTURE

1-1. Conclusion

The results of Cooperative Exploration Survey conducted from 1982 through 1985 in Northern Sumatora, Republic of Indonesia, are summarized as follows:

(1) The granite in the Hatapang Area is considered to be tin bearing granite to belong to part of the Thai-Malaysian-Indonesian tin mineralized zone. At the contact between the granite of the Mabar river and the sedimentary rock, anomalous areas were found by the geochemical survey but the tin mineralized showing could not be confirmed on the ground surface.

(2) In the Pagar Gunung mineralized zone in the Muara Sipongi Area, 4 mineralized zones, Mineralized Zone I (silver, lead and zinc mineralization), Mineralized Zone I' (gold, silver, copper, lead and zinc mineralization). Mineralized Zone II (sphalerite, pyrrhotite and pyrite mineralization) and Mineralization Zone III (pyrite mineralization) were confirmed, and the expected possible ore reserve of the Mineralization Zones I and I' which seem to be most promising is 800,000 t average width (thickness) 0.88 m, silver 68 g/t, Cu 0.45%, Pb 1.20% and zinc 4.60%.

(3) The ultrabasic rock in the Pasaman Area mostly consists of harzburgite and it is considered that economically worthwhile chrome deposit which is embedded is too small.

1-2 Recommendation for future programme

It is recommendated Indonesian Government as following idea to continue the survey in the project area.

(1) Pagar Gunung Minneralized Zone
Implementation of the drilling survey to confirm that the silver bearing lead-zinc deposit embeded in the argellaceous rock predominancy facies, especially in the eastwest extention of the Mineralized Zone I', which was newly found by the third phase drilling survey.

(2) Implementation of geochemical, geophysical and drilling surveys to confirm the possibitity of the mineralized zone embeded horizone (Patahajang Formation, Sedimentary Rock and Pyroclastic Rock Member) distributed in the range from Pagar Gunung Mineralized Zone to Barute Mineralized Zone-Patahajang Mineralized Alteration Area (eastwest extention 6 km), especially in the anomalous area (EW 3 km x SN 1 km) found in the range by the geochemical survey (soil).

REFERENCE

Geology and Geochemistry

1. Aoki K. (1978); Petrology of Upper Mantle, Igneous Rock and its Genesis, Chikyu Kagaku (Geoscience) Vol. 3 41 – 86 (Iwanami Shoten) (in Japanese)
2. Aramaki S. et al (1972); Chemical Composition of Japanese Granites Part 2 Variation Trends and Average Composition. Jour. Gel. Soc. of Japan Vol. 78, No. 1, p.39 – 49
3. Aramaki S. (1978); Origine of Felsic Magma Igneous and its Genesis, Chikyu Kagaku (Geoscience) Vol. 3 138 – 150 (Iwanami Shoten) (in Japanese)
4. Bemmelen R. W. (1970); Geology of Indonesia 2 vols, Martinus Nijinhoff The Hague (2nd ed.)
5. Ben-Avraham, Z. (1978); The Evolution of Marginal Basin and Adjacent Shelves in East and South Asia, Tectonophysics 45, p.269 – 288
6. Cameron N. R. et al (1980; The Geological Evolution of Northern Sumatra, Ninth Indonesian Petroleum Association Convention
7. Clark M. C. G. et al (1982); Geological Map of the Pematangsiantar Quadrangle Sumatra (1/250,000)
   Geological Research and Development Center, Indonesia
8. Clark M. C. G. & Surjono (1982); Primary Tungsten Occurences in Sumatra and the Indonesian Tin Islands, Bull. Directorate of Mineral Resources Indonesia No. 5 bul. Vol. 1
9. Coleman R. L. (1977); Ophiolite, Springer – Verlag, Berlin
10. Dickey J. S. Jr. (1975); A Hypothesis of Origin for Podiform Chromite Deposits, Geoch. et Cosmochim. Vol. 39 1061 – 1074
11. Finaudi M.T. and Burt D.M. (1982); Introduction-Terminology, Classification and Composition of Skarn Deposits (A Special Issue Devoted to Skarn Deposits),
    Econ. Geol. vol. 77 No. 4, 745 – 754
12. Geochemical Study Group (1975); Hand Book of Geochemical Exploration (in Japanese) Mining and Metallugical Institute of Japan
13. Haan W. De (1921); Herinneringen aan mijnbouwkundig exploratiewerk in het Zuiden der Residentie Tapanoeli.
    Geol. Mijinb. Gen., Mijinb. Serie, Vol. I 1912 – 1221, 229 – 296.
14. Hamilton W. (1978); Tectonic Map of the Indonesian Region United State Geological Survey
15. Hamilton W, (1979); Tectonics of the Indonesia Region, USGS Prof. Rep. 1078
16. Hoskins K. F. G (1979); Tin Distribution Patterns, Geol. Soc. Malaysia, Bull. Vol. 11 Dec. 1 – 70
17. Hutchison C. S. (1973); Tectonic Evolution of Sundaland: A Phanerozoic Synthesis
    Geol. Soc. Malaysia, Bulletin 6, July, p.61 – 86
18. Hutchison C. S. (1975); Ophiolite in South Asia, Bulletin of Geological Society of America, Vol. 86, 797 – 806
19. Ishihara, S. (1977); The Magnetite-series and Ilmenite-series Granitic Rocks, Mining Geology 27, No. 145, p.293 – 305
20. Ishihara S. et al (1979); The Magnetite-series and Ilmenite-series Granitoids and Their Bearing of Tin Mineralization Particularly of the Malay Peninsular region,
    Geol. Soc. Malaysia Bull. Vol. 11, Dec. 103 – 110
21. Ishihara, S. et al (1980); grainites and Sn-W Deposites of Peninsular Thailand, Mining Geology Special Issue No. 8
22. IUGS (1973); Plutonic Rocks, Classification and Nomenclature Recommended by the

IUGS, Subcommission on the Systematics of Igneous Rocks. Geotimes Oct. 1973.

23. Katili J.A. (1967); On the Occurrence of Large Transcurrent Fault in Sumatra, Indonesia, Jour. of Geoscience, Osaka City University Vol. 10 Art 1 – 1 5 – 17

24. Katili J.A. (1969); Permian Volcanism and its Relation to the Tectonic Development of Sumatra, Bull. Volcanologique XXXIII-2, p.530 – 540

25. Katili J.A. (1970); Naplet Structure and Transcurrent Faults in Sumatra, Bull. National Institute of Geology and Mining Bandung vol. 3 No. 1 11 – 28

26. Katili J.A. (1973); Geochronology of West Indonesia and its Implication on Late Techtonics Tectonophysics 19, p.195 – 212

27. Katili, J.A. (1973); Plate Tectonics and its Significance in the Search Mineral Deposits in Western Indonesia, CCOP Technical Bulletin Vol. 7

28. Katili, J.A. and Hartono, H. M. S, (1979); Van Bemmelen Contributions to the Growth of Geotechnics and the Present State of Earth-Science Research in Indonesia, Geologie Mijinbouw Vol. 58 (2), p.107 – 116

29. Katili, J.A. (1981); Geology of South Asia with Paticular Reference to the South China Sea, Bull. of the Geological Research and Development Center of Indonesia No. 4, March 1981, p.1 – 12

30. Klompe H.F., Katili J.A., Johannas and Soekendar (1961); Late Paleozoic Volcanic Activity in The Sunda Land Area,
Pacific Sci. Cong. 9th Bangkok 1975 Proc. v 12 204 – 216

31. Mitchell A. H. G. (1979); Rift-Subduction-and Collision-Related Tin Belts, Geol. Soc. Malaysia, Bull. Vol. 11, Dec. p.81 – 102

32. Mori T. and Banno S. (1973); Petrology of Periodotite and Garnet Clinopyroxenite of Mt. Higashi Akaishi Mass, Central Shikoku, Japan (Subsolidus Relation of Anhydrous Phase, Contr. Mineral & Petrol. 41 301 – 323

33. OMRDC (1971); Summary Report on the Survey of Sumatra No. 5 Block (unpublished).

34. Page B. G. N. (1981); The Serpentinites of Northern Sumatra, Bull. Directorate of Mineral Resources Indonesia No. 3 Vol. 1 103 – 113

35. Prime, H. N. A. et al (1975); Isotope Geochronology in the Indonesian Tin Belt, Geol. Mijinbouw 54, p.61 – 70

36. Rock N. M. S., A. Djunuddin and et al (1980); Geology of the Natal Teluk Dalam (Part) Quadrangles, DMR/IGS Northern Sumatra Project (unpublish)

37. Rocksalagora, W. and Djumhani (1971); Metallic Mineral Deposits of Indonesia, XII Pacific Science Congress

38. Silitonga P. H., Kastowo (1975); Geological Map of Solok Quadrangle, Sumatra Direktorat Geologi, Indonesia

39. Takahashi, M. and et el (1980); Magnetite Series/Ilmenite Series vs I-Type/S-Type Granitoids,
Mining Geology Special Issue No. 8

40. Taylor D. and Hutchison C. C. (1978); Pattern of Mineralization in Sourth Asia. Their Relationship to Broad Scale Geological Features and the Relevance of Plate Tectonics Concepts to their Understanding.
Eleventh Commonwealth Mining and Metallurgical Congress

41. Tsusue, A. and Ishihara, S. (1974); The Iron-Titanium Oxide in the Granitic Rocks of Southwest Japan
Mining Geology, Vol. 24, p.13 – 30

Geophysical Survey

42. J.S. Summer (1976); Principles of Induced Polarization for Geophysical Exploration

43. Kaku H. (1966); On the Coupling Effect in the Induced Poralization Method, Butsuri Tanko, 19 (405)

44. Wait J. R. (1958); Discussions on a Theoretical Study of Induced Electrical Polarization, Geophysics, 23

45. Hallof P. C. (1964, 1967); A Comparison of the Various Parameter Employed in the Variable Frequency Induced Polarization Method,

46. Pelton W.H., Ward S.H. Hallof P.G., Sill W.R. and Nelson P.H. (1977); Mineral Discrimination and Removal of Induced Coupling with Multi-frequency IP, Metal Mining Agency of Japan, 1980 – 1982
Report on Research and Development Survey for Mineral Resources – Spectral IP

Drilling Survey

1. Cumming J.D. (1975); Diamond Drilling Handbook J.K. Smit & Sons Diamond Products Ltd. *Toront*