REPORT
THE COOPERATIVE MINERAL EXPLORATION IN THE TASIKMALAYA AREA, WEST JAVA THE REPUBLIC OF INDONESIA

PHASE II

MARCH 1996

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

REPORT

ON

THE COOPERATIVE MINERAL EXPLORATION

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PREFACE

The Japanese Government, in response to a request extended by the Government of Indonesia, decided to conduct a mineral exploration in the Tasikmalaya area, West Java, and entrusted the survey to the Japan International Cooperation Agency (JICA) and the Metal Mining Agency of Japan (MMAJ).

The Government of the Republic of Indonesia appointed the Directorate of Mineral Resources to make the survey as a counterpart to the Japanese team. The survey was carried out from 1994 jointly by experts from both governments.

The Second Phase of the Cooperative Mineral Exploration consists of geological survey, geochemical survey, geophysical survey and drilling exploration for precious- and base-metal resources in the Tasikmalaya area.

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

We wish to express our sincere appreciation to the officials concerned of the Government of the Republic of Indonesia for their close cooperation extended to the team.

March 1996

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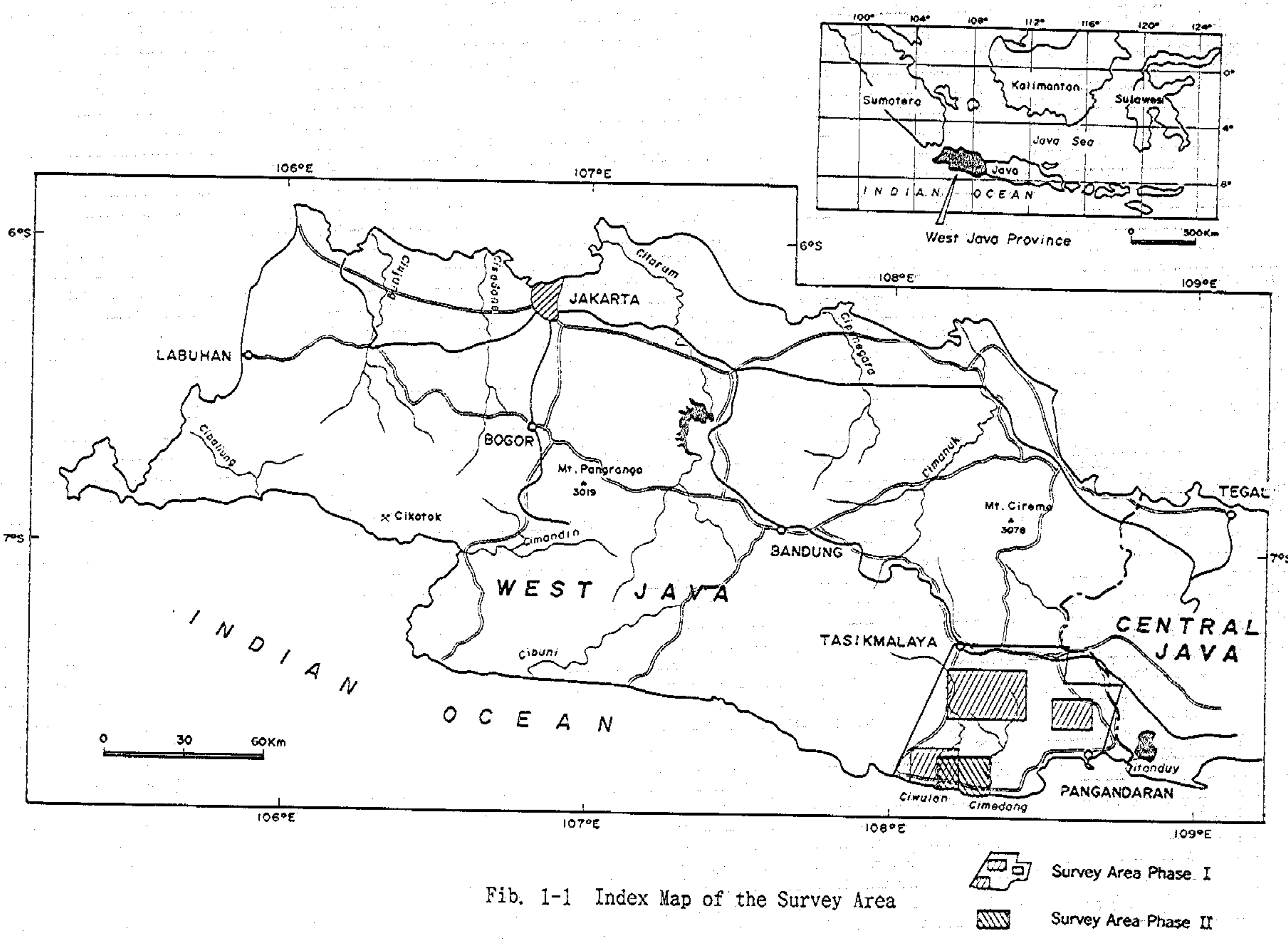

Fib. 1-1 Index Map of the Survey Area

SUMMARY

The survey this year corresponds to the second phase of the Cooperative Mineral Exploration in the Tasikmalaya area. The principal objective of this project is to find a new mineral deposit in the Tasikmalaya area through the exploration and examination of geology and mineralization. The works this phase were composed of geological survey, rock-chip geochemical survey, gravity geophysical survey, IP electric survey and drilling exploration in the Cisasah-Cidadap-Cibuniasih area where was thought to have a potential for the massive sulfide deposit. A survey length of nearly 170 km was traversed, and more than 300 rock-chip samples and 150 alteration samples were collected through the geological survey and geochemical rock-chip sampling. The gravity survey was made using LaCoste gravimeters over an area of 340 km^2, and Bouguer anomaly maps were prepared. The Time-Domain IP electric survey was carried out in the Cibuniasih area, and the IP resistivity and chargeability anomalies were analyzed. The drilling program this phase consisted of seven vertical holes of diamond drilling totaling 1,704.10 m. Among these holes, two vertical holes totaling 401.00 m (MIT-1~2) were drilled within the area for the purpose of investigating the basement structure and the nature of alteration haloes of massive sulfide mineralization. The other five holes totaling 1,303.10 m (MIT-3~7) targeted to the lower extension of the most significant rock-chip geochemical anomalies and IP chargeability anomalies.

Miocene dacitic volcanic and pyroclastic rocks, called green tuff in the field, are widespread in the Cisasah-Cidadap-Cibuniasih area. Two massive anhydrite-gypsum ores (Cisasah and Cidadap) and a barite bed (Cibuniasih) were found within the green tuff. Stratabound manganese ores, ferruginous chert layers and silicified zones, most of which were thought to be genetically related to the massive sulfide mineralization, are developed near the occurrences of gypsum and barite. Details of the volcano-stratigraphy and hydrothermal alteration of these mineral occurrences were studied this phase.

These stratabound deposits occur at a couple of horizons within the green tuff succession comprising dacitic tuff, fine tuff, pumice tuff and tuff-breccia. Dacite lava occurs among the pyroclastic members. The structure of the green tuff is characterized by a regional gentle synclinorium and local basin structures. It generally shows gentle western dip in the eastern part of the area. Whereas in the western part, green tuff dips gently to the east. These foldings have axes of N-S to NE-SW directions. A couple of basin structures, about 10 km in diameter was recognized in the central-northern and central-southern parts of the area. The total thickness of the green tuff was estimated to exceed to 300 m amidst the basin. The Bentang calcareous sandstone, and Kalipucang limestone in some cases, occur above the green tuff.

On the basis of the result of the X-ray diffraction analysis, six hydrothermal alteration zones -- silicified zone, sericite-chlorite-mixed layer zone, montmorillonite-kaolin zone, zeolite zone, pyrophyllite-kaolin zone, and carbonitized zone -- were distinguished regionally in this area. Among these alteration zones, three zones were recognized to be closely related to the massive sulfide mineralization arranging in the order of -- central sericite-chlorite zone, intermediate montmorillonite-kaolin zone, and peripheral zeolite zone. The sericite-chlorite zone occurs in the most strongly altered area. According to the result of alteration survey, intense sericite-chlorite alteration zones were delineated in several locations within the survey area.

The stratigraphic succession of the massive sulfide mineralization was categorized into several zones together with the host green tuff members in descending order as follows: hanging-wall green tuff, manganese zone, intermediate green tuff, barite-galena bed, anhydrite-gypsum zone, and footwall green tuff. The assemblages of alteration minerals in each of the above-mentioned six zones were defined in details this phase. The mode of occurrence and distribution of geochemical anomalies for metallic elements and alkali components from which the alteration index (A.I.) was calculated were examined through the rock-chip geochemistry, and several significant anomalous zones were outlined. Five potential mineralized areas thus chosen are: Cisasah, Cikoplok-Panyairan, Cidadap, Cibuniasih, and Balekambang.

As a result of the gravity survey in conjunction with the geologic structure of this area, three important structural components -- basin and basement uplift, fault, and local trough -- were defined. Two basins and three uplifts were distinguished in this area: Cikalong basin, Cibongas basin, Middle Ciwulan uplift, Pasir Gintung uplift, and Pasir Garu uplift. Several steep gravity gradients were observed and considered geologically as faults. Some of them are N-S system: at the western side of the Cikalong basin, at the western side of the Pasir Garu uplift, and one extending from Cibuniash to the north. Another is E-W system: at the northern side of the Cikalong basin. A local trough was found in the vicinity of Cibuniasih barite bed on the analytical result of gravity residuals. It is located at the flank of the gravity structure between the Pasir Gintung uplift and Cikalong basin, stretching to the southwest. Another trough structure was recognized at the south of Cisasah gypsum mine stretching to the northeast. The known stratabound mineral showings lie on the flank of the gravity structure from an uplift to a basin, which was interpreted to be situated at the margin of a basin facing to a basement uplift. The Cibuniasih barite bed occurs on the flank of the Pasir Gintung uplift to the Cikalong basin. The Cisasah gypsum deposit is situated on the flank of the Middle Ciwulan uplift to the Cibongas basin. The Cidadap gypsum deposit, which is not so distinctive as the former two cases, looks to be located at the middle of the Middle Ciwulan basin down to a gravity low near the coast of Indian Ocean. Another interesting feature from the gravity geophysical point of views is the spatial relationship of manganese ores to gypsum or barite ores. The stratabound manganese ores occur near the gypsum or barite, and always occupy structurally at a higher position to them.

The Time-Domain IP (Induced Polarization) electric survey was carried out in the Cibunlasih area. Anomalies of the chargeability (more than 4.0 mV•S/V) were mainly detected at: (a) south-western part of lines C, D, (b) south-western part of line A ((a) and (b) are located in Sukasari), and (c) middle part of lines J, K, L (Bihbul). These anomalies occur from shallow into deep zones (about 150 m below the surface) in distinct expanse, and were detected in the low resistivity background ranging from 5 to 30 ohm-m which corresponded to tuff of the Upper Member of the Jampang Formation. Especially, anomalies (a) occur in the very low resistivity (>10 ohm-m) zones which coincide with gravity trough structure.

These anomalies have no distinct relation to the resistivity pattern and are not so different from low background, indicating that they are related to the mineralization with clay alteration. Silicification and sericite-chlorite alteration were observed at drill hole MIT-7 whose target was the shallow anomaly at No. 16 on line I. This type of alteration is expected to occur in an anomalous area.

Smaller scale anomalies were detected at: (d) in the vicinity of Nos. 11 and 16 on line I, (e) in the vicinity of No. 8 on line H, (f) in the vicinity of No. 5 on line E, and (g) in the vicinity of No. 36 on line A.

Four holes (MIT-1~4) totaling 962.60 m were drilled in the western part of the Cisasah-Cidadap-Cibunlasih area. Although no intersection of massive sulfide ore has been caught in these reconnaissance drill holes, a significant amount of information regarding the volcano-stratigraphy and hydrothermal alteration associated with massive sulfide mineralization was obtained. Among four holes, the most intense hydrothermal alteration was caught in MIT-4.

The other three holes (MIT-5~7) totaling 741.50 m were drilled in the eastern part of the Cisasah-Cidadap-Cibunlasih area. The result of these holes provided a significant amount of information regarding the volcano-stratigraphy and hydrothermal alteration associated with massive sulfide mineralization. It also contributed to check the relationship between the IP anomaly and mineralization/alteration figures in the study area. Among three holes, the most intense hydrothermal alteration was caught in MIT-7.

The area in the vicinity of Cisasah, especially from the Cisasah gypsum mine to Panyosogan, is a significant potential prospect of massive sulfide deposit. Because it is situated geologically on a favorable structural location: at the margin of the Cibongas basin where is facing to the Middle Ciwulan basement uplift, and also because pervasive sericite-chlorite alteration is distributed both on the surface and below the surface. The southeastern part of the area is covered by the Bentang calcareous sandstone. Several alteration horizons were caught in the drill hole MIT-4. One of them, probably the middle one in which significant pyrite dissemination was accompanied, was interpreted to be correlated to the Cisasah gypsum ore horizon. Due to the existence of a mining concession (KP 912, 90 ha), the drilling activity was limited this year. After the expiration of this concession in the next phase, an exploration program comprising the IP survey and follow-up drilling can evaluate the potential of this area. It is recommended that the detailed IP survey shall be made within an area of 4 to 5 km^2 which covers the Cisasah gypsum deposit and its eastern area. After the IP survey, a reconnaissance drilling for testing the IP anomalies shall be made. The target depths should be set slightly deeper to the east because it is going to approach the green tuff basin.

The area in the vicinity of Cibuniasih, especially to the south of the Cibuniasih barite bed, is thought to be another significant potential prospect of massive sulfide deposit; it is situated structurally at the marginal part of the Cikalong basin facing to the Pasir Gintung basement uplift; an extensive sericite-chlorite alteration zone occurs on the surface and in the depth; and a series of distinctive IP chargeability anomalies was detected at several places. The prospective locations are Sukasari and Bihbul. Sukasari is located 1,200 m southwest of the Cibuniasih barite bed. The surface of the location is widely covered by the Kalipucang limestone. Some of the chargeability anomalies caught in Sukasari are still open both to the northwest and to the southeast. The other alteration zones occur to the southwest of Sukasari as well. Bihbul is located 1,200 m southeast of Cibuniasih barite bed. Remarkable IP chargeability anomalies were detected below the rice-field where some quartz floats with limonite dissemination were found in green tuff outcrops. Two drill holes (MIT-6 and 7) were dug in these IP anomalies, and three intensive alteration zones (upper, middle and lower horizon) consisting mainly of silicification and sericitization-chloritization with significant dissemination of pyrite were caught in these drill holes. The drilling activity this phase was limited because it was done in the rainy season. The follow-up drilling for targeting some IP anomalies which were caught this phase and will be detected by the additional IP survey next phase is necessary in the dry season next year. An exploration program comprising additional IP survey in Sukasari, and reconnaissance drilling for testing IP anomalies in Sukasari and Bihbul is recommended in the next phase. The total area is around 20 km^2.

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PART I OVERVIEW

PART I OVERVIEW

Chapter 1 Introduction

1-1 Background and Objective

The Indonesia-Japan Cooperative Mineral Exploration has been carried out in seven areas of the Republic of Indonesia: Sulawesi (1970-1972), Kalimantan (1974-1977), West Kalimantan (1979-1981), North Sumatra (1982-1984), South Sumatra (1985-1987), Pegunungan Tigapuluh (1989-1990) and Toraja (1991-1993). As a result of these works, a large amount of information regarding metallic mineral resources was obtained. The exploration also contributed to the technical progress of the Geological Survey of Indonesia and the Directorate of Mineral Resources, as well as to the acquisition and accumulation of knowledge regarding geology and mineral deposits of the country.

The Ministry of Mines and Energy of Indonesia planned to conduct mineral exploration in the Tasikmalaya area, West Java, and requested the cooperation of the Japanese Government. In August 1994, the Japanese Government, responding to the request, sent a mission for discussing the Scope of Work and to make a program of the first phase survey. As a result of consultations with the Directorate of Mineral Resources, the counterpart of the Japan International Cooperation Agency and the Metal Mining Agency of Japan, an agreement was reached for cooperative mineral exploration in the Tasikmalaya area on August 25, 1994.

The survey this year was the second phase of the Cooperative Mineral Exploration in the Tasikmalaya area, West Java Province, the Republic of Indonesia.

The principal objective of this project is to find a new mineral deposit in the Tasikmalaya area through the exploration and examination of geology and mineralization. It is also important to pursue technology transfer to the Indonesian counterpart organization in the course of the project.

In 1994, preliminary investigation and the first phase field survey were carried out for the purpose of assessing the potential of mineral resources in the Tasikmalaya area. The major works completed during the first phase were satellite image photogeological interpretation, review of the existing geological information, geological survey and geochemical exploration. The entire study area was 3,200 km^2, and the field survey was made in three areas of approximately 1,000 km^2 in total -- Salopa, Sidamulih and Cisasah

The program this year was composed of geological survey, rock-chip geochemical survey, gravity and IP geophysical surveys and drilling exploration in the Cisasah-Cidadap-Cibuniasih area. The major purpose of this phase was to define target zones for the further exploration within the survey area. Exploration efforts were concentrated on the prospective areas which were extracted in the first phase survey. It was also required for the further exploration to elucidate the nature and characteristics of mineralization in the survey area.

1-2 Conclusions and Recommendations of the First Phase Survey

1-2-1 Conclusions of the First Phase Survey

On the basis of the results of the first phase works comprising satellite image photogeological interpretation, review of the existing geological information, geological survey and geochemical exploration, the following conclusions were obtained.

<u>Salopa Area</u>

(1) The JERS-1 SAR data were processed and two scenes of monochrome image of 1:200,000 scale were prepared. The topography, drainage systems, geology and geologic structure were analyzed on these images. A total of eleven geologic units was classified and identified within the area. These photogeologic units were examined during the field survey, and relatively good correlation with the results of geological survey was obtained. Photolineaments and circular structures were extracted on the image in the survey area. Among them, a complex circular structure centered near Salopa was interpreted to be an old volcanic depression related to the volcanic activity of the Upper Member of the Jampang Formation. No field evidence connecting this photogeological structure to the vein system has been found during the field survey. It must be further studied in the next phase survey.

(2) A total of 17 epithermal gold showings was found through geological survey and geochemical exploration in the Salopa area. Among them, the Ciniru-Cikuya prospect showed a significant potential of epithermal gold deposit. Several gold-bearing quartz veins and network veins occur at the junction of S. Ciniru and S. Cipanawar. Gold was recognized in a series of quartz veins/networks of mainly NW direction. Test samples taken from the quartz vein outcrops on the river-bed showed significant gold and silver values. Distinctive gold anomalies were caught by panning survey, stream sediment survey and reconnaissance soil survey in this prospect. A group of quarzt veins/networks trending NW and NNE is developed at S. Cikuya. Significant gold and silver grades were obtained from grab samples of old workings. Small but solid geochemical gold anomalies were also found in this prospect. These two prospects are located in an area of 8 km (NW-SE) by 5 km (NE-SW) in the southern part of the Salopa area. Some anomalies of panning survey and stream sediment geochemistry were caught at the middle reaches of S. Cimedang which was situated at the middle of these two prospects. Gold mineralization is expected to be continued in this zone.

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Note MRD : Mineral Resources Department

NED : Nikko Exploration and Development Co., Ltd.

Chapter 2 Geography of the Survey Area

2-1 Location and Access

The island of Vanua Levu is approximately 180 km east-west, 35 km north-south and approximately 5,500 km^2 in areal extent. It is located at latitude 16°07′S-17°01′S and longitude 178°29′E- 179°57′W, and is approximately 2,800 km east of the eastern coast of Australia, approximately 2,000 km north of New Zealand and approximately 2,000 km south of the equator.

The major population centers are developed along the coast, namely Labasa, Savusavu and Nabouwalu. Entrance to Fiji is via air and usually through the international airport at Nadi on Viti Levu. Flight from Viti Levu to Vanua Levu by commercial airplane takes 25 minutes via either Nadi or Nausori near Suva. Existing roads circle the island except for the northeastern part. The majority of the main roads between Labasa and Savusavu, and Labasa and Nabouwalu is paved.

2-2 Topography and Drainage

The island shows generally gentle undulation in the northern part and steep mountainous topographic feature. Dominant rivers such as the Dreketi and Labasa Rivers have developed in the northern part of the island and carry silt to the sea, resulting in the development of lowlands with mangrove plants in some areas. The mountains are around 600m to 900m in elevation, with the highest peak Mountain Nasorolevu, reaching 1,032m. The top of the mountain range is gentle in topography, characterized by flat peaks around which a narrow drainage system has developed with numerous waterfalls. The cone shaped volcanoes vary in size such as large Bua Volcano, and in contrast, the smaller one east of Viani Bay.

2-3 Climate and Vegetation

As Vanua Levu belongs to the tropical rain forest climatic zone, it has two seasons, dry (April - November) and wet(December - March). Also, it is located in the monsoon zone and there is a southeasterly trade wind throughout the year. Precipitation on the northern side of the island is relatively low, and high on the southern side. The monthly temperature and precipitation observed at Labasa and Nabouwalu is listed below.

(Data in 1994)

			Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sept.	Oct	Nov.	Dec.	Annual
Labasa	Temp. (℃)	high	31.3	32.0	31.9	30.9	29.6	28.7	29.3	29.3	29.3	30.7	31.4	32.4	30.6
		low	22.5	22.6	22.8	21.9	20.0	17.3	18.3	17.5	18.8	18.6	21.5	21.5	20.3
	Precipitation (mm)		250	531	522	69	21	76	1	3	85	13	120	94	1,785
Nabouwalu	Temp. (℃)	high	30.6	30.7	30.1	28.8	27.3	26.1	25.6	26.2	25.6	26.8	28.9	29.6	28.0
		low	24.9	24.8	24.9	24.5	23.1	22.0	21.1	22.1	21.4	22.3	23.7	24.3	23.3
	Precipitation (mm)		348	417	569	103	123	163	53	12	76	6	116	191	2,177

The greater part of Vanua Levu is covered by dense forest, while some areas are covered with planted pine trees. There are many palms along the coast.

Chapter 3 Available Geological Information

3-1 Outline of Past Geological Surveys

An outline of the geology of Fiji was reviewed and summarized by Rodda (1989), Okuda (1989) and others. Geological maps of Vanua Levu at 1:50,000 have been published covering the whole island by the Geological Survey of Fiji (now the MRD). The sheet number, area and the index map are shown below.

1-2-2 Recommendations for the Second Phase Survey

Salopa Area

Structural analysis must be made on the area where indications of gold mineralization were extracted through the first phase survey by means of photogeology using airphotos. It was for the purpose of studying the relationship of structural factors to the gold mineralization, especially the circular structure recognized on the SAR image.

It was recommended that the major mineralized zones be explored by the detailed geological survey and soil survey in the second phase. Reconnaissance drilling was also recommended to test the geochemical anomalies delineated by the soil survey.

The promising prospects for the detailed survey and drilling were as follows:

(a) Ciniru-Cikuya prospect (40 km^2)

(b) Cikondang-Citambal-Ciseel prospect (40 km^2)

Sidamulih Area

No further work was recommended in the Sidamulih area.

Cisasah Area

It was recommended that the semi-detailed survey for massive sulfide deposit comprising geological survey and alteration survey be made on an area of 20 km (E-W) by 15 km (N-S) in which Cisasah, Cidadap and Cibunlasih are included. Structural drilling would be necessary for the purpose of exploring the horizon of mineralization and catching the alteration halo.

The gravity survey was also recommended over the prospect in order to investigate the basement structure and structural setting of massive sulfide mineralization.

1-3 Outline of the Second Phase Survey

1-3-1 Survey Area

The second phase field survey was carried out in the Cisasah-Cidadap-Cibuniasih area (300 km^2) which was selected on the basis of the results of the first phase survey. It is located in the southeastern part of West Java Province. The location map of the survey area is shown in Fig. 1-2.

1-3-2 Exploration Theme

The exploration this year corresponded to the second phase of the three-year cooperative mineral exploration program in the Tasikmalaya area.

The works this phase were composed of geological survey, geochemical survey, geophysical survey and drilling exploration in the Cisasah-Cidadap-Cibuniasih area.

The major themes of geological and geochemical surveys were to survey mineral showings in the prospects, to catch geochemical anomalies, and to define target mineralization for the next phase exploration by means of the detailed investigation on geology and mineralization in the area. The potential of massive sulfide deposit was looked for in the Cisasah-Cidadap-Cibuniasih area.

The major exploration themes of geophysical survey were to analyze the relationship between mineralization and geophysical properties and to catch geophysical anomalies in the survey areas. Two geophysical methods were employed this phase. The gravity survey was made for investigating the basement structure by which the massive sulfide mineralization was supposed to be controlled. The IP electric survey was tested for extracting IP anomalies which were expected to be related to the massive sulfide mineralization in the survey area.

The major themes of drilling exploration were to test the lower parts of the mineralized zones which were delineated by geological, geochemical and geophysical surveys.

1-3-3 Exploration Work

The field work in the Cisasah-Cidadap-Cibuniasih area was composed of geological survey, rock-chip geochemical survey, gravity survey, IP electric survey and drilling. It consisted of approximately 300 km^2 in area (the gravity survey covered over an area slightly larger than the geological and geochemical surveys).

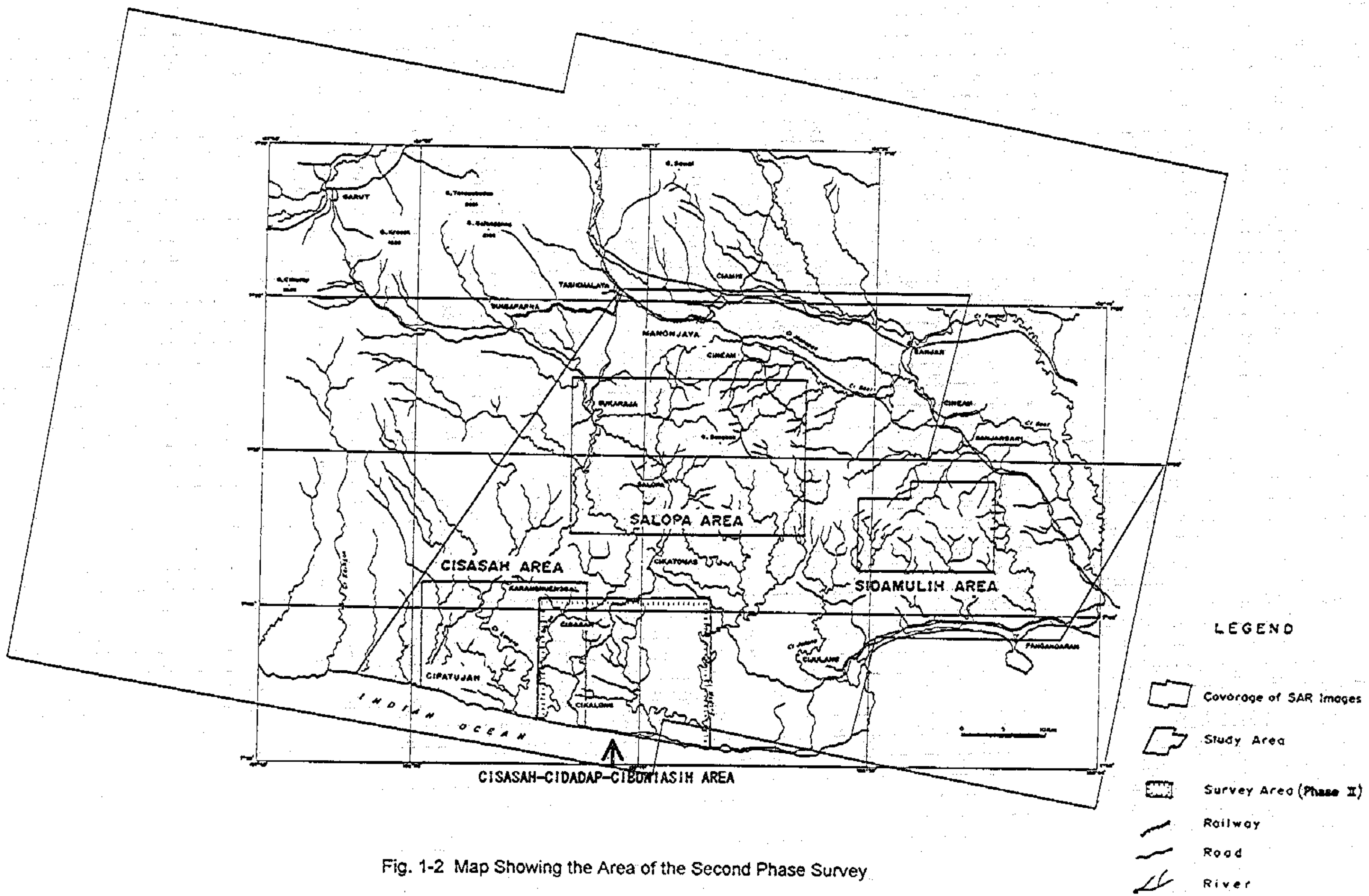


Fig. 1-2 Map Showing the Area of the Second Phase Survey

A series of 1:10,000 scale route maps was produced through surveying with fifty-meter tape and a Brunton-type compass. The results of the geological survey was compiled on 1:25,000 scale maps.

Geological survey and rock-chip sampling were made along major drainage systems at a sampling interval of approximately 1 piece per 500 m length.

A survey length of nearly 170 km was traversed, and 319 rock-chip samples and 155 alteration samples were collected altogether this phase.

Gravity survey was carried out at 316 stations using LaCoste gravimeters G-178 and G-365. Gravity value was determined based on the reference station DG. 0 (977,976.38mgal) at the main hall of GSI in Bandung. Leveling and positioning were mainly done by GPS (Global Positioning System) static method with the vertical error less than 1 m.

Rocks of the survey area were sampled and the density was measured for the gravity correction and density modeling of structural analysis. One hundred twenty-two samples were collected.

Bouguer anomalies were calculated and mapped. For the isolation of local anomaly from regional anomaly field due to deep crustal structure, gravity residuals were mapped and analyzed. Two-layer profile model analysis was applied for quantitative analysis.

Time-Domain IP survey was carried out in the Cibuniasih area which was extracted by the preceding geological, geochemical and gravity surveys. The configuration is dipole-dipole array with 50m spacing and N=1,2,3,4,5 in frequency 0.25 Hz. Resistivity and chargeability of selected rock and ore samples were measured in the laboratory in Japan by the same method as field measurement.

Sections and plan maps of apparent resistivity and chargeability were made. The interpretation of these results was done with the results of geological and geochemical surveys. The integrated analysis was made through the results of field work and laboratory work with full use of available data. Two-dimensional model simulation was applied for typical anomalous pseudo-section of resistivity and chargeability.

The drilling program this phase consisted of seven vertical holes of diamond drilling totaling 1,650 m. The minimum size of core was BQ. Drill logs were prepared at a scale of 1:200. A total of 142 geochemical samples, 53 alteration samples and 17 ore assay samples were obtained from drill cores.

Two vertical holes totaling 401.00 m (MIT-1 ~ 2) were drilled within the area for the purpose of investigating the basement structure and the nature of alteration haloes of massive sulfide mineralization. A series of scout drilling was conducted in the promising zones which were delineated from the results of geological survey, rock-chip geochemical survey and IP electric survey. The program consist of five vertical holes of diamond drilling totaling 1,303.10 m (MIT-3 ~ 7). It targeted mainly to the lower extension of the most significant rock-chip geochemical anomalies. Some of the target zones were selected on the basis of the IP geophysical analysis.

The amount of works done this phase is summarized as follows:

Survey	Amount of works
1. Geological & Geochemical Surveys	
Survey Area	300 km^2
Traverse Length	170 km
2. Geophysical Survey	
Gravity Survey	
Survey Area	340 km^2
Survey Point	316 pts
IP Electric Survey	
Survey Line	23.2 km
Survey Point	2,080 pts
3. Drilling	7 holes (Vertical -90 degrees) Total 1,704.10 m

The amount of samples for chemical analyses and laboratory works is as follows:

Chemical Analysis & Lab Work	Amount of Samples
1. Geological & Geochemical Surveys	
Thin Sections	12 pcs
Polished Sections of Ore	14 pcs
X-Ray Diffraction Analysis	155 pcs
Chemical Analysis	
a) Ores (Au,Ag,Cu,Pb,Zn,Fe,Mn,Ba)	30 pcs
b) Rock-Chips (Au,Ag,Cu,Pb,Zn,As Sb,Fe,Mn,Ba,CaO,MgO,K_2O,Na_2O)	314 pcs
2. Geophysical Survey	
Gravity Survey	
Specific Gravity	122 pcs
IP Electric Survey	
Resistivity & Chargeability	26 pcs
3. Drilling	
Thin Sections	22 pcs
Polished Sections of Ore	15 pcs
X-Ray Diffraction Analysis	53 pcs
Chemical Analysis	
a) Ores (Au,Ag,Cu,Pb,Zn,Fe,Mn,Ba)	17 pcs
b) Rock-Chips (Au,Ag,Cu,Pb,Zn,As Sb,Fe,Mn,Ba,CaO,MgO,K_2O,Na_2O)	142 pcs

1-3-4 Survey Team

The geological and geochemical surveys of the second phase were carried out during the period from June 26 to August 2, 1995. Geophysical survey was made within the period from June 26 to December 5. Drilling exploration proceeded from July 31, 1995 to January 5, 1996. Laboratory works and reporting followed the field works. The organization of the survey team was as follows:

[Metal Mining Agency of Japan]

Eishi ENDO	Coordinator
Tetsuo SUZUKI	Coordinator, Manila Office

[Members of Indonesian Team]

Koswara Yudawinata	(DMR)	Coordinator and Geologist
Deddy T. Sutisna	(DMR)	Team Leader and Geologist
Atok S. Prapto	(DMR)	Geologist
Syahya Sudarya	(DMR)	Geologist
Erwin Hamzah	(DMR)	Geophysicist
Didi Setiamulya	(DMR)	Geophysicist
Ario	(DMR)	Geophysicist
Edi	(DMR)	Geophysicist
Supriadi	(DMR)	Surveyor
Iyus	(DMR)	Surveyor
Yatno	(DMR)	Surveyor
Warno	(DMR)	Drilling Engineer
Ruhiat	(DMR)	Drilling Engineer

[Members of Japanese Team]

Kohei IIDA	(NED)	Team Leader and Chief Geologist
Hideya KIKUCHI	(NED)	Geologist
Kazuyo HIROSE	(NED)	Geologist
Yasushi AOKI	(NED)	Geophysicist
Saburo TACHIKAWA	(NED)	Geophysicist
Shin'ichi SUGIYAMA	(NED)	Geophysicist
Susumu HORIGUCHI	(NED)	Drilling Engineer
Mitsuo SASAKI	(NED)	Drilling Engineer
Hiromasa INABE	(NED)	Drilling Engineer

*Note: DMR means Directorate of Mineral Resources
NED means Nikko Exploration and Development Co., Ltd.

Chapter 2 Geography of the Survey Area

2-1 Location and Access

Java is the fifth biggest island in Indonesia. The area is 127,000 km^2 and the population is nearly 100 millions. It forms a couple of island arcs stretching from northwest to east. One is the Greater Sunda Islands comprising Sumatra, Java, Kalimantan and Sulawesi. The other is the Lesser Sunda Islands branching from the former one at Java and continuing to Bali, Flores and Timor.

Java has its own traditional culture. It is a mixture of major three historical origins; a Hindu culture came in the 0th - 9th centuries, a local Java one born in the 10th - 14th centuries, and Islamic one introduced in the 15th century.

The survey area is located in the southeastern part of West Java, and is called the Tasikmalaya area. It is under the jurisdiction of West Java Province.

The access to the area is obtained either through sealed road or railway from Jakarta to Tasikmalaya via Bandung. The distance from Jakarta is approximately 250 km along the road, and it takes about 6 hours by motorcar. Tasikmalaya, which is the major city of the southeastern part of West Java, is located at the northwestern corner of the survey area.

The survey area (regional study area), shaped as a convex polygon of approximately 64 km by 50 km, is situated in a hilly land.

Access inland is rather easy. The road networks, connecting villages each other, are relatively well maintained in the area. Generally speaking, major roads are asphalt paved. While village roads, which are accounted for more than three fourths, are unsealed.

The estimated population of the Tasikmalaya area is something around 3 millions. Nearly 90 percent of the inhabitants are Sundanese and the remainder comes from other areas in Indonesia.

2-2 Topography and Drainage System

The survey area lies on the hilly southern flanks extending from the Java dividing range at the north down to the south coast of the island. The Java dividing range consists of a series of active volcanoes, running east-west to the north of the survey area. The closest volcano to the area is Gn. (Gunung) Sawal. It has a peak of 1,784 m above the sea. The topography of the survey area is mostly gentle. The greater part of the area stands between 100 and 500 m in elevation. There are several mountains of more than 1,000 m in the survey area. The altitude of the highest peak, Gn. Bongkok, is 1,144 m.

Rivers in the survey area flow down to south into the Indian Ocean. S. (Sungai) Cimedang and Ciwulan are the major drainage systems in the central to the western part of the survey area. Ciseel is the major drainage system in the eastern part of the survey area.

2-3 Climate and Vegetation

It is situated in a tropical monsoon climate zone. It has two seasons: rainy and dry. The rainy season generally starts from November and continues till February. The dry season begins in March and ends at October.

The mean temperature in the study area is between 23 and 30 °C. The annual rainfall ranges from 2,000 to 3,000 mm (climatological data for Tasikmalaya).

Some part of hilly land is covered by tropical rain forest. The highland area of the dividing range, however, belongs to the tropical highland forest -- broad leafed evergreen vegetation and coniferous vegetation. Most of alluvial plains and flanks of hills among the mountains are reclaimed, and paddy rice is cultivated. On steep hills among the mountains, a rubber plantation is developed as well as dry field rice and vegetables are planted.

Chapter 3 Geology of the Survey Area

3-1 Geological Setting of the Southeastern Part of West Java

The southeastern part of West Java belongs to the Neogene Sunda-Banda arc (Carlile and Mitchell, 1994). The Sunda-Banda arc was located on the southern margin of Sundaland which was constructed as a continental massif on the Paleogene or older basement.

The subduction of the Indian Ocean plate beneath the Sunda-Banda arc has been active since at least Eocene time. Available radioactive age determination data suggest that the magmatism related to this subduction took place in two distinct periods; the first was in late Eocene to early Miocene, and the second was in late Miocene to Pliocene. The early volcanic event produced the so-called "Old Andesites" (Van Bemmelen, 1949) which were exposed extensively along the south coast of Sumatra and Java Islands. They are mostly composed of tholeiitic volcanic rocks. On the contrast, the later Neogene event yielded a series of volcanic and pyroclastic rocks of medium to high K calc-alkaline composition. The axis of the latter volcanism has shifted about 60 km to the north from the former one. It roughly coincides with a chain of the recent volcanic front.

3-2 Geology and Geologic Structure of the Tasikmalaya Area

The southeastern part of West Java is made up of two major physiographic belts: hilly southern to central belt and northern volcanic belt. The Tasikmalaya area (regional study area) corresponds to the former belt. The latter belt lies outside the study area.

The geology of hilly southern to central belt is composed mainly of a series of Oligocene-Miocene sedimentary and volcanic rocks of the Jampang Formation. The Jampang Formation is made up of volcanic/pyroclastic rocks and sediments. The volcanic members consist mainly of andesitic to basaltic rocks which is correlated to the "Old Andesites". Dacitic pyroclastic rocks occur at the upper portion of the Jampang Formation in some areas. The Jampang Formation is overlain uncomformably by a series of sedimentary and pyroclastic rocks of the middle Miocene to Pliocene age. They are called the Kalipucang, Bentang and Halang Formations. The Kalipucang Formation is mainly composed of reef limestone. The Bentang Formation is mainly composed of calcareous sandstone. The Halang Formation is mainly composed of turbidites and tuffaceous sediments. These rocks have been intruded by dykes and sills of dacite/andesite and granodiorite.

The northern belt of the district is mostly occupied by Quaternary andesitic to basaltic volcanic rocks. These volcanics consist of lava, agglomerate, tuff and lahar (volcanic mud flow) deposit of Pleistocene to Holocene. The Halang Formation also occurs sporadically within the northern belt.

The tectonic regime of this district is dominated by NW to WNW and E-W trending faults and folding axes. This district has experienced at least twice of intensive orogenies. The first phase occurred in middle Miocene which resulted in uplift and was followed by the intrusion of dacite and granodiorite. It was accompanied by strong faults and folding movements within the Jampang Formation.

The second phase of the orogeny took place during the Plio-Pleistocene time. It has produced a series of faults which exhibit either strike-slip or thrust nature.

3-3 Mineralization

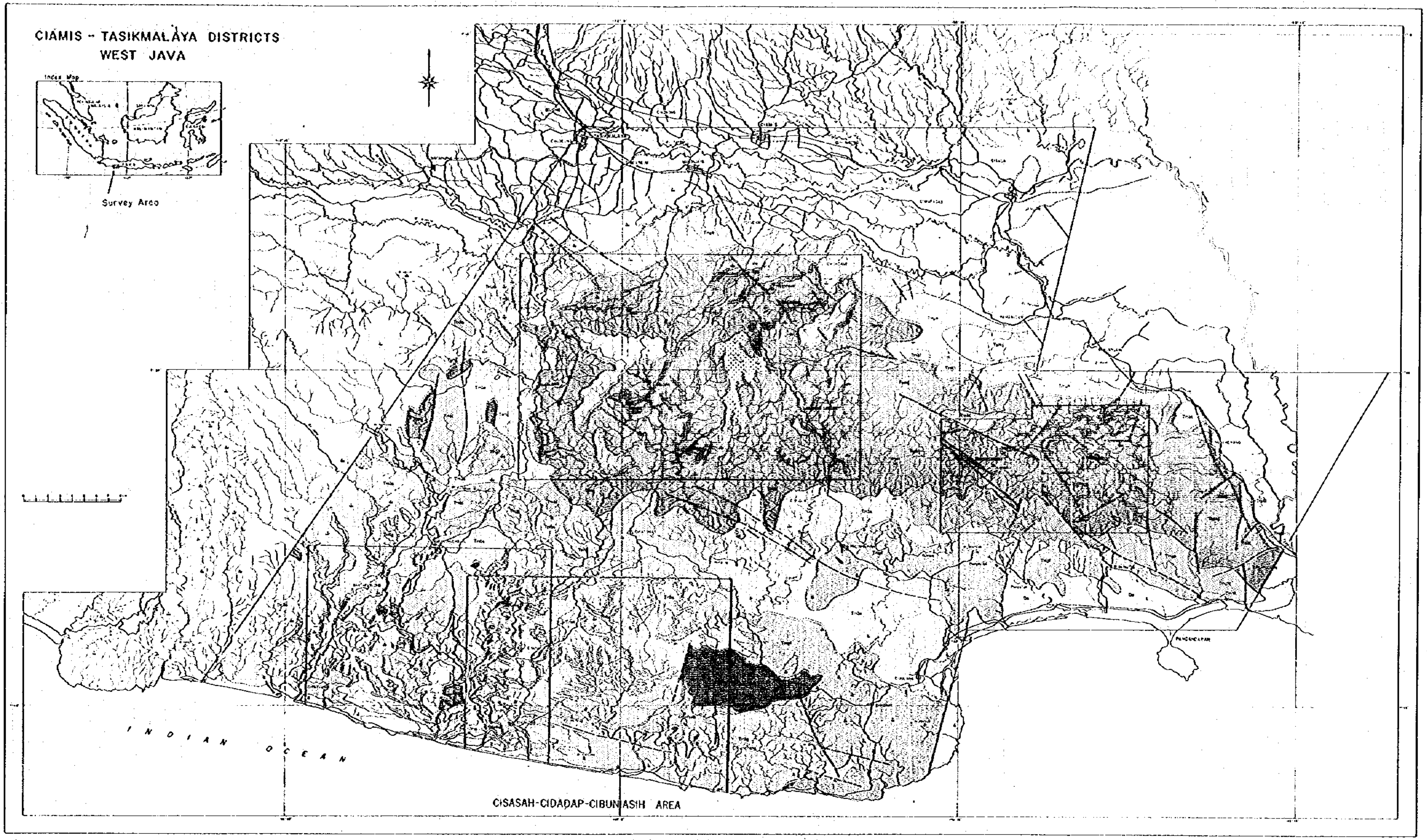
There are three kinds of metallic mineralization known in the southeastern part of West Java. These are epithermal gold-bearing quartz veins, lead-zinc veins and massive sulfide deposit.

Epithermal gold-bearing quartz veins occur in the hilly central belt. The known deposits are Cikondang, Citambal and Ciniru. They are hosted mainly by moderately to steeply dipping NW to NNE faults within andesitic or dacitic volcanic rocks of the Jampang Formation. Gold veins show low sulfide content; gold occurs as electrum with some manganese minerals in a quartz ± calcite gangue. They belong to the low-sulfidation adularia-sericite type epithermal gold deposit.

Lead-zinc veins were found in the northern volcanic belt and southern coastal area. Gn. Sawal is one of these deposits.

Massive sulfide deposit is expected to occur in the southwestern part of the study area because several indications of massive sulfide mineralization are known. The indications include the occurrences of gypsum and barite ores, and sericite-chlorite-montmorillonite alteration in Miocene dacitic pyroclastic rocks.

In addition to these metallic mineral potentials, the occurrences of some important industrial minerals are known in the Tasikmalaya area. Among them, phosphate resources are currently exploited and significantly contributed to the nation's agriculture. Phosphorite is found near Sidamulih and Sukaraja in the eastern part of the study area.



LEGEND

HOLOCENE	Alluvial Deposits	Qa	Silt, sand, gravel and pebble ~ Younger volcanic rocks
PLEISTOCENE	Older-Younger Volcanic Rocks	QTv	Volcanic breccia, lava and tuff
PLIOCENE	Bentang Formation	Tmpb / Tmbs	Tuffaceous sandstone, sandstone, calcareous sandstone and limestone lenses.
	Halang Formation	Tmph	Turbidites comprising alternations of sandstone, claystone and sandstone
LATE MIOCENE	Kalipucang Formation	Tmkl	Foraminiferal limestone and sandy limestone.
MIDDLE-EARLY MIOCENE	Pamutuan Formation	Tmpa	Sandstone, calcarenite, marl, tuff, claystone
		Tmpl	Calcarenite and clastic limestone intercalated with marl.
	Genteng Member (Jampang Formation)	Tmjg	Tuff intercalated with dacitic breccia and limestone lenses.
	Nusakambangan Formation	Tmnt	Tuff, lapilli tuff, sandstone and interbedded with mudstone.
OLIGOCENE	Jampang Formation	Tomj	Andesitic to basaltic volcanic breccia, lava and tuff, tuffaceous sandstone, with intercalation of sandstone, siltstone, claystone and limestone.

Intrusives:

- An — Andesite
- Basalt
- Hornblende Andesite
- Tda — Dacite
- Tdqp — Quartz Porphyry
- Granodiorite

Fig. 1-3 Geology and Geologic Profile of the Tasikmalaya Area

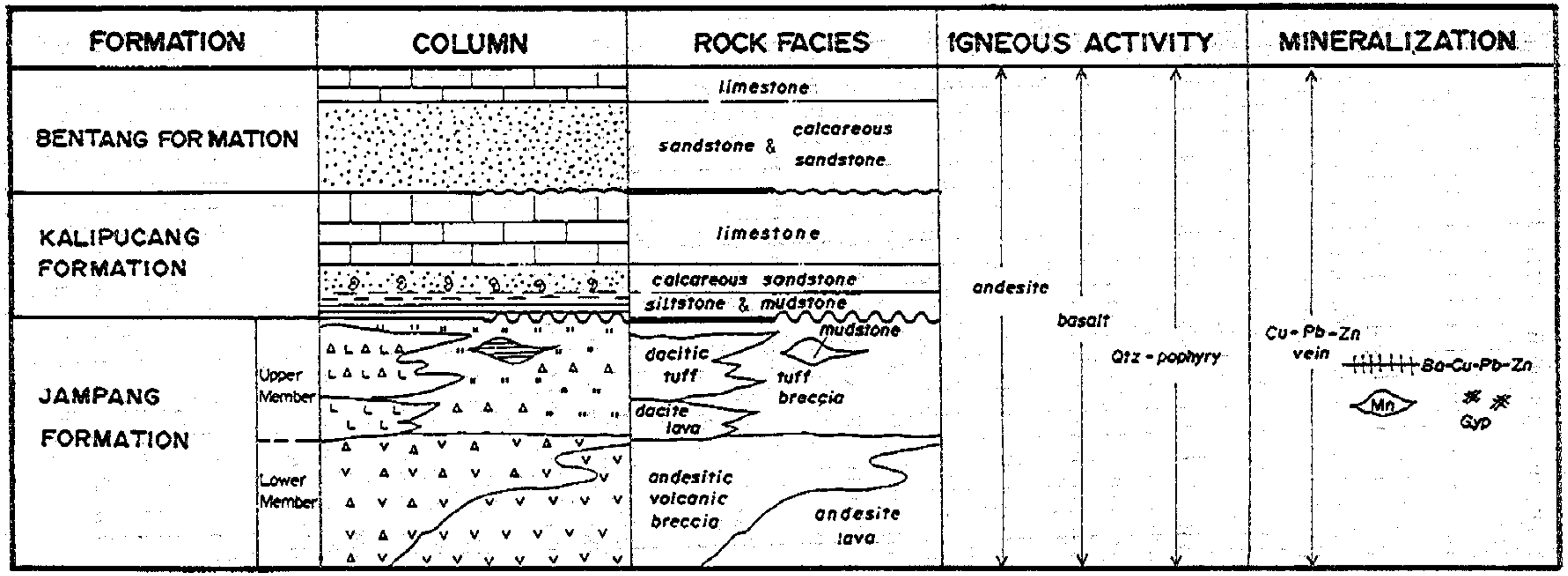


Fig. 1-4 Stratigraphic Column of the Tasikmalaya Area

Chapter 4 Discussion on the Results of the Second Phase Survey

4-1 Geology, Geologic Structure and Mineralization

Miocene green tuff of the Upper Member of the Jampang Formation is widespread in the Cisasah-Cidadap-Cibuniasih area. Two massive anhydrite-gypsum ores and a barite bed were found within the green tuff. These are: Cisasah (gypsum), Cidadap (gypsum), and Cibuniasih (barite). Stratabound manganese ores, ferruginous chert layers and silicified zones, which were thought to be genetically related to the massive sulfide mineralization, are developed near gypsum and barite occurrences. These stratabound deposits occur at a certain horizon within green tuff comprising dacitic tuff, fine tuff, pumice tuff and tuff-breccia. Dacite lava occurs among the pyroclastic members.

The structure of green tuff is characterized by a regional gentle synclinorium and local basin structures. It generally shows gentle western dip in the eastern part of the area. Whereas in the western part, green tuff dips gently to the east. These foldings have axes of N-S to NE-SW directions. A basin structure, about 10 km in diameter and is called Cikalong Basin, is recognized in the central-southern part of the area. The total thickness of green tuff is estimated to exceed to 300 m amidst the basin. There are other small basins and local thicken parts of green tuff scattered in the survey area.

The Bentang calcareous sandstone, and Kalipucang limestone in some cases, occur above the green tuff. At Cidadap, gypsum ore is overlain directly by the Bentang fossil-rich sandstone. There is no mudstone layer covering the massive sulfide horizon. It suggests that the waning stage of mineralization is characterized by a shallow-water oxidation environment.

The stratigraphic succession of the massive sulfide mineralization can be categorized into several zones together with the footwall, intermediate and hanging-wall green tuff members in descending order as follows:

(a) Hanging-wall green tuff
(b) Manganese zone
(c) Intermediate green tuff
(d) Barite-galena bed
(e) Anhydrite-gypsum zone
(f) Footwall green tuff

Barite bed is composed of a sulfide assemblage of galena-sphalerite-pyrite-chalcopyrite-covelline with barite + quartz gangue. Significant results of gold and silver assays were obtained in the Cibuniasih barite bed.

Anhydrite-gypsum zone is mainly composed of massive anhydrite-gypsum ore with sericitic clay containing gypsum veins. Pyrite is strongly disseminated, and a small amount of chalcopyrite, galena and sphalerite are impregnated within anhydrite-gypsum zone. Colloform texture was observed in pyrite under the microscope.

Manganese zone is composed of rhodochrosite, manganese oxide minerals (such as pyrolusite and psilomelane) and pyrite. Patches of ferruginous chert consisting of hematite-rich silica materials were sometimes found within manganese ore.

Quartz veins and footwall silicified zones are well-developed near stratabound gypsum and barite occurrences. Quartz vein in Balekambang and silicified zone in Panyairan are the representatives for these footwall silicified zones. Basemetal sulfide minerals, such as chalcopyrite, pyrite, sphalerite and galena, are significantly concentrated in these zones. They show a distinctive N-S direction which is parallel to the major faults in the Cisasah-Cidadap-Cibuniasih area.

The assemblages of alteration minerals in each of the above-mentioned six zones are as follows:

(a) Montmorillonite(-zeolite)

(b) Montmorillonite-sericite

(c) Montmorillonite-chlorite-sericite-kaolin-mixed layer mineral (chlorite-montmorillonite mixed layer)

(d) Quartz-sericite-chlorite

(e) Quartz-sericite

(f) Quartz-sericite-chlorite

The regional alteration of green tuff is characterized by the occurrences of montmorillonite, sericite, chlorite and zeolite. The assemblages of these alteration minerals were classified regionally into three alteration zones: (1) central sericite-chlorite(-mixed layer mineral) zone, (2) intermediate montmorillonite-kaolin zone, and (3) peripheral zeolite zone. This mode of zoning is nearly similar to that of in the Hokuroku district. The degree of hydrothermal alteration, however, is weaker in the Cisasah-Cidadap-Cibuniasih area than in the Hokuroku district.

An N-S step fault system was inferred from geologic structure, arrangement of surface showings of mineralization and alteration, and the analytical result of Bouguer anomalies in the Cisasah-Cidadap-Cibuniasih area. It was interpreted as the dominant structural factor controlling the Miocene submarine dacite eruption, and submarine exhalative sulfide mineralization probably associated with the dacitic volcanic activity. The known mineral deposits are situated structurally on the flanks of the basement uplift down to the green tuff basin, which were interpreted to be situated at the margin of the basin facing to the basement uplift. Some of the significant mineral showings were interpreted to be located in the local trough structures by the analysis of Bouguer anomalies.

The occurrences of stratabound manganese ores and ferruginous chert layers indicate that these locations were under shallow sea, oxidation environments at the time of their formation. Massive sulfide deposit, however, is understood to be formed under locally stagnant, reduction environments from the studies in the Hokuroku district. Moreover, sealing factor such as a pile of pyroclastic rock or basalt layer could be necessary for the preservation of precipitated sulfides.

Many quartz veins and footwall silicified zones have been found within the survey area so far. They were interpreted to be genetically related to massive sulfide mineralization. Significant massive sulfide deposit may exist, though covered under the piles of post-ore pyroclastic and/or clastic sediments.

The green tuff may be developed, though yet to be confirmed, over a wide area along the southern coast of Indian Ocean in West Java. The results of investigation on the geological setting and mode of massive sulfide mineralization could become an example for the other areas in this district.

4-2 Geochemistry

Rock-chip geochemical survey was carried out in the Cisasah-Cidadap-Cibunlasih area this phase. The primary purpose of the survey was to catch the alteration haloes associated with massive sulfide mineralization. A total of 314 rock-chip samples was collected from an area of 300 km^2. Most of the samples were taken from green tuff members cropped out in the survey area. Some were from volcanic breccia and andesite lava of the Lower Member of the Jampang Formation. Data of these geochemical analyses were statistically processed, and the result was cross-checked with the result of the alteration survey carried out during the geological survey. Several significant anomalous zones were outlined through the rock-chip geochemical survey this phase. The correspondence of metallic elements is very well each other. They occur concentrated at some small areas except Fe. Whereas the distribution of anomalous A.I. is rather wide. It shows that the anomalies of metallic elements tend to occur within the alteration haloes which are outlined by the distribution of anomalous A.I. values.

The major anomalous zones thus defined are: Cisasah, Cikoplok-Panyairan, Cidadap, Cibuniasih, and Balekambang.

Cisasah: Several anomalies of Au (up to 1,100 ppb), Ag (up to 6.40 ppm), Cu, Pb, Zn, As, Sb, Fe (up to 20.0 %), Mn (more than 10,000 ppm) and Ba of rock-chips were found in this area. Anomalies of A.I. values are widely distributed in this area covering Cipari, Cisasah and Panyosogan. Most of these anomalies occur within the sericite-chlorite alteration zone. The

A.I. values in the western part are not anomalous, although the chlorite-sericite alteration zone is exposed on the surface.

Cikoplok-Panyairan: Small Zn and Fe anomalies of rock-chips were detected along S. Cikoplok. A few anomalies of A.I. occur at Panyairan. A pervasive sericite-chlorite alteration zone is exposed in this area covering from the lower reaches of Cikoplok up to Panyairan.

Cidadap: Several anomalies of Au, Ag, Cu (up to 4,530 ppm), Pb (807 ppm), Zn (up to 1,910 ppm), As, Sb, Fe and Mn of rock-chips were detected in this area. Anomalies of A.I. values are also concentrated in this area. These anomalies almost correspond to the sericite-chlorite alteration zone.

Cibuniasih: One Au anomaly and several anomalies of Ag (up to 64.60 ppm), Pb, Sb, Mn (more than 10,000 ppm) and Ba (more than 10,000 ppm) of rock-chips were found in this area. Intense A.I. anomalies are also distributed around Cibuniasih area. These anomalies almost overlap with the sericite-chlorite alteration zone.

Balekambang: One Au anomaly (500 ppb) and a few Pb, Zn (up to 1,225 ppm), Fe and Mn anomalies of rock-chips were detected along S. Cipura Bangsa. A couple of A.I. anomalies was found in this area. These anomalies occur roughly within the sericite-chlorite alteration zone.

In the rock-chip geochemical survey, CaO, MgO, K_2O and Na_2O were analyzed along with usual geochemical elements, and the alteration index (A.I.), proposed and demonstrated in the Hokuroku Kuroko district in Japan, was introduced for the indicator of hydrothermal alteration associated with the massive sulfide mineralization. The anomalous zones defined by A.I. (A.I.≥79 %) are: Cisasah, upper reaches of Cigoronggong, Cidadap, Cibuniasih, and Balekambang. These anomalous zones occur roughly within the sericite-chlorite alteration zones outlined by the X-ray diffraction analysis. The following relationships were observed between the geochemical anomalies and hydrothermal alteration zones; (1) anomalies of metallic elements occur in and around the known mineral showings, (2) anomalies of A.I. values represent the alteration haloes surrounding the anomalies of metallic elements, and (3) these geochemical anomalies are roughly distributed within the sericite-chlorite alteration zones. However, the correspondences between anomalous zones by X-ray and those by A.I. are not always well in details. It shows that the behaviors of these alkali metals are not numerically related to the degrees of hydrothermal alteration associated by the massive sulfide mineralization. Firstly, the A.I. index can not represent the alterations accompanied by strong silicification, such as footwall silicified zone with sericite alteration, and gypsum zone with silicification and sericitization. Secondly, it is only applicable within the sericite-chlorite alteration zone. It is not useful in the entire regional alteration zoning -- sericite-chlorite zone through montmorillonite-kaolin zone to zeolite zone.

4-3 Geophysics

(1) Gravity Survey

Gravity survey was carried out in the Cisasah-Cidadap-Cibuniasih area for the purpose of clarifying the basement structure and geological setting of massive sulfide deposit in the second phase. As a result of the analysis of gravity residuals in conjunction with geologic structure of this area, three important structural components -- (1) basin and uplift, (2) fault, and (3) local trough -- were defined.

Following two basins and three uplifts were distinguished in this area.

- Cikalong basin and Cibongas basin
- Middle Ciwulan uplift, Pasir Gintung uplift and Pasir Garu uplift

The Cikalong basin, located from Pasir Nyatu to the lower reaches of Cimedang, is the most remarkable gravity low in the survey area. This basin is about 10 km from east to west and interpreted 500m to 700m in depth from the surface in its center. To it's west, the gravity gradient is steep towards the Cikalong-Cikatomas road, and continues up to the Middle Ciwulan uplift. The eastern slope, in contrast, is relatively gentle. It goes up until the Pasir Gintung uplift. This basin was interpreted to be composed of the green tuff basin probably formed during the middle Miocene Period. At the north of the Cikalong basin, there are three smaller gravity lows arranged in the E-W direction. These were named the Cibongas basin altogether.

The gravity highs - in Pasir Gintung, in the middle reaches of Ciwulan and at Pasir Garu - coincide well with the distribution of the Lower Member of the Jampang Formation. Therefore, they are considered to be the uplifts of the basement.

Several steep gravity gradients, interpreted as steep change of basement depth, were observed and considered geologically as faults. Some of them are N-S system: at the western side of the Cikalong basin, and at the western side of the Pasir Garu uplift. There is other gravity gradients not so steep but interpretable to be faults from the geological evidence at the north of Cibuniasih. Another is E-W system: at the northern side of the Cikalong basin.

A local trough was found in the vicinity of Cibuniasih barite digging on the gravity residuals map. It is located at the flank of the gravity contour between the Pasir Gintung uplift and Cikalong basin, stretching to the southwest. Another trough structure was recognized at the south of Cisasah gypsum mine stretching to the northeast.

The known stratabound mineral showings lie on the flank of gravity contour from an uplift to a basin. The Cibuniasih barite bed occurs in a local gravity trough structure on the flank of the Pasir Gintung uplift to the Cikalong basin. The Cisasah gypsum deposit is situated on the flank of gravity contour from the Middle Ciwulan uplift to the Cibongas basin. The Cidadap gypsum deposit, which is not so distinctive as the former two cases, looks to be located at the middle of the Middle Ciwulan uplift down to a gravity low near the coast of Indian Ocean. These mineral deposits were interpreted to be formed at the margin of a basin facing to a basement uplift. The local trough structure of green tuff which occurs on the flank from a basement uplift to a basin seems to provide favorable loci for the deposition and preservation of massive sulfide deposit.

Another interesting feature from the gravity geophysical point of views is the spatial relationship of manganese ores to gypsum or barite ores. The stratabound manganese ores occur near the gypsum or barite, and always occupy structurally at a higher position to them.

(2) IP Survey

Time-domain IP (Induced Polarization) survey was carried out in the Cibuniasih-Balekambang area which was extracted by the preceding geological, geochemical and gravity surveys. The objective of the survey is to clarify the electric characteristics of the subsurface zones and thus to detect IP anomalies related to the mineralization of this prospective area.

As the results, anomalies of the chargeability (more than 4.0 mV•S/V) were detected mainly at the following three locations:

(a) south-western part of lines C, D
(b) south-western part of line A ((a) and (b) are located in Sukasari)
(c) middle part of lines J, K, L (located in Bihbul)

These anomalies occur from shallow into deep zones (about 150 m below the surface) in distinct expanse, and were detected in the low resistivity background ranging from 5 to 30 ohm-m which corresponded to tuff of the Upper Member of the Jampang Formation. Especially, anomalies (a) occur in the very low resistivity (>10 ohm-m) zones which coincide with gravity trough structure.

These anomalies have no distinct relation to the resistivity pattern and are not so different from low background, indicating that they are related to the mineralization with clay alteration. Silicification and sericite-chlorite alteration were observed at drill hole MIT-7 whose target was the shallow anomaly at No. 16 on line I. This type of alteration is expected to occur in an anomalous area. Large-scale silicification, however, is difficult to consider from the resistivity structure of this area.

Groups of shallower and smaller scale anomalies extend from anomalies (c) in the E-W direction arranging like the right handed echelon. These are :

- in the vicinity of Nos. 11 and 16 on line I
- in the vicinity of No. 8 on line H

Other small anomalies occur in the vicinity of No. 5 on line E and No. 36 on line A.

The three major anomalous zones were interpreted by the model simulation as follows:

Anomalies (a) : Mineralized zones of several-tens-meter-scale are expected in the deep zones at No. 10 and No. 16 of line D. It is supposed that this mineralized zone at No. 16 extends in the NW-SE direction to lines C and E, and that the center of mineralization is near line C. The anomaly below No. 10 is one of the strongest in the survey area, although the extension of the eastern side is not clear because of lack of survey line. These two anomalies are most interesting for the further exploration, incorporating with locating in the local gravity trough structure. Another weak mineralized layer is supposed to exist in the shallow zone at No. 5 of line D.

Anomalies (b) : A mineralized zone of several-tens-meter-scale is supposed to be in the deep zone at No. 11 of line A. This mineralization seems to extend in the SE direction to line B. Other inclined mineralized layers at Nos. 5 and 18 are supposed to occur in the middle depth zone of line A. The extensions of these three anomalies to the west and to the south are not known because of lack of survey line.

Anomalies (c) : A relatively weak mineralized layer is supposed to be in the shallow zone at No. 20 of line K. It probably extends north-westward to line J. As anomalies at lines I, H and G were detected only in the shallower zones, this stratified mineralization in the shallow depth may be a common feature in Bihbul. A mineralized zone of several-tens-meter-scale may exist in the deep zone at No. 18 of line K. Because of the existence of stratified mineralization mentioned above, however, accurate interpretation of the deeper part is difficult. Another relatively weak mineralized layer is supposed to occur in the middle depth zone at No. 26 of line K.

The predominantly low resistivity zone ranging from 5 to 30 ohm-m in the survey area was supported to be tuff of the Upper Member of the Jampang Formation by the result of laboratory test. One of the reasons for its low resistivity was considered to be originated from widespread montmorillonitized tuff.

4-4 Potential of Mineral Resources

Following to the first stage, the potential of massive sulfide deposit has been investigated again in this phase in the Cisasah-Cidadap-Cibuniasih area. The prospect is still in the early stage of exploration; only indications of massive sulfide deposit such as barite, gypsum and stratabound manganese ores have been known. In this phase, we have studied: (a) structural settings of known mineral showings, (b) volcano-stratigraphy of the green tuff sequence, (c) mode of occurrence of alteration haloes associated with massive sulfide mineralization, and (d) characteristic features of IP anomaly. Seven holes were drilled both in the western and eastern parts of the survey area. Although no intersection of massive sulfide ore has been caught in these reconnaissance drill holes, a significant amount of information regarding the volcano-stratigraphy and hydrothermal alteration associated with massive sulfide mineralization was obtained. Significant IP chargeability anomalies were delineated in the Cibuniasih prospect this phase.

Several green tuff basins and basement uplifts were distinguished in the Cisasah-Cidadap-Cibuniasih area through the geological survey and gravity geophysical survey this phase. The known mineral diggings and mining pits were interpreted to be situated structurally at the margins of the basin facing to the basement uplift. Some of the significant mineral showings were interpreted to be located in the local trough structures by the analysis of Bouguer anomalies.

Stratigraphic sequences of the green tuff members were studied in the course of geological survey, and the details were investigated petrographycally as well as the geochemical aspect of view.

Three zones of alteration minerals were extracted for the alteration haloes of mineralization, and the regional zoning was recognized in the following order: central sericite-chlorite-mixed layer zone, intermediate montmorillonite-kaolin zone, and peripheral zeolite zone. The sericite-chlorite zone occurs in the most intensely altered area, whose distribution is at an order of a few kilometers horizontally. It is surrounded by the montmorillonite-kaolin zone. The zeolite zone constitutes the outermost part within the green tuff area. Several intense sericite-chlorite-mixed layer alteration zones were delineated in the vicinity of Cisasah, Cikoplok, Cidadap, Cibuniasih and Balekambang. The vertical order of assemblages of alteration minerals within and near the massive sulfide deposit was investigated in detail both at the existing mineral showings and in the drill holes this phase. Six categories of mineral assemblages were distinguished, and the assemblage of montmorillonite-chlorite-sericite-kaolin-mixed layer mineral was interpreted to be most closely related to the massive sulfide ore horizon. On the basis of these results, a couple of sericite-chlorite alteration horizons were picked up within the survey area for the promising areas of massive sulfide deposit.

Several significant anomalous zones of the chargeability (more than 4.0 mV•S/V) were detected at the southwestern part of lines C, D, southwestern part of line A (these are located in Sukasari), and middle part of lines J, K, L (Bihbul) in the Cibuniasih prospect.

These anomalies are situated from shallow or middle zones into deep zones (around -150 m). These zones occur in the relatively low resistivity (<10 ohm-m) area. It means that they are probably related to such mineralization that accompany clay alteration.

Significant assay results (up to 2.17 g/t Au, 662 g/t Ag, 38.64 % Pb, etc.) were returned from grab samples in the Cibuniasih barite bed. Outcrops of footwall silicified zones containing sulfide dissemination/networking were found in the survey area this phase. Some of them showed significant assay results (up to 0.06 g/t Au, 34 g/t Ag, 3.46 % Cu, 0.12 % Pb, >10.00 % Zn, 7.90 % Fe at 25 cm in width). These are a positive indication of the possibility of massive sulfide deposit of economic grade somewhere around these localities.

In comparison with the Kuroko deposit in the Hokuroku district, the geology and mineralization of this area is characterized by the following features: small magnitude of submarine dacitic volcanic activity (small scale of green tuff basin and relatively thin pile of green tuff sequences), weak regional hydrothermal alteration, and not reduction but oxidation environments (shallow sea) at the waning stage of mineralization.

The major part of the survey area is covered by the Kalipucang limestone or Bentang calcareous sandstone. The exploration for this kind of blind deposit must be followed by steady steps. Therefore, it takes a certain period of exploration. On the basis of the past experiences in the Hokuroku district, a significant massive sulfide deposit may exist in such places as the following conditions: (a) at the marginal zone within the extensive development of green tuff basin, (b) intensive activity of dacite lava, and (c) occurrence of intensive hydrothermal alteration haloes.

Through the second stage exploration works, we have limited the survey targets into two potential areas: (1) east of Cisasah, and (2) south of Cibuniasih. Although the upper zone among a couple of massive sulfide mineralized horizons are exposed on the surface in these prospects, the lower extensions close to the green tuff basin, where the surface parts are covered by the Kalipucang limestone or Bentang calcareous sandstone may have a possibility for the favorable loci for the massive sulfide ore deposition. Further exploration efforts are required for the evaluation of these prospects.

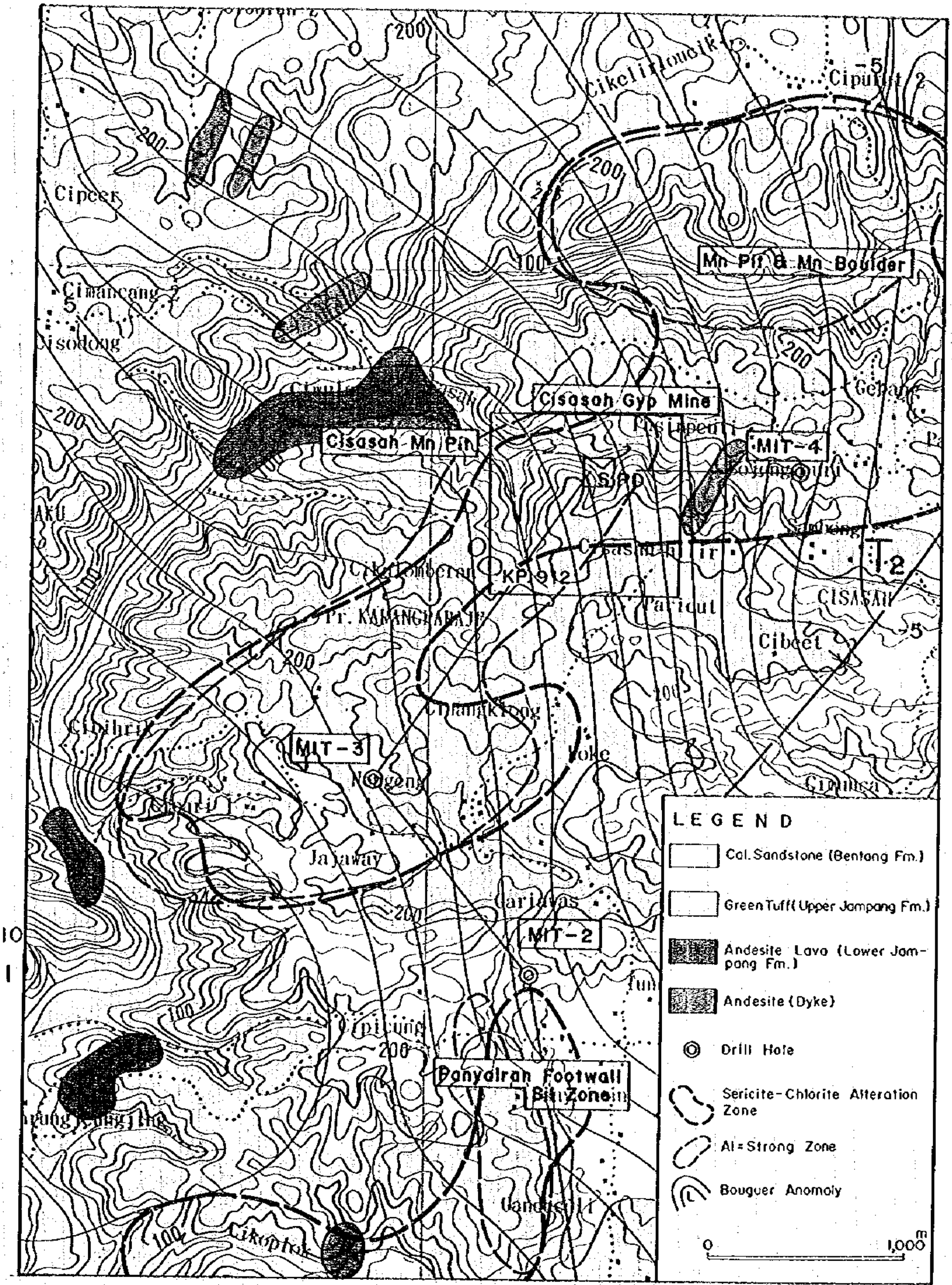


Fig. 1-5 Integrated Interpretation of the Survey Results in the Western Part of the Cisasah-Cidadap-Cibuniasih Area

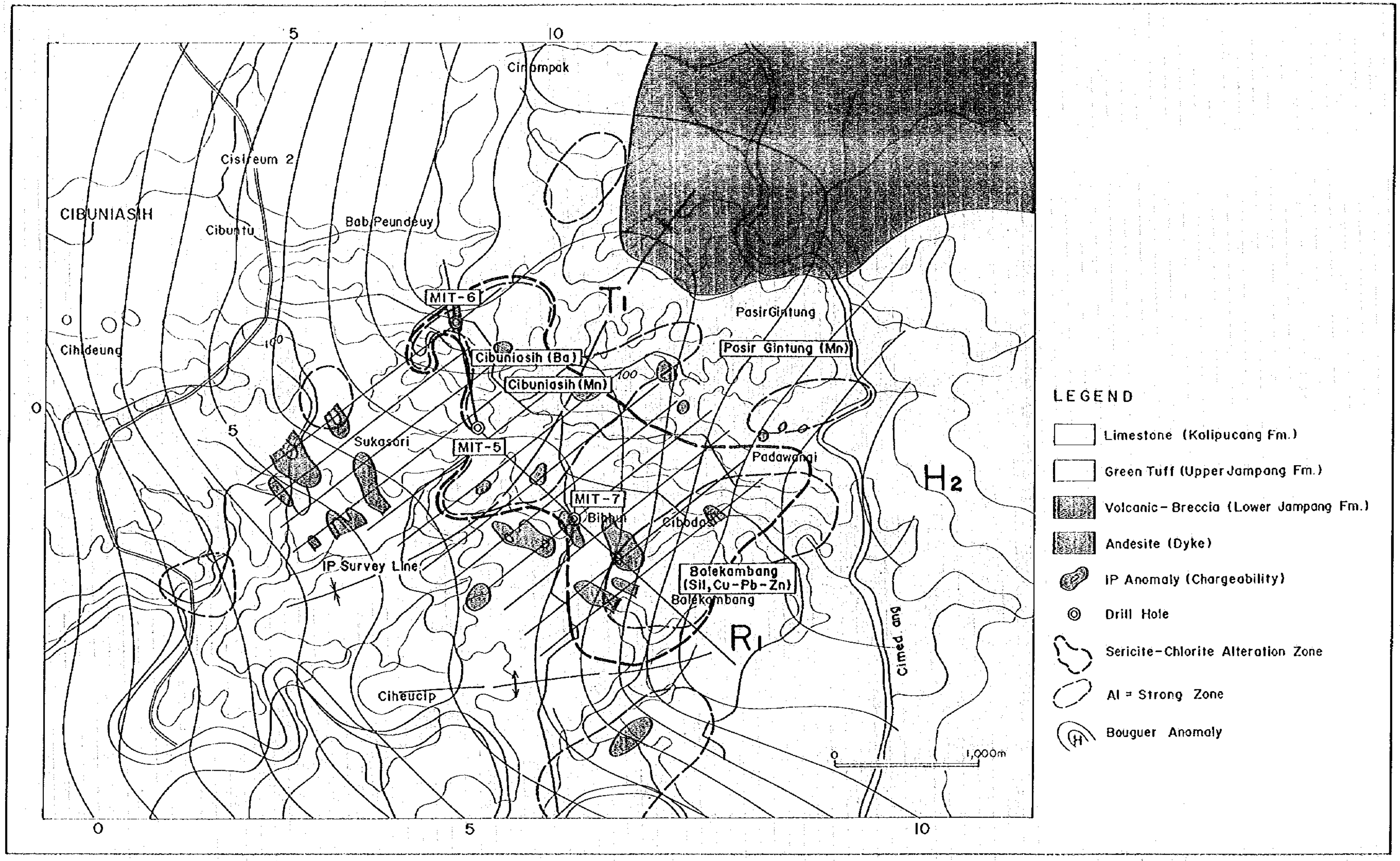


Fig. 1-6 Integrated Interpretation of the Survey Results in the Eastern Part of the Cisasah-Cidadap-Cibuniasih Area

Chapter 5 Conclusions and Recommendations

5-1 Conclusions

On the basis of the results of the second phase works comprising geological survey, rock-chip geochemical survey, gravity geophysical survey, IP electric survey and drilling exploration, the following conclusions are obtained.

(1) Miocene dacitic volcanic and pyroclastic rocks (called green tuff) are widespread in the Cisasah-Cidadap-Cibunlasih area. Two massive anhydrite-gypsum ore deposits and a barite bed were found within the green tuff. Stratabound manganese ores, ferruginous chert layers and silicified zones are developed near these gypsum and barite occurrences. Details of the volcano-stratigraphy and hydrothermal alteration of these mineral occurrences were studied this phase. These stratabound deposits occur at a couple of horizons within the green tuff succession. The structure of the green tuff is characterized by a regional gentle synclinorium with axes of N-S to NE-SW and local basin structures. A couple of basin structures, about 10 km in diameter was recognized in the central northern and central southern parts of the area. The total thickness of the green tuff was estimated to exceed to 300 m amidst the basin. The Bentang calcareous sandstone, and Kalipucang limestone in some cases, occur above the green tuff.

(2) On the basis of the result of the X-ray diffraction analysis, six hydrothermal alteration zones -- silicified zone, sericite-chlorite-mixed layer zone, montmorillonite-kaolin zone, zeolite zone, pyrophyllite-kaolin zone, and carbonitized zone -- were distinguished regionally in this area. Among these alteration zones, three zones were recognized to be closely related to the massive sulfide mineralization arranging in the order of -- central sericite-chlorite zone, intermediate montmorillonite-kaolin zone, and peripheral zeolite zone. The alteration survey revealed several intense sericite-chlorite alteration zones within the survey area. The stratigraphic succession of the massive sulfide mineralization was categorized into several zones together with the host green tuff members. The assemblage of alteration minerals in each zone was defined in details this phase. The mode of occurrence and distribution of geochemical anomalies for metallic elements and alkali components (and alteration index A.I. calculated from alkali components) were examined through the rock-chip geochemical survey, and several significant anomalous zones such as Cisasah and Cibunlasih were outlined in the survey area.

(3) As a result of the gravity survey in conjunction with the geologic structure of this area, three important structural components -- basin and basement uplift, fault, and local trough -- were defined. Two basins and two uplifts were distinguished in the survey area: Cikalong basin, Cibongas basin, Middle Ciwulan uplift, Pasir Gintung uplift, and Pasir Garu uplift. The

known stratabound mineral showings lie on the flank of the gravity structure from an uplift to a basin, which was interpreted to be situated at the margin of a basin facing to a basement uplift. The Cibuniasih barite bed occurs on the flank of the Pasir Gintung uplift to the Cikalong basin. The Cisasah gypsum deposit is situated on the flank of the Middle Ciwulan uplift to the Cibongas basin. The Cidadap gypsum deposit, which is not so distinctive as the former two cases, looks to be located at the middle of the Middle Ciwulan basin down to a gravity low near the coast of Indian Ocean. Several steep gravity gradients were observed and considered geologically as faults of N-S and E-W systems. A local trough structure of the basement was found in the vicinity of Cibuniasih barite bed on the gravity residuals map. It is located at the flank of the gravity structure between the Pasir Gintung uplift and Cikalong basin, stretching to the southwest. Another trough structure was recognized at the south of Cisasah gypsum mine stretching to the northeast.

(4) Time-Domain IP (Induced Polarization) electric survey was carried out in the Cibuniasih area. Anomalies of the chargeability (more than 4.0 mV•S/V) were mainly detected at: (a) south-western part of lines C, D, (b) south-western part of line A ((a) and (b) are located in Sukasari), and (c) middle part of lines J, K, L (Bihbul). These anomalies occur from shallow into deep zones (about 150 m below the surface) in distinct expanse. These anomalies were interpreted to be related to the mineralization with clay alteration. Smaller scale anomalies were detected at: (d) in the vicinity of Nos. 11 and 16 on line I, (e) in the vicinity of No. 8 on line H, (f) in the vicinity of No. 5 on line E, and (g) in the vicinity of No. 36 on line A.

(5) A drilling program comprising 7 holes totaling 1,704.10 m was conducted in the Cisasah-Cidadap-Cibuniasih area this phase. Four holes (MIT-1~4) totaling 962.60 m were drilled in the western part, and another 3 holes (MIT-5~7) totaling 741.50 m in the eastern part. The results of these holes provided a significant amount of information regarding the volcano-stratigraphy and hydrothermal alteration associated with massive sulfide mineralization, although no intersection of massive sulfide ore has been caught in these holes. It also contributed to check the relationship between the IP anomaly and mineralization/alteration figures in the survey area. Among these holes, relatively intense hydrothermal alteration was caught in MIT-4 in the western area, and MIT-7 in the eastern area respectively.

(6) The area in the vicinity of Cisasah, especially from the Cisasah gypsum mine to Panyosogan, is a significant potential prospect of massive sulfide deposit. Because it is situated geologically on a favorable structural location: at the margin of the Cibongas basin where is facing to the Middle Ciwulan basement uplift, and also because pervasive sericite-chlorite alteration is distributed both on the surface and below the surface. The southeastern part of the area is covered by the Bentang calcareous sandstone. Several alteration horizons were caught in the drill hole MIT-4. One of them, probably the middle one in which significant pyrite dissemination was accompanied, was interpreted to be correlated to the Cisasah

gypsum ore horizon. Due to the existence of a mining concession (KP 912), the drilling activity was limited this year. After the expiration of this concession in the next phase, an exploration program comprising IP survey and follow-up drilling can evaluate the potential of this area.

(7) The area in the vicinity of Cibuniasih, especially to the south of the Cibuniasih barite bed, is thought to be another significant potential prospect of massive sulfide deposit; it is situated structurally at the marginal part of the Cikalong basin facing to the Pasir Gintung basement uplift; an extensive sericite-chlorite alteration zone occurs on the surface and in the depth; and a series of distinctive IP chargeability anomalies was detected at several places. The prospective locations are Sukasari and Bihbul. Sukasari is located 1,200 m southwest of the Cibuniasih barite bed. The surface of the location is widely covered by the Kalipucang limestone. Some of the chargeability anomalies caught in Sukasari are still open both to the northwest and to the southeast. The other alteration zones occur to the southwest of Sukasari as well. Bihbul is located 1,200 m southeast of Cibuniasih barite bed. Remarkable IP chargeability anomalies were detected below the rice-field where some quartz floats with limonite dissemination were found in green tuff outcrops. Two drill holes (MIT-6 and 7) were dug in these IP anomalies, and three intensive alteration zones (upper, middle and lower horizon) consisting mainly of silicification and sericitization-chloritization with significant dissemination of pyrite were caught in these drill holes. The drilling activity this phase was limited because it was done in the rainy season. The follow-up drilling for targeting some IP anomalies which were caught this phase and will be detected by the additional IP survey next phase is necessary in the dry season next year.

5-2 Recommendations for the Third Phase Survey

East of Cisasah Prospect

It is recommended that the detailed IP survey shall be made within an area of 4 to 5 km^2 which covers the Cisasah gypsum deposit and its eastern area. After the IP survey, a reconnaissance drilling for testing the IP anomalies shall be made. The target depths should be set slightly deeper to the east because it is going to approach the green tuff basin.

South of Cibunlasih Prospect

An exploration program comprising the additional IP survey and reconnaissance drilling for the area of about 20 km^2 is recommended in the next phase. The additional IP survey must be made in Sukasari where IP chargeability anomalies caught this phase are still open to three directions: to NW, SW and SE. After defining IP anomalies, the drilling shall be carried out in Sukasari and Bihbul for the purpose of evaluating the potential for the massive sulfide ore deposit.

PART II DETAILED DISCUSSIONS

PART II DETAILED DISCUSSIONS

Chapter 1 Geological Survey

1-1 Outline of the Area

The Cisasah-Cidadap-Cibuniasih area is located about 40 km south-southwest of Tasikmalaya. It is facing the Indian Ocean. The area lies along the lower reaches of S. Ciwulan and S. Cimedang in the southwestern part of the first phase regional study area. The altitude of the area is not high; most of the area is situated between 50 and 250 m above sea level.

The area lies geologically among the distribution of volcanic rocks and pyroclastic rocks of the Jampang Formation. The Kalipucang limestone occurs in the central to the northern part of the Cisasah-Cidadap-Cibuniasih area. Calcareous sandstone of the Bentang Formation covers these rocks mainly in the western and southern parts of the area. The general trend of these formations is nearly NE-SW with minor disorders.

Based on the results of the first phase survey comprising the review of the existing geological information, photogeological analysis on the JERS-1 SAR images, geological survey and stream sediment geochemical survey, this area was selected for the potential area of massive sulfide deposit. The second phase survey covered over a rectangular area of 300 km^2. The field works this phase were composed of geological survey, rock-chip geochemical survey, gravity geophysical survey, IP electric survey and drilling. The major themes followed in the geological survey are: (1) to investigate the basement structure by which massive sulfide mineralization is supposed to be controlled, and (2) to catch alteration haloes associated with massive sulfide deposit.

1-2 Survey Method

The second phase geological works in the Cisasah-Cidadap-Cibuniasih area consisted of geological survey and alteration survey. The area, approximately 300 km^2, was selected based on the results of the first phase survey.

Prior to the field work, a series of topographic maps of 1:10,000 scale was prepared from the compilation of existing topographic maps (1:50,000) and airphotos. Several sets of GPS instruments were employed for locating major surveying points in the field.

During the field works, geology, massive sulfide mineralization and the degree of hydrothermal alteration were surveyed, and samples for X-ray diffraction analysis and other laboratory studies were collected together with samples for assaying at every major outcrop and mineral showing. The degree of alteration of pyroclastic/volcanic rocks of the Jampang

Formation (mainly that of the Upper Member) was carefully judged and recorded on the field note by geologist on the basis of the following criteria:

·Plagioclase of volcanic rocks: 0. fresh & clear, 1. white & angular, 2. rounded, 3. moya-moya

·Mafic minerals of volcanic rocks: 0. fresh, 1. foggy, 2. indistinct, 3. disappeared

·Glass/pumice of pyroclastic rocks: 0. fresh & clear, 1. bubbles included, 2. patchy/lenticular, 3. pressed/layered

·Lithic fragment of pyroclastic rocks: 0. original, 1. sub-angular, 2. moya-moya, 3. indistinct

Other features of mineralization and hydrothermal alteration such as silicification, sulfide dissemination and gypsum impregnation were also checked in the survey. Based on these observations in the field, a series of alteration maps was prepared. The result was cross-checked with the result of X-ray diffraction analysis, and the zonal distribution of alteration haloes of massive sulfide mineralization was investigated.

Several significant mineralized localities were found during the field survey. The route maps of 1:10,000 scale were produced by these surveys, using 50-meter tape with a Brunton-type compass. The important outcrops, mineral showings and old workings were studied in much detail (sketches of 1:100 to 1:200), and samples were taken for laboratory analysis.

A total length of more than 170 km was explored during the survey in the Cisasah-Cidadap-Cibuniasih area, and the geological information was compiled into a geologic map of 1:25,000 scale. The geology and geologic profile of the Cisasah-Cidadap-Cibuniasih area are shown in Fig. 2-1.

The numbers of samples collected in the survey are: 155 altered rock and clay samples for X-ray diffraction analysis, 12 rock samples for thin sections, and 30 ore samples for assaying (Au, Ag, Cu, Pb, Zn, Fe, Mn and Ba) and polished sections. The results of laboratory works and assaying are briefly summarized in Tables 2-1 to 2-4.

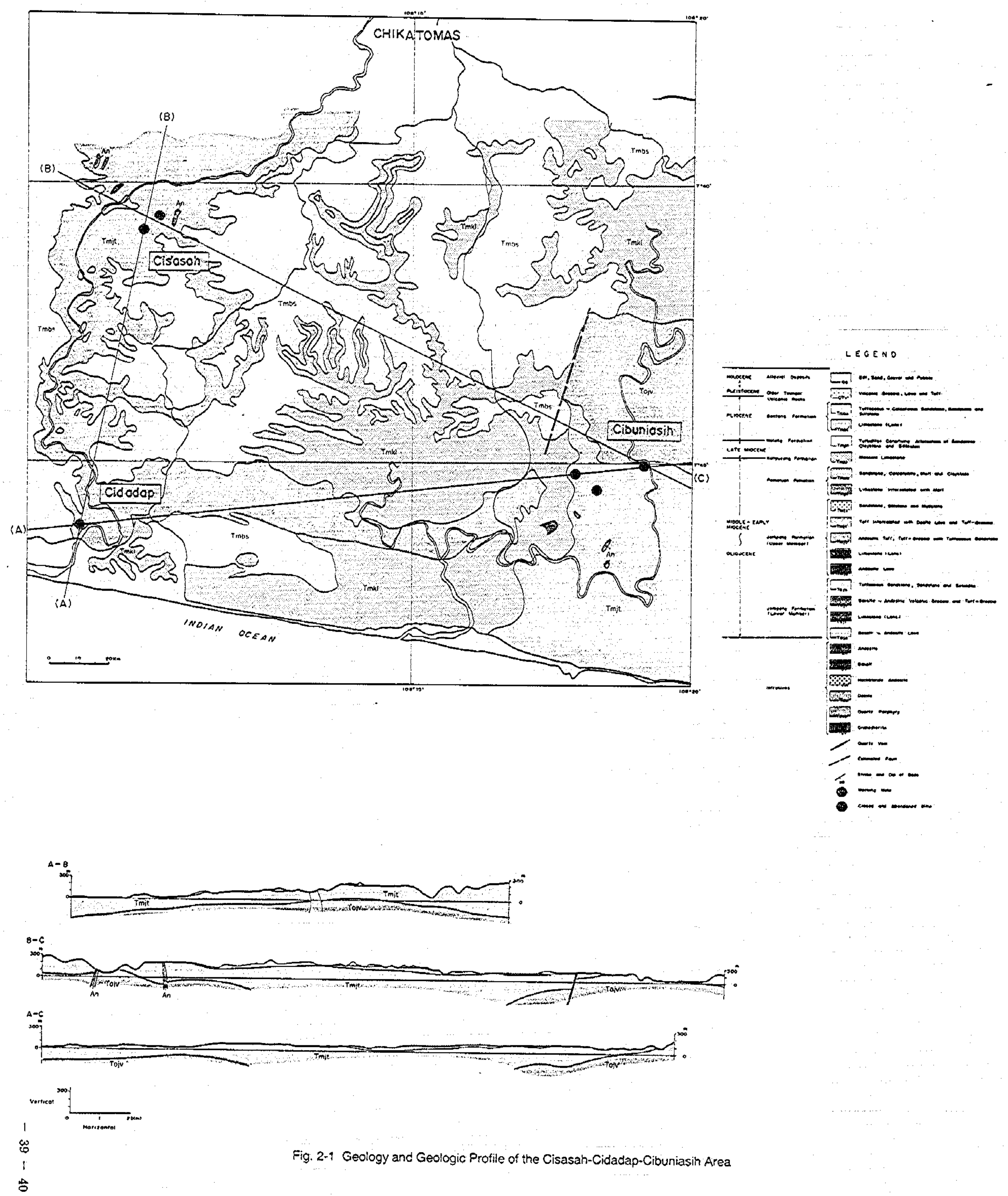


Fig. 2-1 Geology and Geologic Profile of the Cisasah-Cidadap-Cibuniasih Area

Table 2-1 Results of Microscopic Observation of Thin Sections in the Cisasah-Cidadap-Cibuniasih Area

Sample No.	Locality	Rock Name	Formation	Texture	Phenocryst/Crystal Frag.									Groundmas/Matrix						Alteration
					Qz	Kf	Pl	Bi	Hb	Px	Ol	Ep	Op	Qz	Kf	Pl	Hb	Px	Gl	
AI19T	Cibitung	Dacite	Tomj	Porp		○	●		·				·			○				Pl·Hb→Ca·Ep·Se·Ch
AI24T	Cisodong	Limestone	Tmkl	Clas																Ca·Qz·Op
AH51T	Pasir Gintung	Andesite	Tomj	Porp			●			○			·			○		·		Pl·Px→Ch
AH82T	Cibihbul	Andesite	Tan	Porp			●						·			○			·	Pl→Ch·Ca·Ep
AH87T	Cibuniasih	Dacite	Tomj	Porp	○		●						·	·		○			·	Pl→Se·Ch
AH102T	Cimedang	Andesite	Tomj	Porp			●			·			·			○		·		Pl·Px→Se
AD21T	Ciburag	Tuff	Tomj	Pycl	○								·						●	Gl→Se·Ch
AD22T	Cikadu	Dacitic Tuff	Tomj	Pycl	○	△	△						·						●	Gl→Se·Ch
AD108T	Balekambang	Hornblende Andesite	Tomj	Porp			○		·				·	·						Pl·Hb→Ch·Se
AK8T	Citoe	Hornblende Andesite	Tomj	Porp			●		○	△			·			△		·	△	Pl→Ca·Ch·Se,Hb·Px→Ch
AK14T	Citoe	Hornblende Andesite	Tomj	Porp			●		○				·	·		△			·	Pl→Se,Pl·Hb→Ch,Sil
AK41T	Cisarua	Pumice Tuff	Tomj	Pycl	△		△		△				·	·					·	Pl→Ch

Abundance of Minerals: ●;Abundant, ○;Common, △;Rare, ·;Trace
Formation Names : Tomj;Jampang Formation, Tmkl;Kalipucang Formation, Tmpa;Pamutuan Formation, Tmbs;Bentang Formation, Tmph; Halang Formation, Qtv;Old Volcanic Rocks, Tgd;Granodiorite, Tda;Dacite, Tan;Andesite (dyke)
Textures : Pycl;Pyroclastic, Clas;Clastic, Porp;Porphyritic, Lepb;Lepidoblastic, Glom-gr;Glomerophyric granular, Hypd-gr;Hypidiomorphic-granular, Ophi;Ophitic, Int-gr;Inter-granular, Hol-pp;Holocrystalline-porphyritic
Minerals : Qz;Quartz, Kf;Potash feldspar, Pl;Plagioclase, Bi;Biotite, Hb;Hornblende, Px;Pyroxene, Ol;Olivine, Ep;Epidote
Op;Opaque Minerals, Gl;Glass, Ch;Chlorite, Se;Sericite, Ca;Carbonates

Table 2-2 Results of X-Ray Diffraction Analysis in the Cisasah-Cidadap-Cibuniasih Area (1)

No.	Sample No.	Remarks	Rock Unit	Locality	Clay Minerals								Zeolites					S-Salts			Carbonates			Silicates			Flds		Miscellaneous Minerals						
					Mo	Ch	Se	Mu	Ka	Ha	Pr	Mx	Cp	Md	Lm	Hu	Fr	Al	Gy	Ja	Ca	Ak	Si	Cr	Tr	Qz	Pl	Kf	Py	Go	He	Mg	Ba	Sp	Gn
1	AI1X	Grey clay (fine tuff), Py	Tomj	Cidadap																						C			F					R	F
2	AI2X	Gy-grey clay, Py		Cidadap		R													F							R			R						
3	AI3X	Gy-grey clay, Py		Cidadap		R													F							R									
4	AI4X	Gy-grey clay, Py		Cidadap	F	F																				R		R							
5	AI5X	Fine tuff	Tomj	Cidadap	R				R?																	A	C								
6	AI7X	Tuff, Limonite	Tomj	Cidadap		F	R																			C									
7	AI8X	Gy-grey clay, Py		Cidadap																															
8	AI9X	Tuff-breccia, Sil, Py	Tomj	Cidadap			R		R																	A			R						
9	AI11X	Lapilli tuff	Tomj	Cibitung	F		R?		R																	A	A								
10	AI13X	Lapilli tuff	Tomj	Cibitung	F		R																			A	C								
11	AI14X	Lapilli tuff	Tomj	Cibitung	F				R																	A	F								
12	AI16X	Tuff-breccia	Tomj	Cibitung	F				R																	A	C								
13	AI20X	Coarse tuff	Tomj	Cisodang	F								R	F												A									
14	AI22X	Fine tuff	Tomj	Cisodang																															
15	AI25X	Tuff	Tomj	Cisodang	A																					F									
16	AI28X	Decite	Tomj	Cikoplok	F		R		R																	A	C								
17	AI31X	Andesite, Py	Tomj	Cikoplok	F				F										R							A	C								
18	AI33X	Andesite, Py	Tomj	Cikoplok	R		R?		R?																	A	A								
19	AI35X	Tuff-breccia	Tomj	Cikoplok	F				R																	A	C								
20	AI37X	Decite	Tomj	Cikoplok	F																					A	F								
21	AI39X	Dacite	Tomj	Cikoplok	F	R																				A	F								
22	AI40X			Cikoplok			R		R																	A		F						F	
23	AI42X	Pumice tuff, Py	Tomj	Cikoplok	R																					A		F							
24	AI43X	Tuff/lava, Py	Tomj	Cipicung																						A	A								
25	AI45X	Basalt	Tomj	Cipicung			R		R																	R	F								
26	AI47X	Andesite	Tomj	Cipicung			R																			A	R								
27	AI49X	Pumice tuff	Tomj	Cipicung	R		R		R																										
28	AI50X	Tuff	Tomj	Cimuncar			R							F			F									F	F	R							
29	AI51X	Decite	Tomj	Roke	R																					A	R								
30	AI53X	Lapilli tuff	Tomj	Roke			R																			A	F	R							
31	AI55X	Fine tuff	Tomj	Roke			R																			A	R	R							
32	AI57X	Fine tuff	Tomj	Roke										R										F		R									
33	AI60X	Fine tuff	Tomj	Cikalongberam										R										C			R	F							
34	AI62X	Tuff	Tomj	Cisasah Mn Pit	A																			F			R								
35	AI69X	Gy ore		Cisasah Gy Mine			R												R																
36	AH2X			Cicempalung			F																			C	R	R							
37	AH5X			Sukasari			R																			C	R	F							
38	AH8X			Sukasari																	R					F		R					C	F	F
39	AH11X			Cibodas	R									F										F		R	F								
40	AH13X	Fine tuff	Tomj	Cibodas									C	C													C								
41	AH14X	Tuff	Tomj	Cibodas			F																	C											
42	AH15X	Tuff	Tomj	Cibodas									C	F												F	F								
43	AH16X	Tuff	Tomj	Cimedang								F									R					A	R								
44	AH17X	Sil-rock		Cimedang			R																			A			R						
45	AH18X	Fine tuff, Sil	Tomj	Cimedang	R	R																				A	F								
46	AH19X	Tuff-breccia	Tomj	Cipadawangi	F	R								R												F	F	R							
47	AH21X			Cipadawangi										F			C																		
48	AH22X	Dacitic tuff	Tomj	Cibihbul										F		R																			
49	AH24X	Dacitic tuff	Tomj	Cibihbul	F				R								F							F											
50	AH26X			Cibihbul										F			C									F									
51	AH28X	Tuff/lava	Tomj	Cibihbul	F									F													F								
52	AH31X			Cihaseum	R				F												C					A									
53	AH32X	Dacitic tuff	Tomj	Cigintung	F																			F		R									
54	AH33X	Dacitic tuff	Tomj	Cigintung	F																			C		R									

Abundance of Minerals : A;Abundant, C;Common, F;Few, R;Rare

Abbreviations : Mo;Montmorillonite, Ch;Chlorite, Se;Sericite, Mu;Muscovite, Ka;Kaolin, Ha;Halloysite, Pr;Pyrophyllite, Mx;Mixed Layer, Cp;Clinoptilolite, Md;Mordenite, Lm;Laumontite, Hu;Heulandite, Fr;Ferrierite, Al;Alunite, Gy;Gypsum, Ja;Jarosite, Ca;Calcite, Ak;Ankerite, Si;Siderite, Cr;Cristobalite, Tr;Tridymite, Qz;Quartz, Pl;Plagioclase, Kf;Potash Feldspar, Py;Pyrite, Go;Goethite, He;Hematite, Mg;Magnetite, Ba;Barite, Sp;Sphalerite, Gn;Galena

Table 2-2 Results of X-Ray Diffraction Analysis in the Cisasah-Cidadap-Cibuniasih Area (2)

No.	Sample No.	Remarks	Rock Unit	Locality	Clay Minerals								Zeolites					S-Salts			Carbonates			Silicates			Flds		Miscellaneous Minerals						
					Mo	Ch	Se	Mu	Ka	Ha	Pr	Mx	Cp	Md	Lm	Hu	Fr	Al	Gy	Ja	Ca	Ak	Si	Cr	Tr	Qz	Pl	Kf	Py	Go	He	Mg	Ba	Sp	Gn
55	AH34X	Dacitic tuff	Tomj	Cigintung									C	C												A									
56	AH36X			Cigintung	R								C	F		C								C											
57	AH37X	Dacitic tuff, Sil	Tomj	Cigintung												R								F		C	C								
58	AH40X			Cigintung									F											F		C	F								
59	AH42X			Cigintung	R											F								F			C								
60	AH44X	Tuff	Tomj	Cigintung	F																						R								
61	AH45X	Tuff	(Tomj)	Cinolad	F																						R								
62	AH46X	Dacitic tuff	Tomj	Cinolad	R											C								F											
63	AH47X	Sil-rock, Py		Cinolad	F																					A	C								
64	AH49X	Dacitic tuff	Tomj	Cinolad	F								F	C												C									
65	AH50X	Andesite	Tomj	Cirateun	F																R						C								
66	AH52X	Tuff	Tomj	Cibodas			R																			A	R	R							
67	AH53X			Parekan	R				R																	A	C								
68	AH54X			Parahan					R?			C														A	A								
69	AH55X	Tuff	Tomj	Parahan					R			C														A	A								
70	AH56X	Lapilli tuff	Tomj	Cipurabangsa		R																				A								R	
71	AH58X			Cipurabangsa	F	F																				A	C								
72	AH59X			Cipurabangsa	F				R																	A	R								
73	AH60X	Fine tuff	Tomj	Cibuluh	F	F																				A	A								
74	AH61X	Fine tuff	Tomj	Cijambe	F									R										F		R									
75	AH63X	Dacitic tuff	Tomj	Cipadawangi	F								F	F												C									
76	AH66X	Tuff	Tomj	Cipadawangi	R		R																	C											
77	AH67X	Dacitic tuff	Tomj	Cipadawangi	F																			F		R									
78	AH68X			Cipadawangi																				F		F									
79	AH69X	Dacitic tuff	Tomj	Cipadawangi	F																			F		R	F	R							
80	AH71X	Sil-rock		Cimedang	F																					A	C								
81	AH72X	Dacitic tuff	Tomj	Cicampelung	F								F	C												F									
82	AH73X	Dacitic tuff, Sil	Tomj	Cicampelung	F																A					C	C								
83	AH74X	Tuff	Tomj	Ciautera	F				R																	A	R								
84	AH75X	Tuff-breccia	Tomj	Cibihbul																															
85	AH77X	Tuff-breccia, Py	Tomj	Cibihbul		R	R?		F																	A	A								
86	AH78X	Sil-rock		Cibihbul	R	R																				A	F								
87	AH79X			Cibihbul							C															A									
88	AH80X			Cibihbul			R																			A	R								
89	AH81X	Tuff-breccia, Py	Tomj	Cibihbul	F				C		C															A									
90	AH83X	Tuff-breccia	Tomj	Ciaurupan	R	R																				C	A								
91	AH84X			Ciaurupan			R																			C	C								
92	AH86X	Dacitic tuff, Sil	Tomj	Ciuncal																						A	R	F	R						
93	AH88X	Dacitic tuff	Tomj	Cicampelung	F									R										F		F	F								
94	AH89X			Cicampelung	F																					A									
95	AH90X			Cicampelung	F		R																			A	F								
96	AH91X			Cicampelung	R																					A									
97	AH92X	Mn ore		Cicampelung	F																					A									
98	AH93X			Ciguranteng	R																					A				R					
99	AH94X	Tuff-breccia	Tomj	Ciguranteng		R																				A	F		F						
100	AH96X	Tuff-breccia, Qz-Py vein	Tomj	Ciguranteng			R																			A			R						
101	AH97X	Volcanic breccia, Py	Tomj	Ciguranteng		R											R									A			F						
102	AH99X			Cimedang											C											A	R	R							
103	AH100X			Cinampa	R																					A		R							
104	AH101X	Tuff-breccia	Tomj	Cinampa	R																					A									
105	AH103X	Volcanic breccia	Tomj	Cipancawangi		R																				A	R		R						
106	AD3X	Tuff	Tomj	Cimedang	R																A					R									
107	AD4X	Tuff	Tomj	Cimomon	R								F	C																					
108	AD5X	Tuff	Tomj	Cimomon	F								F	C																					

Abundance of Minerals : A;Abundant, C;Common, F;Few, R;Rare

Abbreviations : Mo;Montmorillonite, Ch;Chlorite, Se;Sericite, Mu;Muscovite, Ka;Kaolin, Ha;Halloysite, Pr;Pyrophyllite, Mx;Mixed Layer, Cp;Clinoptilolite, Md;Mordenite, Lm;Laumontite, Hu;Heulandite, Fr;Ferrierite, Al;Alunite, Gy;Gypsum, Ja;Jarosite, Ca;Calcite, Ak;Ankerite, Si;Siderite, Cr;Cristobalite, Tr;Tridymite, Qz;Quartz, Pl;Plagioclase, Kf;Potash Feldspar, Py;Pyrite, Go;Goethite, He;Hematite, Mg;Magnetite, Ba;Barite, Sp;Sphalerite, Gn;Galena

Table 2-2 Results of X-Ray Diffraction Analysis in the Cisasah-Cidadap-Cibuniasih Area (3)

No.	Sample No.	Remarks	Rock Unit	Locality	Clay Minerals								Zeolites					S-Salts			Carbonates			Silicates			Flds		Miscellaneous Minerals						
					Mo	Ch	Se	Mu	Ka	Ha	Pr	Mx	Cp	Md	Lm	Hu	Fr	Al	Gy	Ja	Ca	Ak	Si	Cr	Tr	Qz	Pl	Kf	Py	Go	He	Mg	Ba	Sp	Gn
109	AD6X	Tuff	Tomj	Cimomon/Cipari																															
110	AD7X	Tuff	Tomj	Cibuniasih	C				R																										
111	AD11X	Dacite	Tomj	Sidamulya	R				R																	A									
112	AD12X	Dacite	Tomj	Brujul	F																					A									
113	AD14X	Tuff-breccia	Tomj	Genteng	R		R																			C	C								
114	AD15X			Cikeler 2	F																					A									
115	AD17X	Dacitic tuff	Tomj	Cikeler 1	R?																					A	R								
116	AD18X	Tuff	Tomj	Sirnagalih	R?				R																	A	C								
117	AD20X	Sandstone	Tmbs	Sirnagalih	F								F	C												A									
118	AD23X	Dacite	Tomj	Cikalong	R																					F									
119	AD24X	Dacitic tuff	Tomj	Kp Sidong												C								R			F								
120	AD26X	Fine tuff	Tomj	Kp Sidong	R								C	C																					
121	AD28X	Tuff	Tomj	Kp Cimade	R		R?						C	A																					
122	AD29X	Fine tuff	Tomj	Rancapicung	R								R	F												R									
123	AD30X	Fine tuff	Tomj	Cisasah-Cidadap	C																C					A	C								
124	AD33X	Tuff-breccia	Tomj	Cisasah-Cidadap	A																					A		R							
125	AD34X	Fe-chart		Pasung Kiper	F		R		R																										
126	AD36X	Lapilli tuff	Tomj	Kp Cikalong	R		R?		R																										
127	AD38X	Tuff-breccia	Tomj	Kp Cikalong		F	R?		F																	A	C								
128	AD40X	Tuff-breccia	Tomj	Cibitung	F		R		R																	C	A								
129	AD44X	Fine tuff	Tomj	Cibitung					F			C									F					A	F								
130	AD46X	Tuff-breccia	Tomj	Cigorowong	R																					C	C								
131	AD48X	Dacitic tuff, Sil	Tomj	Cigorowong					R			F														A	A								
132	AD50X	Tuff	Tomj	Cikupa	F																					A	A								
133	AD51X	Tuff-breccia, Sil	Tomj	Cikoplok	R									F												F									
134	AD53X	Tuff-breccia, Sil	Tomj	Cikoplok	F				R																		R								
135	AD55X	Andesite	Tomj	Cikoplok					F			R														A	F								
136	AD57X	Lapilli tuff, Sil	Tomj	Cikoplok			R																			A	C								
137	AD58X	Dacitic tuff, Sil	Tomj	Cigorowong/Singkir	R		R		R																	A									
138	AD60X	Tuff	Tomj	Cigorowong/Singkir					R																	A	A								
139	AD62X	Tuff-breccia	Tomj	Cigorowong/Singkir	R				R																	A	F								
140	AD64X	Tuff-breccia	Tomj	Cigorowong/Singkir	F				R																	A	C								
141	AD66X	Tuff	Tomj	Citieuk	R?		R?		R																	C	R	R	R						
142	AD68X	Tuff	Tomj	Cipeunding			R?		R																	A									
143	AD71X	Tuff, Sil	Tomj	Cigorowong	F								F	C												A	A								
144	AD73X	Tuff	Tomj	Cigorowong	R?								C	C												F									
145	AD76X	Tuff	Tomj	Ciawitali	C																														
146	AD77X	Tuff	Tomj	Cimuncar	C				R?				F	F												R	R								
147	AD79X	Fine tuff, Sil	Tomj	Cimuncar	R?								C	C																					
148	AD81X	Tuff-breccia	Tomj	Cimuncar					F																	F									
149	AD82X	Tuff	Tomj	Cibeet	R				R																										
150	AD84X	Tuff	Tomj	Cibeet																				C		F									
151	AK2X	Tuff	Tomj	Kp Wangun					R																										
152	AK14X	Andesite	Tomj	Citoe	F																					A									
153	AK15X	Tuff/lava	Tomj	Citoe	C																					A	F	R							
154	AK16X	Tuff/lava	Tomj	Citoe	F																					C	F								
155	AK17X	Tuff/lava	Tomj	Citoe																						R	F								
156	AK18X	Tuff-breccia/lava	Tomj	Cikondang	F																					A	F								
157	AK26X	Tuff	Tomj	Cikondang	F																						R								
158	AK52X	Lapilli tuff	Tomj	Cimajaya	F	R																				F									
159	AK54X	Tuff-breccia	Tomj	Cimajaya	F	R																				C	F								
160	AK56X	Fine tuff	Tomj	Cilimus	F		R						R	F												C									
161	AK81X		-	Cisarua	R				F																	A									

Abundance of Minerals : A;Abundant, C;Common, F;Few, R;Rare

Abbreviations : Mo;Montmorillonite, Ch;Chlorite, Se;Sericite, Mu;Muscovite, Ka;Kaolin, Ha;Halloysite, Pr;Pyrophyllite, Mx;Mixed Layer, Cp;Clinoptilolite, Md;Mordenite, Lm;Laumontite, Hu;Heulandite, Fr;Ferrierite, Al;Alunite, Gy;Gypsum, Ja;Jarosite, Ca;Calcite, Ak;Ankerite, Si;Siderite, Cr;Cristobalite, Tr;Tridymite, Qz;Quartz, Pl;Plagioclase, Kf;Potash Feldspar, Py;Pyrite, Go;Goethite, He;Hematite, Mg;Magnetite, Ba;Barite, Sp;Sphalerite, Gn;Galena

Table 2-3 Results of Ore Microscopy in the Cisasah-Cidadap-Cibuniasih Area

Sample No.	Locality	Minerals									Remarks
		Py	As	Cp	Sp	Gn	Cv	Ag	Sc	Io	
AI40P	Panyairan	△		·	○	·					Siliceous ore
AI61P	Cisasah									·	Manganese ore (rhodochrosite, psilomelane)
AI65P	Cisasah									○	Manganese ore (pyrolusite, psilomelane), colloform
AI104P	Panyairan	○		○	○						Siliceous ore
AH56P	Balekambang	△		·							Siliceous ore
AH68P	Padawangi									○	Manganese ore (psilomelane, pyrolusite), colloform
AH94P	Ciguranteng	△		·	·		·				Pyrite dissemination in silicified andesite
AH97P	Ciguranteng	△									Pyrite dissemination in silicified andesite
AH110P	Cibuniasih	·		○	○	△	·				Barite ore
AH148P	Pasir Gintung										
AD13P	Brujul	·								○	Manganese ore (psilomelane, pyrolusite), colloform
AD102P	Balekambang	△		△	·					·	Pyrite dissemination in silicified tuff
AD106P	Balekambang	△		·							Siliceous ore
AK86P	Cibuniasih	△		○	○	○					Siliceous ore

Abundance of Minerals: ○ ;Common, △ ;Rare, · ;Trace

Abbreviations : Py;Pyrite, As;Arsenopyrite, Cp;Chalcopyrite, Sp;Sphalerite, Gn;Galena
Cv;Covelline, Ag;Argentite, Sc;Specularite, Io;Iron Oxide

Table 2-4 Assay Results of Ore Samples in the Cisasah-Cidadap-Cibuniasih Area

Sample No.	Au g/t	Ag ppm	Cu ppm	Pb ppm	Zn ppm	Fe %	Mn ppm	Ba ppm
AI002	<0.03	2	20	55	130	0.69	220	20
AI003	<0.03	<1	10	<5	40	0.53	100	<20
AI006	<0.03	1	310	35	780	3.24	290	60
AI009	<0.03	<1	240	15	60	2.77	680	280
AI010	<0.03	95	9,650	4,600	>50,000	6.66	780	20
AI026	<0.03	<1	30	5	185	4.46	>50,000	1,140
AI040	<0.03	17	6,420	590	>50,000	11.50	900	<20
AI058	<0.03	<1	60	5	765	13.65	210	20
AH009	0.51	>200	730	12,420	8,290	0.76	70	10,720
AH039	<0.03	<1	15	20	30	0.88	60	520
AH048	<0.03	1	15	30	400	25.00	2,860	540
AH056	0.06	34	34,600	1,160	>50,000	7.90	740	20
AH057	<0.03	2	4,910	5	7,370	6.43	740	20
AH059	<0.03	1	2,180	5	990	5.91	1,080	20
AH068	<0.03	8	580	2,130	2,600	0.58	>50,000	16,540
AH076	<0.03	<1	20	10	55	1.90	1,060	40
AH077	<0.03	<1	10	<5	105	5.01	320	20
AH079	<0.03	<1	10	<5	<5	4.46	50	20
AH081	<0.03	<1	10	<5	5	4.78	90	<20
AH094	<0.03	64	14,060	480	11,080	10.25	3,850	80
AH095	<0.03	8	100	15	20	9.04	40	<20
AH096	<0.03	5	75	20	5	9.69	20	20
AH144	<0.03	<1	65	55	65	7.37	8,620	360
AH148	<0.03	<1	45	<5	70	4.32	>50,000	16,020
AK003	<0.03	<1	10	<5	5	0.32	1,640	33,600
AD010	<0.03	<1	80	45	210	>30.00	11,280	1,300
AD013	<0.03	<1	75	30	20	3.35	90	120
AD032	<0.03	<1	550	10	495	4.17	5,380	820
AD034	<0.03	<1	110	<5	160	>24.00	8,610	400
AD083	<0.03	<1	20	<5	20	3.34	220	20

1-3 Geology and Geologic Structure

1-3-1 Introduction

The geology of the Cisasah-Cidadap-Cibuniasih area is composed of the following four stratigraphic units:

·Andesitic to basaltic lava, volcanic breccia, tuff-breccia (Jampang Formation - Lower Member)

·Dacite lava, tuff-breccia, pumice tuff, fine tuff (Jampang Formation - Upper Member)

·Massive limestone (Kalipucang Formation)

·Calcareous sandstone with intercalations of tuff and limestone (Bentang Formation)

The general trend of these formations is NE-SW. They form a series of gentle foldings with the axes of NE-SW to N-S direction. A basin structure of rather thick piles of volcanic and pyroclastic rocks of the Upper Member of the Jampang Formation was recognized in the central-southern part of the survey area. Major faults which cut Neogene volcanic-sedimentary sequences are of the N-S system. Intrusive bodies of quartz-porphyry and andesite occur in these formations. Based upon the photogeological analysis on the SAR images, the geologic structure of the Cisasah-Cidadap-Cibuniasih area is characterized by the development of lineaments trending NE direction.

1-3-2 Stratigraphy

<u>Jampang Formation (Lower Member)</u>

The Lower Member of the Jampang Formation in the Cisasah-Cidadap-Cibuniasih area is composed mainly of volcanic breccia and lava of andesitic to basaltic composition. It exposes widely along the middle reaches of Cimedang in the eastern part of the area. At the western side of the middle reaches of Cimedang, it is composed of the alteration of andesite lava flow and volcanic breccia in the lower part (northern area). Whereas in the upper part, which is distributed at the southern area, the volcanic breccia becomes dominant. It is also exposed at branch rivers of the upper reaches of Citoe in the central part of the area. It occurs along Ciwulan river in the western part of the area as well. They are the oldest rocks in the study area. Volcanic breccia and andesite lava locally show propylitic alteration near intrusive bodies of quartz-porphyry.

Jampang Formation (Upper Member)

The Upper Member of the Jampang Formation is widely distributed within and around the Cisasah-Cidadap-Cibuniasih area. It is composed of dacitic tuff, fine tuff, pumice tuff, tuff-breccia and dacite lava. They show green color, and are called green tuff in the field.

In the western side of the middle reaches of Cimedang, thick green tuff is widely exposed. The upper part of green tuff is composed of pumice tuff, lapilli tuff and tuff-breccia. The lower part of the green tuff sequence consists mainly of tuff-breccia and dacite lava flow. Dacite sometimes shows hyaloclastic texture.

In the central-southern part of the survey area, green tuff is well developed. It is composed of fine tuff, pumice tuff and lava flow. The Upper Member of the Jampang Formation was thought to be thick in the area.

Green tuff sometimes shows montmorillonite, chlorite and zeolite alteration. It is the host rock of massive sulfide mineralization.

Kalipucang Formation

The Kalipucang Formation is represented by massive, sometimes crystalline, reef limestone in the Cisasah-Cidadap-Cibuniasih area. It is distributed in the central part of the survey area. It also occurs in the southern part of the area. Karst topography and limestone caves are extensively developed in the Kalipucang limestone area. The thickness was estimated to be up to 50 m at the central part of the survey area.

Bentang Formation

The Bentang Formation occurs all over the area, covering hills in the Cisasah-Cidadap-Cibuniasih area. It is mainly composed of calcareous sandstone, tuffaceous sandstone and siltstone. Many fossils are contained in the calcareous member of the Bentang Formation. Thin lenses of limestone are interbedded within calcareous sandstone. The tuffaceous member, which is correlated to the upper part of the Bentang Formation, occurs in the northwestern part of the survey area. The Jampang green tuff is sometimes overlain directly (unconformably) by the Bentang calcareous sandstone in the survey area.

1-3-3 Intrusive Rocks

Quartz-Porphyry

Several small stocks and dikes of quartz-porphyry are distributed in the central to the western parts of the Cisasah-Cidadap-Cibuniasih area. They occur within the Jampang Formation. Quartz-porphyry is a porphyritic rock of acidic composition. Under the microscope, phenocrysts of plagioclase, quartz and hornblende were observed. Some part of a quartz-porphyry body shows an aphanitic dacitic appearance.

Andesite

Many small andesite dykes spread over the Cisasah-Cidadap-Cibuniasih area. It occurs mainly in the Upper Member of the Jampang Formation. It shows grey to black color, massive feature. Under the microscope, phenocrysts of plagioclase, pyroxene and hornblende were observed.

1-3-4 Geologic Structure

Fold Structure

The geologic structure of the Cisasah-Cidadap-Cibuniasih area is characterized by the occurrence of a regional synclinorium. The strata of the Jampang Formation generally show gentle western dip in the eastern part of the area. Whereas in the western part of the area, the strata dip gently to the east. These foldings have axes of N-S to NE-SW directions.

Basin Structure

A basin structure is recognized within the Upper Member of the Jampang Formation in the central-southern part of the Cisasah-Cidadap-Cibuniasih area. It was called Cikalong Basin. It has a diameter of approximately 10 km. The green tuff sequence of the Upper Member of the Jampang Formation shows thick, more than 300 m amidst the basin. It becomes thinner, less than 100 m at the margin of the basin. It was confirmed by the structural analysis of Bouguer anomaly during the gravity survey this phase.

Fault

Faults of N-S system are distinctive within the Lower Member of the Jampang Formation in the survey area.

In Pasir Gintung, andesite lava and volcanic breccia of the Lower Member of the Jampang formation are contacted with green tuff by an N-S fault.

Along the upper reaches of Citoe in the central part of the survey area, andesite lava flow and volcanic breccia crop out at the riverbeds among the Kalipucang limestone bounded by several N-S faults.

In the central-southern part, the thick sequence of green tuff, which forms the above-mentioned basin structure, is bounded by several series of normal faults of N-S system both at the eastern and western marginal zones. A series of dacite lava flows occurs along these faults, indicating that they were erupted through the faults.

Faults of NE system, which were picked up through the satellite image photogeological interpretation of the first phase, have not been encountered during the geological survey. This type of fractures probably exists as igneous joints and/or minor faults of small displacement.

1-4 Mineralization and Hydrothermal Alteration

1-4-1 Regional Alteration

On the basis of the result of the X-ray diffraction analysis, the following six hydrothermal alteration zones were distinguished in a regional scale: (a) silicified zone, (b) sericite-chlorite-mixed layer (chlorite-montmorillonite mixed layer) zone, (c) montmorillonite-kaolin zone, (d) zeolite zone (mainly comprising mordenite, clinoptilolite and heulandite), (e) pyrophyllite-kaolin zone, and (f) carbonitized zone. Three kinds of the degree of alteration -- S (strong), M (moderate), and W (weak) -- were allocated to each zone. In case of silicification, the result of X-ray analysis was not sufficient for the determination of alteration. The alteration intensity by means of mineralogical observation was took into counting together.

The classification of alteration zones was matched well with the observation result of alteration intensity. It was also cross-checked with the result of geochemical alteration index (A.I. -- mentioned in the geochemistry section).

Three alteration zones are arranged in the following order: (1) central sericite-chlorite-mixed layer zone, (2) intermediate montmorillonite-kaolin zone, and (3) peripheral zeolite zone. The sericite-chlorite zone occurs in the most intensely altered area, whose distribution is at an order of a few kilometers horizontally. It is surrounded by the montmorillonite-kaolin zone. The zeolite zone constitutes the outermost part within the green tuff area. The major localities where sericite-chlorite-mixed layer minerals were detected are: in the vicinity of Cisasah, Cidadap, Cigoronggon, Cikoplok, and Cibunlasih.

The montmorillonite-kaolin alteration bears two different meanings. Regionally it occurs at the intermediate zone between the central sericite-chlorite zone and the outer zeolite zone. Whereas in the vicinity of the massive sulfide deposit, the occurrences of intense montmorillonitization appear to be accompanied stratigraphically by the manganese deposition. Examples of the latter case are: Pasir Gintung, Cimomon, Cisodong, and Cisasah manganese pit.

The silicified zone shows two modes of occurrences. Firstly, it occurs as silicified zones or quartz veins in the Lower Member of the Jampang Formation, for example in Ciguranteng. The genetic relationship to the massive sulfide mineralization in this case is still under the discussion. Secondly, it occurs in the footwall of the massive sulfide horizon. The latter case occurs in: Pasir Gintung, Balekambang, Cidadap, Panyairan, etc..

The major localities of hydrothermal alteration thus identified are described in the next clause together with mineralized occurrences.

1-4-2 Mineralization

Indications of massive sulfide mineralization and associated alteration were caught in many places in the Cisasah-Cidadap-Cibuniasih area in the course of the geological survey. Stratabound gypsum and manganese deposits have been found and exploited at Cisasah and Cidadap in the western part of the area. Barite beds and manganese deposits were found at Cibuniasih and Pasir Gintung in the eastern part of the survey are. Sulfide dissemination accompanied by silicification and clay alteration were observed at several localities both in the eastern part and western part of the Cisasah-Cidadap-Cibuniasih area. Silicified zones with a significant amount of sulfide minerals occur at Balekambang near Cibuniasih. Most of these indications are hosted by pyroclastic rocks of the Upper Member of the Jampang Formation. However some of them -- such as silicified zones and quartz veins -- occur within the Lower Member.

The stratigraphic succession of the massive sulfide mineralization can be categorized into several zones together with the footwall, intermediate and hanging-wall green tuff sequences in descending order as follows: (a) hanging-wall green tuff, (b) manganese zone, (c) intermediate green tuff, (d) barite-galena bed, (e) anhydrite-gypsum zone, and (f) footwall silicified zone.

Barite bed is composed of a sulfide assemblage of galena-sphalerite-pyrite-chalcopyrite-covelline with barite + quartz gangue. Significant results of gold and silver assays were obtained in the Cibuniasih barite bed. Anhydrite-gypsum zone is mainly composed of massive anhydrite-gypsum ores with sericitic clay. Pyrite is strongly disseminated, and a small amount of chalcopyrite, galena and sphalerite are impregnated within anhydrite-gypsum zone. Colloform texture was observed in pyrite under the microscope. Manganese zone is composed of rhodochrosite, manganese oxide minerals (such as pyrolusite and psilomelane) and pyrite. Patches of ferruginous chert consisting of hematite-rich silica materials were sometimes found within and around the manganese zone.

The assemblages of alteration minerals in each of the above-mentioned six zones are: (a) montmorillonite, (b) montmorillonite-sericite, (c) montmorillonite-chlorite-sericite-kaolin-mixed layer mineral (chlorite-montmorillonite mixed layer), (d) quartz-sericite-chlorite, (e) quartz-sericite, and (f) quartz-sericite-chlorite. These assemblages of alteration minerals are only applicable in the vicinity of the massive sulfide deposit.

The details of mineralized occurrences and associated hydrothermal alteration are described below.

Cisasah

Stratabound gypsum ore occurs in green tuff at the Cisasah gypsum mine. So-called green tuff is composed of dacite lava, tuff-breccia, pumice tuff, lapilli tuff and fine tuff of the Upper Member of the Jampang Formation. These tuffs are altered into montmorillonite, chlorite and sericite, showing green color. Four zones were distinguished stratigraphically in ascending order: (a) foot-wall green tuff, (b) grey massive anhydrite-gypsum ore with reddish clayey tuff containing gypsum veins, (c) silicified tuff-breccia, and (d) hanging-wall green pumice tuff. Pyrite is strongly disseminated in (b) zone. A small amount of sphalerite and galena were found both in zone (b) and (c) in the Cisasah gypsum mine. Significant Au and Ag values were obtained from gypsum ores in the Cisasah mine. The massive sulfide ore is expected to occur in a horizon between (c) and (d).

The assemblages of alteration minerals detected in each zone by X-ray diffraction analysis are: (a) quartz-sericite-chlorite, (b) montmorillonite-sericite-chlorite-kaolin-mixed layer mineral, (c) quartz-sericite-chlorite, and (d) montmorillonite-sericite.

Manganese ore occurs above the gypsum ore horizon in green tuff. Four zones were distinguished either in the Cisasah gypsum mine or in the Cisasah manganese pit: (e) green pumice tuff, (f) rhodochrosite and manganese oxide (pyrolusite and psilomelane) ore, (g) montmorillonitized pumice tuff with a patch of rhodochrosite, and (h) hanging-wall green tuff. Manganese ores are distributed widely in the Cisasah area. The Cisasah manganese pit, which was mined out last year, is located about 400 m WSW of the Cisasah gypsum mine. Another manganese ore was backhoe-excavated 250 m WSW to the manganese pit. Manganese ores were also found at a couple of localities along the upper reaches of Ciwulan (at Gebang and Cipurut).

Ferruginous chert is frequently found associated with manganese ore in this area. It occurs from (b) up to (h) horizons. The distribution of these mineralization and alteration localities in the Cisasah area were shown in a figure in the Phase I Report. Fig. 2-2 shows a schematic section of each mineralized zone in the Cisasah area.

Gypsum ore is mined by private company at a rate of a few tons per day. One mining concession (KP 912, 90 ha) for manganese ore and one local mining concession (SIPD) for gypsum ore are registered in this area.

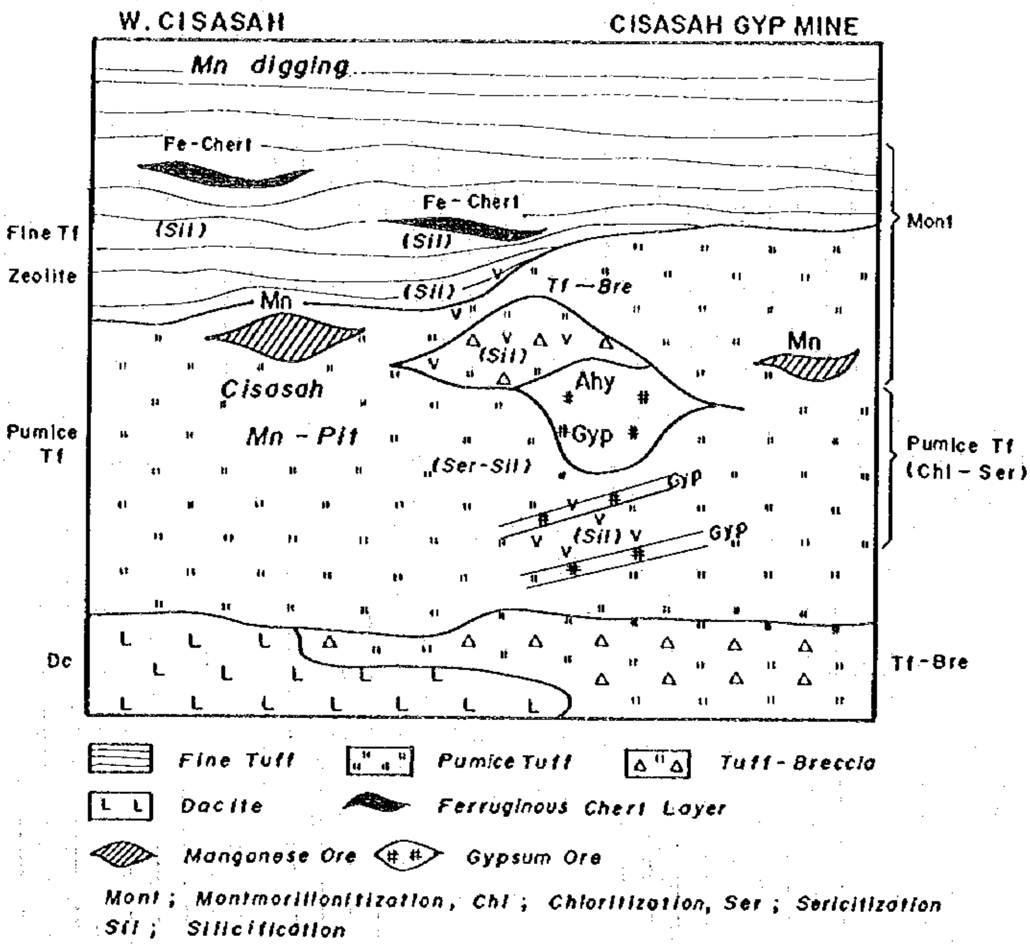


Fig. 2-2 Schematic Section of Mineralization in the Cisasah Prospect

Cidadap

At Cidadap, stratabound gypsum ore occurs in green tuff below the boundary of green tuff of the Jampang Formation and calcareous sandstone of the Bentang Formation. Above the footwall green pumice tuff, the following three zones were recognized in ascending order: (a) grey massive anhydrite-gypsum ore with clayey tuff containing gypsum veins, (b) light grey clayey fine tuff, (c) a thin layer of white silicified tuff-breccia. Anhydrite-gypsum ore forms isolated masses up to 10 m in thickness within grey clay zone. Grey clay is mainly composed of sericite and quartz with some pyrite dissemination. Tuff-breccia at the northwestern pit wall is silicified and reddish stained by hematite. Sulfide minerals were found in (a), (b) and (c) zones. Pyrite and sphalerite (marmatite) are disseminated in (a) and (b) zones. Pyrite, sphalerite and chalcopyrite are disseminated in (c) zone. The dissemination of base-metal minerals is very little and sporadic in both cases.

Gypsum ore has been mined intermittently for 10 years in the Cidadap area. Four pits, approximately 50 m in diameter each, are distributed in the area. These gypsum deposits are arranged in the NNE-SSW direction for 600 m. A silicified tuff occurs among the gypsum deposits. It is situated southwest of the current pit. It is composed of silicified tuff and tuff-breccia. Pyrite is disseminated commonly in silicified zone. It looks like footwall silicified zone of massive sulfide deposit.

Gypsum ore is produced currently in a small scale (10 t/day) by a local government company. One mining concession for gypsum ore (KP 471, 120 ha) is registered in this area.

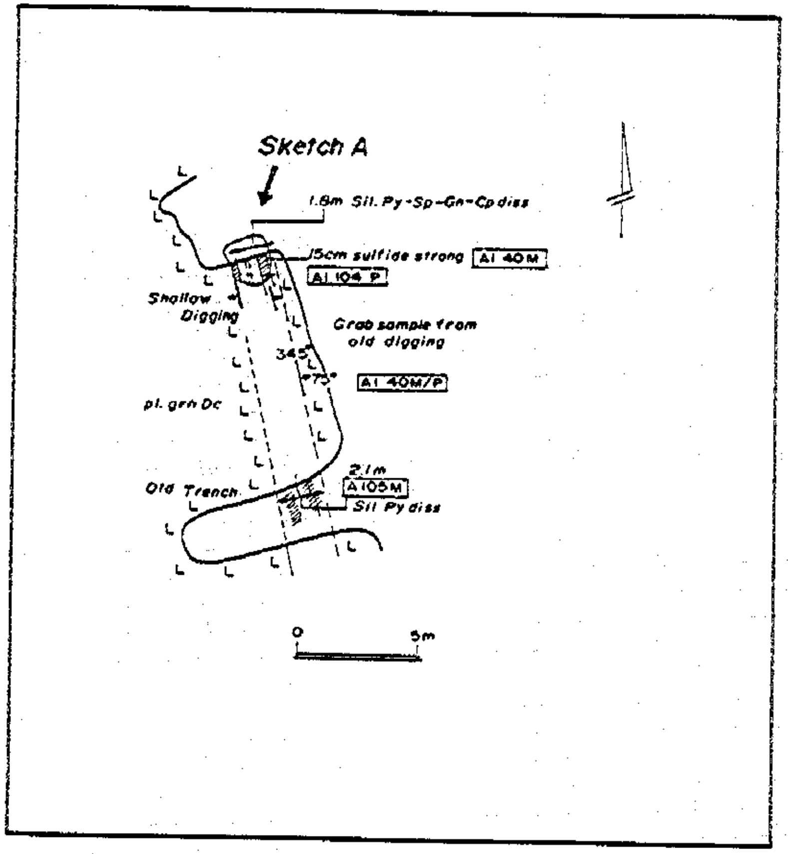
In a wider scale, there are several indications of mineralization/alteration in the Cidadap area as mentioned below. These mineralized zones are distributed from N to S.

Ferruginous chert occurs in green tuff at the upper reaches of S. Cidadap. Another ferruginous chert zone was found in green tuff at S. Cikalong about 2 km NNE of Cidadap gypsum mine.

A couple of silicified zones were recognized in green tuff and andesite lava (Lower Member of Jampang Formation) along the middle to the lower reaches of Cisodong located to the north of S. Cikalong.

Cikoplok-Cipari

At Panyairan, the upper reaches of Cikoplok in the western part of the survey area, massive, partly brecciated dacite lava is silicified and sulfide minerals are strongly disseminated. Pyrite, sphalerite, galena and chalcopyrite were distinguished in the sulfide concentration. Silicification, chloritization, sericitization and montmorillonitization were observed in this zone. The silicified zone, approximately 2 m in width, trends N-S to NNE with steep E-dip. A significant assay result was obtained from some grab samples in this location:



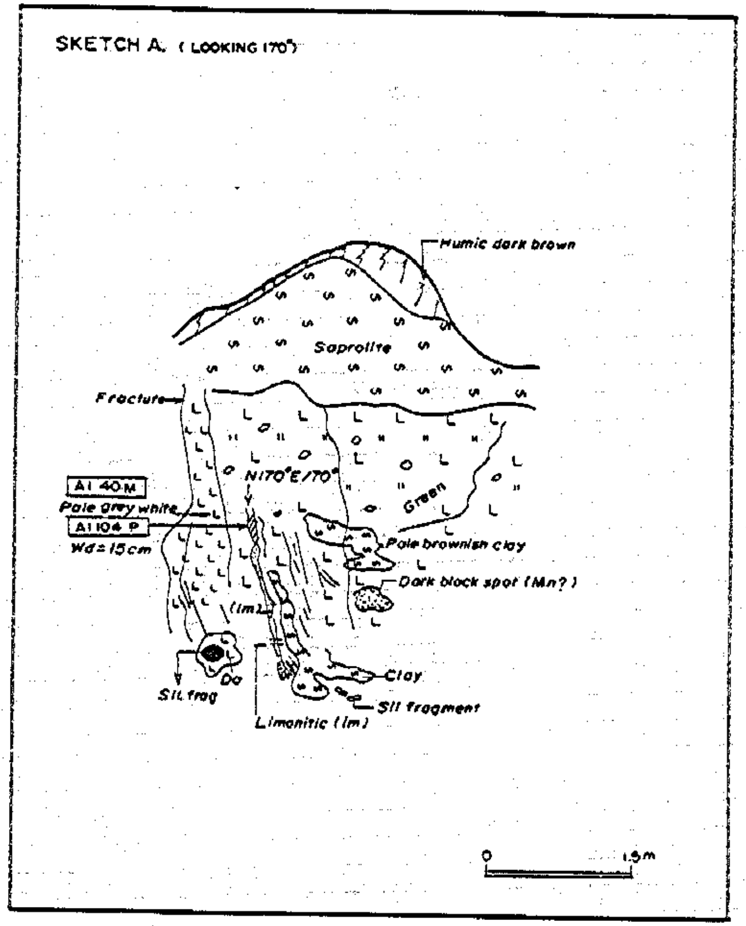


Fig. 2-3 Sketch of Sulfide Mineralization in the Panyairan Prospect

<0.03 g/t Au, 17 g/t Ag, 0.64 % Cu, 0.06 % Pb, >10.00 % Zn, 11.50 % Fe (AI40M). This zone was interpreted as a footwall silicified zone of massive sulfide mineralization. A couple of old diggings for mainly gold prospecting are found in this zone. Fig. 2-3 shows the occurrence of the silicified zone in Panyairan.

Along the lower reaches of Cikoplok, similar kind of silicified zone occurs at several localities. They are hosted in pale green tuff and tuff-breccia of the Upper Member of the Jampang Formation. Pyritization was commonly observed in these silicified zones. At Cipari, a couple of silicified zones were found in pale green to green lapilli tuff (Upper Member) and andesite (Lower Member). These silicified zones are located at the northern extensions of the Cisodong silicified zone mentioned above.

Upper Reaches of Cigoronggong

Silicified and/or argillized zones occur at several localities along the upper reaches of Cigoronggong (Cibitung). Argillization is composed mainly of montmorillonitization and some of sericitization and chloritization.

Cibunlasih

A barite bed was found at the upper reaches of S. Cihaseum, a branch of Cimedang in the eastern part of Cisasah-Cidadap-Cibunlasih area. Barite ores occur in a green tuff member (dacitic tuff at the hanging-wall side, and dacitic tuff, fine tuff and tuff-breccia at the footwall side) of the Jampang Formation together with quartz and sulfide minerals such as galena, sphalerite, chalcopyrite and pyrite. Some of these barite ores showed a significant concentration of gold and silver (refer to the Phase I Report). Montmorillonitization and chloritization were observed in the hanging-wall dacitic tuff. Whereas in the footwall tuff, silicification and sericitization were observed together with montmorillonite-chlorite alteration. Limonite after pyrite is disseminated in the footwall side of the barite bed. Patches of manganese ore (a small black/red banded ore) occur just above the barite bed. A ferruginous chert bed was found near the barite bed in the hanging-wall dacitic tuff. Fig. 2-4 shows a sketch of the barite occurrence.

About 700 m SE of the barite bed, manganese ore was found in green tuff of the Jampang Formation. A couple of pits were dug in this location. Manganese ore consists of rhodochrosite and manganese oxides. Black and red banded structure, originally formed during the sedimentation, is distinct in ore zone. The host green tuff is intensively decolorized (silicified, montmorillonitized and chloritized). Colloform texture composed of manganese oxides and limonite was observed under the microscope. Manganese ores of similar texture

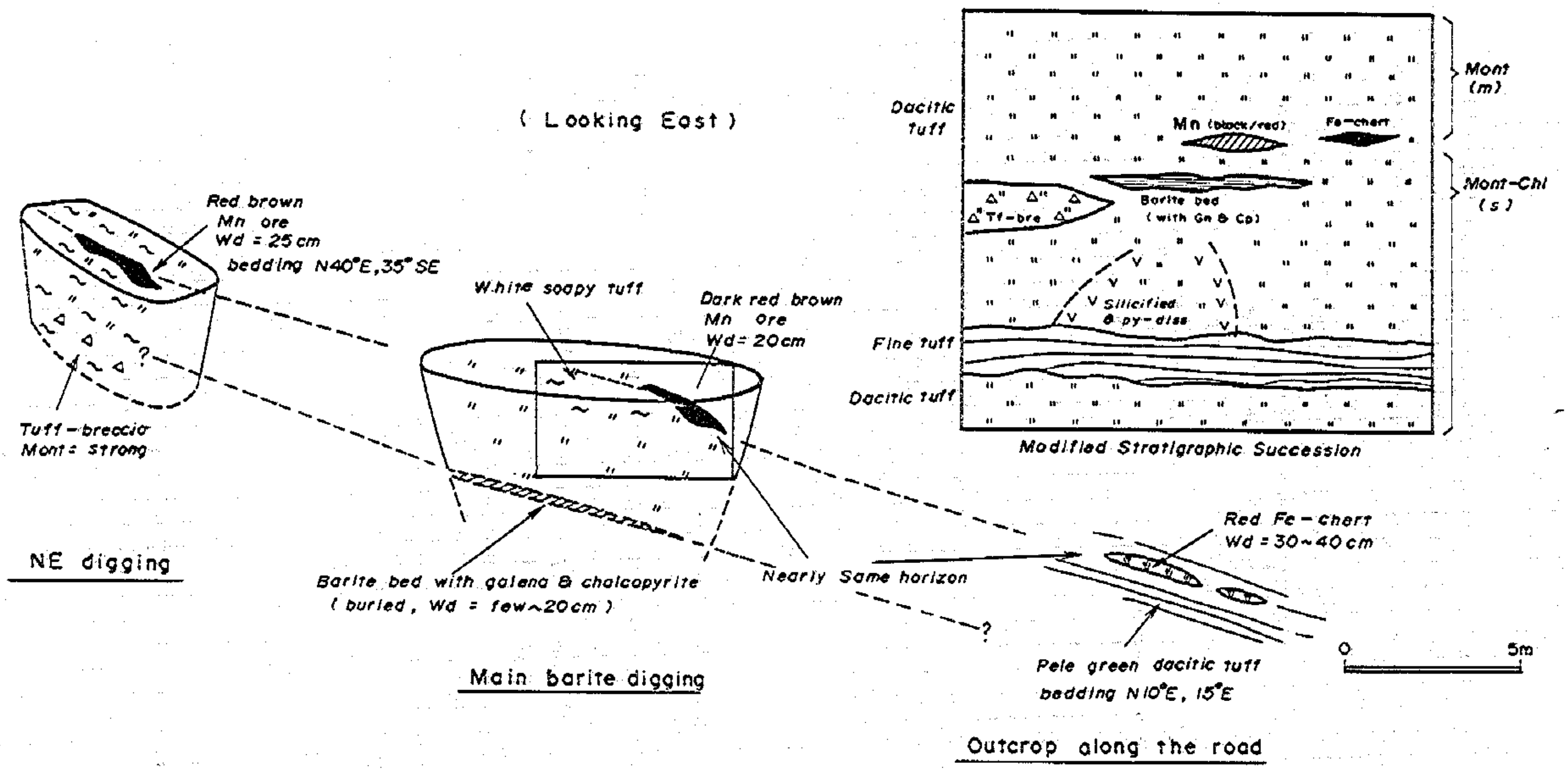


Fig. 2-4 Schematic Occurrence of Barite Bed in the Cibuniasih Prospect

were also found in green tuff in Pasir Gintung, some 2.5 km E of the Cibuniasih barite bed. Manganese ore was mined in a small scale by local companies a few years ago.

At the upper reaches of Ciguranteng (a branch of Cimedang) which is located 2.5 km north of the Cibuniasih barite bed, quartz veins and silicified zones are developed within green tuff. They were interpreted as a footwall silicified zone accompanied by the massive sulfide mineralization.

Balekambang

A remarkable silicified zone was observed in Balekambang, approximately 3 km SE of the Cibuniasih barite bed. It shows 2 to 4 m in width, strikes N to NNE and dips steeply to west. It extends about 30 m. It is hosted by grey massive, partly brecciated andesite lava. The zone contains significant amount of sulfide minerals. Chalcopyrite, pyrite, sphalerite and galena were identified. A significant assay result was returned: 0.06 g/t Au, 34 g/t Ag, 3.46 % Cu, 0.12 % Pb, >10.00 % Zn, 7.90 % Fe at 25 cm in width (AH56M). The host rock adjacent to the vein is sericitized with limonite dissemination and network.

Silicified zones and clayey veins were found in the vicinity of this zone. They are distributed in the N-S direction, extending down to the south of Cimedang river. These zones were interpreted as the footwall silicified zones of the massive sulfide mineralization. Fig. 2-5 shows the occurrence of the silicified zone in Balekambang.

Upper Reaches of Citoe

During geochemical survey, gold was detected along some places at branch rivers of the upper reaches of Citoe in the central part of the area where volcanic breccia of the Lower Member of the Jampang Formation was exposed among the Kalipucang limestone. It was thought to be derived from auriferous silicified breccias contained in the volcanic breccia of the Lower Jampang member, genetically similar to that in the Sidamulih area (refer to the Phase I Report).

1-5 Discussion

In the course of field survey this phase, the extensive distribution of dacitic pyroclastic rocks of the Upper Member of the Jampang Formation, which is so-called green tuff, was proved over the survey area. The green tuff is composed of pumice tuff, lapilli tuff, tuff-breccia and fine tuff. So-called moya-moya tuff, which is dacite lava, also occurs in the green tuff succession. So far as the result of survey this phase, the structure of these tuffs is extremely

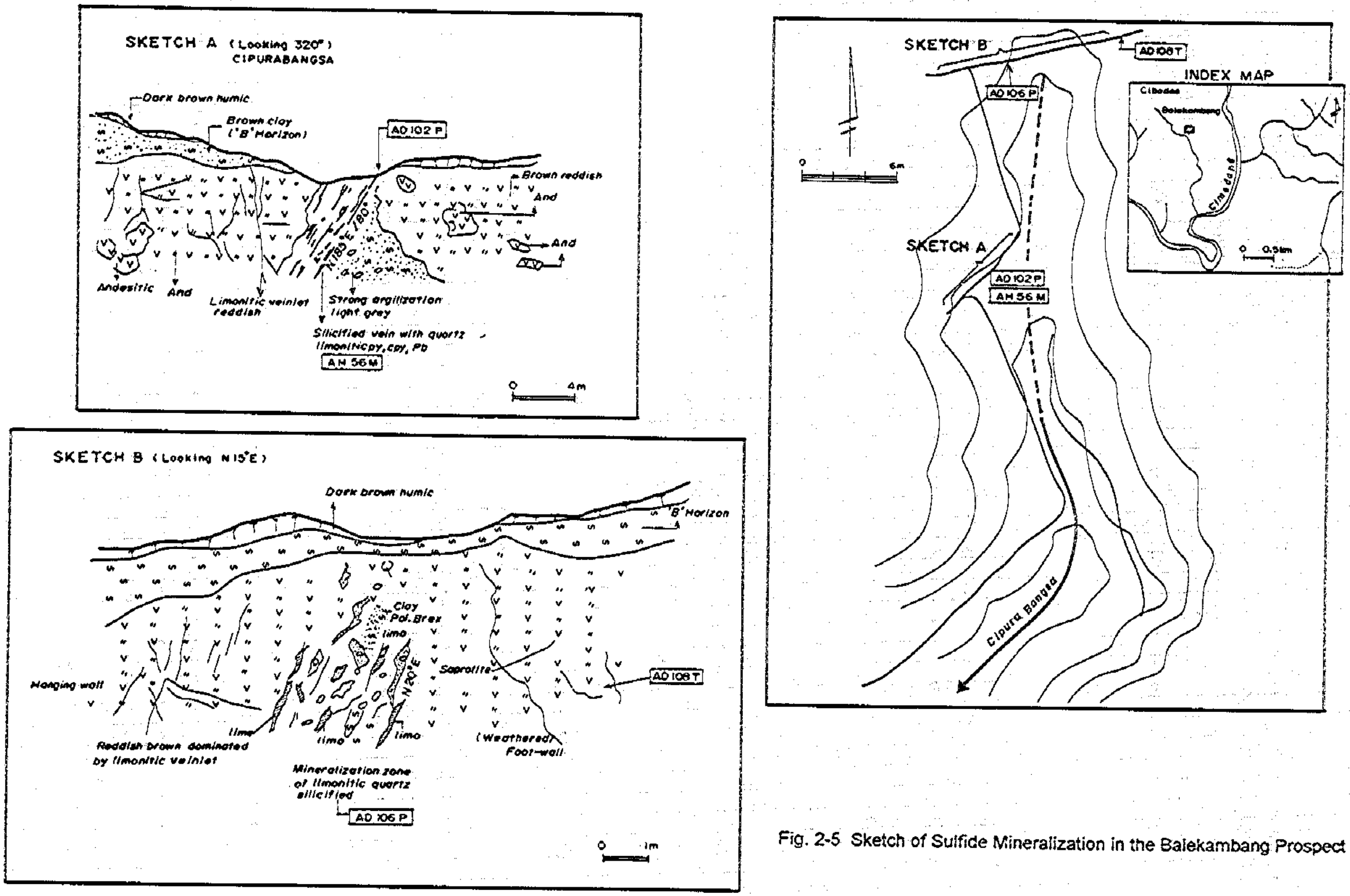


Fig. 2-5 Sketch of Sulfide Mineralization in the Balekambang Prospect

monotonous and flat. The thickness is around 200 m in the vicinity of the Cisasah gypsum mine. It exceeds to 300 m at the center of the Cikalong basin in the southern area. They are overlain by the Kalipucang limestone or the Bentang calcareous sandstone. They crop out mainly along creeks and low-altitude areas within the survey area.

The results of field surveys which were conducted mostly at the Cisasah and Cidadap gypsum mines and some at Cibuniasih, indicate that the size and magnitude of submarine dacitic volcanic activity in this area were comparatively smaller-scale and weaker than those of in the Hokuroku district in Japan. The total accumulation of green tuff is thin. Lava and coarse pyroclastic members are rather minor in the green tuff succession. The succession is characterized by the absence of mudstone layer, like the M2 mudstone in the Hokuroku district, although thin lenses of mudstone are intercalated in green tuff. Together with this, the occurrence of coral reef limestone near the massive sulfide horizon indicates that the volcanic activity of green tuff in this area occurred under rather shallow sea. As stratabound manganese deposit and ferruginous chert layer occur at the hanging-wall side of the massive sulfide horizon, it can be estimated that the conditions of the waning stage of massive sulfide mineralization became an oxidation environment in the sea. The massive sulfide deposit of a certain size could be formed from the thick sulfide accumulation under the reduction environment of deep sea. It is supposed to be an important factor for the preservation of massive sulfide ore that the sulfide should be covered by sealing rocks such as pyroclastics or basalt lava flows just after the precipitation.

Some characteristic features of hydrothermal alteration around the massive sulfide ore zone in this area were investigated by the laboratory studies. In the Cisasah and Cidadap gypsum mines, the quartz-sericite zone is distributed in the footwall -- including gypsum zone -- of the massive sulfide horizon. The alteration zone of the massive sulfide horizon is characterized by the quartz-sericite-chlorite assemblage. Montmorillonite, kaolin and mixed-layer mineral were detected in the massive sulfide horizon by X-ray diffraction analysis. The mixed layer mineral is chlorite-montmorillonite mixed layer. Montmorillonitization was observed in the hanging-wall side of the horizon commonly. The lateral extent of hydrothermal alteration has been studied in detail. The distribution of alteration zones is small from the observation at the sporadic outcrops of green tuff in the survey area.

Chapter 2 Rock-Chip Geochemical Survey

2-1 Sampling and Chemical Analysis

The rock-chip geochemical survey was carried out in the second phase for the purpose of catching the alteration haloes associated with massive sulfide mineralization, as well as for defining hidden mineralized zones.

Based on the studies of the Kuroko deposits in the Hokuroku district, the hydrothermal alteration associated with the massive sulfide mineralization is assumed to be composed of two major zones in a regional scale -- say in an order of several km: (1) central sericite-chlorite zone, and (2) outer montmorillonite-zeolite zone, although several subdivisions are possible (already explained in the geology section). Geochemically, the regional alteration figures of the green-tuff horizon are characterized by the following features:

(1) Contents of Na and Ca tend to increase toward the outer zone from the mineralization center.

(2) Whereas K and Mg decrease toward the outer zone.

On the accumulation of empirical exploration excises in the Hokuroku district, the alteration index (A.I.) was proposed by Ishikawa et al. (1976) as a measure of the degree of alteration associated with the Kuroko mineralization:

$$A.I. = 100 \times (MgO + K_2O) / (Na_2O + K_2O + CaO + MgO)$$

In the rock-chip geochemical survey, CaO, MgO, K_2O and Na_2O were analyzed along with usual geochemical elements such as base and precious-metals, and the spatial behaviors of these alkali metals were investigated in the Cisasah-Cidadap-Cibuniasih area this phase.

Altered rock and clay samples were collected from every outcrop along the major drainage systems. The number of rock-chip samples collected during the survey this phase was 319, which corresponded to a sampling density of approximately one sample per 1 km2. The samples, after being air-dried and crashed under 80-mesh in the field, were analyzed at Chemex Labs Ltd. for 14 elements/components (thereafter called as "elements"): Au, Ag, Cu, Pb, Zn, As, Sb, Fe, Mn, Ba, CaO, MgO, K_2O and Na_2O. The methods of analysis and limits of detection are shown in Table 2-5.

Table 2-5 Methods of Analysis and Limits of Detection of Rock-Chip Samples

Element	Method of Analysis	Detection Limit	Upper Limit
Au	Fire assay with Ext-AA finish	1 ppb	10 ppm
Ag	ICP-AES organic extraction	0.05 ppm	200 ppm
Cu	ditto	0.5 ppm	5,000 ppm
Pb	ditto	0.5 ppm	5,000 ppm
Zn	ditto	1 ppm	5,000 ppm
As	ditto	0.2 ppm	5,000 ppm
Sb	ditto	0.2 ppm	1,000 ppm
Fe	Aqua regia digestion with AA finish	0.05 %	20 %
Mn	ditto	5 ppm	10,000 ppm
Ba	TOT digeston with AA finish	10 ppm	10,000 ppm
CaO	XRF whole rock analysis	0.01 %	100 %
MgO	ditto	0.01 %	100 %
K_2O	ditto	0.01 %	100 %
Na_2O	ditto	0.01 %	100 %

* AA means Atomic Absorption method

Table 2-6 Major Analytical Results of Rock-Chip Samples in the Cisasah-Cidadap-Cibunlasih Area

(1)

Sample No.	Au ppb	Ag ppm	Cu ppm	Pb ppm	Zn ppm	As ppm	Sb ppm	Fe %	Mn ppm	Ba ppm	CaO %	K_2O %	MgO %	Na_2O %	AL %
AI001	20	1.20	13	31.0	20	160.0	9.0	3.6	80	440	0.45	6.93	2.77	0.11	94.20
AI004	32	0.42	209	807.0	1,910	100.0	<0.2	2.1	800	1,720	3.77	4.30	4.04	0.18	67.80
AI006	1	0.02	128	5.5	37	595.0	7.6	2.4	180	80	0.08	0.14	0.23	<0.01	80.61
AI007	<1	<1.00	4,530	20.0	1,900	–	–	6.4	2,000	140	0.06	2.90	8.63	0.03	99.2
AI008	19	1.82	813	25.5	325	99.8	<0.2	2.1	60	1,660	3.98	4.39	1.21	0.21	57.20
AI009	7	0.02	333	17.5	68	334.0	7.2	3.8	760	280	0.44	1.95	0.45	<0.01	84.2
AI018	<1	<0.02	51	<0.5	69	0.2	<0.2	5.7	660	40	3.36	0.28	8.58	1.96	62.48
AI024	1	<0.02	7	19.0	63	2.6	<0.2	6.9	6,400	220	35.20	0.21	1.72	0.01	5.20
AI026	<1	<0.02	16	4.5	69	238.0	2.4	4.7	>10,000	1,180	0.29	0.68	0.40	0.19	69.2
AI031	1	0.06	31	3.0	50	2.6	<0.2	5.0	1,800	220	4.99	1.22	2.27	3.10	30.14
AI033	<1	0.90	2	3.0	162	4.6	<0.2	2.9	1,600	360	1.75	2.48	2.46	3.51	48.4
AI034	<1	0.90	3	1.0	100	1.0	<0.2	2.6	1,700	450	1.47	3.94	2.93	3.42	58.42
AI035	<1	0.32	22	4.5	1,256	1.8	<0.2	2.7	1,600	160	2.90	1.67	2.40	3.42	39.17
AI042	<1	<0.02	5	17.5	96	0.6	<0.2	2.6	230	150	0.13	8.09	0.40	0.13	97.03
AI043	<1	0.10	13	12.0	27	4.8	<0.2	6.0	55	10	0.08	0.17	0.13	<0.01	77.12
AI044	<1	<0.02	16	14.5	165	7.4	<0.2	4.0	180	120	0.06	3.53	1.02	<0.01	98.51
AI045	<1	<0.02	10	15.5	43	16.0	<0.2	2.5	1,500	100	0.05	0.11	0.12	<0.01	79.58
AI046	<1	<0.02	61	3.5	114	7.0	<0.2	6.0	780	80	1.47	0.51	3.70	0.71	65.88
AI047	<1	<0.02	8	4.0	91	0.4	<0.2	2.2	270	40	0.07	0.55	1.14	0.08	91.85
AI048	<1	<0.02	26	4.5	123	0.2	<0.2	6.4	1,100	130	4.51	1.44	4.51	2.73	45.11
AI051	<1	<0.02	5	9.0	37	0.4	<0.2	0.8	480	140	0.39	4.42	1.39	0.28	89.66
AI052	<1	<0.02	8	9.5	44	6.6	<0.2	5.6	140	10	0.48	0.37	0.71	<0.01	68.83
AI053	<1	<0.02	2	1.5	164	1.2	<0.2	1.6	330	360	0.11	6.59	1.10	0.74	90.09
AI054	<1	<0.02	15	1.0	134	2.6	<0.2	6.3	1,700	70	1.95	2.41	5.20	3.01	60.54
AI055	<1	<0.02	1	<0.5	13	0.2	<0.2	0.3	40	150	0.09	4.18	0.63	0.01	97.9
AI056	<1	<0.02	4	4.5	85	2.2	<0.2	1.7	280	140	0.59	3.16	1.96	0.36	82.98
AI058	<1	0.10	16	12.0	11	47.4	30.8	9.4	170	20	0.09	0.09	0.04	<0.01	56.77
AI060	<1	<0.02	2	3.5	4	0.4	<0.2	0.4	65	300	0.68	4.83	0.43	0.41	82.63
AI061	<1	<0.02	10	3.0	44	126.0	11.4	0.7	>10,000	2,000	1.82	0.95	2.01	0.79	53.14
AI063	<1	<0.02	2	13.0	28	0.2	<0.2	0.9	120	50	0.22	1.56	2.11	<0.01	94.13
AI064	<1	<0.02	0	6.0	19	0.8	0.6	4.5	110	60	0.18	1.45	1.99	0.30	87.70
AI065	<1	6.40	5	548.0	10	217.0	959.0	20.0	1,700	120	0.11	0.18	0.13	0.01	75.51
AI066	<1	0.06	11	10.0	4	25.4	8.2	1.2	70	60	0.09	7.87	0.21	0.03	98.54
AI067	1	2.10	20	24.5	7	68.2	9.0	8.2	190	120	0.23	0.32	0.15	<0.01	66.29
AI069	240	6.32	22	198.0	277	36.0	0.8	0.9	240	80	1.70	0.12	2.70	0.39	57.43
AH007	190	64.60	31	522.0	155	39.2	30.0	0.6	150	>10,000	0.29	0.55	0.58	0.20	75.74
AH016	<1	<0.02	12	3.5	184	<0.2	<0.2	5.7	700	120	0.16	1.01	2.95	0.28	90.00
AH017	9	0.50	153	39.5	43	39.2	0.2	6.6	80	110	0.05	1.84	0.50	<0.01	97.54
AH018	<1	0.04	7	5.0	196	4.0	0.4	3.9	3,600	200	1.05	0.28	3.15	3.77	41.58
AH019	<1	0.10	18	8.5	106	0.8	<0.2	8.4	1,500	300	2.22	1.69	5.29	2.06	61.89
AH028	2	1.32	6	53.0	46	1.6	0.4	1.0	160	2,200	3.09	2.02	1.56	1.70	42.70
AH032	<1	0.02	1	3.5	13	4.4	<0.2	1.2	65	300	0.33	0.10	2.06	<0.01	86.43
AH033	<1	0.02	3	5.0	35	<0.2	<0.2	1.4	85	100	0.40	0.18	1.74	<0.01	82.44
AH046	10	1.24	4	56.5	42	2.6	<0.2	0.8	130	2,200	2.56	0.83	1.09	0.52	38.40
AH047	77	3.14	7	181.0	26	409.0	5.6	1.5	100	1,200	0.92	9.93	0.72	0.71	88.73
AH049	<1	0.02	6	7.5	131	4.8	<0.2	1.1	390	1,860	2.27	2.39	0.38	0.92	51.37
AH052	<1	<0.02	10	1.5	1,225	<0.2	<0.2	5.4	830	320	0.36	2.14	3.22	0.70	83.82
AH056	<1	<0.02	6	5.5	219	0.6	<0.2	5.3	1,300	100	0.23	0.66	1.66	1.93	51.75
AH061	<1	<0.02	3	1.5	434	0.2	<0.2	5.7	3,000	170	0.53	0.91	3.24	4.71	40.39
AH062	<1	0.40	100	9.0	176	0.4	0.4	6.5	730	60	5.83	0.51	4.43	2.59	36.02
AH066	<1	<0.02	5	3.5	14	<0.2	<0.2	0.5	100	40	0.13	0.89	0.97	<0.01	93.05
AH067	<1	<0.02	8	5.5	65	88.8	0.4	2.5	>10,000	900	0.33	1.45	2.24	0.28	65.81
AH071	<1	<0.02	9	1.5	100	3.4	<0.2	5.4	1,600	140	2.19	2.09	1.96	2.18	48.10
AH072	14	<0.02	4	5.0	75	0.2	<0.2	2.0	560	840	2.76	1.89	1.09	1.44	41.50
AH074	<1	<0.02	3	4.0	210	<0.2	<0.2	2.4	170	60	0.26	0.61	1.51	<0.01	86.74
AH075	<1	0.04	8	4.5	173	9.4	<0.2	5.7	1,900	160	1.16	0.96	4.30	3.26	54.34
AH077	<1	0.16	2	1.0	74	1.8	<0.2	3.3	210	120	0.15	2.64	5.25	0.85	88.75
AH083	<1	0.02	10	30.5	342	1.4	<0.2	6.4	3,900	100	6.94	0.16	5.75	3.86	55.18
AH085	<1	0.12	34	145.0	257	10.8	<0.2	3.8	3,200	1,060	0.11	5.20	0.40	0.07	96.83
AH090	<1	0.02	3	1.5	14	0.8	<0.2	0.3	45	360	0.07	3.84	1.45	0.15	96.0
AH091	<1	0.50	2	6.5	19	0.2	<0.2	2.5	3,100	200	0.10	2.24	1.33	0.04	98.2
AH092	<1	0.02	13	9.5	29	75.6	5.2	2.4	5,700	130	0.18	0.51	1.74	0.01	92.9
AH094	<1	<1.00	10,760	280.0	2,220	–	–	8.6	3,500	120	0.20	0.70	3.43	0.95	78.22
AH096	33	4.00	80	7.0	17	68.6	0.2	8.2	60	40	0.08	1.42	0.24	0.04	93.26
AH098	<1	0.16	30	3.5	86	3.2	<0.2	5.3	1,200	150	2.66	0.45	4.76	3.07	47.72
AH101	<1	0.02	39	3.5	257	1.4	<0.2	6.2	2,500	2,500	0.09	6.07	1.28	0.07	97.87
AH103	<1	<0.02	43	1.5	61	15.2	1.6	3.8	5,500	640	3.96	0.36	1.16	1.09	23.17
AH104	<1	<0.02	30	3.5	806	1.6	<0.2	4.4	1,100	100	0.30	1.27	3.64	0.81	61.56

Table 2-6 Major Analytical Results of Rock-Chip Samples in the Cisasah-Cidadap-Cibuniasih Area (2)

Sample No.	Au ppb	Ag ppm	Cu ppm	Pb ppm	Zn ppm	As ppm	Sb ppm	Fe %	Mn ppm	Ba ppm	CaO %	K_2O %	MgO %	Na_2O %	Al %
AH105	<1	<0.02	18	9.0	174	7.2	<0.2	5.7	970	80	0.52	0.23	1.91	1.60	50.2[illegible]
AH106	500	0.12	14	61.0	21	8.2	<0.2	2.3	550	80	0.11	0.15	0.09	<0.01	66.85
AH111	5	1.04	15	93.0	84	1.6	0.4	1.9	550	3,400	1.92	2.23	1.79	1.22	56.15
AH116	1,100	3.92	95	504.0	562	399.0	0.2	3.6	140	50	0.67	7.41	2.54	0.12	92.64
AH117	17	1.64	5	26.0	9	43.8	0.2	0.3	70	100	29.97	0.63	0.35	0.13	3.15
AH139	<1	<0.02	2	4.5	27	<0.2	<0.2	0.9	280	2,200	1.15	2.02	1.47	0.36	69.80
AH140	<1	<0.02	1	3.5	13	<0.2	<0.2	0.5	60	1,800	1.32	2.24	0.85	0.58	61.92
AH141	<1	<0.02	1	3.0	8	0.5	<0.2	0.5	510	2,000	1.60	2.13	0.60	0.67	54.60
AH142	<1	<0.02	1	1.5	8	8.2	<0.2	0.5	160	100	0.15	4.32	0.78	0.12	94.97
AH144	<1	<0.02	8	2.5	24	2.8	<0.2	2.5	80	30	0.19	1.24	2.51	0.01	94.94
AH146	<1	<0.02	5	2.0	7	<0.2	<0.2	0.9	20	220	0.15	1.93	0.68	0.03	93.55
AH147	<1	0.06	6	22.5	37	0.5	<0.2	1.0	1,000	320	0.45	2.39	0.81	0.11	85.11
AD006	<1	<0.02	30	15.0	31	27.6	<0.2	7.7	230	30	0.28	0.39	1.40	<0.01	86.10
AD007	<1	<0.02	20	8.0	44	2.6	<0.2	3.2	50	40	0.09	0.14	1.00	<0.01	92.01
AD008	<1	<0.02	95	13.0	75	19.4	<0.2	12.4	95	50	0.31	0.18	1.56	0.42	70.33
AD010	<1	0.08	69	81.0	105	84.4	1.6	20.0	>10,000	2,700	0.32	0.06	0.39	0.11	51.14
AD011	<1	<0.02	2	1.0	11	0.6	<0.2	0.6	210	220	0.15	4.53	0.75	0.67	86.56
AD013	<1	0.36	51	27.0	13	73.2	<0.2	2.8	30	100	0.09	3.07	0.53	0.06	96.00
AD014	<1	<0.02	2	12.0	60	5.4	<0.2	4.1	180	60	0.19	1.10	1.12	<0.01	91.77
AD018	<1	<0.02	9	12.0	58	64.6	<0.2	4.2	55	20	0.09	0.11	0.43	<0.01	84.51
AD019	<1	<0.02	43	21.0	73	8.0	<0.2	9.4	240	220	0.55	0.73	1.66	0.05	61.13
AD025	<1	0.22	115	32.0	236	<0.2	<0.2	0.3	110	940	1.10	3.38	0.76	0.26	75.27
AD030	3	3.38	7	70.5	66	103.0	24.6	0.6	50	680	0.91	1.46	1.68	0.02	77.15
AD031	<1	0.02	36	23.5	104	1.4	<0.2	3.9	5,800	840	1.34	1.32	4.44	0.03	80.79
AD036	<1	<0.02	6	<0.5	189	0.8	<0.2	6.0	830	60	0.20	0.41	6.30	4.16	60.50
AD037	<1	<0.02	3	18.0	169	21.4	2.0	6.9	850	30	0.38	0.80	5.65	4.81	54.63
AD038	<1	0.04	764	2.5	170	52.4	<0.2	7.5	510	40	0.47	0.97	6.35	3.72	63.60
AD039	<1	<0.02	2	1.5	117	2.6	<0.2	6.3	380	90	1.73	1.97	5.70	1.99	67.34
AD041	<1	0.20	128	3.5	120	1.8	<0.2	5.8	1,500	90	1.76	0.46	4.69	3.46	49.57
AD044	<1	0.06	9	4.5	108	3.0	<0.2	5.1	900	300	1.49	2.23	5.16	2.00	67.93
AD063	<1	<0.02	2	3.5	16	3.6	<0.2	2.4	1,200	120	0.57	0.62	1.63	0.02	79.23
AD077	<1	<0.02	4	10.5	40	3.0	<0.2	2.1	630	300	0.19	0.34	1.92	<0.01	91.91
AD080	<1	<0.02	40	2.5	72	1.0	<0.2	2.7	200	820	0.86	3.81	0.98	0.27	60.91
AD081	<1	0.04	30	7.0	28	0.4	0.4	4.0	120	20	0.16	0.20	0.63	<0.01	83.06
AK017	<1	0.62	7	21.5	2	2,280.0	29.8	7.3	70	160	1.22	2.78	0.30	2.46	45.50
AK049	<1	<0.02	2	0.5	92	1.2	<0.2	5.3	910	160	1.86	1.56	4.58	0.57	71.61
AK054	<1	<0.02	22	5.0	88	<0.2	<0.2	2.3	370	140	0.96	3.76	3.13	0.09	86.81
AK070	<1	<0.02	14	6.0	29	2.8	<0.2	5.5	200	10	0.21	0.06	1.10	<0.01	84.35
AK073	<1	<0.02	21	7.0	26	2.0	<0.2	5.1	360	30	0.67	0.09	0.53	<0.01	47.73
AK075	<1	<0.02	17	5.0	63	<0.2	<0.2	8.5	300	140	2.33	0.39	2.60	1.11	46.50
AK079	<1	<0.02	14	5.0	83	11.6	<0.2	5.0	1,600	220	3.98	1.25	1.57	1.62	33.49

2-2 Statistical Data Processing

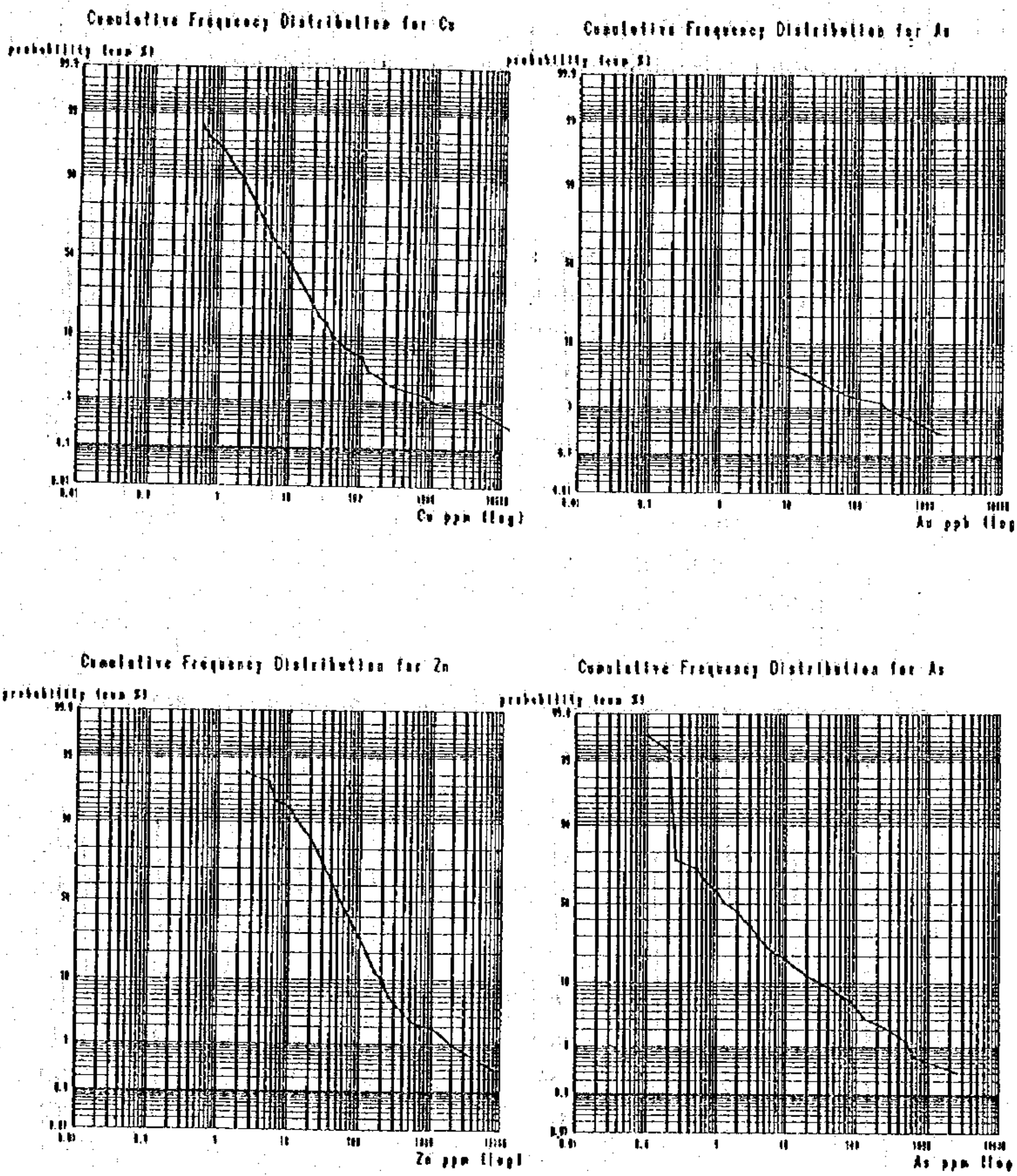
The distribution of geochemical data of some elements tends to show a close approximation to the logarithmic normal distribution in most cases. After the mode of distribution being examined, the common logarithmic conversion of the respective analytical values was adopted, if necessary, in the statistical data processing. When an analytical value was less than the detection limit, a value half of the lower limit was substituted in the calculation.

At first, statistical properties of geochemical data were checked. Basic statistical figures were calculated. Distribution histograms of each element were drawn out. Correlation coefficients among 14 elements were examined.

Then the selection of threshold values for anomalies was made. The cumulative frequency distribution of each element which showed the logarithmic normal distribution was plotted on the logarithmic probability graph using computer. If an element displayed any significant curvature, then the threshold was determined from the corresponding value on the curve. If any specific curvature was not recognized on the curve, then the threshold was calculated by the value of twice (or one time in some cases) the standard deviation added to the mean of the element. The thresholds of Cu, Pb and Zn were obtained on the logarithmic probability graphs. While those of Au, Ag, As, Sb, Fe, Mn and Ba were determined by the statistical calculation mentioned above. Values of alkali components were calculated and examined in the same way. The cumulative frequency distribution graphs are shown in Fig. 2-6.

A series of maps showing geochemical anomalies of rock-chips for each element was produced. Values of each sample were expressed by one of two kinds of symbols (anomalous or non-anomalous) on the map. Geochemical anomalies for each element were cross-checked on the maps. The results of geological survey, especially those of the distribution of mineralized zones and hydrothermal alteration haloes, were also referred. The massive sulfide mineralization and associated alteration were presented by the distribution of most of the analyzed elements in rock-chip geochemistry. The Au and Ag anomalies of rock-chips were well-correlated with the occurrences of mineralized and altered zones. The distributions of some other elements such as Cu, Pb, Zn, As and Sb also well-corresponded to the zonal distribution of alteration haloes and mineralized zones. The association of these geochemical elements was explained by the mineral assemblages of ores and alteration minerals. Consequently these elements were thought to be good indicators of massive sulfide mineralization in this area.

The statistical data processing of the A.I. values was made in the same way as the other geochemical elements. No specific curvature was recognized on the curve of A.I. values, so the threshold was calculated by the value of twice the standard deviation added to



(Cu and Zn have a distinctive curvature on the curve.
Au and As, on the other hand, show no such specific point.)

Fig. 2-6 Cumulative Frequency Distribution Graphs of Rock-Chip Geochemistry the mean of the element. Thus 79 % was adopted to the threshold for the anomaly of A.I.. There were some overflows of analytical values because these alkaline components were not measured properly in many mineralized samples. A.I. values could no be calculated on such samples. Therefore, those overflow data were regarded indicating for significant alteration. The distribution of A.I. values was drawn on the map. The major anomalous zones thus obtained by the analysis of A.I. values are: Cisasah and the surrounding area (including Cipari), upper reaches of Cigoronggong, Cidadap, Cibunlasih and the surrounding area, and Balekambang.

These results were integrated together, and several significant anomalous zones were outlined. Five potential mineralized areas thus chosen are described in the next section. The distribution of geochemical anomalies was drawn by computer shown in the appendices.

2-3 Anomalies of Rock-Chip Geochemistry

Cisasah: Five Au anomalies and several anomalies of Ag, Cu, Pb, Zn, As, Sb, Fe, Mn and Ba of rock-chips were found along S. Cisasah centered at the Cisasah gypsum mine. They showed significant anomalous values: up to 1,100 ppb Au, up to 6.40 ppm Ag, 95.2 ppm Cu, up to 594 ppm Pb, 562 ppm Zn, up to 399 ppm As, up to 959 ppm Sb, up to 20.0 % Fe , more than 10,000 ppm Mn and up to 3,400 ppm Ba. Anomalies of A.I. values are extensively distributed in this area as well. Most of these anomalies occur within the sericite-chlorite alteration zone.

Cikoplok-Panyairan: Small Zn (1,255 ppm) and Fe anomalies of rock-chips were detected along S. Cikoplok. A few anomalies of A.I. occurs at the upper reaches of Cikoplok. The sericite-chlorite alteration zone covers pervasively from the lower reaches of Cikoplok up to Panyairan.

Cidadap: Five Au anomalies and several anomalies of Ag, Cu, Pb, Zn, As, Sb, Fe and Mn of rock-chips were detected in this area. They showed significant anomalous values: up to 32 ppb Au, up to 3.38 ppm Ag, up to 4,530 ppm Cu, 807 ppm Pb, up to 1,910 ppm Zn, up to 595 ppm As, 24.6 ppm Sb, 6.4 % Fe and 5,800 ppm Mn. Anomalies of A.I. values are also concentrated in this area. These anomalies almost correspond to the sericite-chlorite alteration zone.

Cibunlasih: One Au anomaly and several anomalies of Ag, Pb, Sb, Mn and Ba of rock-chips were found in this area. They showed significant anomalous values: 190 ppb Au, up to 64.60 ppm Ag, 522 ppm Pb, 30 ppm Sb, more than 10,000 ppm Mn and more than