REPORT ON THE COOPERATIVE MINERAL EXPLORATION IN THE MACDOUGALL AREA THE REPUBLIC OF ZIMBABWE

SUMMARY

MARCH 1992

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

P R E F A C E

In response to the request the Government of Zimbabwe, the Japanese Government decided to conduct a mineral exploration in the Macdougall Area and entrusted the survey to the Japan International Cooperation Agency(JICA) and in turn JICA entrusted the execution of this survey to the Metal Mining Agency of Japan(MMAJ), since the survey was a professional survey programme of mineral exploration.

The survey was conducted from from 9 September, 1989 to February, 1992, and completed as schedule with the cooperation of the Zimbabwe Government, particularly the Geological Survey Department of the Ministry of Mines.

This report describes the summary of the results of the all programmes of the Macdougall Area.

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

We wish to express our deep appreciation to the officials concerned of the Government of Zimbabwe for their close cooperation extended to the team.

March 1992

Kensuke Yanagiya

Kensuke YANAGIYA
President
Japan International Cooperation Agency

Gen-ichi FUKUHARA
President
Metal Mining Agency of Japan

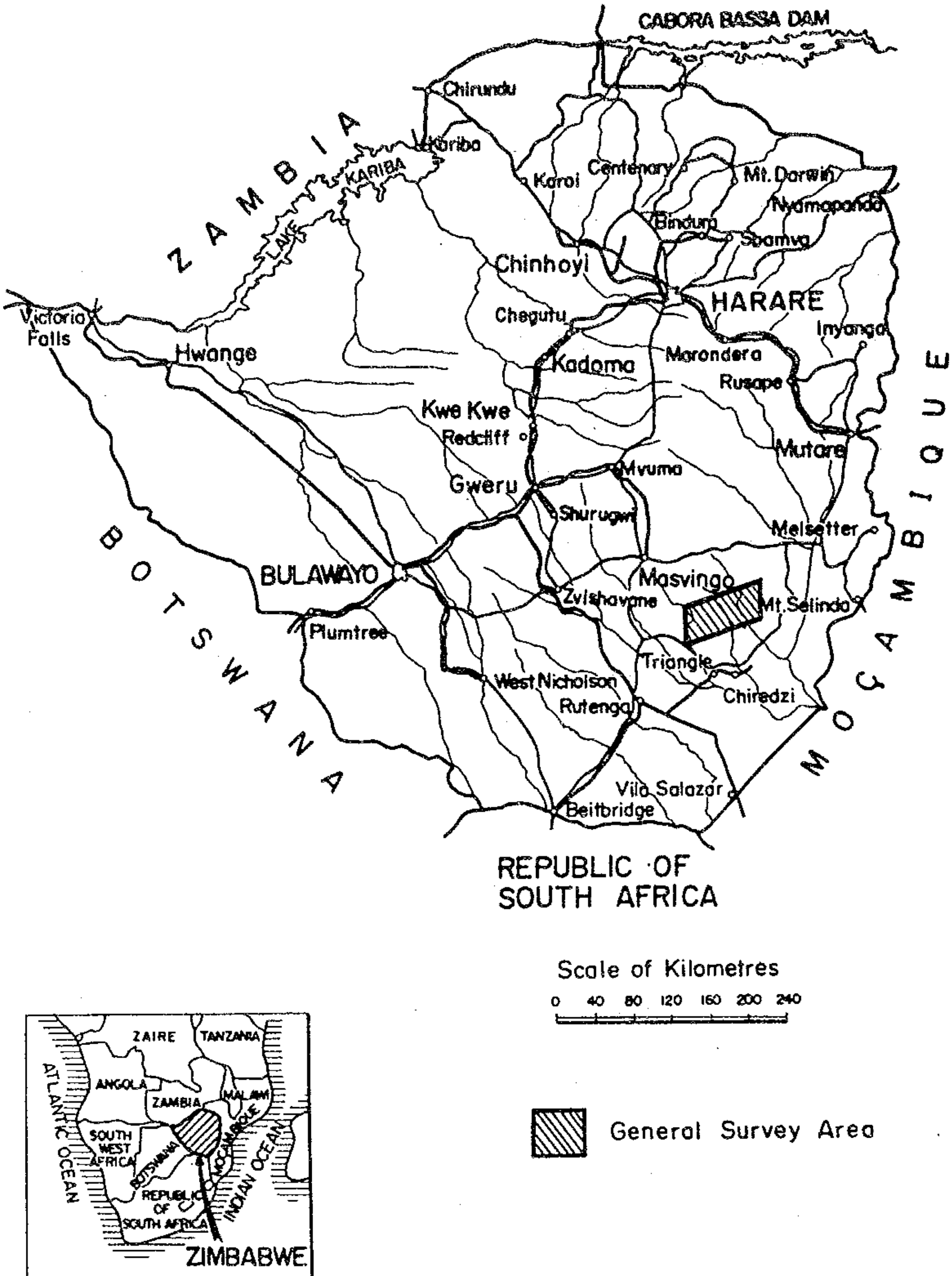


FIG. G-1 Location of the Macdougall Area, Zimbabwe

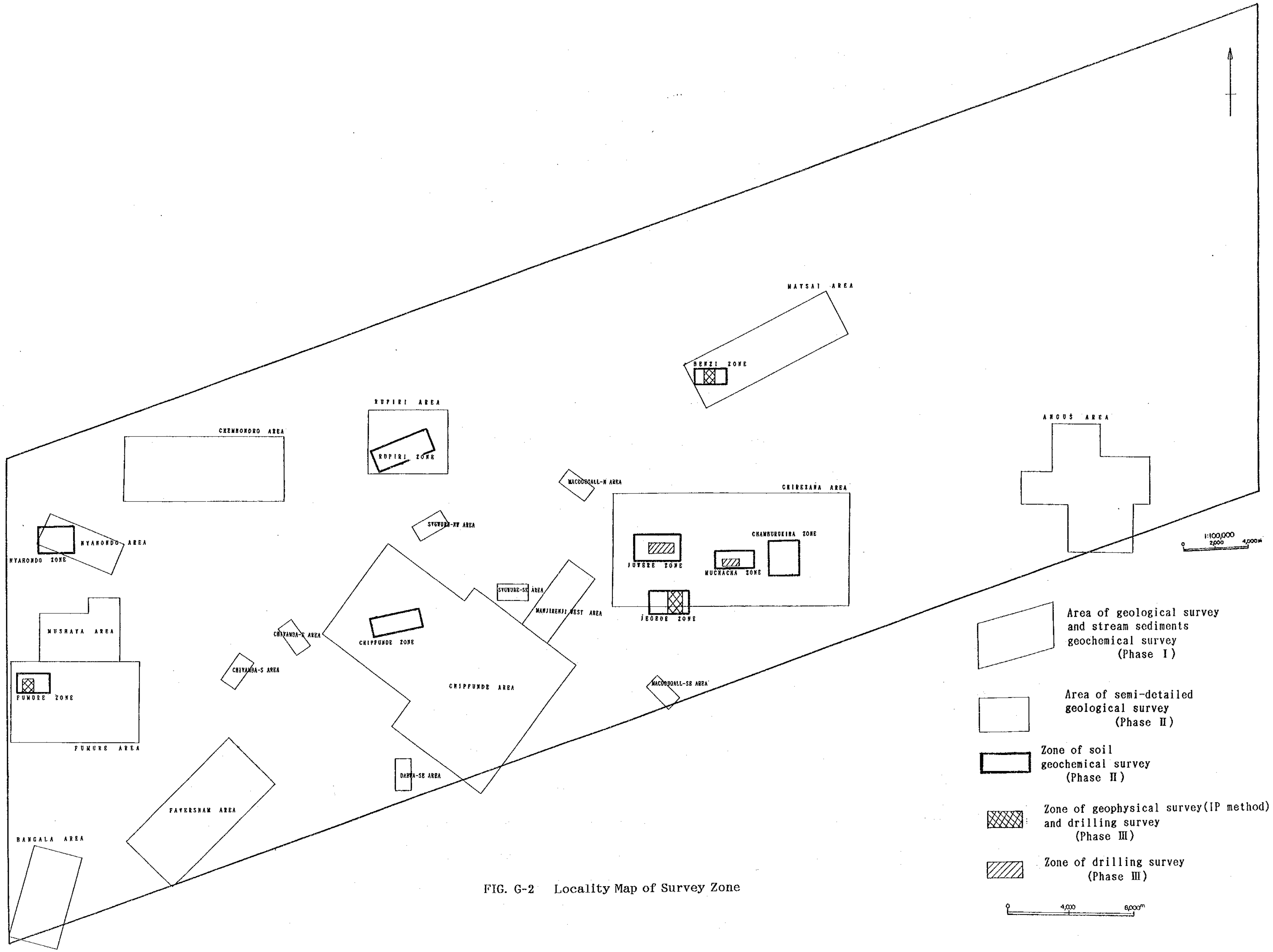


FIG. G-2 Locality Map of Survey Zone

SUMMARY

The mineral exploration in the Macdougall Area was conducted from from 9 September, 1989 to February, 1992.

PHASE I

The details and contents of the survey are summarized as follows:
Also interpretation of Landsat image was conducted covering the whole survey area.

PHASE I : CONTENTS OF THE SURVEY

KIND OF SURVEY	CONTENTS			
	AREA	ROUTE	GEOCHEMICAL SAMPLES	
			STREAM SEDIMENTS	PANNED SAMPLES
GEOLOGICAL RECONNAISSANCE GEOCHEMICAL SURVEY (STREAM SEDIMENTS)	2,300 km²	1,200 km	2,305	150

As a result of the survey, the following zones were evaluated as a promising zones for gold mineralization and selected for the target zones of soil geochemical survey.

REASON	NUMBER OF ZONES	EXTENT (km²)
GEOCHEMICAL ANOMALIES BY M. S. S.	10	349
GEOCHEMICAL ANOMALIES BY P. S. S.	2	137
GEOCHEMICAL ANOMALIES BY S. S. S.	7	14
TOTAL	19	500

M. S. S.:MULTIPLE STREAM SEDIMENTS, P. S. S.:PANNED STREAM SEDIMETS,
S. S. S.:SINGLE STREAM SEDIMENTS

PHASE II

The contents of survey of Phase II are summarized as follows:

PHASE II : CONTENTS OF THE SURVEY

KIND OF SURVEY	CONTENTS		
SEMI-DETAILED GEOLOGICAL SURVEY	AREA	ROUTE	SOIL SAMPLES
SOIL GEOCHEMICAL SURVEY	500 km²	500 km	10,047

During the semi-detailed geological survey, a special attention was paid for the phenomena related to gold mineralization such as :

①sulphides
②Fe-hydroxides
③quartz vein/stockwork
④pegmatite quartz & k-feldspar

By considering the result of the semi-detailed geological survey, the following nine zones were selected for the target zones of soil geochemical survey.

ZONE NAME	BASE LINE (m)	SAMPLING LINE(m)	SOIL SAMPLES
JUWERE	1,500	2,970	1,560
JEGEDE	2,500	1,470	1,277
MUCHACHA	2,500	1,020	907
BENZI	2,000	1,020	728
RUPIRI	3,800	1,470	1,593
CHIPFUNDE	3,200	1,200	898
FUMURE	2,000	1,260	696
NYAHONDO	2,200	1,680	1,057
CHAMBURUKIRA	1,900	2,190	1,331
		T O T A L	10,047

More than 10,000 B-horizon soil samples were collected and Au, Ag, As, Bi, Cu, F, Zn, Cr, Ni and Fe of the samples were analysed.

PHASE Ⅲ

After the interpretation of semi-detailed geological and soil geochemical surveys carried out Phase Ⅱ, the following three zones were evaluated as the most promising zones for gold mineralization and selected for target zones of geophysical survey(IP method).

The details of Phase Ⅲ are shown as follows:

P H A S E Ⅲ : C O N T E N T S O F T H E S U R V E Y

KIND OF SURVEY & ZONE	CONTENTS	
1 GEOPHYSICAL SURVEY(IP)		
① Benzi	SURVEY LINE	3.00 Km
	NO. OF LINE	3 LINES
	NO. OF SURVEY	198
② Jegede	SURVEY LINE	3.80 Km
	NO. OF LINE	3 LINES
	NO. OF SURVEY	262
③ Fumure	SURVEY LINE	2.85 Km
	NO. OF LINE	3 LINES
	NO. OF SURVEY	183

2 DRILLING SURVEY	DRILL HOLE NO.	DEPTH(m)	INCLINATION	DIRECTION
① Juwere	MJZM-1	90.00 m	-70°	0°
	MJZM-2	90.00 m	-70°	0°
	MJZM-3	90.00 m	-70°	0°
② Muchacha	MJZM-4	90.05 m	-70°	0°
	MJZM-5	90.00 m	-70°	0°
③ Benzi	MJZM-6	150.00 m	-60°	0°
	MJZM-7	150.00 m	-50°	0°
④ Jegede	MJZM-8	150.30 m	-65°	0°
	MJZM-9	90.00 m	-70°	0°
	MJZM-10	150.00 m	-60°	0°
	MJZM-11	90.00 m	-70°	0°
⑤ Fumure	MJZM-12	150.30 m	-70°	0°
	MJZM-13	150.00 m	-60°	0°

And also the mineralized zones and geochemical anomalies detected by the Phase Ⅱ were selected for the targets of drilling survey in Juwere zone (MJZM-1, MJZM-2, MJZM-3) and Muchacha zone(MJZM-4, MJZM-5).

On the other hand, a geophysical survey in Benzi zone, Jegede zone and Fumure zone suggested low resistivity zones and high PFE zones indicating a high potential for the existence of sulphide mineralization.
A drilling survey in these zones was conducted and some drilling holes intersected the sulphide zones of dissemination and banding.
As a result of an assay of the sulphides intersected by drilling, no any encouraging results were obtained.
Total 13 drilling holes account for a depth of 1,530.65 meters.

A flowchart of the survey and a flowchart for selection of promising mineralized zone in the survey area are shown Fig. G-3 and Fig. G-4, respectively.

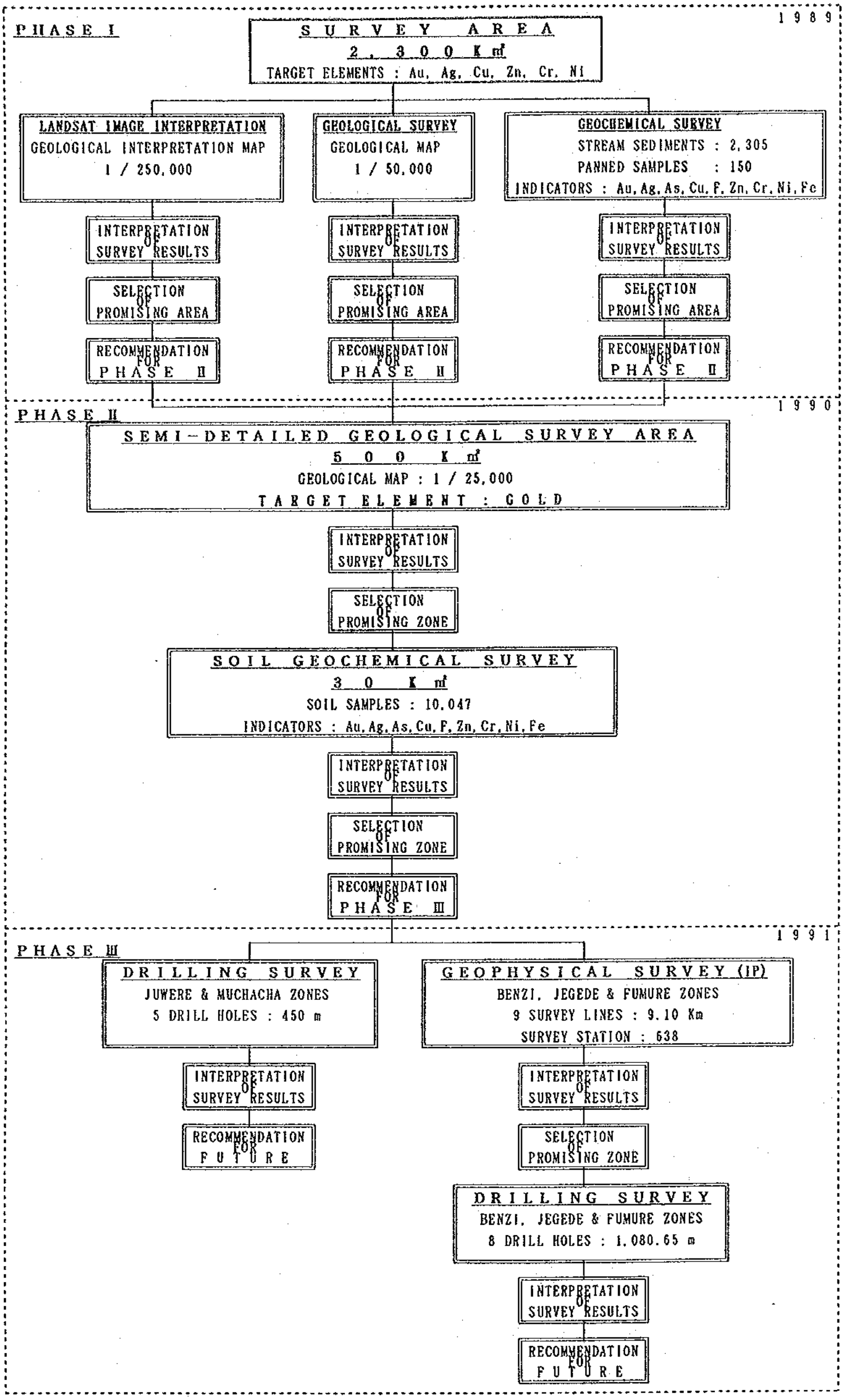


FIG. G-3 Flowchart of the Survey

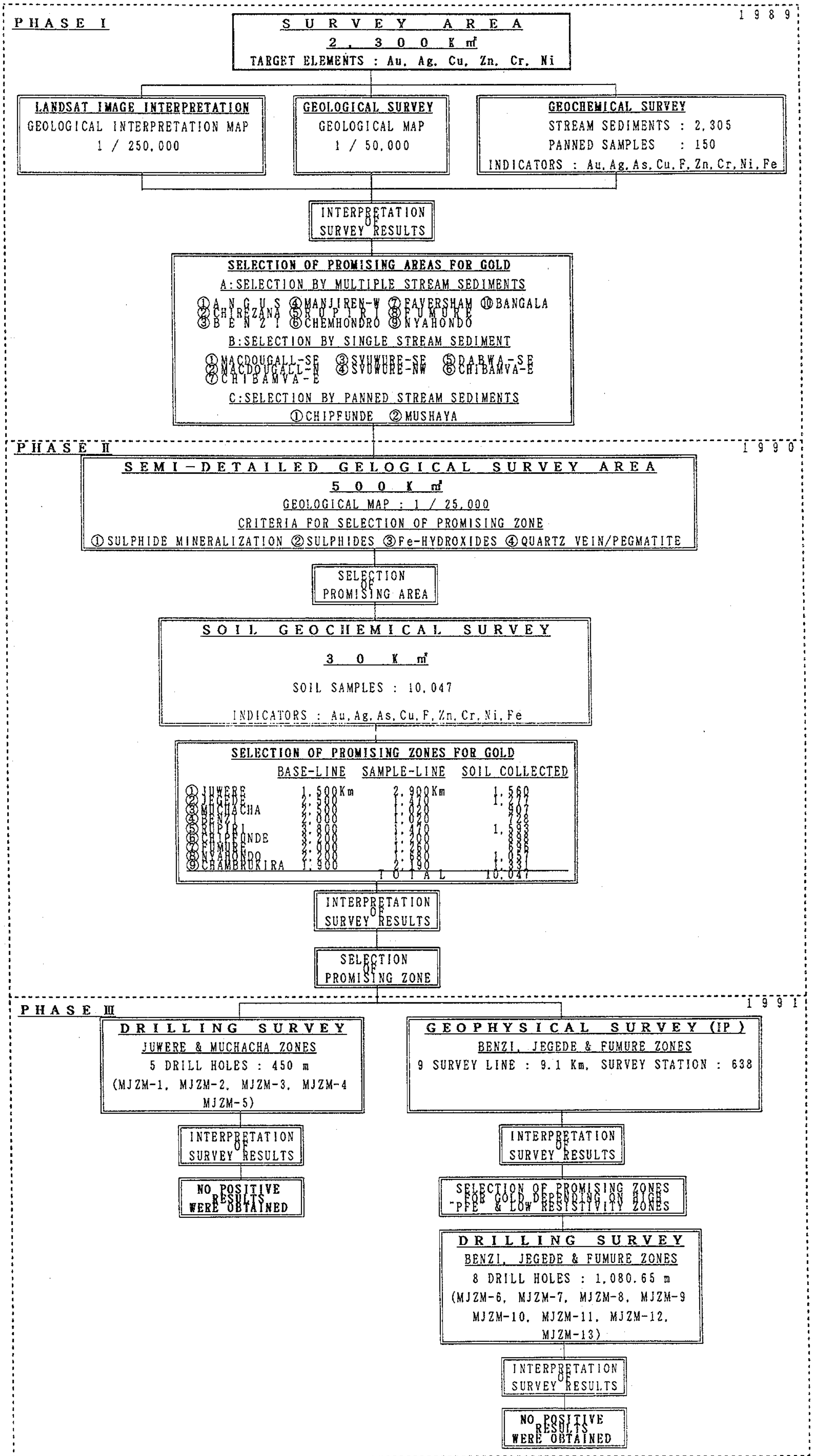


FIG. G-4 Flowchart of Selection for Promising Area

C O N T E N T S

LIST OF FIGURES AND TABLES

PART I GENERAL REMARKS

PART Ⅰ GENERAL REMARKS

CHAPTER 1 INTRODUCTION

1-1 AREA AND PURPOSE OF THE SURVEY

AREA

The survey area lies within the catchment area of the Savi river which is located in the south-eastern part of the Republic of Zimbabwe. The mileage and time required by vehicle from Harare to the survey area are roughly 430 Km and about five hours, respectively.

The survey area, 500 km^2, is included in the area having the base points being at longitude 31° 15' west and latitude 20° 30' south in the southwest edge, and at longitude 32° 00' west and latitude 20° 15' south in the northeast edge. Lake Macdougall is nearly at the center of the survey area.

The area is served by the main tar road from Harare, branching off the Masvingo through Zaka to Chiredzi. This road traverses the survey area and good quality gravel road and tracks of variable condition serve as survey routes. Major parts of the area are accessible to a 4-wheel drive vehicle during the dry season

Phase Ⅰ survey was carried out on an area of 2,300 km^2, then 19 selected survey zones in Phase Ⅱ accounted to 500 km^2, and finally more restricted zones were a target for Phase Ⅲ survey(FIG. G-2).

PURPOSE

Since the geological features of the Macdougall area which is to be surveyed, are similar to those of the Renco Deposit, the possibility of finding a similar deposit in the area is thought to be high. At Phase Ⅰ, geological reconnaissance survey, and geochemical survey by stream sediments were carried out to evaluate the feasibility of finding a deposit in the areas.

At Phase Ⅱ, semi-detailed geological and soil geochemical survey were conducted to evaluate the potential of gold mineralization on 19 selected zones by the results of Phase I survey.

At Phase Ⅲ, geophysical and drilling survey were carried out finally to confirm the gold mineralization on the selected five zones.

1-2 METHOD AND CONTENTS OF THE SURVEY

PHASE Ⅰ

At Phase Ⅰ, Landsat image interpretation, geological survey, and geochemical exploration of stream sediment were carried out.

In the Landsat image analysis, the following kinds of images were composed from CCT (taken on September 3, 1984) to be used for geological analysis:

a) False-colour, full-scene, scale: 1/250,000

b) False-colour, sub-scene, scale: 1/100,000

c) Ratio image, sub-scene, scale: 1/100,000

d) Full scene, black-and-white image, scale: 1/500,000

e) Ratio image (black-and-white), full-scene, scale: 1/200,000

f) Principal component image, scale: 1/100,000

These images were used to try to divide the area into geological units, to determine the geological structure, and to find alteration zones.

In the geological survey, efforts were made to clarify the geology and the extent of mineralization of the survey area to indicate promising deposits, making use of the results of the Landsat image analysis. For the field survey, a topographical map in scale of 1:50,000, was enlarged to a scale of 1:25,000 and used as a route map. The survey route was determined by examining the results of the Landsat image analysis and taking the geological structure of the survey area into consideration. Aerial photographs and magnetic susceptibility meters were used in the survey.

In the geochemical exploration, stream sediment was collected after careful study of sampling conditions.

Although it was first determined to collect stream sediment samples for panning where heavy minerals were concentrated directly on the bedrock, it was difficult to find locations which satisfy these conditions because bedrock is rarely exposed; consequently, samples were collected at any locations where heavy minerals were concentrated. Panned samples were examined under a microscope to check for the presence of gold and platinum particles, and to identify the main constituent minerals.

PHASE I : CONTENTS OF THE SURVEY

KIND OF SURVEY	CONTENTS			
	AREA	ROUTE	GEOCHEMICAL SAMPLES	
			STREAM SEDIMENTS	PANNED SAMPLES
GEOLOGICAL RECONNAISSANCE GEOCHEMICAL SURVEY (STREAM SEDIMENTS)	2,300 km²	1,200 km	2,305	150

PHASE II

At Phase II, the survey area was 500 km^2 and geological and soil geochemical surveys were carried out. In the geological survey, efforts were made to clarify the geology and the extent of mineralization of the survey area to indicate promising deposits, making use of the results of the Phase I. For the field survey, a topographical map in scale of 1:50,000, was enlarged to a scale of 1:25,000 and used as a route map. The survey route was determined by examining the results of the Landsat image analysis and taking the geological structure of the survey area into consideration.

In the geochemical survey, soil samples were collected according to a pre-laid grid(at 30-meter interval and 100-meter spaced line) measured by tape and transit after careful study of sampling conditions. Duplicated sampling were taken at several points. Fraction of -80 mesh were taken and analyzed on the elements of Au, Ag, As, Bi, Cu, F, Zn, Cr, Ni and Fe. B-horizon samples are preferred, since they are often the sample media of metal accumulation.

PHASE II : CONTENTS OF THE SURVEY

KIND OF SURVEY	CONTENTS		
	AREA	ROUTE	SOIL SAMPLES
SEMI-DETAILED GEOLOGICAL SURVEY SOIL GEOCHEMICAL SURVEY	500 km²	500 km	10,047

PHASE III

Geophysical IP survey and drilling survey were carried out in Phase III.

Nine survey lines totaling 12 km with three hundred and six survey points were measured in the IP survey and laboratory IP test was conducted in Japan after completion of the field survey on 25 typical rock specimens taken from the survey area. The survey was done by the team with the cooperation of the Geological survey Department Which dispatched a geophysicist and technician to the survey.

The drilling work was contracted by R. A. Longstaff (Pvt) Ltd., based in Harare. The drilling survey consists of thirteen drill holes, total length of 1,530.65 metres.

PHASE III : CONTENTS OF THE SURVEY

KIND OF SURVEY & ZONE	CONTENTS			
1 GEOPHYSICAL SURVEY(IP)				
① Benzi	SURVEY LINE NO. OF LINE NO. OF SURVEY	3.00 Km 3 LINES 198		
② Jegede	SURVEY LINE NO. OF LINE NO. OF SURVEY	3.80 Km 3 LINES 262		
③ Fumure	SURVEY LINE NO. OF LINE NO. OF SURVEY	2.85 Km 3 LINES 183		
2 DRILLING SURVEY	DRILL HOLE NO.	DEPTH(m)	INCLINATION	DIRECTION
① Juwere	MJZM-1 MJZM-2 MJZM-3	90.00 m 90.00 m 90.00 m	-70° -70° -70°	0° 0° 0°
② Muchacha	MJZM-4 MJZM-5	90.05 m 90.00 m	-70° -70°	0° 0°
③ Benzi	MJZM-6 MJZM-7	150.00 m 150.00 m	-60° -50°	0° 0°
④ Jegede	MJZM-8 MJZM-9 MJZM-10 MJZM-11	150.30 m 90.00 m 150.00 m 90.00 m	-65° -70° -60° -70°	0° 0° 0° 0°
⑤ Fumure	MJZM-12 MJZM-13	150.30 m 150.00 m	-70° -60°	0° 0°

1-3 TERMS AND MEMBERS OF THE SURVEY

Terms and members of the survey from Phase I, Phase II, and Phase III are as follows:

PHASE I

Terms: from 4 September, 1989 to 20 February, 1990

PLANNING AND MANAGING(PHASE I)

JAPANESE MEMBER		ZIMBABWEAN MEMBER	
HIDEO HIRANO*	METAL MINING AGENCY OF JAPAN	N. BAGLOW	GEOLOGICAL SURVEY DEPARTMENT
HIROSI SHIMOTORI	METAL MINING AGENCY OF JAPAN		
MASATSUGU OGASAWARA	GEOLOGICAL SURVEY OF JAPAN		

* GEOLOGICAL SURVEY OF JAPAN FROM 1990

FIELD SURVEY(PHASE I)

JAPANESE MEMBER		ZIMBABWEAN MEMBER	
FUMIO WADA	DOWA	TAFIRENYIKA CHIYANIKE	GEOLOGICAL SURVEY DEPARTMENT
TSUTOMU KODAMA	DOWA	FOBES MUGUMBATE	
SHIN-ICHI IWAYA	DOWA		
HEIZABURO YAMAMOTO	DOWA		
TOSIAKI KAZAMA	DOWA		
HIROSHI YOKOYAMA	DOWA		
SOUICHIRO TANAKA	DOWA		

PHASE II

Terms: from 20 June, 1990 to 18 February, 1991

PLANNING AND MANAGING(PHASE II)

JAPANESE MEMBER		ZIMBABWEAN MEMBER	
TAKAHISA YAMAMOTO	METAL MINING AGENCY OF JAPAN	J. L. ORPEN	GEOLOGICAL SURVEY DEPARTMENT
HIROSHI SHIMOTORI	METAL MINING AGENCY OF JAPAN	N. BAGLOW	GEOLOGICAL SURVEY DEPARTMENT

FIELD SURVEY(PHASE II)

JAPANESE MEMBER		ZIMBABWEAN MEMBER	
FUMIO WADA	DOWA	TAFIRENYIKA CHIYANIKE	GEOLOGICAL SURVEY DEPARTMENT
TSUTOMU KODAMA	DOWA		
SHIN-ICHI IWAYA	DOWA		

PHASE III

Terms: from 6 June, 1991 to 20 February, 1992

PLANNING AND MANAGING(PHASE Ⅲ)

JAPANESE MEMBER		ZIMBABWEAN MEMBER	
TAKAHISA YAMAMOTO	METAL MINING AGENCY OF JAPAN	J. L. ORPEN	GEOLOGICAL SURVEY DEPARTMENT
TOSHIHARU MOROZUMI	METAL MINING AGENCY OF JAPAN	S. M. N. NCUBE	GEOLOGICAL SURVEY DEPARTMENT

FIELD SURVEY(PHASE Ⅲ)

JAPANESE MEMBER		ZIMBABWEAN MEMBER	
FUMIO WADA	DOWA	TAFIRENYIKA CHIYANIKE	GEOLOGICAL SURVEY DEPARTMENT
MASARU FUJITA	DOWA	P. MPOFU	
SHIN-JI FUJIKAWA	DOWA		

CHAPTER 2 PREVIOUS WORKS

Although some explorations based on E. P. O. were carried out within the area, few geological studies have been performed.

Approximately 10 % of the area lies in the area mapped by Odell(1975). The earliest 1 : 1,000,000 geological maps of the country did not distinguish between the gneisses of the Limpopo Mobile Belt and those of the Zimbabwe Craton,but the author showed that a structural and metamorphic gradation existed between the two geological terrains.

E. P. O. No. 299 was granted to Johannesburg Consolidated Investment Company Limited on the 11th October, 1969. E. P. O. covers 540 km^2 situated between the Chiredzi and Mkwasine rivers. Field work started on 5 January and was completed on 25 February 1970. The soil samples were collected and analysed for copper and nickel. A number of copper soil anomalies were found during the regional traversing. They were attributed to the lithological control of the bedrocks.
Claims were not pegged prior to the revocation of the order.

E. P. O. No. 300 was granted at the same time as E. P. O. 299. This covers the northernmost part of the survey area. The reservation was covered by reconnaissance soil sampling and geological mapping at scale of 1:25,000 and 1 : 50,000. In all a total of 61,700 samples were analysed and numerous copper anomalies were found in a belt extending 3 km north of the Turgwe river and 9 km from Resurgwe river(Turgwe copper prospects).

E. P. O. No. 353 was granted in August 1970 for the purpose of detailed exploration of the Turgwe copper prospects. A total 11,424 soil samples were collected and analysed for copper, nickel and cobalt. Detailed soil sampling, geological mapping, a magnetometer survey, trenching and wagon drilling defined two mineralized zones over the pyroxinite and contact between the pyroxinite and the gabbro.

The extension of the Turgwe copper prospect was reserved under E. P. O. No. 355. The area was geologically mapped and geochemically soil sampled. All

anomalous results were examined in the field.
No significant mineralization of any kind was found.

E. P. O. No. 462 was granted to Prospecting Venture Limited on 22 February 1974 in respect to copper, nickel, lead, and precious metals. This covers north-western most portion of the survey area. Later E. P. O. No. 548 was granted in December 1979 covering 9.6 % of the area originally covered by E. P. O. No. 462.
Reconnaissance drainage sampling of the E. P. O. No. 462 led to the soil sampling of 23 areas of anomalous geochemistry. Traces of mineralization worthy of further work were found in four of the 23 blocks.
Finally, no small deposits of an economic grade of mineralization of interest to smallworkers were detected during the tenure of the E. P. O.

The Northern Marginal Zone of the Limpopo Mobile Belt comprises high grade metamorphic rocks. No formal lithologic or stratigraphic subdivision of the rocks has been made. The emplacement ages of the rocks in the Northern Marginal Zone are uncertain but are probably more than about 2,870 Ma(Barton, 1983; Hickman, 1978). Metamorphic conditions in the Northern Marginal Zone are thought to have been greater than 750 ℃ and 5 kilobars at about 2,870 Ma ago(Robertson and Du Toit, 1981). It is thought that this metamorphic event was strong enough to eliminate any possible previous metamorphic evidents. A second metamorphism may have occurred about 2,700 Ma ago. This is roughly coeval with the last metamorphism in the Southern Marginal Zone.

Also this belt has been affected by deformations. On the this topic, agreement has not been reached among researchers. In the Northern Marginal Zone, at least two regional deformational events are recognized(Robertson and Du Toit, 1981)but the age of these deformations is uncertain.

Occurrences of mineralization in the Northern Marginal Zone are quite limited. Economic mineralization of chromite within a serpentinite complex and highly folded gold mineralization in enderbites at Renco deposit are the principal ones. Exploration for Cu-Ni mineralization has been largely unsuccessful although small deposits associated with mafic granulite are found.

CHAPTER 3 GENERAL GEOLOGY

The Limpopo Mobile Belt is an extensive east-north-east trending of high grade metamorphic rocks that lies between the Zimbabwe and Kaapvaal cratons. It is approximately 600 km long by 300 km wide and continues across the southern portion of Zimbabwe into Botswana.
The belt may be subdivided into three zones, that is, northern and southern marginal zones and a central zone. The northern marginal zone is further subdivided into a granulite subzone, characterized by metamorphism of granulite facies and a

a zone suffered intense shear deformation and retrograde metamorphism.

In regard to geological structure, the predominant feature throughout the Northern Marginal Zone is a persistent east-north-easterly foliation. Isoclinal folding is strongly suggested due to constant south dipping of the foliation. But the rock units in the area are complexly folded and refolded on all scale.

Measurements of foliation have been made of the orientation of the mineral banding in the granulite. These data are presented in stereographic projections. No significant differences of foliation pattern are recognized in either the southwestern or northeastern area. The poles have been interpreted as the predominant fold axis.

In the central part of the area, the mafic granulite forms flow folding which is revealed by Landsat image and the mapping. This type of folding is recognizable throughout the area on a small scale in individual outcrops.

CHAPTER 4 GENERAL CIRCUMSTANCES OF THE SURVEY AREA

4-1 TRANSPORTATION

The survey area lies within the catchment area of the Savi river which is located in the south-eastern part of the Republic of Zimbabwe. The mileage and time required by vehicle from Harare to the survey area are as followed;

① Harare to Beatrice : 50 Km / 0.7 hour
② Beatrice to Chivhu : 80 Km / 1.0 hour
③ Chivhu to Gutu : 80 Km / 1.0 hour
④ Gutu to Zaka : 90 Km / 1.3 hour
⑤ Zaka to Chiredzi : 90 Km / 1.3 hour

The area is served by the main tar road from Harare, branching off the Masvingo through Zaka to Chiredzi. This road traverses the survey area and good quality gravel road and tracks of variable condition serve as survey routes. Major parts of the area are accessible to a 4-wheel drive vehicle during the dry season

4-2 CIRCUMSTANCES

The topography in the area is characterized by the gentle undulation of peneplain due to the bedrock geology of Archaean rocks. The area, lying at about 600 m elevation, covers the junction between the lowvelt and highvelt country. The highest peak in the area is Demba Mountain (1,059 m) and other prominent peaks are Babaninga M.(1,037 m) and Muromahoto M.(1,001 m) both lying in the northern part of the area. The alignment of the mountains and hills are strongly influenced by the geological structure prevailing in the area. The main drainages in the area are the Mashavutwe River, Chiredzi R., and Turwi R., and these flow down to the Savi River. Although most drainages dry up in the dry season, these 3 rivers have discharged all year round.

The climate of the area is clearly divided into two seasons, a dry season from April to October and a wet season from November to March. The temperature in October rises to more than 40° c due to the low elevation of some 600 m and low latitude of 20° s. Annual rainfall average of 700 mm and 600 mm have been recorded at Zaka and Baffalo Range to the north and south of the survey area, respectively. Almost all rainfall concentrates in the wet season, especially December to February. Vegetation in the area consists mainly of mopane and mangwe with a few baobao, acacias, and palms. The well-managed ranches are generally well-grassed, but the area of over-grazing has caused depletion of vegetation. Although the large scale sugar cane cultivation prevails in the lowvelt country south of the survey area, agriculture within the survey area is limited to small scale.

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

5-1 CONCLUSIONS

This mineral exploration survey was executed for three years according to the following survey scheme.

① Phase I: LANDSAT image interpretation, reconnaissance geological survey, and geochemical survey by stream sediments

② Phase II: Semi-detailed geological survey and soil geochemical survey

③ Phase III: Geophysical survey (IP method) and drilling survey

Though any gold mineralized zone was not consequently detected through this exploration survey, it can be evaluated as a significant result that mineralized zones of sulphide minerals are detected as the result of drilling survey in the surveyed zones where sulphide minerals are hardly detected as the result of field survey when considering the fact that all of main gold deposits in Zimbabwe are associated with sulphide minerals. It is possible to detect mineralization of sulphide minerals and, therefore, gold deposits and other useful deposits by continuously applying the above survey methods to similar geological environments.

5-2 RECOMMENDATIONS

According to the survey results for three years and the conclusion obtained through the study of them, we would like to recommend the following for future.
The following survey methods adopted by the survey team were effecive as the mineral exploration survey for the regional metamorphic belts of the granulite facies like Limpopo Mobile Belt in Archaean.

① Phase I: LANDSAT image, rough survey of geology, and geochemical survey by stream sediments

② Phase Ⅱ: Semi-detailed geological survey and soil geochemical survey

③ Phase Ⅲ: Geophysical survey (IP method) and drilling survey

However, the climate and topographical factors in this country tends to produce a pseudo-soil geochemical anomaly in topographic depressed portion, sloped portion and a boundary between the alluvial and soil layers. Therefore, a geophysical survey(e.g. IP method) must be carried out to confirm the existence of sulphide minerals in soil geochemical anomalous zones, and after the interpretation of the IP survey results, a planning of drilling survey should be conducted.

In this country, growth of soil is not very remarkable, which is generally several tens centimetres or less. Under this environment, the survey with airborne electromagnetic method is an exploration method suitable for evaluation of the possibility of sulphide minerals distributed in a wide zone. Therefore, the method is worth studying in future.

PART Ⅱ DETAILS OF SURVEY

CHAPTER 1 LANDSAT IMAGE INTERPRETATION

1-1 Survey Method

In many geological applications, Landsat data are used with other types of geoscience data. Comparisons of analyzed image data with geological, geophysical, and geochemical data are an important component of the interpretive process.

CCT(Computer Compatible Tape) used in this interpretation is the data from Landsat TM(Thematic Mapper) which fully covers the study area(Fig.2-1-1). Using the data, a GEOPIC equivalent image was produced. Correction of radiometric, edge and contrast stretching which were essential for an application to geological interpretation were done in the process of developing the image. The following 6 kinds of image were prepared:

a) False-colour image full-scene, 1:250,000
b) False-colour image sub-scene, 1:100,000
c) Ratio image sub-scene, 1:100,000
d) Black & white image full-scene, 1:500,000
e) Black & white ratio image full-scene, 1:200,000
f) Principal component image sub-scene, 1:100,000

1-2 Survey Results

Effort was concentrated into the determination of geological units and structure, and also detection of hydrothermally altered zones.

An interpretation of geological units and structure through Landsat images was conducted chiefly based on the differences of susceptibility to weathering, tones, vegetation patterns, drainage pattern and density. As a results of the interpretation, the following 6 geological units were detected(FIG.2-1-2):

(1) Geological Unit

<u>Unit Pg (Paragneisses)</u> : The relatively low resistance reduces relief, causing an unclear fracture pattern. However, an N-S fracture pattern can be observed, though it is not distinct. No bedding pattern can be seen because it is covered with surface soil or located in a metamorphic rock area.

For the drainage pattern, one limited by an N-S fracture and another showing a lattice or dendritic shape are found.

The boundary between this unit and Unit Gf has not been established clearly and can be narrowly distinguished by tracing a weak linear pattern on the image with reference to the existing geological map. In some places, however, a small change in the drainage pattern is observed. In case that the detailed drainage is observed by using the 256 BGR image in the vicinity of the boundary, the Gf side often shows lattice or parallel (meeting at right angles to the direction of foliation) pattern. However, the Pg side shows a dendritic shape and even a slight change in drainage pattern.

Unit Gf (Gneissose granulite and felsic granulite) : The resistance is slightly high and the axis of synform forms a ridge. The fracture pattern has made the largest development in the N-S direction, but fracture in the NE-SW and NW-SE directions is also found. The pattern also seems to be found in the ENE-WSW direction, but it is difficult to determine the properties of the fracture pattern because of the overlap with foliation which dominates the survey area.
Foliation is observed based on topographical properties and slight differences in contrast (i.e. 256 BGR of the ratio image), but is weak.
The drainage pattern shows a lattice shape in the western survey area, where regular folding has developed, but shows a dendritic shape in the eastern area.
Felsic granulite and gneissose granulite, which are included together in this unit, are difficult to differentiate from each other in the image.

Unit Mg (Mafic granulite) : The resistance is of about medium class in comparison with other geological units. The fracture pattern cannot be observed clearly because the distribution of this unit is shown in a thin layer shape or vein shape, but is considered to be the same as that of Unit Gf.
In regard to foliation, the detailed structure within this unit is unclear, but the pattern can be observed from the manner by which this unit is distributed in Unit Gf. That is, this unit generally extends in the ENE-WSW direction. In the western part of the survey area, rocks have been folded with relatively longer wave length than that in the eastern part and also show favorable continuity of foliation. In the eastern part, however, there are many folds which have short wave length, the details of which are unclear, and the continuity of foliation is also inferior to that in the western part.
The drainage pattern cannot be observed clearly because the distribution of this unit is shown as a thin layer shape or vein shape and also because it is distributed in a small area. However, the pattern is probably considered to be the same as that of Unit Gf.
This unit is one of those which have the most distinguishable image contrasts among geological units distributed in the survey area. It is clearly observed in the image which includes band 3 of TM, and is particularly shown clearly in the comparative image at a ratio 3/1, which is often used for extracting Fe-hydroxide.

Unit If (Iron formation) : The resistance is at a normal level. The fracture pattern, foliation, and drainage pattern cannot be observed because of the small distribution area of this unit.
The unit closely resembles Unit Mg in terms of the contrast in images, but this unit is slightly superior in image texture.

Unit Do (Dolerite) : The resistance is relatively low.

The fracture pattern cannot be observed owing to the small distribution area of this unit, but fracture is thought to have developed less frequently.
The drainage pattern also cannot be observed adequately because this unit is distributed in a small area.
The image contrast is almost the same as that of Unit Mg, so that distinction between the two is difficult to make. However, we have made the distinction based on the fact that this unit has a slightly higher saturation of green in the 234 BGR image and has a characteristic distribution pattern (linear-band type distribution). The distribution pattern seems to show that this unit has intruded chiefly along a N-S (partially E-W to NE-SW) fracture.
In almost all cases, the direction of foliation of this unit crosses those of Unit Gf and Unit Mg.

Unit Gg (Gneissose granite) : The relatively low resistance reduces relief.
The fracture pattern is generally unclear but unlike Unit Gf and Unit Mg, the fracture in the ENE-WSW direction is observed comparatively clearly. However, the pattern if this direction may be a linear pattern from something other than a fracture (e.g. foliation). The drainage pattern shows a dendritic shape.
The boundary between this unit and Unit Gf is not clear, but we have expressed it in FIG. 2-1-2(1) by tracing a faint linear pattern on the image.

(2) Geological Structure

The lineament shows N-S, NE-SW, NW-SE, and ENE-WSW direction, among which the N-S direction is the most conspicuous(FIG.2-1-3). The lineament of this type is shown as a clear straight line when an image of a small scale (1:500,000) is observed over a wide range. However, it appears as a group of more than one (relatively) short lineament when an image of greater scale (1:100,000) covering only the survey area is observed, and it is also cut by other-direction lineaments in many cases. As the N-S type lineament group in this survey area, one group (partially intruding dolerite) and two groups are distributed in an area near the western end of the area and in its eastern side, respectively. Among these lineaments, many of those in the eastern part have dolerite intrusions. The dolerite has also intruded slightly into the NE-SW lineament. Lineaments in the E-W direction are estimated to exist in a large quantity, but they are difficult to extract because their directions coincide with that of foliation.
A group of NE-SW lineaments, which traverse the northern end of Lake Macdougall located in the central part of the survey area, has developed for only units Gf and Mg. The western side to this lineament group is covered by a comparatively regular fold structure but the eastern side is covered by a more complicated structure which is difficult to identify. Considering that the fold axis adjacent to the lineament group runs not in the ENE-WSW direction but slightly in the NW-SE

direction, this lineament group might have had a rightward angle. (A bookshelf-type fracture can also be considered by combining the fracture at the boundaries between Units Pg and Gf and Units Gf and Gg with this lineament groups.) The NW-SE lineament along the Turwi River at the eastern end of the area has good continuity without being crossed by other lineaments. Accordingly, this is the newest lineament.

When the formation of the lineaments in the survey area is considered from these facts, they are thought to have developed in the following order:

1. ENE-WSW and NW-SE direction (formed the ENE-WSW fold axis)
2. N-S and NE-SW direction (with dolerite intrusion)
3. NW-SE direction

A rose diagram of lineaments was shown in FIG. 2-1-3.

(3) Hydrothermal Alteration Detected by Landsat Image Interpretation

Alteration in the area extends in a very restricted area around the mineralized zone. At Renco mine, the wall rock alteration is an effect of pegmatite intrusion,
but no relationship exists between degree of alteration and gold mineralization (Bohmke and Varndell, 1986).

Within a mineral province, areas with numerous fracture intersections are good exploration targets because fractures are conduits for hydrothermal(ore-forming) solution.

For the purpose of delineation of alteration zones in the area, spectrum measurement was conducted on rocks from the principal geological units(FIG.2-1-4).

The relation between the major fractures and the mineralized zones were interpreted, but no significant alteration areas are selected because they do not show good coincidence of the geochemical anomalies, mineralized zones and concentration of fractures, and no acting mines exist in the area.

Based on the results of the measurement, the following two main zones are selected on the Landsat image.

1)Fe-hydroxides, chlorite, epidote etc. having Fe in their molecular formulas.

2)Representative clay minerals such as montmorillonite, sericite, kaolinite etc..

Minerals included in 1) are characterized by strong absorption of spectrum on band 1 and result in exaggerated DN value of band 3/1. This is reflected as red colour on the ratio image of band 3/1.

Minerals included in 2) can be classified from other minerals due to high DN value of band 5/7. As a result of the interpretation of ratios on each band, band 3/5 shows similar tendency with band 5/7. This results in an exaggerated blue colour on the ratio image.

According to the interpretation results, minerals of 1) category roughly correspond in distribution to the geological unit of mafic granulite.
On the other hand, the minerals of 2) category mainly distribute within the geological units of gneissose granulite and felsic granulite. The existence of the minerals are shown by clear absorption spectrum indicating the clay minerals on the measurement. This result indicates that the minerals such as montmorillonite etc. are under producing in the delineated zones, although no alteration zones were detected during geological survey.

The detailed investigation on the mode of occurrence of the alteration zones detected by the Landsat image needs a further study of X-ray diffractometry on the rock specimens from the area.

Together with ratio image interpretation, also principal component image was investigated to detect the alteration zones, but no positive results were obtained because of high correlation coefficient among bands in the principal component.

1-3 Considerations

It can be concluded that a Landsat interpretation provides a bird's-eye view that allows the geological interpreter to see landform in its entirety.

Landsat image has an advantage of permitting reconnaissance survey to be concluded in a limited period over a large area where no geoscience data are available, due to its good consistency and uniformity in contrast to aerial photography.
Ratio image (band 3/5, 4/3, 3/1 BGR) is good for the interpretation of geological units and structure, and also false-colour image for geological structures.

According to the exploration on ore deposits, many deposits are formed by hydrothermal solution, that invade the country rock. During formation of the ore minerals, these solutions also interact chemically with the country rock to alter the mineral composition beyond the site of ore deposition and form zones of hydrothermal alteration around the ore deposits. Not all alteration, however, is associated with ore bodies, and not all ore bodies are marked by alteration zones. These zones are valuable indicators of possible deposits.

In Renco deposit, situated to the southwest of the area, the wall rock alteration is possibly an effect of pegmatite intrusion, but no relationship exists between the degree of alteration and Au mineralization other than very erratic distribution. Indeed, several instances of high Au values have been recorded in country rock outside the limits of alteration, suggesting some minor redistribution of Au(Bohmke & Varndell, 1986).

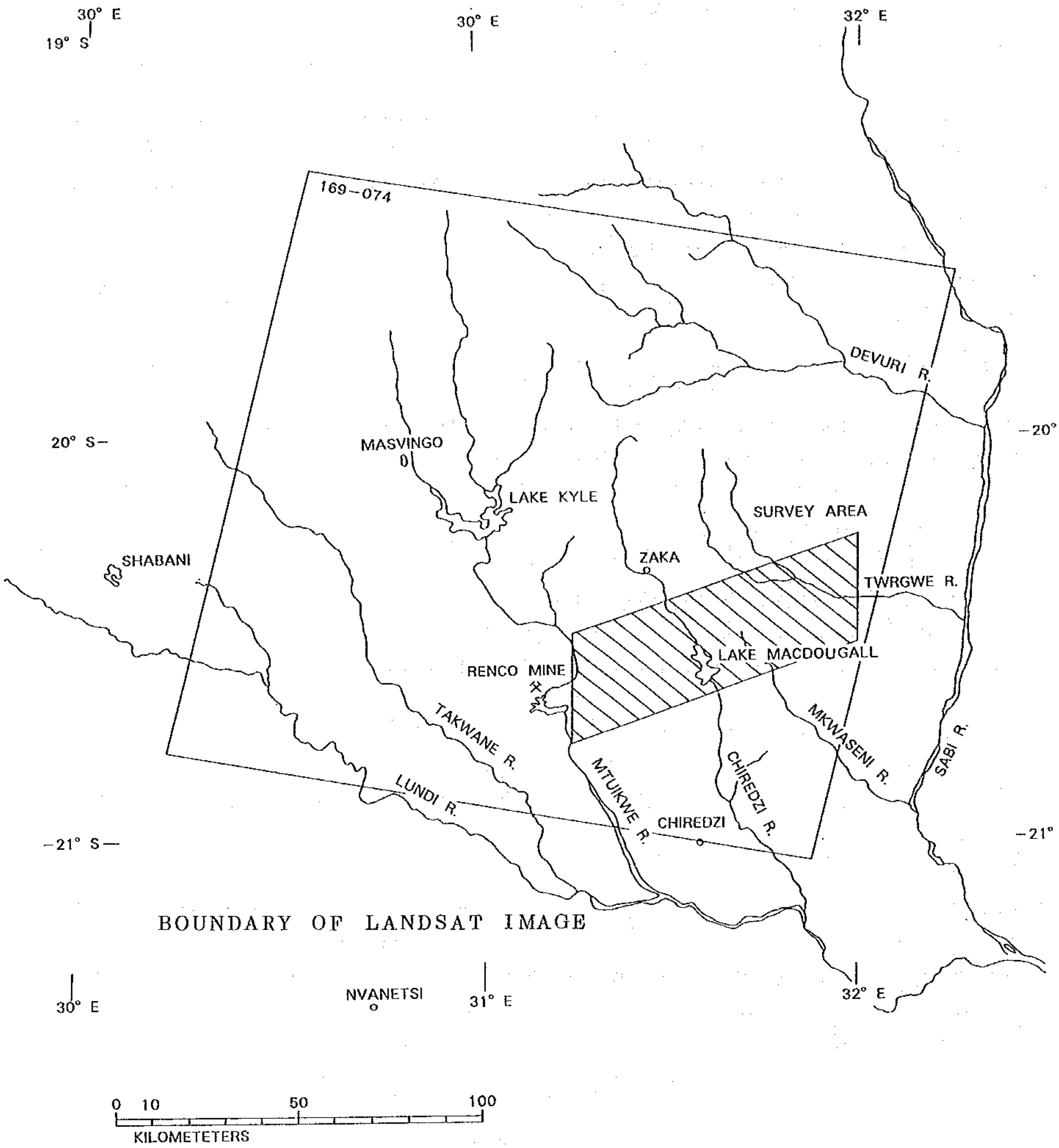


FIG. 2-1-1 Locality Map of Landsat Image

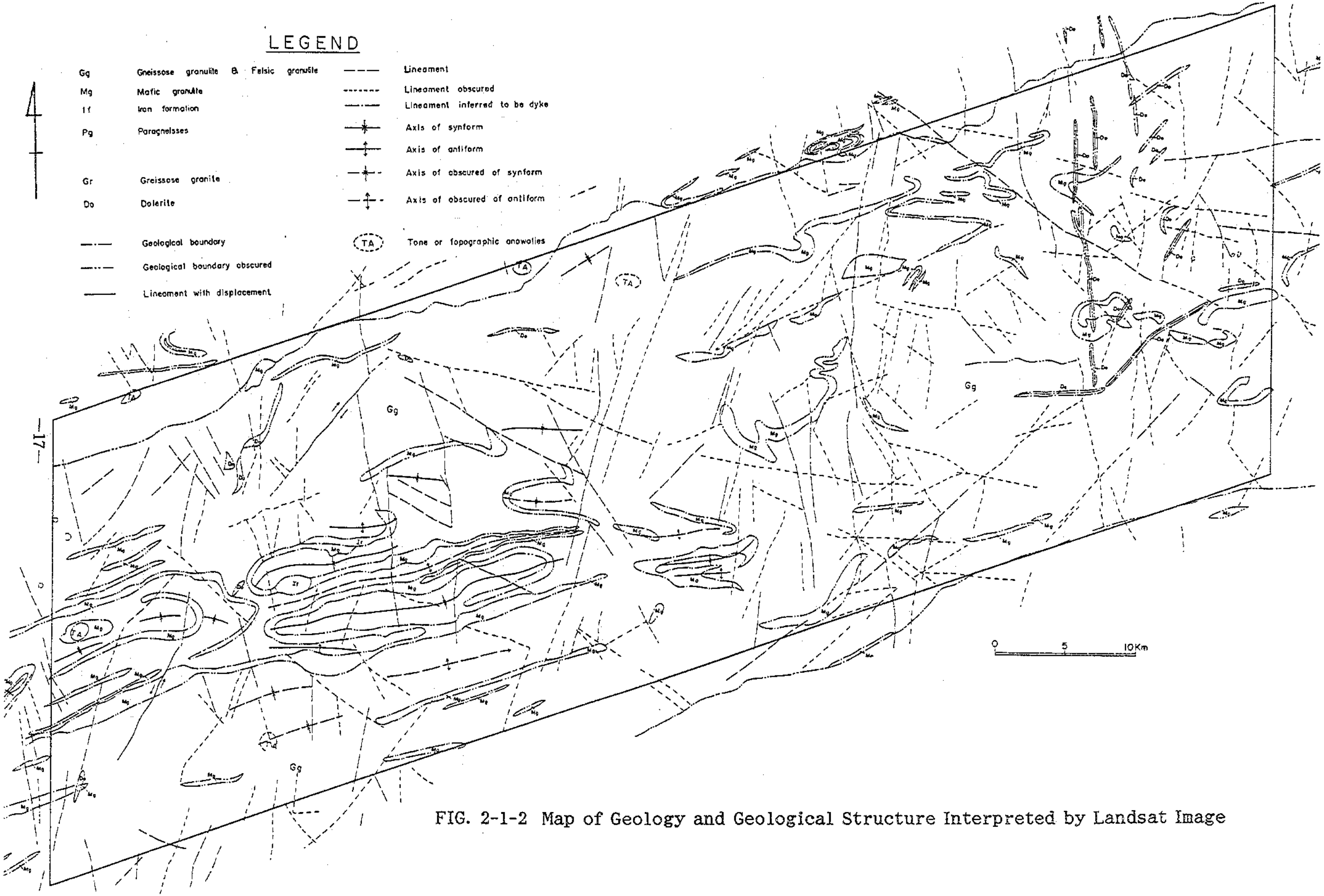
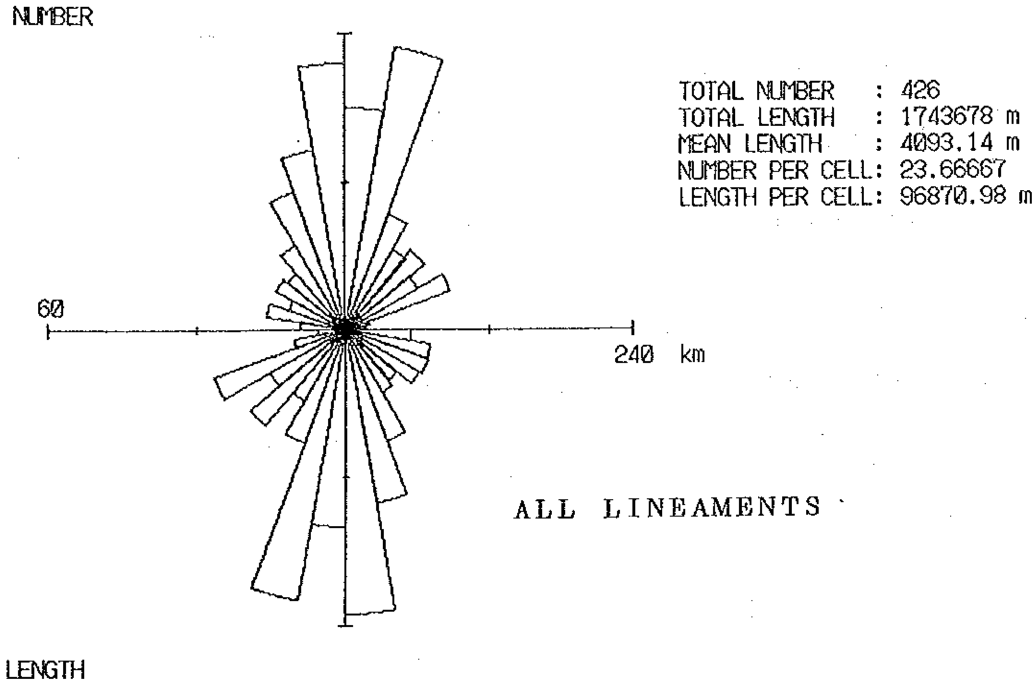


FIG. 2-1-2 Map of Geology and Geological Structure Interpreted by Landsat Image



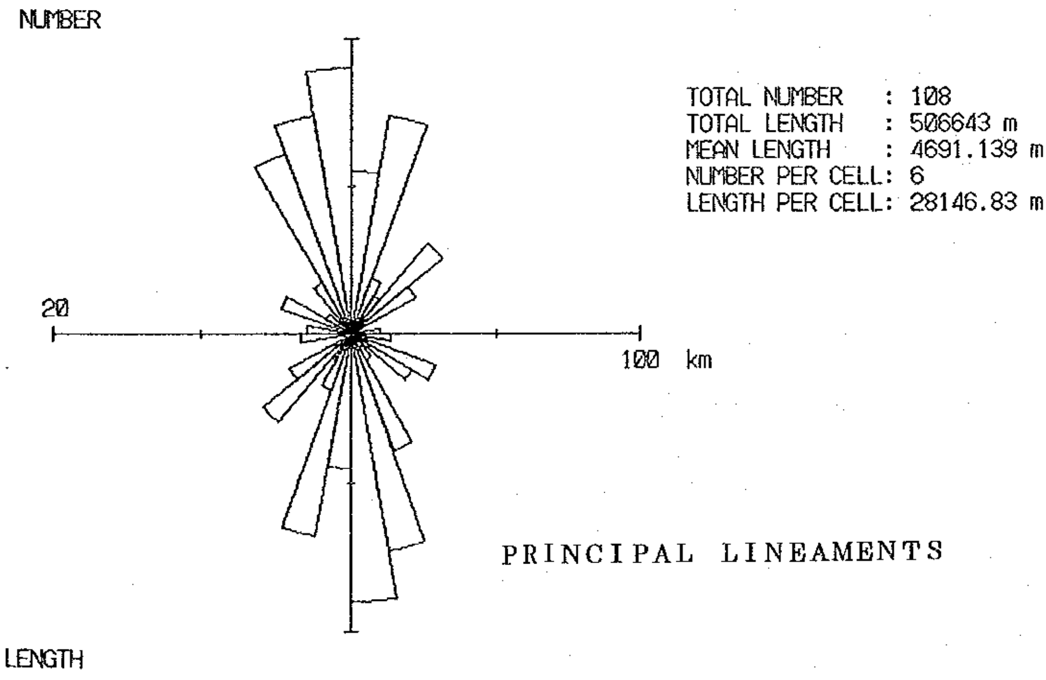


FIG. 2-1-3 Rose Diagram of Lineaments Interpreted by Landsat Image

CHAPTER 2 GEOLOGICAL RECONNAISSANCE SURVEY

2-1 GEOLOGY

The geology in this survey area consists of gneissose granite, gneissose granulite, felsic granulite, mafic granulite, iron formation, and dolerite.

It is considered that these rocks have ENE-WSW foliation and show a southward dip as usual. In addition, the survey area is considered to be dominated by isoclinal folding. However, at Zaka Road, which runs through the eastern part of the survey area, the northward dipping foliation is recognized in mafic granulite and suggests that folding is likely to be somewhat opened around the above-mentioned location. In the field, foliation changes gradually and a fold structure is recognized only in a limited place, but on an image, the geological structure can often be traced. The lineaments are concentrated most in the NNW-SSE direction which meets the ENE-SWS foliation at right angles. However, it is difficult to consider as a result of either image interpretation or a field survey, that such lineaments have greatly displaced the geological units, because the units in the survey area have good sideward continuity.

The major tectonic lines in the survey area are Sazaume-Makambe tectonic line, Murerezi tectonic line and Turwi tectonic line. The area has been possibly subjected block movement by these tectonic lines.

Idealized geological column was shown in FIG.2-2-1.

Details of such rocks are as follows:

Gneissose granite has a mineral combination of quartz, potassium feldspar, plagioclase, and biotite. The result of mode analysis shows the following average composition of this rock in the survey area:

Quartz 84.2%	Plagioclase 0.6%
Pyroxene 0%	Potassium feldspar 12.8%
Biotite 2.3%	

The rock containing clinopyroxene is also found locally but is found in the vein part of quartz. Accordingly, it may be different from granitic rock. The texture shown usually by this rock is entirely equigranular and the tectonic grade of the rock is considered to be slightly low in comparison with high grade metamorphic rocks in the Limpopo Mobile Belt, which is distributed to the south of this rock.

Gneissose granulite is a mineral combination of quartz, plagioclase, potassium feldspar, monoclinic and orthopyroxene, biotite, and garnet. The mineral composition of this rock, which has been obtained through mode analysis, is as follows:

Quartz 38.5%	Plagioclase 38.1%
Potassium feldspar 17.5%	Biotite 5.1%
Pyroxene group 4.0%	Amphibole 0.4%
Garnet 0.1%	Opaque minerals 1.2%

ABSOLUTE AGE	GEOLOGIC TIME	SYSTEM/GROUP	ROCK TYPES	GEOLOGIC COLUMN	MINERALIZATION
	PLEISTOCENE /RECENT	KALAHARI	ALLUVIUM AEOLIAN SANDS		ALLUVIAL GOLD
	CRETACEOUS～ UPPER JURASSIC		ALKALINE VOLCANICS SANDSTONE ETC		
	JURASSIC TRIASSIC PERMIAN	KAROO	RHYOLITE BASALT SANDSTONES, SILTSTONES, ETC. GLACIAL BEDS, COAL MEASURES, MUDSTONES		TUNGSTEN, COPPER
	LATE PRECAMBRIAN	SIJARIRA TENGWE RIVER MAKUTI RUSHINGA	SANDSTONES, SHALES, CONGLOMERATE. ETC. LIMESTONE, DOLOMITE & ORTHOQUARTZITE PARAGNEISS, METASEDIMENTS & AMPHIBOLITE		zinc, copper, lead copper
	MID PRECAMBRIAN	MALAPUTESE & KAHIRE	PARAGNEISS, METASEDIMENTS & AMPHIBOLITE		COPPER
		UMKONDO	LIMESTONE, SHALE, QUARTZ & BASALT QUARTZ-MICA SCHISTS, ORTHOQUARTZITE, ETC.		COPPER
		LOMAGUNDI	STRIPPED SLATES & MINOR QUARTZITE DOLOMITE & ORTHOQUARTZITES		COPPER, lead
			META-ARKOSE & BASIC METAVOLCANICS		COPPER, SILVER, GOLD
		PIRIWIRI	PHYLLITE & MINOR QUARTZITES		TIN, TUNGSTEN, COPPER GOLD, TANTALUM, manganese lead, zinc
2700 -2600 Ma*		LIMPOPO MOBILE BELT	IRON FORMATION (If) MAFIC GRANULITE (Mg) FELSIC GRANULITE (Fg) GNEISSOSE GRANULITE (Gg)	DOLERITE 1700 Ma Gg Mg Fg Gg Fg	CHROME, GOLD, TUNGSTEN zinc
	EARLY PRECAMBRIAN	BEITBRIDGE	PARAGNEISSES, HIGH-GRADE SEDIMENTS & ANORTHOSITIC GNEISSES		copper, magnetite
3200 Ma 3300 Ma 3500 Ma		SHAMVAIAN BULAWAYAN SEBAKWIAN	METASEDIMENTS, FELSIC METAVOLCANICS METASEDIMENTS, FELSIC METAVOLCANICS ANDESTIC & DACITIC METAVOLCANICS BASALTIC METAVOLCANICS WITH METASEDIMENTS ULTRAMAFIC LAVA & INTRUSIONS		GOLD, SILVER, IRON ORE COPPER, NICKEL, LEAD, ZINC, MANGANESE, TUNGSTEN PYRITE
3600 -3500 Ma		ARCHAEAN GRANITIC ROCKS	OLDER GNEISS COMPLEX		

MINERAL PRODUCED : GOLD
MINERAL NOT PRODUCED: copper

* : METAMORPHIC AGE

FIG. 2-2-1 Idealized Geological Column

Others 3.0%
This rock shows entirely equigranular granoblastic texture and has mostly undergone tectonic metamorphism.

Felsic granulite is a mineral combination of quartz, potassium feldspar, plagioclase, biotite, and garnet and is characterized by containing no pyroxene group mafic mineral. The mineral composition of this rock, which has been obtained through mode analysis, is shown below:

Quartz 34.0% Plagioclase 29.3%
Potassium feldspar 36.2%

This rock contains various textures from isogranualr to ribbon quartz, and has become mylonite-type rock by undergoing tectonic metamorphism.

Mafic granulite is a mineral combination of monoclinic and orthopyroxene, amphibole, quartz, plagioclase and garnet, and some thin sections may not contain any minerals other than the pyroxene group. The mineral composition of this rock, which has been obtained through mode analysis, is as follows:

Quartz 0% Plagioclase 52.7%
Pyroxene 39.6% Amphibole 2.8%
Opaque minerals 4.0% Biotite 0.1%

The texture of this rock has changed in such a manner from isogranular to polygonal and to heterogranular, and seems to have undergone comparatively weak tectonic metamorphism.

Iron formation is a special mineral combination of quartz and opaque minerals and its mineral composition obtained from mode analysis is shown below:

Quartz 67.8% Opaque minerals 30.8% Others 1.4%

This rock shows ribbon quartz texture and has become a mylonite type by undergoing strong tectonic metamorphism.
(By the Phase III survey, some of iron formation was determined to be mineralized quartzite)

Dolerite is an intrusive rock and the mineral combination of quartz, clinopyroxene, and orthopyroxene. This rock can be classified into two categories based on the mineral volume of the clinopyroxene and orthopyroxene. The mineral composition of this rock, which has been obtained from mode analysis, is as follows:

Quartz 0.3% Plagioclase 42.4%
Pyroxene 29.0% Potassium feldspar 0.3%
Biotite 0.6% Amphibole 19.0%
Alteration mineral (chlorite) 8.1%
Opaque minerals 1.5%

This rock shows ophitic and intersertal texture and seems to have undergone no tectonic metamorphism.

2-2 GEOLOGICAL STRUCTURE

Geological structure of the area is characterized by prominent ENE-WSW foliation. In general, the foliation dips toward south-south-east, therefore tightly folded isoclinal folding is envisaged. The dips, however, are variable in and amount in the northeastern part of the area(FIG.2-2-2).

In the area west of the Murerezi structure line, which traverses the survey area, ENE-WSW foliation is predominant. On the other hand, this tendency has been disturbed considerably in the eastern area. To clarify these conditions, the foliation which has been taken from a LANDSAT images to understand the entire state of the survey area, is shown in FIG. 2-2-3. However, when stereo-net diagram, on which strikes and dips confirmed in the field survey have been plotted, is examined, both areas show a similar tendency. This might be because the foliation crossing to the ENE-WSW direction has usually poor continuity and therefore, the measuring frequency is exceedingly lower than that for the ENE-WSW direction.

Tectonic metamorphism(deformation) in the survey area is not necessarily understood (frequency and timing) by researchers. Generally speaking, it is difficult to obtain a corresponding relationship between the time of deformation found in some area and the time of deformation in another area. This is because direction

---

Note)

The classification of texture based on microscopic observation on thin sections has been performed in accordance with Bard (1986). As a result of the microscopic observation, we have found the texture from equigranular rocks to mylonite, which have been produced through tectonic metamorphism. The survey area is located in what is called the "Limpopo Mobile Belt" and has undergone strong tectonic metamorphism. Metamorphism had developed in the area, so that we considered it possible to classify rocks by texture. In this report, therefore, we have classified rocks into the following seven types of texture, paying attention to fine and uniform granualtion of minerals, which are found in thin sections.

(1) Isogranular	0
(2) Polygonal	0
(3) Heterogranul	0
(4) Framed Porphyroclastic	1
(5) Protomylonitic	2
(6) Augenmylonitic	3
(7) Ribbon Quartz	4

The isogranular, polygonal, and heterogranular types of texture are slightly different from one another and have not undergone tectonic metamorphism. Since no fine granualtion of minerals has developed in such types of texture, we have designated them Tectonic Grade 0. The framed porphyroblastic texture has been designated Tectonic Grade 1 because the texture has been formed after rocks at the stage of tectonic grade 0 underwent tectonic metamorphism and after the fine granualtion of minerals commenced.

For the protomylonitic texture, finely granulated minerals increase further in volume and almost no original texture is found. Therefore, this stage has been designated Tectonic Grade 2.

For the augenmylonitic texture, minerals in the original rock are finely granulated to about 0.1 mm or less in diameter and such granulated minerals are contained at larger volumes than that of potassium feldspar which has been left in an eyeball shape. This stage has been designated Tectonic Grade 3.

For the ribbon quartz texture, the augenmylonitic texture has undergone tectonic metamorphism and quartz is arranged in a ribbon shape. This stage has been designated Tectonic Grade 4.

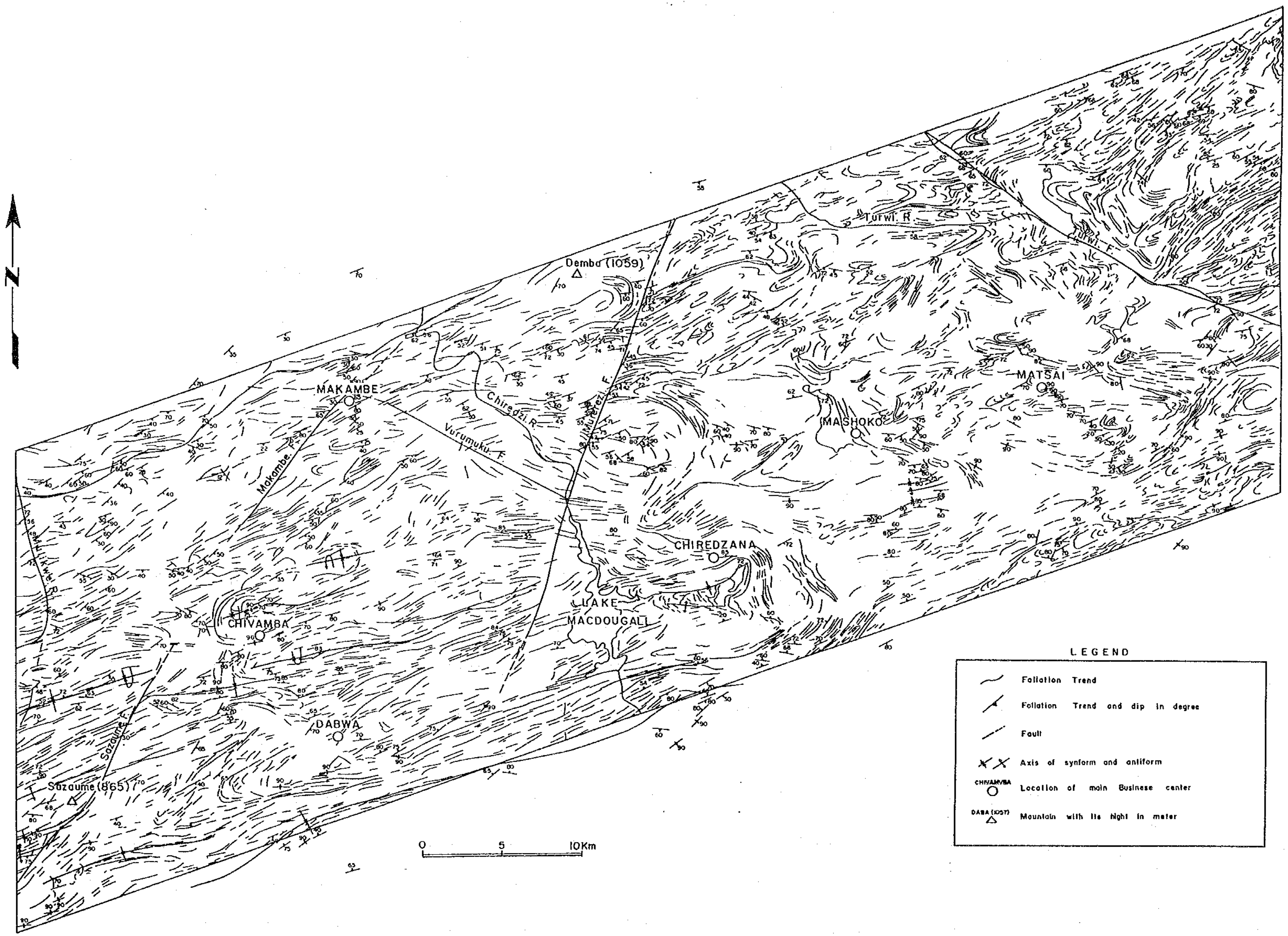
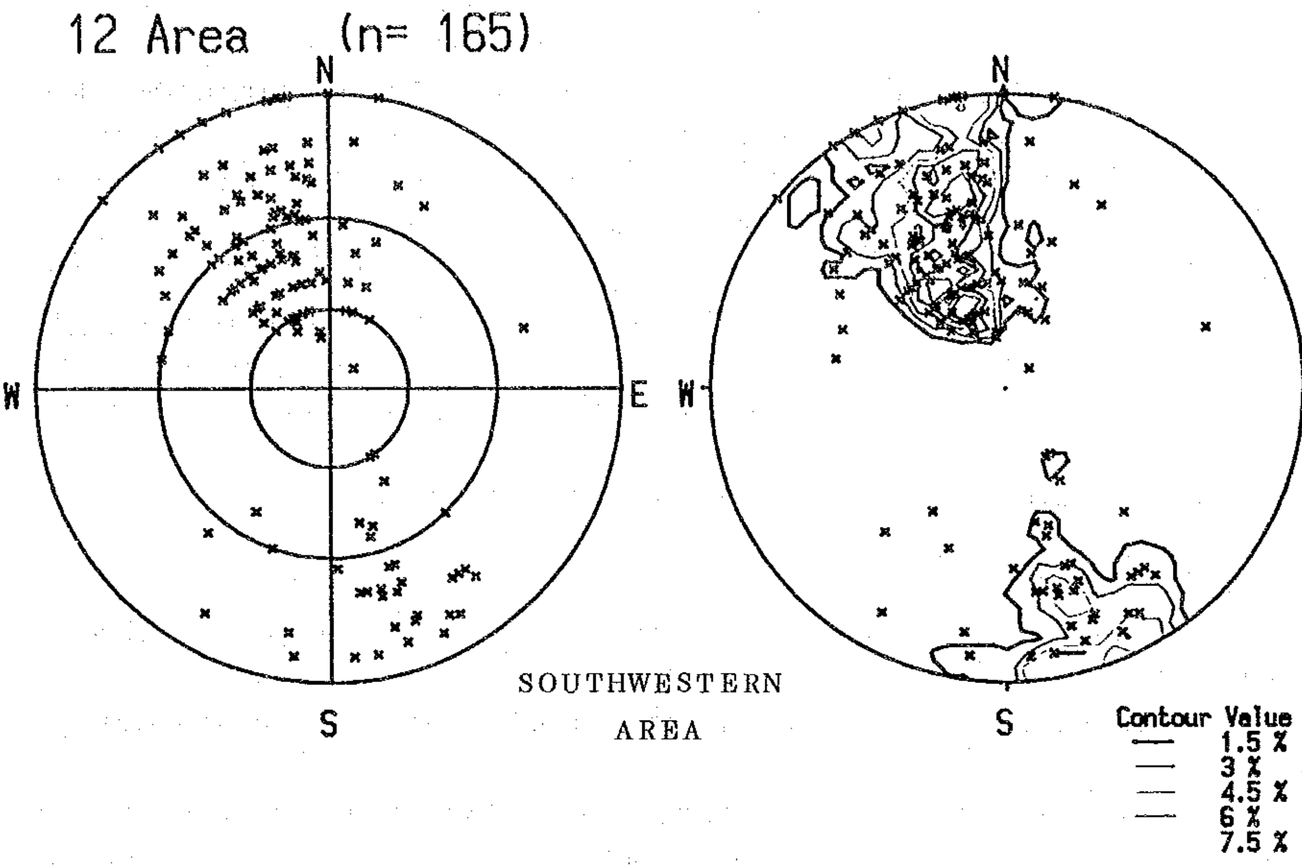


FIG. 2-2-2 Map of Geological Structure



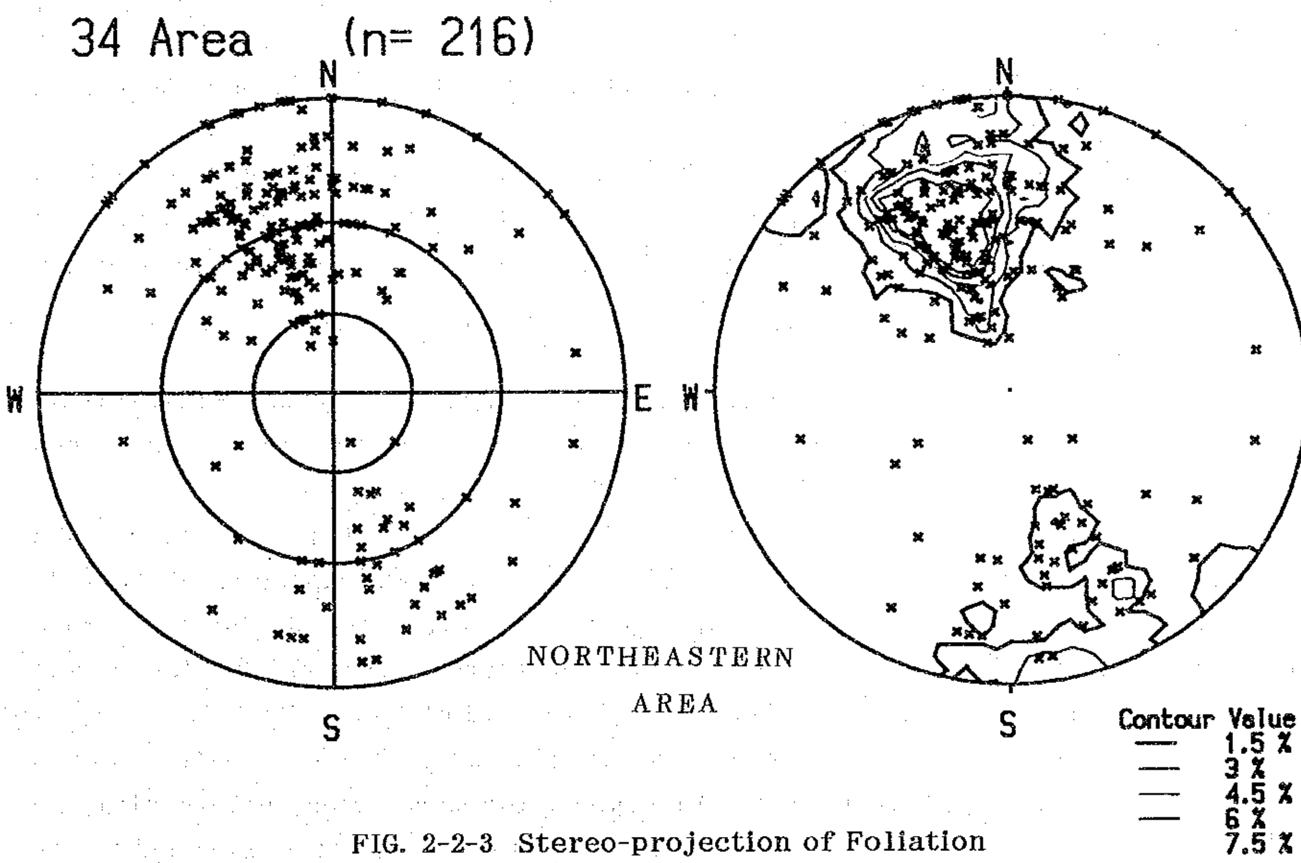


FIG. 2-2-3 Stereo-projection of Foliation

the consecutive occurrence of several deformations impairs the clarity of previous deformations. Researchers tend to recognize the deformation which has been recorded the most notably at the time of investigation as the most universal deformation in an survey area. In the survey area, deformation history can be seen twice at least as pointed out by Robertson & Du Toit in 1981.

Since, in the survey area, the extension of dolerite intruding the Umkondo Formation, which is adjacent to the eastern part of the area, exists and this dolerite has undergone no mylonite-type deformation, it can be estimated that the deformation in the survey area occurred before 1,700 Ma (Stagman, 1978), the time of dolerite intrusion.

A geological map and sections were shown in FIG.2-2-4 and FIG.2-2-5.

2-3 MINERALIZATION

The genesis of the most important types of Archaean gold deposits in Zimbabwe ,namely gold-bearing iron-formation, auriferous volcaniclastic sediments, and vein and shear-zone deposits, can be interpreted within the framework of the evolving Rhodesian craton.

It also is enabled to classify into stratabound(iron-formations and volcaniclastic-hosted) and non-stratabound(veins and mineralized shear zones). Stratabound deposits are of only minor importance, whereas the veins and mineralized shear zones have yielded approximately 82 % of the gold in Zimbabwe.

The majority of the mineralizations in the area are of the gold-quartz veins which were generated during the metamorphism and deformation which postdated the main Limpopo high-grade metamorphism.

Although this is little doubt that the intrusions activity resulted in considerable mobilization and precipitation of enhanced concentrations of gold It, however, is not clear that what types of the intrusion activity are responsible for the mineralizations in the area.

Mineralized Zone

Only few mineralized zones were reported so far in the area. The following zones were visited by our survey members. The general description on the zones are as follows:

Jegede mineralized zone: The mineralized zone is located in the east of Lake Macdougall and 2.5 km south of Matara School. Although exposure of rock is scarce, it is supposed that mafic granulite is a country rock of the auriferous quartz vein. Width and strike-dip of the veins are approximately 1.20 m and east-west/85 s, respectively. disseminated and veinlet-like limonite, partly representing jaspar-like, are common in veins. Fine grained pyrite still remain in the form of dissemination and veinlets against the weathering. 6 pits with the dimension of 3 m(length) x 0.6 m(width) x 1.5～0.6 m(depth) distribute around the 30

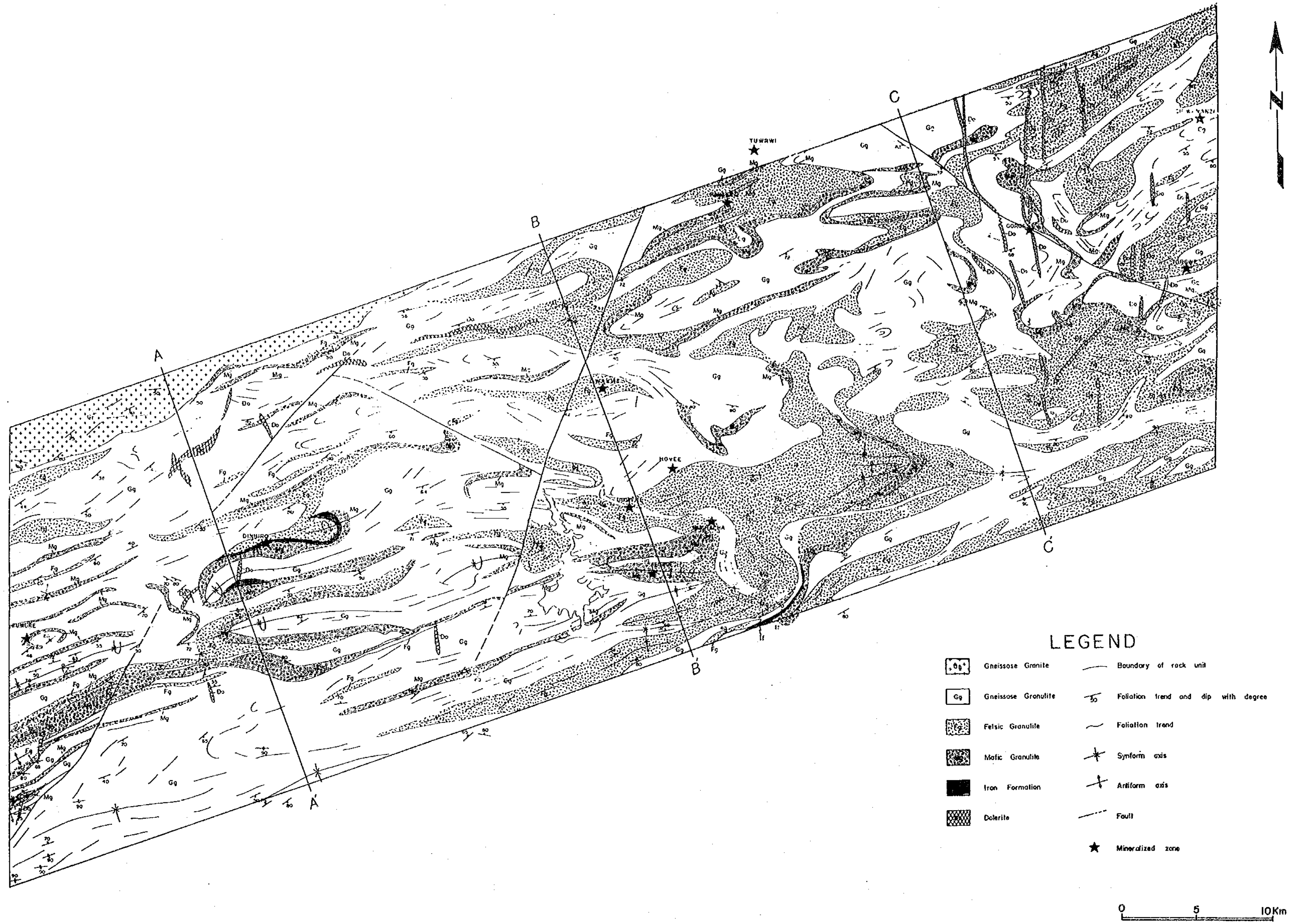


FIG. 2-2-4 Geological Map

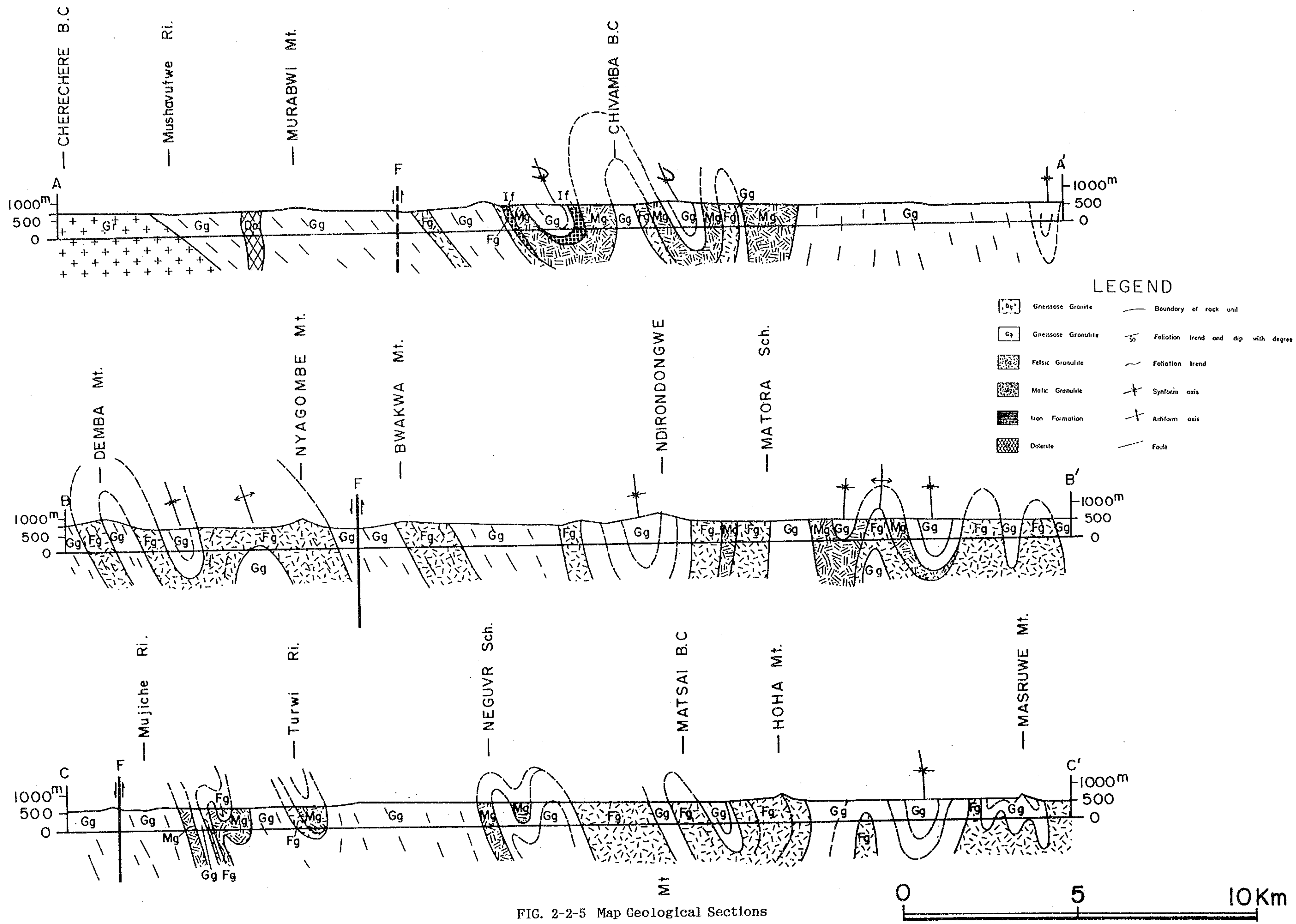


FIG. 2-2-5 Map Geological Sections

m x 50m. The auriferous quartz vein systems are recognized crossing a few pits, therefore the continuation of the veins are guaranteed. Assay result in Masvingo Laboratory of a sample from the zone was Au 5.3 g/t.

The results of microscopic observation on polished sections and polished thin sections are summarized as follows:

Ore minerals from the mineralized zone consist of small amount of pyrrhotite, pyrite, marcasite, chalcopyrite, covelline and magnetite-ilmenite.

The majority of pyrrhotite is changing into a very small aggregation of pyrite and marcasite, although fresh pyrrhotite exists in same quantity. From the textural point of view, pyrrhotite shows birds-eye texture.

Pyrite appears in part as pyrite-marcasite veinlet. Chalcopyrite commonly associates with pyrrhotite and pyrite. Covellines form tiny lamella aggregation and occupy the rim of chalcopyrite crystals. Magnetites are commonly changing into Fe-hydroxides, although single crystal and magnetite-ilmenite association exists.

The assay results of samples taken from the zone are shown as follows:

JEGEDE MINERALIZED ZONE

	Au (ppb)	Ag (ppm)	As (ppm)	Bi (ppm)	Cu (ppm)	F (ppm)	Zn (ppm)	Cr (ppm)	Ni (ppm)
①	12	0.80	763	0.40	367	61	256	207	44
②	6	0.60	67	0.30	228	139	216	99	24

Judging from the assay results, the zone is characterized by rather concentration of Au, As, Cu and Zn compared with other mineralized zone in the survey area.

<u>Juwere mineralized zone</u>:The mineralized zone is located in the east of Lake Macdougall and 2.0 km northwest of Matara School. Few rocks outcrop, but it is supposed that charnockite or leucoclatic rock is a country rock of the auriferous quartz vein. Although no definite vein systems are recognized, strike of the veins are assumed to be north-south judging to the intermittent continuation of quartz and limonite vein. Disseminated and veinlet-like limonite with quartz are common in veins. Fine grained pyrite still remain in the form of dissemination and veinlets against the weathering. 3 pits with the dimension of 3 m(length) x 0.6 m(width) x 1.0~0.5 m(depth) distribute for 20 m with direction of north to south.

The results of microscopic observation on polished sections and polished thin sections are summarized as follows:

Ore minerals from the mineralized zone consist of small amount of pyrrhotite, pyrite, marcasite, chalcopyrite and covelline.

The majority of pyrrhotite is changing into a very small aggregation of pyrite and marcasite, although fresh pyrrhotite exists in same quantity.

Pyrite appears as an aggregation of single pyrite crystals and also associates with pyrrhotite and/or chalcopyrite.

Chalcopyrite commonly associates with pyrrhotite and pyrite.

Covellines form tiny lamella aggregation and occupy the rim of chalcopyrite crystals.

The assay results of samples taken from the zone are shown as follows:

JUWERE MINERALIZED ZONE

	Au (ppb)	Ag (ppm)	As (ppm)	Bi (ppm)	Cu (ppm)	F (ppm)	Zn (ppm)	Cr (ppm)	Ni (ppm)
①	1461	< 0.50	1.00	15.70	324	86	88	258	31
②	97	0.05	1.00	0.20	639	49	194	7	52

Judging from the assay results, the zone is characterized by rather concentration of Au, Bi, and Cu compared with other mineralized zone in the survey area.

<u>Turwi mineralized zone</u>:The zone is located in the northeastern most part of the area. Mafic rock is possibly a country rock of the mineralized zone. The vein system, consisting highly silisified part, are not clear. Disseminated fine pyrites are in the silisified material. Limonite also occurs as a form of dissemination and veinlets.

Four trenches with the dimension of 10～30 m(length) x 1.0～0.6 m(width) x 1.0～0.5 m(depth) distribute around the 50 m x 50m. Each trench has north- south, east-west and northeast-southwest direction.

The assay results of samples taken from the zone are shown as follows:

TURWI MINERALIZED ZONE

	Au (ppb)	Ag (ppm)	As (ppm)	Bi (ppm)	Cu (ppm)	F (ppm)	Zn (ppm)	Cr (ppm)	Ni (ppm)
①	< 1.00	< 0.50	< 1.00	< 0.10	22	96	36	630	17
②	< 1.00	< 0.50	< 1.00	< 0.10	7	< 10	19	326	19

Judging from the assay results, the zone is characterized by rather concentration of Cr compared with other mineralized zone in the survey area.

<u>Panganai mineralized zone</u>: The mineralized zone is situated in the northeastern most part of the area near Turwi. Vein system is not clear. Gossan, consisting limonite and hematite, shows a breccia structure and the original rock is unknown. The breccia structure has an appearance of "breccia dyke" often accompanied with epithermal vein deposits of Japan. Druses in the breccia have

small quartz(ϕ =1～2mm).

The assay results of a sample taken from the zone are shown as follows:

PANGANAI MINERALIZED ZONE

	Au (ppb)	Ag (ppm)	As (ppm)	Bi (ppm)	Cu (ppm)	F (ppm)	Zn (ppm)	Cr (ppm)	Ni (ppm)
①	2	0.60	3.00	0.10	15	104	71	630	29

Judging from the assay results, the zone is characterized by rather concentration of Cr compared with other mineralized zone in the survey area.

Gorgwe mineralized zone: The mineralized zones are located in the north eastern part of the area, along the Turwi river and its tributary for approximately 2 km. Country rocks of veins is gneissose granulite. Both width and strike of the veins are quite variable presenting 0.1 m～1.5 m and N30W～N80E. The modes of occurrences of the zone are characterized by the veinlets and network accompanied by alkali feldspar and quartz, partly with minor amount of epidote and chlorite. No gossan is recognized in the zone due to lesser amount of sulphide.

The results of microscopic observation on polished sections and polished thin sections are summarized as follows:

Ore minerals from the mineralized zone consist of small amount of ilmenite-hematite, magnetite, pyrite, and chalcopyrite.

Ilmenite-hematite commonly show an exsolution texture.

Magnetite shows often idiomorphic or irregular form.

Fe-hydroxides are accompanied with rim of pyrite.

Chalcopyrite commonly exists as very fine crystal and irregular form.

The assay results of samples taken from the zone are shown as follows:

GORGWE MINERALIZED ZONE

	Au (ppb)	Ag (ppm)	As (ppm)	Bi (ppm)	Cu (ppm)	F (ppm)	Zn (ppm)	Cr (ppm)	Ni (ppm)
①	2	<0.50	<1.00	<0.10	18	217	102	<1.00	30
②	2	<0.50	<1.00	<0.10	25	481	68	<1.00	28
③	1	<0.50	<1.00	<0.10	59	527	142	<1.00	64
④	1	<0.50	<1.00	<0.10	45	77	85	353	82
⑤	2	<0.50	<1.00	<0.10	27	161	85	224	20

Judging from the assay results, the zone is characterized by rather concentration of F compared with other mineralized zone in the survey area.

Dinhiro mineralized zone: The mineralized zone is located in the western part of the area, along the hill of same name. Country rocks is gneiss or mafic rock. Both width and strike/dip of the veins are 0.3 m～1.5 m and N50E/75 NW, respectively. The vein consists of stratiformed limonite and hematite and siliceous materials as a matrix. The vein system obliquely superimposes on the foliation of the country rock. Judging from the vein occurrence and pits distribution, the zone consists of the paralleled a few vein systems.

The results of microscopic observation on polished sections and polished thin sections are summarized as follows:

Ore minerals from the mineralized zone consist of small and very small amount of magnetite-ilmenite, Fe-hydroxides, ilmenite and pyrrhotite.

Magnetite-ilmenite shows an exsolution texture and ilmenite, showing lattice like exsolution, remains unaltered.

Pyrrhotite presents a form of tiny rounded bleb.

The assay results of samples taken from the zone are shown as follows:

DINHIRO MINERALIZED ZONE

	Au (ppb)	Ag (ppm)	As (ppm)	Bi (ppm)	Cu (ppm)	F (ppm)	Zn (ppm)	Cr (ppm)	Ni (ppm)
①	< 0.01	< 0.50	1.00	0.10	25	14	51	614	23
②	5	< 0.50	1.00	0.10	234	32	38	151	16

Judging from the assay results, the zone is characterized by rather concentration of Cr and Cu compared with other mineralized zone in the survey area.

Hovee mineralized zone: The mineralized zone is located in the central part of the area and upper reaches of the Mukwasini river. Although many boulders of gneiss scatter around the vein, the country rock is not known. Mafic rock, possibly dyke having strike of N40E, exists peneconcordantly to the vein. Vein consists mainly of quartz with banded and disseminated limonite and minor amount of pyrite and chalcopyrite dissemination.

Gneiss nearby the vein possibly suffers some shearing. Twenty meters of continuation is confirmed on the field. There is a trench having the dimension of 7 m(length) x 2.0 m(width) x 1.0 m(depth).

The results of microscopic observation on polished sections and polished thin sections are summarized as follows:

Ore minerals from the mineralized zone consist of small and extremely small amount of pyrrhotite, pyrite, marcasite, chalcopyrite, covelline and ilmenite.

pyrrhotite is almost changing into marcasite or a very small aggregation of pyrite and marcasite.

From the textural point of view, pyrrhotite shows birds-eye texture.

Pyrite commonly appears as an euhedral crystal and includes very tiny marcasite within its crystal.

Almost all marcasite resulted from an alteration product of pyrrhotite.

Chalcopyrite is replaced by covelline, presenting lamella aggregation, and associates with pyrrhotite.

The assay results of sample taken from the zone are shown as follows:

HOVEE MINERALIZED ZONE

	Au (ppb)	Ag (ppm)	As (ppm)	Bi (ppm)	Cu (ppm)	F (ppm)	Zn (ppm)	Cr (ppm)	Ni (ppm)
①	13	0.06	<1.00	0.10	491	16	552	13	55

Judging from the assay results, the zone is characterized by rather concentration of Au, Cu, and Zn compared with other mineralized zone in the survey area.

Muchacha mineralized zone: The mineralized zone is located in the central part of the area and just east of Chirezana business center. Although many boulders of garnet gneiss scatter around the vein, the country rock is not known. Vein consists mainly of quartz with banded and disseminated limonite and minor amount of disseminated fine pyrite.

The vein has a strike of N80E and a dip no-determined. There is a pit having the dimension of 1.6 m(length) x 1.0 m(width) x 1.0 m(depth).

The mode of occurrence is somewhat similar to Juwere, Jegede and other mineralized zones except Gorge zone.

The results of microscopic observation on polished sections and polished thin sections are summarized as follows:

Ore minerals from the mineralized zone consist of medium to very small amount of pyrrhotite, pyrite, marcasite, chalcopyrite, covelline and Fe-hydroxides.

pyrrhotite is almost changing into marcasite or a very small aggregation of pyrite and marcasite.

From the textural point of view, pyrrhotite shows birds-eye texture.

Pyrite commonly appears as an euhedral crystal.

Almost all marcasite shows an aggregation of tiny crystals.

Chalcopyrite is replaced by covelline, presenting lamella aggregation, and associate with pyrrhotite and pyrite.

The assay results of samples taken from the zone are shown as follows:

MUCHACHA MINERALIZED ZONE

	Au (ppb)	Ag (ppm)	As (ppm)	Bi (ppm)	Cu (ppm)	F (ppm)	Zn (ppm)	Cr (ppm)	Ni (ppm)
①	129	0.70	46.00	1.40	345	57	270	<1	208
②	6	0.50	48.00	0.30	160	17	880	64	42

Judging from the assay results, the zone is characterized by rather concentration of Au, As, Zn and Cu compared with other mineralized zone in the survey area.

Fumure, Chiwanza and Gwakwa mineralized zones were also studied and sampled. The mode of occurrences , however, of the zones have not been fully understood due to insufficient outcrops.

Fumure

The assay results of the samples from these zones are shown as follows:

FUMURE MINERALIZED ZONE

	Au (ppb)	Ag (ppm)	As (ppm)	Bi (ppm)	Cu (ppm)	F (ppm)	Zn (ppm)	Cr (ppm)	Ni (ppm)
①	10	<0.50	4.00	<0.50	4	20	21	47	24
②	<1	<0.50	5.00	<0.01	12	<10	26	332	14

Judging from the assay results, the zone is characterized by rather concentration of Cr and Au compared with other mineralized zone in the survey area.

Chiwanza

The assay results of the sample from these zones are shown as follows:

CHIWANZA MINERALIZED ZONE

	Au (ppb)	Ag (ppm)	As (ppm)	Bi (ppm)	Cu (ppm)	F (ppm)	Zn (ppm)	Cr (ppm)	Ni (ppm)
①	<1	<0.50	3.00	<0.01	28	20	22	647	27

Judging from the assay results, the zone is characterized by rather concentration of Cr compared with other mineralized zone in the survey area.

Gwakwa

The assay results of the samples from these zones are shown as follows:

GWAKWA MINERALIZED ZONE

	Au (ppb)	Ag (ppm)	As (ppm)	Bi (ppm)	Cu (ppm)	F (ppm)	Zn (ppm)	Cr (ppm)	Ni (ppm)
①	1	<0.50	<1.00	<0.10	25	157	37	78	17
②	1	<0.50	1.00	<0.10	13	32	17	5	21

Judging from the assay results, the zone is not characterized by any concentration of metal compared with other mineralized zone in the survey area.

Renco

The assay results of the samples from the deposit are shown as follows:

RENCO DEPOSIT

	Au (ppb)	Ag (ppm)	As (ppm)	Bi (ppm)	Cu (ppm)	F (ppm)	Zn (ppm)	Cr (ppm)	Ni (ppm)
①	1436	1.50	<1.00	5.30	929	252	108	125	11
②	1497	0.70	<1.00	6.90	2133	<10	71	7	102

Judging from the assay results, the deposit is characterized by concentration of Au, Bi and Cu.

Umkondo

The assay results of the sample from the deposit are shown as follows:

UMKONDO DEPOSIT

	Au (ppb)	Ag (ppm)	As (ppm)	Bi (ppm)	Cu (ppm)	F (ppm)	Zn (ppm)	Cr (ppm)	Ni (ppm)
①	740	<0.5	2	0.1	2751	92	57	<1	19

Judging from the assay results, the deposit is characterized by concentration of Au, and Cu.

The summary of mineralized zones are shown in TABLE 2-2-1.

TABLE 2-2-1 SUMMARY OF MINERALIZED ZONE

NAME OF ZONE	METAL MINERALIZED	STRIKE, DIP & WIDTH	COUNTRY ROCK	PRINCIPAL SULPHIDE MINERAL
①JEGEDE	Au?	E-W/85S, 1.2m	Mafic Granulite	Po, Py, Mc, Cp, Cv
②JUWERE	Au	N-S/?, ?	Gneissose granulite	Po, Py, Mc, Cp, Cv
③TURWI	Au?, Cr??	? /?, ?	Mafic Granulite	Po?, Py?
④PANGANAI	Au?, Cr??	? /?, ?	Gneissose granulite	Po?, Py?
⑤GORWGE	Au??	N30W～N80E/?, 0.1～1.5m	Gneissose granulite	Py, Cp, Mil*
⑥DINHIRO	Au?, Cu, Cr?	N50E/75NW, 0.3～1.5m	Iron Formation	Po,
⑦HOVEE	Au, Cu, Zn	N40E/?, 1.5～3.5m	Mafic Granulite	Po, Py, Mc, Cp, Cv
⑧MUCHACHA	Au, Cu, Zn	N80E/?, ?	Mafic Granulite?	Po, Py, Mc, Cp, Cv
⑨FUMURE	Au?, Cr?	? /?, ?	Mafic Granulite?	?
⑩CHIWANZA	Cr?	? /?, ?	Gneissose granulite?	?
⑪GWAKWA	Au?, Cr?	? /?, ?	Felsic Granulite?	?

* : millerite(NiS)

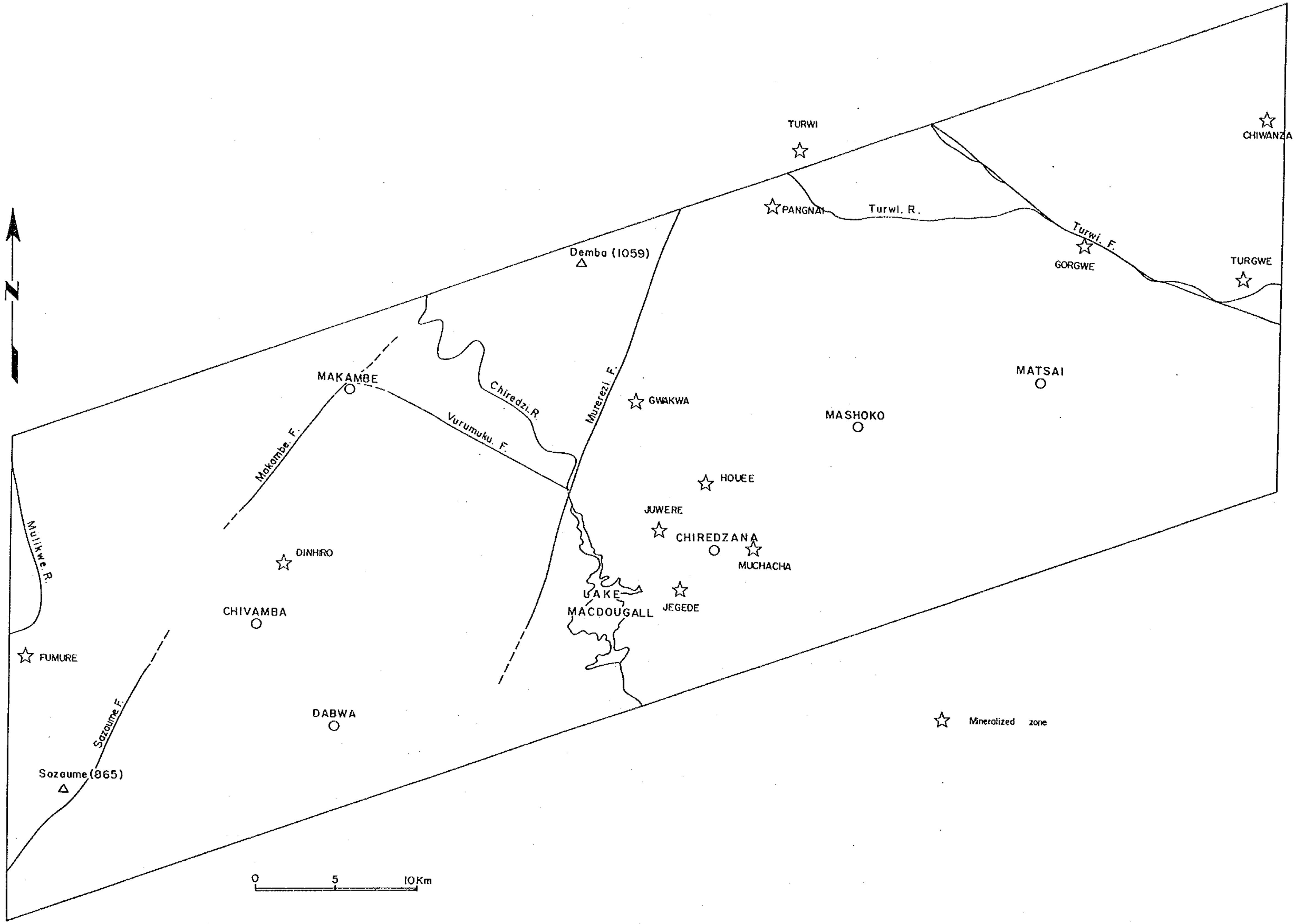


FIG. 2-2-6 Locality Map of Mineralized Zone

CHAPTER 3 GEOCHEMICAL SURVEY

3-1 SURVEY METHOD

(1) Sample Collection

In the geochemical exploration using stream sediments, samples were collected checking sample collecting points, which were established previously so as to cover the entire survey area, on topographical maps. In a survey area of 2,300 km^2, 2,355 stream sediments and 150 panned stream sediments samples were collected. Sample collecting places were on the banks of streams, the sandbanks in streams or underneath rocks, etc., and a sample of about 50g of -80 mesh size was collected in each place.

(2) Preparation of Sample and Detection Limit of Analysis

The samples were dried at the survey base. About a quantity of 20g was separated from each sample for analysis, and after preparing sample lists, samples for analysis were shipped to Iijima Laboratory, Akita, Japan.

Analytical detection limits were as follows;

Au	1 ppb
Ag	0.5 ppm
As	1 ppm
Bi	0.5 ppm
Cu	1 ppm
F	20 ppm
Zn	1 ppm
Cr	1 ppm
Fe	0.01 %

As the frequency of appearance of value below the detection limit was high for Au, As and Bi, statistical treatment was carried out by assuming the values below the detection limit as 0.5 ppb, 0.5 ppm and 0.05 ppm, respectively.

Single variate and multivariate analyses were carried out for the ten elements(Au, Ag, As, Bi, Cu, F, Zn, Cr, Fe) of 2,455 samples collected during this survey. In geochemical data analyses, it has been known empirically that the frequency distribution of the contents of minor elements contained in geochemical samples assumes log normal distribution (Lepeltier, 1969). Accordingly, it has been the general method of determining anomalous values to pay attention to the deviation (anomalous population) from the log normal distribution (background population) shown by the major part of a certain indicator. The population handled in geochemical exploration is usually the composite population of the background population and anomalous population, and it becomes important to divide these two in conformity with actual conditions. Apart from the case where the object composite population assumes log normal distribution, particular consideration is required. In the past, a method to determine background values and threshold values using a cumulative frequency distribution curve by Lepeltier (1969) and Sinclair (1976) has been used as a method to solve this problem.

Since most of indicators in this survey show log normal distribution, background and threshold values were determined on the basis of geometric mean and geometric standard deviation. The calculation was made on each geological units as possible as one can. The geological units were divided into six categories:

Dolerite	:	Rock code 1
Iron formation	:	Rock code 2
Gneissose granite	:	Rock code 6

Since these units have very limited distribution, collection of typical stream sediments originated from them is not expected. Statistical data of all geological units were applied to them.

Mafic granulite	:	Rock code 3
Felsic granulite	:	Rock code 4
Gneissose granulite	:	Rock code 5

3-2 SURVEY RESULTS

(1) Background Geology and Indicator Content

The contents of indicators in the stream sediments depend upon the geological conditions and the degrees of mineralization and alteration of the background area from which the sediments came from. Accordingly, geochemical characteristics for respective geological units are shown in TABLE 2-3-1. However, as the number of samples included in rock code 2 is extremely small, data of all geological units were applied. According to this table, geochemical characteristics on each element are summarized as follows:

Au : Geometric mean(GM) of all geological units is 0.74 ppb but rock code 5 has the largest value of 0.78 ppb. On the other hand, the smallest GM is 0.55 ppb of rock code 6. A comparison on the content of indicator between the area and other area based on data by Flanagan(1976) and Vinogradov(1962) was made. Au content in the area can be pointed out to be rather low. The maximum value in the area is 1,496 ppb.

Ag : GM of all geological units is 0.52 ppm but rock code 6 has the largest value of 0.72 ppm. On the other hand, the smallest GM is 0.41 ppm of rock code 4. A comparison on content of the indicator between the area and other areas based on data by Flanagan(1976) and Vinogradov(1962) was made. Ag content in the area rather high, with a maximum value of 231.1 ppm.

As : Since approximately 95 % of data indicated content below its detection limit, it is difficult to clarify its geochemical character in the area.
GM of all geological units is 0.54 ppm but rock code 3 has the largest value of 0.51 ppm. On the other hand, the smallest GM is 0.51 ppm of rock code 6. A comparison

TABLE 2-3-1 Statistical Parameter of Indicators(Stream Sediments)

21MB-GC1

ROCK NAME & CODE	NO. OF SAMPLE	GEOMETRIC MEAN (PPM) Au(PPB)	Ag(PPM)	As(PPM)	Bi(PPM)	Cu(PPM)	F(PPM)	Zn(PPM)	Cr(PPM)	Ni(PPM)	Fe(%)
ALL GEOLOGICAL UNIT	2,305	0.74	0.52	0.54	0.05	11.74	54.25	51.08	30.90	30.08	3.08
DOLERITE 1	33	0.70	0.63	0.52	0.05	19.08	66.88	55.25	36.07	32.26	3.65
IRON FORMATION 2	4	0.71	1.40	0.50	0.05	14.88	35.46	94.87	67.40	47.84	4.43
MAFIC GRANULITE 3	246	0.77	0.57	0.64	0.06	16.36	68.61	62.55	48.09	42.40	3.87
FELSIC GRANULITE 4	724	0.69	0.41	0.53	0.05	10.37	56.47	50.50	30.52	28.55	2.85
GNEISSOSE GRANULITE 5	1,249	0.78	0.58	0.54	0.05	11.89	45.37	50.35	28.18	20.98	3.14
GNEISSOSE GRANITE 6	49	0.55	0.72	0.51	0.05	8.22	93.07	29.79	38.86	31.90	1.65
PANNED SAMPLES	150	0.92	0.47	1.05	0.07	10.69	64.86	145.88	11.77	38.46	9.42

ROCK NAME & CODE	THRESHOLD (PPM) Au(PPB)	Ag(PPM)	As(PPM)	Bi(PPM)	Cu(PPM)	F(PPM)	Zn(PPM)	Cr(PPM)	Ni(PPM)	Fe(%)
ALL GEOLOGICAL UNIT	3.88 8.90	3.28 8.24	1.13 1.63	0.08 0.11	74.10 186.10	393 1057	223 466	324 1047	151 338	14.70 32.10
DOLERITE 1	3.88 8.90	3.28 8.24	1.13 1.63	0.08 0.11	74.10 186.10	393 1057	223 466	324 1047	151 338	14.70 32.10
IRON FORMATION 2	3.88 8.90	3.28 8.24	1.13 1.63	0.08 0.11	74.10 186.10	393 1057	223 466	324 1047	151 338	14.70 32.10
MAFIC GRANULITE 3	4.16 9.80	4.09 10.93	2.38 4.60	0.10 0.13	97.20 237.00	419 9036	230 442	549 1857	200 435	17.80 38.10
FELSIC GRANULITE 4	2.71 5.36	1.96 4.29	1.03 1.42	0.09 0.11	70.10 182.20	411 1308	229 487	294 913	141 314	14.20 31.60
GNEISSOSE GRANULITE 5	4.57 11.03	3.95 10.47	1.03 1.47	0.09 0.12	74.00 184.50	393 1057	223 466	324 1047	151 338	14.70 32.10
GNEISSOSE GRANITE 6	4.57 11.03	3.95 10.47	1.03 1.47	0.09 0.12	74.19 184.10	393 1057	223 466	324 1047	151 338	14.70 32.10
PANNED SAMPLES	11.63 41.38	3.03 7.71	5.39 12.20	0.21 0.36	54.80 124.10	319 708	511 955	196 796	177 381	40.40 83.60

ROCK NAME & CODE	MINIMUM VALUE (PPM) Au(PPB)	Ag(PPM)	As(PPM)	Bi(PPM)	Cu(PPM)	F(PPM)	Zn(PPM)	Cr(PPM)	Ni(PPM)	Fe(%)
ALL GEOLOGICAL UNIT	0.5	0.25	0.5	0.05	0.5	8	0.5	0.5	0.5	0.16
DOLERITE 1	0.5	0.25	0.5	0.05	0.7	10	11.0	4.0	9.0	1.04
IRON FORMATION 2	0.5	1.40	0.5	0.05	6.0	10	37.0	59.0	31.0	2.20
MAFIC GRANULITE 3	0.5	0.25	0.5	0.05	0.5	8	2.0	0.5	1.0	0.33
FELSIC GRANULITE 4	0.5	0.25	0.5	0.05	0.5	10	0.5	0.5	0.5	0.21
GNEISSOSE GRANULITE 5	0.5	0.25	0.5	0.05	0.5	8	0.5	0.5	0.5	0.16
GNEISSOSE GRANITE 6	0.5	0.25	0.5	0.05	1.0	10	2.0	0.5	5.0	0.16
PANNED SAMPLES	0.5	0.25	0.5	0.05	1.0	10	19.0	0.5	4.0	0.97

ROCK NAME & CODE	MAXIMUM VALUE (PPM) Au(PPB)	Ag(PPM)	As(PPM)	Bi(PPM)	Cu(PPM)	F(PPM)	Zn(PPM)	Cr(PPM)	Ni(PPM)	Fe(%)
ALL GEOLOGICAL UNIT	694	231.0	34.0	5.00	202	527	1060	605	1612	38.72
DOLERITE 1	4	5.8	2.0	0.10	137	469	201	130	130	17.58
IRON FORMATION 2	2	1.4	0.5	0.05	34	527	713	136	57	7.91
MAFIC GRANULITE 3	206	22.4	14.0	0.50	177	494	467	605	389	24.65
FELSIC GRANULITE 4	62	8.8	16.0	0.80	202	478	1060	480	1612	21.56
GNEISSOSE GRANULITE 5	694	231.1	34.0	5.00	177	431	390	554	426	.72
GNEISSOSE GRANITE 6	2	6.3	1.0	0.10	26	336	89	126	94	6.72
PANNED SAMPLES	1510	35.0	7.0	0.90	66	287	597	176	312	37.00

319 : MEAN(m)+2 STANDARD DEVIATION(2δ)

708 : MEAN(m)+3 STANDARD DEVIATION(3δ)

		Au	Ag	As	Bi	Cu	F	Zn	Cr	Ni	Fe
MAFIC ROCK	AVERAGE	4.00	0.10	2.00	0.01	100	370	130	200	160	8.56
INTERMEDIATE ROCK	AVERAGE	-	0.07	2.40	0.01	35	500	72	50	55	5.85
GRANITE	AVERAGE	1.00	0.05	0.25	0.40	12	1,290	85	7	5	1.85
FELSIC ROCK	AVERAGE	4.50	0.05	1.50	0.01	20	800	6	25	8	2.70
MICA SCHIST	AVERAGE	-	0.30	-	-	30	-	70	70	50	4.90

- : NO DATA

on content of the indicator between the area and other area based on data by Flanagan(1976) and Vinogradov(1962) was made. Content in the area is fairly low, with maximum value of 34 ppm.

Bi : Since approximately 95 % of data indicated content below its detection limit, it is difficult to clarify its geochemical character in the area.
GM of all geological units is 0.05 ppm. There is no difference among the GM of elements. A comparison on content of the indicator between the area and other area based on data by Flanagan(1976) and Vinogradov(1962) was made. Content in the area is nearly the same. Maximum value in the area is 5 ppm.

Cu : GM of all geological units is 11.74 ppm but rock code 1 has the largest value of 19.68 ppm. On the other hand, the smallest GM is 8.22 ppm of rock code 6. A comparison on content of the indicator between the area and other areas based on data by Flanagan(1976) and Vinogradov(1962) was made. Cu content of rock code 6 in the area is nearly the same as granite, but a comparison of rock code 1(19.08) and mafic rock(100 ppm) shows the indicator to be fairly low in the area. The maximum value in the area is 202 ppm.

F : GM of all geological units is 54.25 ppm but rock code 6 has the largest value of 19.68 ppm. On the other hand, the smallest GM is 49.37 ppm of rock code 5. A comparison on content of the indicator between the area and other areas based on data by Flanagan(1976) and Vinogradov(1962) was made. F content in the area is fairly low, with maximum value of 527 ppm.

Zn : GM of all geological units is 51.08 ppm but rock code 3 has the largest value of 62.55 ppm. On the other hand, the smallest GM is 29.79 ppm of rock code 6. A comparison on content of the indicator between the area and other areas based on data by Flanagan(1976) and Vinogradov(1962) made clear that Zn content in the area is normal. The maximum value in the area is 1,060 ppm.

Cr : GM of all geological units is 30.90 ppm but rock code 3 has the largest value of 48.09 ppm. On the other hand, the smallest GM is 28.18 ppm of rock code 5. A comparison on content of the indicator between the area and other areas based on data by Flanagan(1976) and Vinogradov(1962) made clear that Cr content in the area is almost same for each rock type. However, the indicator's values fluctuate greatly for rock types according to Flanagan's data . The maximum value in the area is 605 ppm.

Ni : Ni has almost same characteristics with that of Cr. GM of all geological units is 30.08 ppm but rock code 3 has the largest value of 42.40 ppm. On the other hand, the smallest GM is 28.98 ppm of rock code 5. A comparison on content of the indicator between the area and other area based on data by Flanagan(1976) and Vinogradov(1962) made clear that Ni content in the area is almost the same for each rock type. However, values of Flanagan's data fluctuate greatly for various rock types. The maximum value in the area is 1,612 ppm.

Fe : GM of all geological units is 3.08 % but rock code 3 has the largest value of 3.87 %. On the other hand, the smallest GM is 1.88 % of rock code 5. A comparison on content of the indicator between the area and other areas based on data by Flanagan(1976) and Vinogradov(1962) made clear that Fe content in the area is normal. The maximum value in the area is 38.72 %.

The pattern of cumulative frequency curve is very effective in evaluating the geochemical characteristics on each indicator in the target area. Especially, it is important whether the curve shows positive skewness or negative skewness. The positive skewness is essential for the delineation of promising mineralized area. The principal positive skewness detected in the area on all geological units is summarized as follows:

Au : Au shows a kind of positive skewness as shown in FIG.2-3-1. Geochemical values consist of three populations, frequency of each population is 74 %, 25.5 % and 0.5 %. The threshold value includes the upper 2 % of the population.

Ag : Ag also shows a kind of positive skewness as shown in FIG.2-3-1. Geochemical values consist of three populations as well as Au, frequency of each population is 56 %, 43.4 % and 0.6 %. The threshold value includes nearly the upper 2 % of the population.

As and Bi also show positive skewness.

No other indicators(Cu, F, Cr, Ni, Fe) show positive skewness, but instead show negative skewness.

Cumulative frequency curves of panned samples(FIG.2-3-2) show same configuration as stream sediments for the corresponding indicator.

(2) Determination of Threshold Values

Threshold values were determined on the basis of statistical calculation. Determination of threshold is as follows:

Threshold(1) = GM(m) + geometric standard deviation(2δ)

Threshold(2) = GM(m) + geometric standard deviation(3δ)

Attributions of geochemical indicators are shown in TABLE 2-3-1. Threshold values are summarized for each geological unit as follows:

Au : The highest value of threshold(1)(hereinafter threshold) was obtained in rock code 5(4.57 ppb). The lowest value is in rock code 4(2.71 ppb).

Ag : The highest value of threshold was obtained in rock code 3(4.09 ppm). The lowest value is in rock code 4(1.96 ppm).

As, Bi, and Zn : No significant difference of threshold were obtained for each indicator.

Cu : The highest value of threshold was obtained in rock code 3(97.2 ppm). Other geological units show nearly the same values.

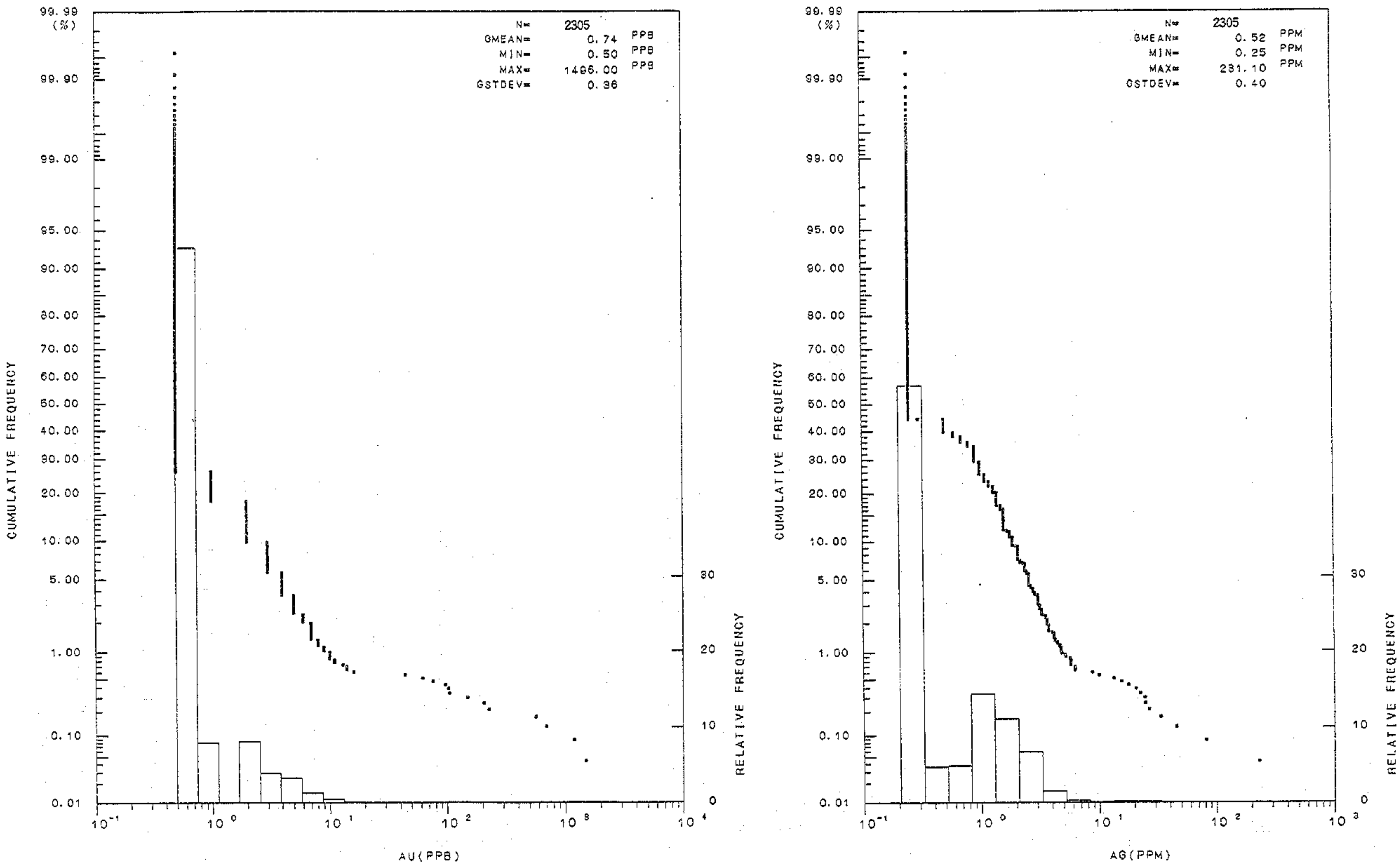


FIG. 2-3-1 Histogram and Cumulative Frequency Curve(Stream Sediments:Au, Ag)

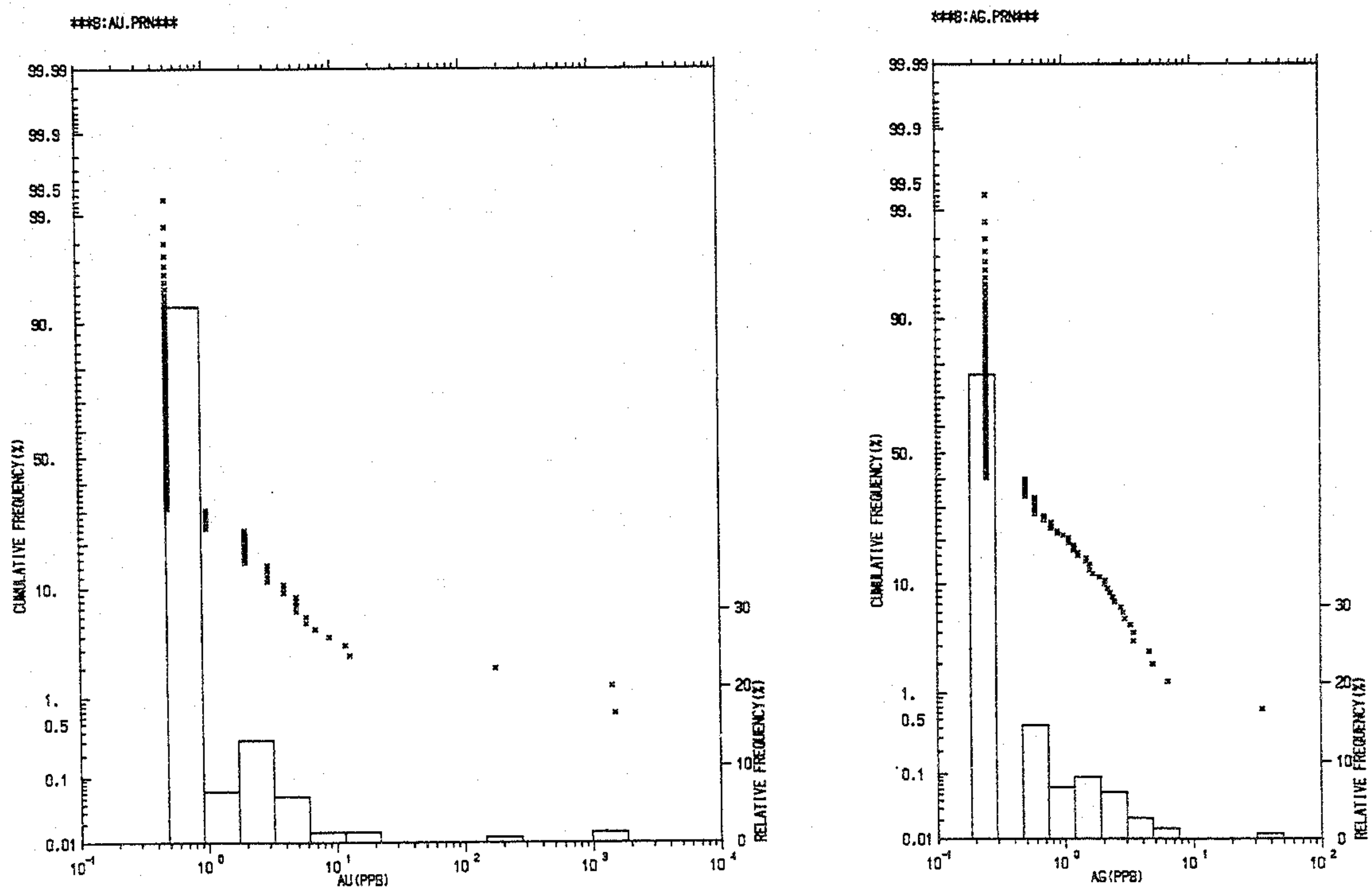


FIG. 2-3-2 Histogram and Cumulative Frequency Curve(Panned Samples:Au, Ag)

Cr : The highest value of threshold was obtained in rock code 3(549 ppm). Other geological units show nearly the same values.

Ni : The highest value of threshold was obtained in rock code 3(200 ppm). Other geological units show nearly the same values.

Fe : The highest value of threshold was obtained in rock code 3(17.8 %). Other geological units show nearly the same values.

We can see a general tendency where rock code 3 has more maximum threshold values.

(3) Correlation Coefficient between Indicators

The correlation coefficients between indicators on a logarithmic base were calculated for the all geological units. In the geological units, correlation coefficients between respective indicators were small, suggesting that the origins of individual indicators are different from each other.

Results of interpretation are summarized below:

All geological units : Cu-Ni, Cu-Fe, F-Ni, Cr-Ni,and Ni-F have correlation in medium degree. Only Zn-Fe has strong correlation.

Rock code 3 : Indicators of Ag-Cu, Cu-Ni, Cu-Fe, F-Ni, Zn-Fe, and Ni-Cr show correlation of medium degree.

Rock code 4 : Indicators of Cu-Cr, Cu-Fe, F-Ni, Zn-Fe, Cr-Ni, and Ni-Fe show correlation of medium degree. Only Zn-Fe has strong correlation.

Rock code 5 : Indicators of Cu-Fe, Zn-Fe, Cr-Ni, and Ni-Fe show correlation of medium degree. Only Zn-Fe has strong correlation.

Panned samples : Indicators of Ag-Cu, Ag-Zn, Cu-Zn, Cu-Fe, and Zn-Fe show correlation of medium degree. Only Zn-Fe has strong correlation.

(4) Principal Component Analysis

After determining the correlation coefficients between indicators, which cannot be extracted by single variable analyses, from multi-dimensional distribution characteristics, these were applied to the determination of character and the evaluation of geochemical anomalies. Results of analysis are shown in TABLE 2-3-2 and TABLE 2-3-3.

General characteristics of each geological unit are summarized below:

All geological units : This indicates general geochemical characteristics in the area. As shown in TABLE 2-3-2, the contribution ratio for the first principal component to all the principal components is about 30%, occupying less than one third of all. The total to the ratio of the fifth principal component amounts to 73 % approximately, so that a greater part of the fluctuation of all the components can be explained by them. However, the contribution ratio of each principal is generally small and not decisive. Each component drops gradually and does not

TABLE 2-3-2 Results of Principal Component Analysis (Stream Sediments:All Geological Units)

PRINCIPAL COMPONENT	EIGEN-VALUE	CONTRIBUTION RATIO	EIGENVECTOR										FACTOR LOADING										SCORE	
			Au	Ag	As	Bi	Cu	F	Zn	Cr	Ni	Fe	Au	Ag	As	Bi	Cu	F	Zn	Cr	Ni	Fe	MAXIMUM	MINIMUM
Z1	2.9107	0.2911 (0.2911)	0.05	0.12	0.15	0.11	0.42	0.32	0.41	0.26	0.45	0.48	0.08	0.20	0.25	0.18	0.72	0.55	0.70	0.44	0.77	0.81	5.531	-6.161
Z2	1.3215	0.1321 (0.4232)	-0.04	-0.68	0.01	-0.10	-0.30	0.33	0.03	0.51	0.18	-0.18	-0.05	-0.78	0.01	-0.12	-0.35	0.38	-0.03	0.58	0.21	-0.21	2.808	-4.461
Z3	1.1293	0.1130 (0.5362)	0.50	-0.16	0.57	0.59	-0.11	-0.20	0.01	-0.01	-0.03	-0.05	0.53	-0.17	0.60	0.63	-0.12	-0.21	0.01	-0.01	-0.04	-0.06	10.705	-1.851
Z4	0.9968	0.0996 (0.6358)	-0.61	-0.32	0.11	0.26	-0.20	-0.07	0.45	-0.31	-0.20	0.24	-0.61	-0.32	0.11	0.26	-0.20	-0.07	0.45	0.31	-0.20	0.24	4.938	-6.399
Z5	0.9077	0.0908 (0.7266)	0.60	-0.27	-0.48	-0.10	-0.11	0.09	0.37	-0.31	-0.15	0.21	0.57	-0.26	-0.46	-0.96	-0.11	0.09	0.36	-0.29	-0.14	0.20	5.537	-4.834
Z6	0.8795	0.0880 (0.8146)	-0.12	0.05	-0.60	0.74	0.08	0.12	-0.16	0.09	0.09	-0.14	-0.11	0.05	-0.56	0.69	0.08	0.11	-0.15	0.09	0.09	-0.13	12.627	-7.499

change markedly.
Factor loading is composed of correlation coefficients between principal components and variables (indicator contents). For the first principal component, Cu, Zn, Ni, and Fe show a high value of 0.70-0.81. Therefore, the first principal component is characterized by high correlation with these indicators.
The second principal component is characterized by strong negative correlation (-0.78) with Ag and correlation (0.58) with Cr.
The third principal component has the medium correlation with Au, As, and Bi.
The fourth principal component has a medium negative correlation with Au and medium correlation with Zn. However, geochemical characteristics are not so clear.
The fifth principal component has a medium correlation with Au, and negative correlation with As.
Histogram and cumulative frequency curve of the principal component score is shown in FIG.2-3-3.

Panned samples : As shown in TABLE 2-3-3, the contribution ratio for the first principal component to all the principal components is about 29%, occupying less than one third of all. The total to the ratio of the fifth principal component amounts to 81 % approximately, so that a greater part of the fluctuation of all the components can be explained by them. However, the contribution ratio of each principal is generally small and not decisive. Each component drops gradually and does not change markedly, as is the case with other indicators.
For the first principal component, Ag and Ni show a medium value(0.40-0.65) and a strong correlation(0.82-0.89) with Cu, Zn, and Fe.
Therefore, the first principal component is characterized by a high correlation with these indicators.
The second principal component is characterized by a strong correlation (0.75-0.77) with F and Cr, and medium correlation (0.66) with Ni.
The third principal component has a medium correlation(0.55-0.71) with As, and Bi.
The fourth principal component is characterized by a medium correlation (0.46) with As and strong correlation(0.83) with Au.
The fifth principal component has a medium correlation with Bi, and Cr,but dose not show any significant geochemical characteristics.
Histogram and cumulative frequency curve of the principal component score is shown in FIG.2-3-4.

(5) Evaluation of the Anomalous Zones

Besides the Au anomalous zones and Ag anomalous zones, concentrations of As anomalous values and Bi anomalous values are also found. Except for these, the

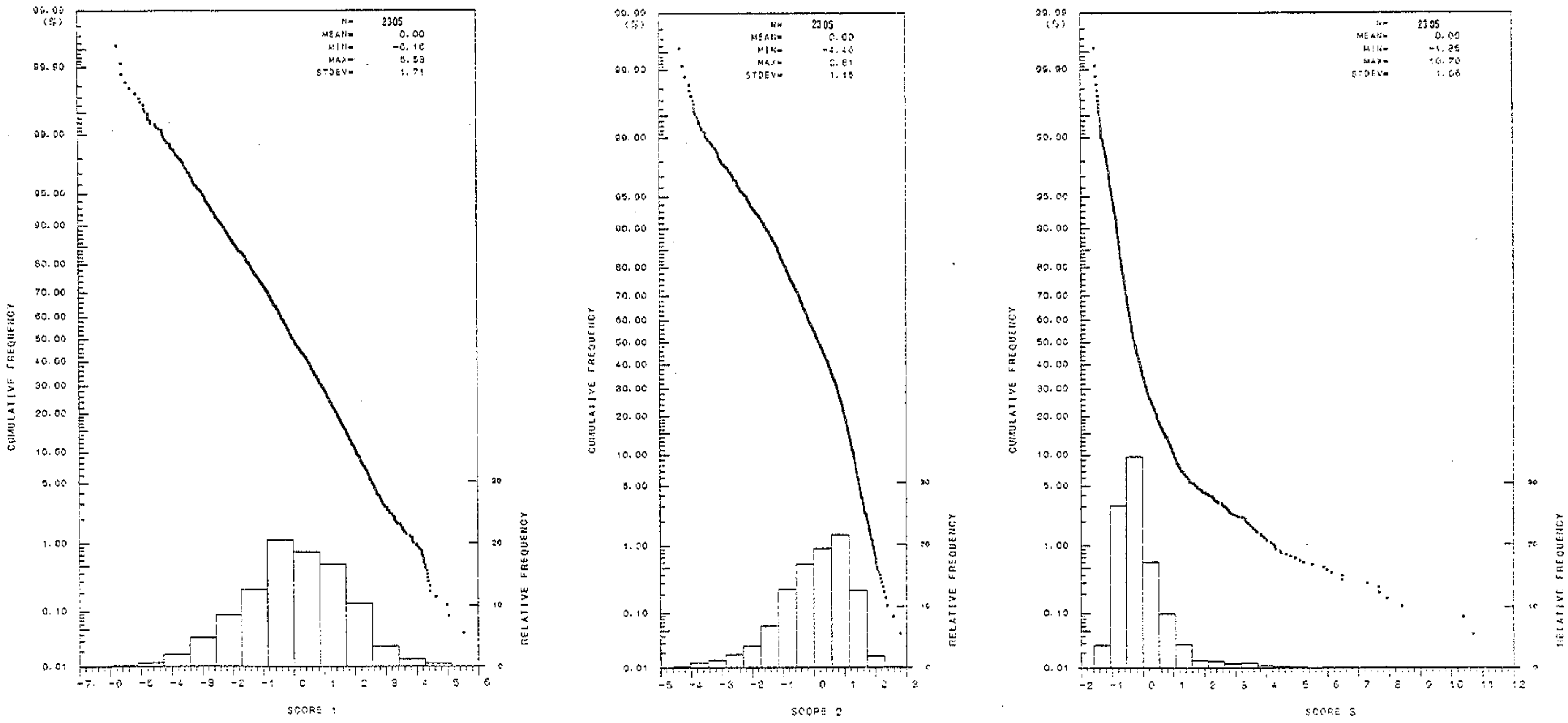


FIG. 2-3-3 Histogram and Cumulative Frequency Curve
(Stream Sediments:PCA 1st～3rd PCA Score)

TABLE 2-3-3 Results of Principal Component Analysis(Panned Samples)

PRINCIPAL	EIGEN-	CONTRIBUTION	EIGENVECTOR										FACTOR LOADING										SCORE	
COMPONENT	VALUE	RATIO	Au	Ag	As	Bi	Cu	F	Zn	Cr	Ni	Fe	Au	Ag	As	Bi	Cu	F	Zn	Cr	Ni	Fe	MAXIMUM	MINIMUM
Z1	2.954	0.295	0.09	0.38	0.13	0.02	0.48	0.13	0.52	-0.07	0.24	0.51	0.16	0.65	0.22	0.04	0.82	0.22	0.89	-0.12	0.40	0.88	4.622	-5.021
Z2	1.853	0.185	-0.15	-0.23	-0.12	-0.21	-0.10	0.57	0.01	0.55	0.49	0.03	-0.20	-0.32	-0.17	-0.29	-0.14	0.77	0.01	0.75	0.66	0.04	3.009	-3.777
Z3	1.278	0.128	0.02	-0.37	0.49	0.63	-0.28	-0.14	0.17	0.01	0.30	0.11	0.02	-0.42	0.55	0.71	-0.32	-0.16	0.19	0.02	0.34	0.13	3.409	-2.055
Z4	1.136	0.114	0.78	0.06	0.43	-0.30	0.05	0.01	-0.15	0.10	0.15	-0.23	0.83	0.06	0.46	-0.32	0.05	0.01	-0.16	0.11	0.16	-0.24	5.314	-2.614
Z5	0.861	0.086	0.31	0.24	-0.50	0.46	0.11	-0.31	-0.00	0.50	0.11	-0.13	0.29	0.22	-0.46	0.43	0.10	-0.29	-0.00	0.47	0.10	-0.12	2.257	-2.290

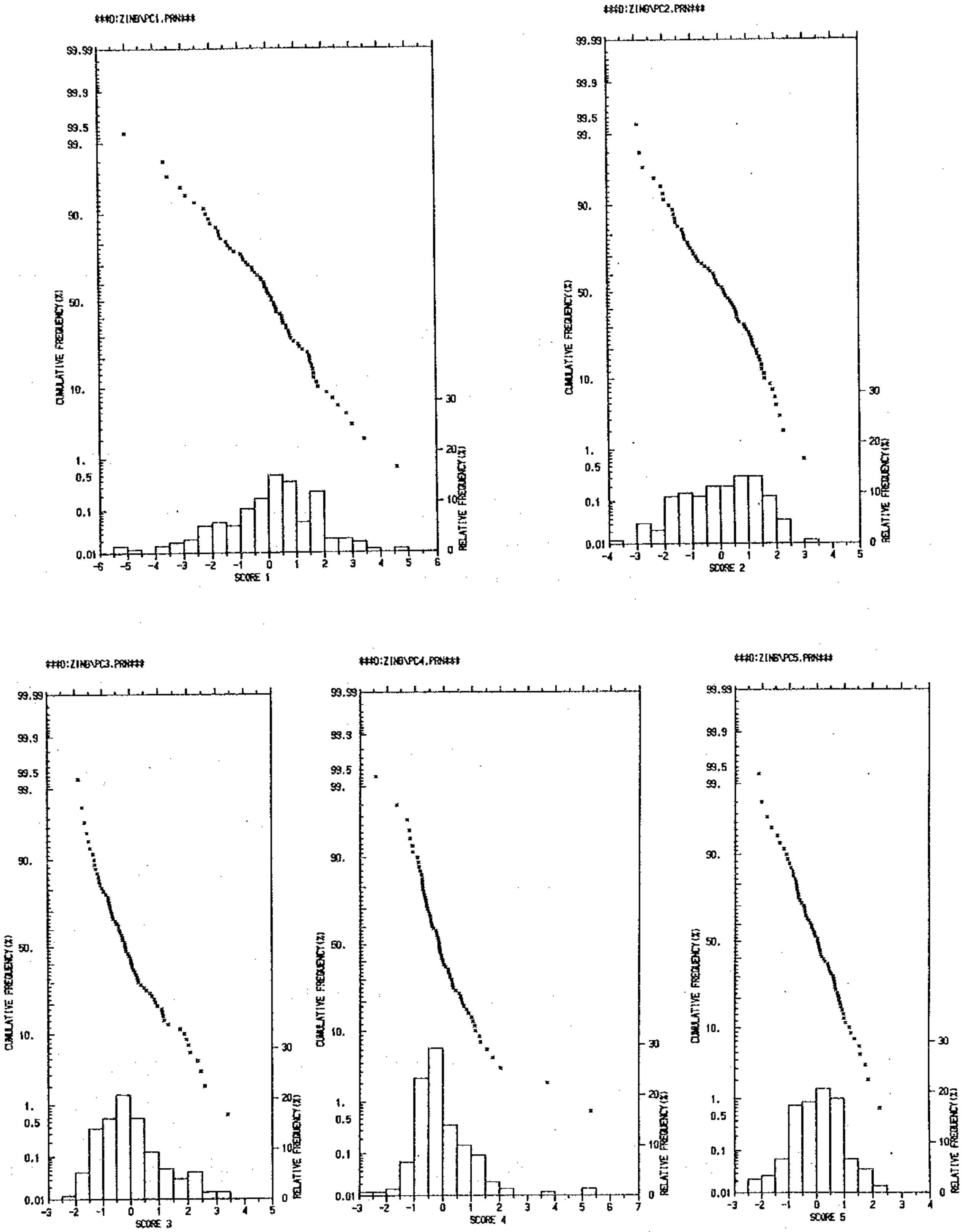


FIG. 2-3-4 Histogram and Cumulative Frequency Curve
(Panned Samples:PCA 1st~3rd PCA Score)

anomalous zones in the survey area consist of a single element found only sporadically.

The general relationships between Au or Ag anomalous zones and anomalous zones of other indicators are shown below:

Au : Thirteen Au anomalous zones as follows were found, as shown in TABLE 2-3-4. The geochemical characteristics of these anomalous zones can be summarized as follows:

I_{Au} : Two Zn anomalous values and four anomalous values in the fourth principal component score in rock code 4 (highly related to Au-As, the same shall apply hereafter), and two anomalous values in the fourth principal component score for the panned samples (Au) were found in this anomalous zone. Consequently, it can be expected that mineralization of Au accompanied with As and sometimes also with Zn is occurring in this anomalous zone.

II_{Au}: Only two Zn anomalous values and one Fe anomalous value were found in this zone.

III_{Au}:Two As anomalous values, six Bi anomalous values and one Zn anomalous value were found. Also two anomalous values in the third principal component score (Zn-Fe) and one anomalous value in the fifth principal component score (Au-As-Bi) in rock code 3, one anomalous value in the fourth principal component score (Au-As) in rock code 4, and two anomalous values in the third principal component score (Au-As-Bi) and one anomalous value in the fourth principal component score (Au-As) in rock code 5 were found. It should also be noted for future reference that one anomalous value in the first principal component score (As-Bi-Cu-F-Zn-Ni-Fe) was found in rock code 1.

IV_{Au}:Two Bi anomalous values and four anomalous values in the fourth principal component score in rock code 4 (Au-As) were found. Also one anomalous value for the panned samples (As-Bi) and two anomalous values in the fourth principal component score (Au) were found in this anomalous zone.

V_{Au}: One Ag anomalous value, three Bi anomalous values, one Cu anomalous value, one Zn anomalous value and one Fe anomalous value were found. In rock code 3, one anomalous value was found in the third principal component score (Zn-Fe). Gwakwa mineralized zone is located near to this anomalous zone.

VI_{Au}:This zone is related most strongly to the results of analysis for elements and principal components. Two Ag anomalous values, two As anomalous values, two Bi anomalous values, one Cu anomalous value and two F anomalous values were found. In rock code 4, eight anomalous values in the second principal component score (Au-Ag), two anomalous values in the third principal component score (As-Bi) and five anomalous values in the fourth principal component score (Au-As) were found. In rock code 5, one anomalous value was found in the third principal component score (Au-As-Bi). For

TABLE 2-3-4 Evaluation of Anomalous Zones

NAME OF ZONE ANOMALY	DIMENSION	NO. OF ANOMALOUS VALUE	STREAM SEDIMENTS																															MINERALIZED	PANKED SAMPLES												"INDEX OF GEOCHEMICAL ANOMALY"	ORDER OF ANOMALY"
			INDICATORS									PRINCIPAL COMPONENT ANALYSIS																							INDICATORS										P. C. A.			
												ROCK CODE 3					ROCK CODE 4					ROCK CODE 5					ALL GEOLOGICAL UNIT																		
	km km		• Ag	• As	• Bi	Cu	F	Zn	Cr	Ni	Fe	Z1	• Z2	Z3	Z4	• Z5	Z1	• Z2	• Z3	• Z4	Z5	Z1	• Z2	• Z3	• Z4	Z5	Z1	• Z2	• Z3	Z4	Z5	ZONE	• Au	• Ag	• As	• Bi	Cu	F	Zn	Cr	Ni	Fe	Z1	• Z4		
I Au	13×5	** 19	-	1	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	1	-	-	-	-	-	-	-	—	-	-	-	-	-	-	-	-	-	-	-	2	0.71	6
II Au	5×3	** 3	-	-	-	-	-	2	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	—	-	-	-	-	-	-	-	-	-	-	-	-	0.40	12
III Au	11×9	** 12	-	2	6	-	-	1	-	1	2	-	-	2	-	1	-	-	-	1	-	-	-	2	1	-	1	-	1	-	-	—	-	-	-	-	-	-	-	-	-	-	-	-	0.36	13
IV Au	4×8	** 6	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	—	-	-	1	1	-	-	-	-	-	-	-	2	0.69	7
V Au	7×2	** 6	1	-	3	1	-	1	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	1.14	2
VI Au	16×5	** 22	2	2	2	1	2	-	-	-	-	-	-	-	-	-	-	8	2	5	-	-	-	1	-	-	-	-	-	-	-	JUWERE	2	2	-	-	1	-	1	-	-	-	3	1	0.79	5
VII Au	3×5	** 5	-	2	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1	-	-	-	-	-	-	—	-	-	-	-	-	-	-	-	-	-	-	-	1.07	3
VIII Au	4×3	** 7	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	-	-	-	-	-	-	—	-	-	-	-	-	-	-	-	-	-	-	-	1.58	1
IX Au	8×4	** 6	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	-	-	1	-	-	-	—	-	-	-	-	-	-	-	-	-	-	-	-	0.59	8
X Au	6×4	** 4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	2	-	-	-	-	-	-	—	-	-	-	-	-	-	-	-	-	-	-	-	0.54	9
XI Au	7×4	** 7	1	3	5	-	-	-	-	-	-	2	-	-	-	1	1	1	-	1	-	-	-	2	-	-	-	-	-	-	-	—	-	-	-	1	-	-	-	-	-	-	-	-	1.04	4
XII Au	6×10	** 7	1	2	5	1	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3	-	-	-	-	-	-	FUMURE	-	-	-	1	-	-	-	-	-	-	-	-	0.45	11
XIII Au	5×5	** 4	2	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	—	-	-	-	-	-	-	-	-	-	-	-	-	0.48	10

**(A) : This(A) is counted as 2 point for the calculation of "INDEX OF GEOCHEMICAL ANOMALY"

* (B) : indicator(B) and score(B) possibly indicate Au-mineralization. These are counted as 1 point for the calculation of "INDEX OF GEOCHEMICAL ANOMALY"

Calculation:

"INDEX OF GEOCHEMICAL ANOMALY"= {(sum of A) + (sum of B)} / extention of anomalous zone(km^2)

Z1, Z2, ······ : PRINCIPAL COMPONENT

P. C. A. : PRINCIPAL COMPONENT ANALYSIS

1, 2, 3······ : NUMBERS OF ANOMALOUS SITES INCLUDED panned samples, two anomalous values for Au and Ag, one anomalous value for Cu and Zn, three anomalous values for the first principal component score (Ag-Cu-Zn-Fe) and anomalous values in the fourth principal component score were found. Juwere mineralized zone belongs to this type of anomalous zone.

VII_{Au}:Two As anomalous values and one Bi and Zn anomalous value were found in the zone. In rock code 5, two anomalous values in the third principal component score (Au-As-Bi) and one anomalous value in the fourth principal component score (Au).

$VIII_{Au}$:Two Bi anomalous values were found. In rock code 5, one anomalous value in the third principal component score (Au-As-Bi) and two anomalous values in the fourth principal component score (Au) were found.

IX_{Au}:One Ag anomalous value and one Bi anomalous value were found. In rock code 5, two anomalous values in the third principal component score (Au-As-Bi) and two anomalous values in the fourth principal component score (Au) were found. It should be noted for future reference that one anomalous value was also found in the second principal component score (Zn-Cu) in rock code 6.

X_{Au}: One Ag anomalous value was found. In rock code 5, one anomalous value in the second principal component score (Ag), one anomalous value in the third principal component score (Au-As-Bi) and two anomalous values in the fourth principal component score (Au) were found.

XI_{Au}:One Ag anomalous value, three As anomalous values and five Bi anomalous values were found. In rock code 3, two anomalous values in the first principal component score (Cu-F-Zn-Cr-Ni-Fe) and one anomalous value in the fifth principal component score (Au) were found. In rock code 4, one anomalous value in the first principal component score (Cu-F-Zn-Ni-Fe), one anomalous value in the second principal component score (Au-Ag) and one anomalous value in the fourth principal component score (Au-As) were found. In rock code 5, two anomalous values were found in the third principal component score (Au-As-Bi). For the panned samples, one Bi anomalous value was found.

XII_{Au}:One Ag anomalous value, two As anomalous values, five Bi anomalous values, one Cu anomalous value and three Ni anomalous values were found. In rock code 5, one anomalous value in the third principal component score (Au-As-Bi) and three anomalous values in the fourth principal component score (Au) were found. For the panned samples, one Bi anomalous value was found. Fumure mineralized zone belongs to this type of anomalous zone.

$XIII_{Au}$:Two Ag anomalous values, one As anomalous value and one F anomalous value were found. In rock code 5, one anomalous value was found in the third principal component score (Au-As-Bi).

Ag :Seven Ag anomalous zones were found. The degree of concentration of Ag anomalous zones is not so conspicuous like that of Au.

Except for Au , the content of other elements was very low in the mineralized zones in the survey area, geochemical anomalous zones were found only sporadically in comparison with those for Au, and the correlation coefficients among indicators was rather weak; consequently, no promising anomalous zones were identified.

On the other hand, 13 Au anomalous zones were detected as a concentration of anomalous geochemical values.
On the basis of the following criteria, finally seven promising Au anomalous zones have been selected.

Criteria:

(1)Number(B) of Au anomalous value which is included in a anomalous zone counts 2 points as a score.

(2)Number(C) of anomalous values of elements(Ag, As, Bi) which are included in an anomalous zone counts 1 point as a score.

(3)Number(C) of anomalous values of principal component score which are geochemically correlated to Au mineralization counts 1 point as a score.

(4)Calculation of "Index of geochemical anomaly"

"Index of geochemical anomaly"= 〔(B)+(C)〕 / (A)

Where, (A) stands for dimension(km^2) of anomalous zone.

The selected calculation results of an "index of geochemical anomaly" are listed below:

ANOMALOUS ZONE	DIMENSION OF A. Z. (A)	SCORE COUNTED BY Au ANOMALY (B)	SCORE COUNTED BY OTHER A. (C)	" INDEX OF GEOCHEMICAL ANOMALY" ((B)+(C)) ／ (A)
① I Au ANOMALY	65 km^2	38	8	0.71
② IV Au ANOMALY	32 km^2	12	10	0.69
③ V Au ANOMALY	14 km^2	12	4	1.14
④ VI Au ANOMALY	90 km^2	44	27	0.79
⑤ VII Au ANOMALY	15 km^2	10	6	1.07
⑥ VIII Au ANOMALY	12 km^2	14	5	1.58
⑦ XI Au ANOMALY	28 km^2	14	15	1.04

A. Z. : ANOMALOUS ZONE　　A. : ANOMALY

Seven Au anomalous zones were selected.

Taking all related factors, especially mineralized zones included, into consideration, the seven anomalous zones were evaluated with priority.
The results are as follows:

ANOMALOUS ZONE	"INDEX OF GEOCHEMICAL ANOMALY" VALUE	PRIORITY
Ⅷ Au ANOMALY	"INDEX OF GEOCHEMICAL ANOMALY" 1.58	A
V Au ANOMALY	"INDEX OF GEOCHEMICAL ANOMALY" 1.14	B
Ⅵ Au ANOMALY	"INDEX OF GEOCHEMICAL ANOMALY" 0.79	B
Ⅶ Au ANOMALY	"INDEX OF GEOCHEMICAL ANOMALY" 1.07	B
X I Au ANOMALY	"INDEX OF GEOCHEMICAL ANOMALY" 1.04	B
I Au ANOMALY	"INDEX OF GEOCHEMICAL ANOMALY" 0.71	C
Ⅳ Au ANOMALY	"INDEX OF GEOCHEMICAL ANOMALY" 0.69	C

Because of no definitive criterion for the discovery of mineralized zones, we calculated an "index of geochemical anomaly" as an expedient.

(6) Relation between Geochemical Anomalies and Mineralization

The mineralization in the area is not so promising judging from the assay results of samples from the mineralized zones. Detected promising mineralized zones are all related to Au mineralization.
The characteristics of the mineralized zones are shown as follows:

NAME M. Z.	MINERALIZATION	ANOMALOUS INDICATORS	GEOLOGY	G. C. ANOMALOUS ZONE(Au)
JEGEDE	Au?	Au-As-Cu-Zn?-Cr??	Mafic Granulite	
JUWERE	Au	Au-Bi-Cu-Cr??	Gneissose granulite	VI Au
TURWI	Au?, Cr??	Au?-Cr??	Mafic Granulite	
PANGANAI	Au?, Cr??	Au?-Cr??	Gneissose granulite	
GORWGE	Au??	Au?-F-Cr??	Gneissose granulite	
DINHIRO	Au?, Cu, Cr?	Au-Cu-Cr	Iron Formation	
HOVEE	Au, Cu, Zn	Au-Cu-Zn	Mafic Granulite	
MUCHACHA	Au, Cu, Zn	Au-As-Bi?-Cu-Zn-Ni?	Mafic Granulite?	
FUMURE	Au?, Cr?	Cr	Mafic Granulite?	X I Au
CHIWANZA	Au?, Cr?	Cr	Gneissose granulite?	
GWAKWA	Au?, Cr?	?	Felsic Granulite?	

G. C. : geochemical M. Z. : mineralized zone

Only Juwere and Fumere mineralized zone are included in the mineralized zones. Consequently, it can be concluded that rather week relationships between the mineralized zone and geochemical anomalous zones are envisaged.

On the other hand, characteristics of the geological anomalous zones are shown as follows: