NAME A.Z.	ANOMALOUS INDICATORS BY STREAM SEDIMENTS	ANOMALOUS INDICATORS BY P. C. SCORE	ANOMALOUS INDICATORS BY PANNED SAMPLES	MINERALIZED ZONE
I Au	As, Zn	Au-As		
IV Au	Bi	Au-As	As-Bi, Au	
V Au	Ag, Bi, Cu, Zn	Zn-Fe		
VI Au	Ag, As, Bi, Cu	Au-Ag, As-Bi, Au-As	Au, Ag, Cu, Zn Ag-Cu-Zn	Juwere
VII Au	As, Bi, Zn	Au-As-Bi, Au		
VIII Au	Bi	Au-As-Bi		
XI Au	Ag, As, Bi,	Au, Au-Ag, Au-As Au-As-Bi	Bi	Fumure

A. Z.: anomalous zones P. C.: principal component

As a result of the interpretation, the following mineralized zones have similar geochemical characteristics(a concentration of Au, Ag, As, Bi, etc.) to those of reef in Renco Deposit.

Jegede mineralized zone
Juwere mineralized zon
Muchacha mineralized zone

An investigation was carried out to delineate the relation between the mineralized zones and geochemical anomalies. Since only Juwere and Fumure mineralized zones are included within the geochemical anomalous zones, the relationship between mineralization and geochemical anomalies of stream sediments and panned samples is not so clear in general. It can be concluded that the above mentioned seven geochemical anomalous zones have rather similar geochemical characteristics to those of three mineralized zones(Jegede, Juwere, and Muchacha mineralized zones) on the basis of their analytical results, especially on the concentration of elements(such as Ag, As, Bi) which are accompanied with Au mineralization.

2-3 CONSIDERATIONS

The degree of concentration of indicators in the survey area depends not only on the geochemical characteristics of the rocks, which constitute the geological unit, but also on the overall geochemical characteristics of the area. When the content of indicators in the survey area was compared with world-wide data of Flanagan (previously mentioned) or those of Vinogradov (previously mentioned), the concentration level of indicators in the survey area may be evaluated objectively, and moreover, indirect mineralization information may be drawn from these data for the content of indicators. Taking geological units into consideration, elements can be classified into the following three groups:
(1) elements which have higher content in the survey area than in other areas, (2) indicators which have about same content compared with other areas, and (3) indicators which have lower content than in other areas.

(1) Ag: It could be seen that only the content of this element in the survey area

is higher than the figures shown by Flanagan (previously mentioned) and Vinogradov (previously mentioned). Consequently, it can be generally concluded from the results of geochemical exploration that the concentration level of this element may be fairly high. As mentioned below, however, the grade of Ag in samples collected in mineralized zones in the survey area was low, and this is not thought to be promising.

(2) Bi, Cr, Ni, Fe: For these indicators, although the content differed with geological units, the content in the survey area turned out to be about the same as in other areas.

(3) Au, As, Cu, F, Zn: For these elements, although the content differed with geological units, the content of indicators in the survey area was generally lower than in other areas. This may indicate that the concentration tendency of these indicators is weaker in the survey area than the world-wide average.

The cumulative frequency curve of indicators was taken into consideration to examine the relationship between the content of indicators and the mineralization process in the survey area. The possibility of mineralization of each indicator can be primarily judged by observing whether the curve shows positive skewness or negative skewness.

The curves for the following indicators show positive skewness:

Au, Ag, As, Bi

Since As and Bi are considered as the indicators of Au mineralization, it can be concluded that Au mineralization and Ag mineralization is possibly occurring in the survey area.

As mentioned above, however, the correspondence of Ag mineralization to the actual mineralized zones is not sufficient; consequently, it is considered that the possibility of Ag mineralization is less than that of Au mineralization.

The geochemical characteristics of mineralization in the survey area can be considered when the correlation between indicators is examined. In all geological units in the survey area (rock codes 1 to 6), the following correlation can be seen:

Cu-Fe, Zn-Fe, Cr-Ni

In addition, the following weaker correlation is frequently seen:

F-Ni, Ni-Fe

In particular, the correlation factor for Zn-Fe is high (0.70 or higher).

These results suggest that, if mineralization is considered, correlation indicators may have been produced in the same mineralization process. There may be another interpretation that the correlation is caused by the basic geochemical characteristics of these indicators.
It should be noted that either Au or Ag has little or no correlation with other elements. The characteristics of indicators can be understood by analyzing the results of principal component analysis, as described in the following:

Noting the principal component structure in the major geological units in the survey area (rock codes 3 to 5), the correlation with indicators such as

Cu-F-Zn-(Cr)-Ni-Fe

can be seen in the first principal component with very few exceptions, while the correlation with

Au-Bi, Au-As, Au-Ag-Bi and As-Bi

can be seen in the other principal components.
This suggests that the patterns of indicator concentration can be classified largely into two groups. It can be thought that the latter combination of indicators shows a part of the Au mineralization characteristics in the survey area.
In other words, it can be considered that the concentration process of the former indicators (Cu-F-Zn-(Cr)-Ni-Fe) probably differs from that of the latter indicators, and that Au mineralization is accompanied with mineralization of Bi, As, Ag, etc..

It can be concluded from the results of the above discussion that the following anomalous zones are promising.

I_{Au} anomalous zones
IV_{Au} anomalous zones
V_{Au} anomalous zones
VI_{Au} anomalous zones
VII_{Au} anomalous zones
VIII_{Au} anomalous zones
XI_{Au} anomalous zones

As a summary of this survey, a interpretation map of the survey results is shown in FIG. 2-3-5.

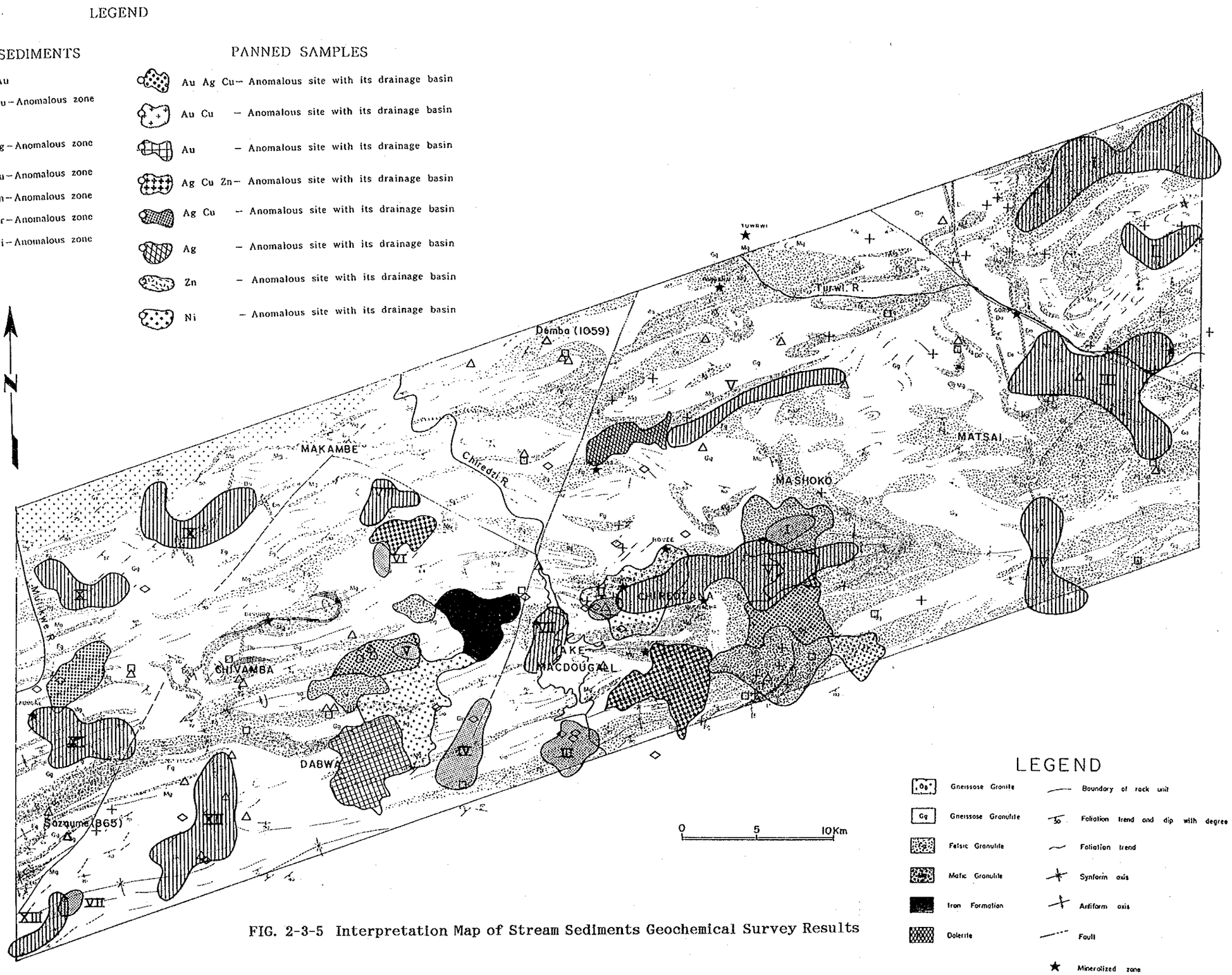

FIG. 2-3-5 Interpretation Map of Stream Sediments Geochemical Survey Results

CHAPTER 4 SEMI-DETAILED GEOLOGICAL SURVEY

4-1 ANGUS AREA

4-1-1 Geology

The present area positions at the eastern end of the surveyed area.

Geological units: The area mainly consists of dolerite, felsic granulite and gneissose granulite (including charnockite). As outcrops are limited to small size ones observed in parts of the marshes in the area, no continuous outcrop suitable for elucidating detailed geological structure exists. These geological units also appear as a rock body extending to an ENE-WSW system.

Gneissose granulite (including charnockite) is most extensively distributed and occupies about 60% of the area. It is normally grayish to pale brownish in color, is composed of middle to fine grains, dense and hard, and has the remarkable foliation of an ENE-WSW system. Inclusion of garnet is general. This is white to pale grayish in color on weathered surfaces, yet has high resistance to weathering, compared with other rocks.

Felsic granulite is observed in range north to south of the area, its distribution area occupies about 50%, it has a grayish color, and has a distribution extending to a NNE-SSW direction as well as gneissose granulite.

Dolerite shows the occurrence of dikes extending to the north and the south.

4-1-2 Geological Structure

In this area there is excellent foliation in an ENe-WSW system. A tectonic line running north to south in the area is postulated from Landsat images and aerial photographs.

4-1-3 Mineralization

A mineralized sign (mainly composed of pegmatite quartz & K-feldspar) was only observed in the distribution region of charnockite and felsic granulite at the center of the area.

No other mineralized signs worthy of remark exist.

In the first year survey, many anomalies from stream sediments and panned samples were detected in the area, but promising mineralized signs were not detected.

There is no field environment worth further surveying in the surveyed area because distribution of outcrops is scarce.

4-2 CHIREZANA AREA

4-2-1 Geology

This area is positioned at the southern side of the surveyed area.

Geological units constituting the area are mainly mafic granulite, felsic granulite, and gneissose granulite (including charnockite). The main outcrops are in the mountains of the northern area, and in an eastern area. These are hardly any outcrops from the center to the southern area because of soil cover. As the geological unit in the area, an ENE-WSW system exists as the main structure but S-N system structures prevail in the eastern area. Gneissose granulite (including charnockite) is most widely distributed and occupies about 60% of the area. It usually has a grayish to pale brownish color, middle to fine grains, dense and hard, and has the remarkable foliation of an ENE-WSW system, and in some cases includes garnet. Also it is distributed over the whole surveyed area.

Felsic granulite can be observed mainly in the north and east of the area and its distribution area occupies about 30%. It has a pale grayish color, and the foliation of an ENE-SSW system is similar to gneissose granulite.

Usually, a pale grayish color is seen, but on weathered surfaces it has a white to pale grayish color, it can be judged to have stronger resistance to weathering than other rocks.

Mafic granulite is also distributed, depending on the structures of an ENE-WSW system, but its foliation is weaker than those of other geological units. It has middle grains and is a massive rock. It forms a reddish soil due to weathering.

4-2-2 Geological Sructure

Also in the area, the geological structure in which the foliation of an ENE-WSW system prevails, is observed. As principal structural lines, the presence to two approximately parallel structural lines running along a NNE-SSW direction in the area, is predicted. As shown in FIG. 2-1-3, a slight dislocation therefrom (the sense of dislocation may be left-lateral and right-lateral) can be postulated to be applied to the geological units.

Other linear structures recognized with Landsat images and aerial photographs may be classified as lineament not accompanied by dislocation. From a microfolding structure recognized in the area, it can be understood that deformations differing in periods have mutually arisen repeatedly, and the structure was subjected to multi-tectonic movements.

4-2-2 Mineralization

Quartz vein/stockwork and pegmatite quartz & K-feldspar, other than in the Juwere mineralized zone, Jegede mineralized zone and Muchacha mineralized zone, were also observed. The summaries of each mineralized zone are as follows.

Juwere mineralized zone: This is a Juwere mineralized zone (1) positioned to the east of Lake Macdougall and the 2 km northwest of Matara School, and another

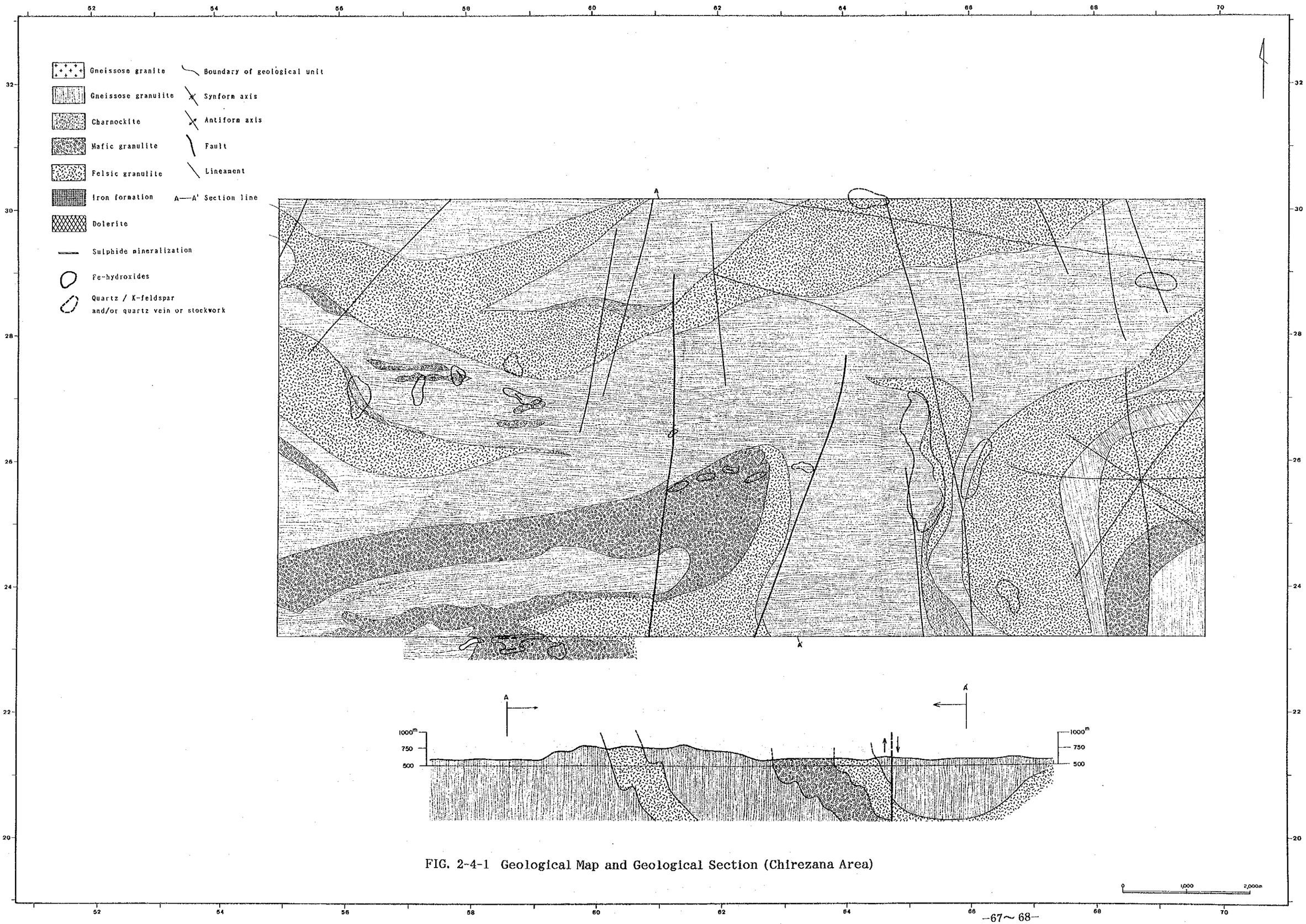

FIG. 2-4-1 Geological Map and Geological Section (Chirezana Area)

(11) positioned to the north about 1 km from Matara School. As country rocks, the former are thought to be mafic granulite, the latter to be Gneissose granulite and partly mafic granulite. The extent of the mineralized zones are at N 30 to W 40 across to the foliation of an ENE-WSW system, and the slopes are approximately perpendicular. Locally, there are foliated country rocks along the extent of the mineralized zones, and no remarkable oblique relation exists. The width of the mineralized zones can now be confirmed to be 5 m, but further extension can be expected. The length may be confirmed to be 20 to 30 m, but beyond that is covered with soil.

Microscopic observation shows that in ore minerals in the mineralized zone, sulphide minerals are composed of medium amounts of pyrite and slight amounts of pyrrhotite, chalcopyrite, covelline and marcasite. In many cases pyrrhotite had been transformed to an aggregate of pyrite and marcasite.

With regard to gangue mineral, microscopic observation of polished thin sections slight amounts of showed sericite, chlorite (?) and epidote (?), large amounts of quartz and medium amounts of plagioclase.

Analytical results of samples collected from the mineralized zone show that the content of metal elements, Au, Bi and Cu is characteristically high, compared with those in other mineralized zones.

Jegede mineralized zone: It is positioned to the east of Lake MaCdougall and 2.5 km south of Matara School. Two mineralized zones of an ENE-WSW system with space of about 200 m are recognized. There may be a high possibility of the presence of mineralized zones of the same type because many floats of Fe-hydroxides between these mineralized zones are recognized. The country rock of the mineralized zones is mafic granulite, the extent of which matches the foliation of an ENE-WSW system. The slope is approximately perpendicular, but in some sites north and south slopes exist. Fine grain sulphide minerals (pyrite and pyrrhotite) are observed along the foliation of country rocks. The width of the mineralized zone can now be confirmed to be 3 m, but further extension can be expected. The length can be confirmed to be 200 m but beyond that is covered with soil.

Microscopic observation shows that ore minerals in the zone are approimately similar to those in the Juwere mineralized zone described above. Sulphide minerals have medium to small amounts of pyrite, and very small amount of pyrrhotite, chalcopyrite, covelline and marcasite. Most covelline arises with peripheral replacement of chalcopyrite.

With regard to gangue minerals, microscopic results from polished thin sections show garnet, orthopyroxene and amphibole, large amounts of quartz, and sericite and chlorite (?) were also recognized.

Analytical results of samples collected from the mineralized zone show a characteristically high content of As compared with those in other mineralized zones.

Muchacha mineralized zone: Positioned to the east, about 2 km from Chirezana b.c. positioned at the central south of the surveyed areas. Some outcrops dotted in the mineralized zone run in the direction of N 80 E, but the direction becomes a WNW-ESEW system by binding the outcrops. The mineralized zone is observed over about 100 m and there is a high possibility of the presence of mineralized zones of the same type, because many floats of Fe-hydroxides can be observed at the surrounding of this mineralized zone. But in the field only a mineralized zone is recognized. The country rock of the mineralized zone is mafic granulite, the extent of which is observed to cross loosely to the foliation of an ENE-WSW system in the surveyed zone, but this is a phenomenon corresponding to local change in the foliation, and as a whole the extent is presumed to match the foliation. The slopes are approximately perpendicular, but in some parts north slopes exist. In the mineralized zone, fine grain sulphide minerals (pyrite and pyrrhotite) are recognized. The width of the mineralized zone can now be confirmed to be 7 m, but further extension can be expected. The length can be confirmed to be about 100 m, but beyond that is covered with reddish soil.

Microscopic observation of polished thin sections shows that ore minerals in the mineralized zone are similar to those in the Juwere mineralized zone and Jegede mineralized zone described above. Sulphide minerals are composed of pyrite, pyrrhotite, chalcopyrite, covelline, marcasite, etc. in small to very small amounts. A small amount of ilmenite is also observed.

The analytical results of samples collected from the mineralized zone show a characteristically high content of Zn, compared with those in other mineralized zones.

The others: The distributions of mineralized signs as shown in FIG.2-4-1, other than in the mineralized zones described above, could be confirmed. The zone which appears most ubiquitous, and has a wide distribution area, is Chamburukira area positioned to the east of the area. The recognized district is in the boundary between granulite and gneissose granulite.

On the first year survey, multiple geochemical anomalies in stream sediment and panned samples were recorded and by inspection the mineralized zone described above could be determined.

These mineralized zones can be judged to be mutually similar by considering the very occurrence of the mineralized zones, kinds of sulphide ores as constituents and the combination of concentrated elements.

Three mineralized zones described above and many mineralized signs in the

zone were recognized, but the mineralized sign distributions, except for Chamburukira zone, are scattered and in addition their areas are narrow.

Consequently, as objective zones for geochemical soil survey,

(1) Juwere mineralized zone,

(2) Jegede mineralized zone,

(3) Muchacha mineralized zone and

(4) Chamburukira zone

were selected.

4-3 MATSAI AREA

4-3-1 Geology

Soils in the area consist mainly of mafic granulite, felsic granulite and gneissose granulite (including charnockite). The distribution form of mafic granulite appears to be governed strongly by the foliation of an ENE-WSW system. On the other hand, felsic granulite is not governed by the foliation direction in the center and north of the area, considering the distribution form(FIG.2-4-2).

Mafic granulite occupies about 10% of the area. It usually has a dark greenish color and is a massive composed of medium grains. Foliation growth is weak. Microscopic results show clinopyroxene in the main, and also an unknown opaque mineral of an unknown mineral name in general. The tectonic grade is weak at 1 (framed porphyroblastic texture).

Felsic granulite was mainly observed from the center to the east of the area, occupying about 30% as a distribution area, pale grayish in color, and the extent of geological units are weak as described above, tectonic grade is 0 (isogranular texture), thus the resistance to tectonic movement is thought to be high.

Gneissose granulite (including charnockite) is distributed over the whole range of the area, it occupies about 60% as a distribution area, is brownish in color, and the growth of the foliation of an ENE-WSW system is remarkable. The tectonic grade in the geological unit is as high as 4, compared with lower tectonic grades in other geological units.

4-3-2 Geological Structure

Two structural lines of a N-S system, accompanied by dislocation, are recognized in the northeast of the area, and felsic granulite appears to be dislocated by the lines. only a lineament not accompanied by dislocation exists. A structural line parallel to the direction of mafic granulite is also recognized in the southwest of the area, but its degree of dislocation is not clear.

4-3-3 Mineralization

Floats of Fe-hydroxides, quartz vein/stockwork and pegmatite quartz &

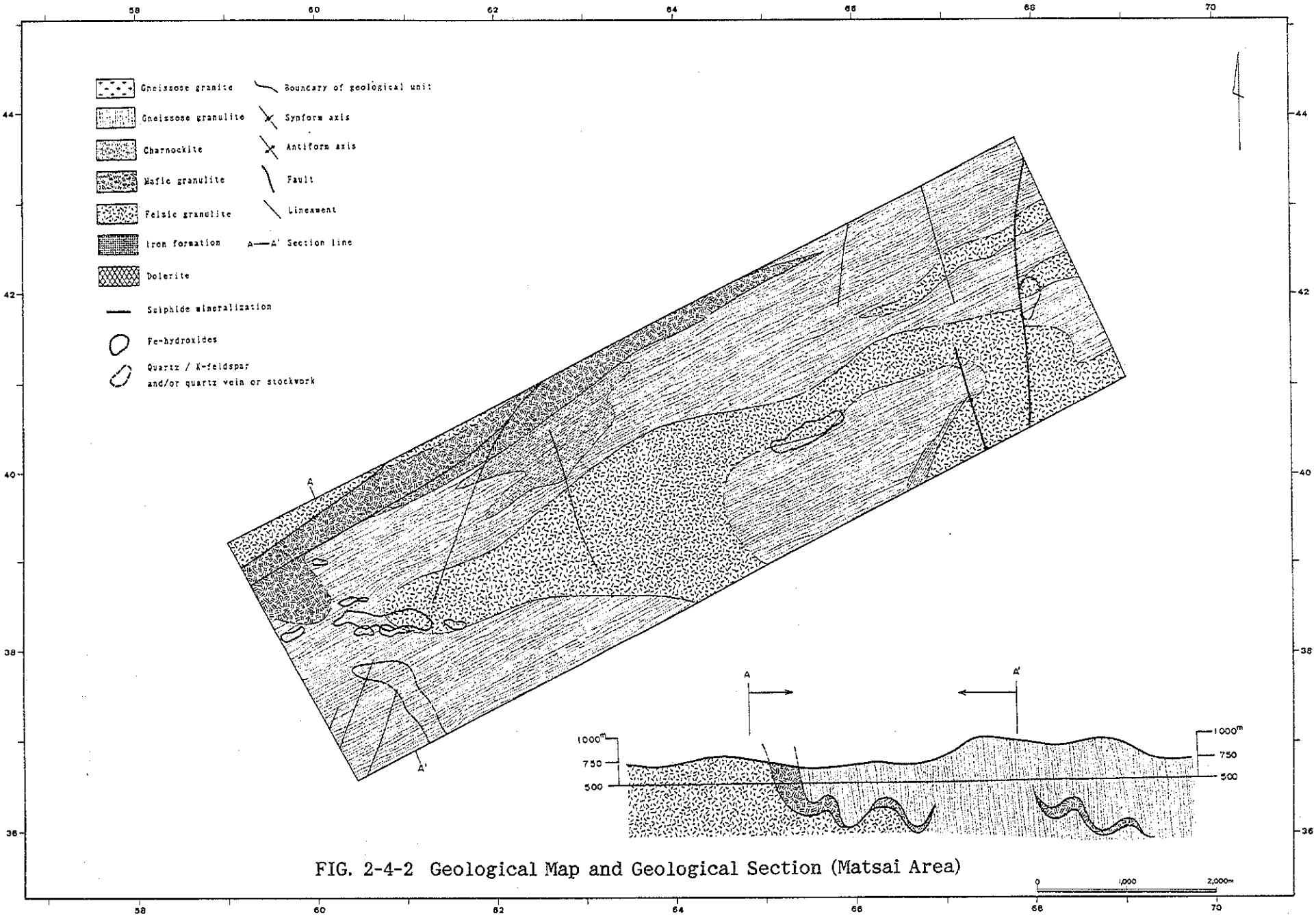

FIG. 2-4-2 Geological Map and Geological Section (Matsai Area)

K-feldspar are ubiquitously distributed in the Chisave mountains in the southwest and north of the area. They can be judged to be promising by considering their distribution area and their continuities.

In addition, distributions of quartz vein/stockwork and pegmatic quartz & K-feldspar were also recorded in the center and northeast of the area. In particular, the latter exists along the above described structural line.

Analytical results of samples collected from the north of the Chisave mountains in the area show that Au, As and Zn are characteristically high, compared with those in other mineralized zones.

As described above, the area considered to be promising as an objective zone of geochemical survey in the area is the northern district of the Chisave mountains where Fe-hydroxides, quartz vein/stockwork and pegmatite quartz & K-feldspar, etc. were observed as mineralized signs.

The distribution of the mineralized signs described above has an occurrence extending to an ENE-WSW system, expected as a mineralized zone. Because of small amounts of sulphides (pyrite, chalcopyrite and pyrrhotite) were also observed, the presence of mineralization can be expected.

4-4 MANJIRENJI WEST AREA

4-4-1 Geology

The geological units in the area are mainly constituted of mafic granulite, felsic granulite and gneissose granulite. The lithofacies of each geological unit at the fields are similar to those in a Chirezana area and a Matsai area.

Mafic granulite is distributed from the center to south of the area, and a continuity further to the south is cut by a Murerezi tectonic line. Its distribution area is estimated to be about 5%.

Felsic granulite is distributed extending to an ENE-WSW system at its center, and is leucocratic rock with foliation. Its distribution area is estimated to be about 10%. Resistance to weathering is high, compared with other rocks.

Gneissose granulite is widely distributed, similar to other areas. It occupies about 85% of the area, usually shows a brownish to grayish color, is medium grained, dense and hard, has a remarkable foliation, and is distributed regulated in an ENE-WSW direction. Its color is apt to become paler through weathering.

4-4-2 Geological Structure

As a geological structure in the area, the presence of a Murerezi tectonic line deserves attention. But in the field proving the presence is difficult. It can be recognized by Landsat images but the presence can only be known by hindrance of the south extent of mafic granulite.

No characteristics of geological structures worthy of special mention could

be found.

4-4-3 Mineralization

On the first year survey, multiple anomalies by stream sediments were recorded, but no promising mineralized signs were observed by the semi-detailed geological survey in Phase II.

As described above, there is no distribution of Fe-hydroxides suggesting the presence of sulphide minerals considered characteristic of mineralization in the area, consequently the area can be judged to be an unsuitable zone for soil geochemical survey.

4-5 RUPIRI AREA

4-5-1 Geology

The area is positioned in the center and somewhat northwest of the survey area. Gneissose granulite (including charnockite) is common. The geological unit mainly consists of mafic granulite, felsic granulite and gneissose granulite (including charnockite). Outcrops of the geological units are common in the north and south of the area, and poor in central portion of the area.

Mafic granulite exists as small rocks (max. 2 km x 0.5 km) in the center of southwest. Its distribution area occupies only about 5%. It is usually a dark greenish color, is massive, and the growth of foliation is weak. Reddish soil is formed by weathering.

There is felsic granulite in the northeast of the area. It has a grayish to white color and is a medium grained rock having well-developed foliation. Its distribution area occupies about 10%.

Gneissose granulite (including charnockite) occupies a distribution area of 85% (charnockite accounts for 5%) in the area. Also charnockite are observed by microscopic observation, but some are too small to be treated as a geological unit. Gneissose granulite near a Vurumuku tectonic line contains chlorite to some extent, and suggests a relation between a tectonic line and hydrothermal alteration.

Its tectonic grade is 3 (augenmylonitic), the degree of deformation is high.

4-5-2 Geological Structure

A Vurumuku tectonic line extending over a Makambe tectonic line and a Murerezi tectonic line exists in the area, but the sense and degree of dislocation are obscure.

4-5-3 Mineralization

Mineralized signs, namely Fe-hydroxides (including quartz vein/stockwork)

were recognized in the northern end (the west of the Mbamba mountain mass) of the mafic granulite existing in the southwest of the area . Three others, pegmatite quartz & K-feldspar or quartz vein/stockwork could also be observed.

From the results of the first year survey, multiple anomalous values indicated by stream sediments were recognized. Mineralized signs considered relating to these anomalies were recognized in the northern end of mafic granulite existing in the southwest of the area, and in other districts.

The distributions of the mineralized signs described above tend to be scattered, but all exist in connection with mafic granulite. In particular, the distribution of Fe-hydroxides existing in the west of the Mbamba mountain mass can be presumed to originate in sulphides, thus the distribution zone of these mineralized signs were selected as suitable for soil geochemical survey.

4-6 CHEMHONDO AREA

4-6-1 Geology

The area, consisting of Limpopo Mobile Belt and Zimbabwe Craton, is situated in the western portion of the survey area. The geological units in the area are dolerite, mafic granulite, felsic granulite, and gneissose granulite, which has the largest extent as same as the other area. The area is characterized by common occrrences of dolerite and tectonic lines(including lineaments).

Mafic granulite distributes in the northern most portion of the area with ENE-WSW extention and is fine to medium grained rock having poorly developed foliation. The extent of mafic granulite is about 2 to 3 % of the area.

Felsic granulite is pale gray in colour, medium grained, compact, and hard rock having foliation. Its body has a dimension of 3 x 0.3 km extended to ENE-WSW direction. Weathered surface shows white in colour but resisitance for weathering is rather higher than that of other geological units. The distribution area is less than 5% in the area.

Gneissose granulite commonly observes in the area. The gelogical unit is gray to dark gray in colour, medium grained, well-foliated and partly garnet-bearing. A medium amount of chlorites are microscopically observed in the rock from northeastern edge of the area.

Its distribution area is estimated to occupy about 75% of the area.

Dolerite is distributed in the center of the area as a form combined by a N-S system and an E-W system. Its distribution area is estimated to occupy 7 to 8% of the area.

Gneissose granite occupies the northwest of the area and the tectonic grade of the area's geological unit is presumed to be high, corresponding to 3 by microscopic observation. Outcrop conditions are poor and the relationship between Zimbabwe Craton and Limpopo Mobile is obscure, even by Landsat images. It has a

grayish color and is a medium to coarse grain rock with abundant K-feldspar. Its distribution area is about 10%.

4-6-1 Geological Structure

The tectonic line, which was postulated by study(Coward et al. 1976) as large and existing at the boundary between a gneissose granite of basement and the Limpopo Mobile Belt, could not confirmed. The tectonic line of a NW-SE system recognized in the west of the area appears to exert a small dislocation on felsic granulite, dolerite and gneissose granulite.

4-6-1 Mineralization

The mineralized signs in the area can mainly be recognized in three zones. In particular, gneissose granulite accompanied by pegmatite quartz & K-feldspar is recognized in the east of Chipfuti, and also in the mountain mass about 2 km north from there, and the Chigonbi mountain mass though the degree of concentration of pegmatite quartz & K-feldspar is poor. No zone with Fe-hydroxides was found.

From first year survey results multiple geochemical anomalies by stream sediments were recorded, and by further survey of Phase II, the distribution zone of a representative mineralized sign was determined to be the zone east of Chipfuti School.

The mineralized sign frequently appears in the east of Chipfuti, but was eliminated from objective zone because of their small scale. The zone can be considered reserve zone behind Chamburukira zone for soil geochemical survey.

4-7 FAVERSHAM AREA

4-7-1 Geology

The area positions near the southwest end of the surveyed area consist only of gneissose granulite (including charnockite) and its structure is governed by an ENE-WSW system.

Gneissose granulite is observed over the whole range of the area, it has a dark grayish to grayish color, is medium grained, has a well-developed foliation and partly contains garnet. The distribution area is estimated to occupy above 90% of the area.

Charnockite is known to be distributed in three rock masses in the north and south of the area, petrologically more massive than gneissose granulite with poor foliation. It usually has a dark grayish color, and its distribution area is estimated to be about 10% of the area. Opaque minerals and mineral compositions similar to enderbite having rather high quantity ratios of pyroxenes, microscopically judged as charnockite, exist.

The tectonic grade of the area shows a polygonal to augenmylonitic texture

and its variation is great.

4-7-2 Geological Structure

There is no remarkable tectonic line and no special characteristic relating to a geological structure. However, there is an anticlinal axis of an ENE-WSW system held between both charnockites and the charnockites are possibly the same rock body.

4-7-3 Mineralization

As mineralized signs, only pegmatite quartz & K-feldspar were observed at the boundary between charnockite and gneissose granulite in the southwest of the area. These zones where mineralized signs are recognized (Faversham 1 and 11) are thought to possibly be the same, considering the presence of the anticlinal axis described above.

On the first year survey, multiple geochemical anomalies by stream sediments were recorded, but no promising mineralized signs were found in Phase II.

The area is judged to be unsuitable for soil geochemical survey, because the mineralized signs described above have a medium degree in dimension and the occurrences of pegmatite quartz & K-feldspar are scattered.

4-8 FUMURE AREA

4-8-1 Geology

The main geological units in the area are iron formations, mafic granulite and gneissose granulite (including charnockite).

Iron formations occur near the northwest end of the area forming the Fumure mountain. It has a pale brownish to white color with a thin band of Fe-hydroxides in quartz. The distribution area is estimated to be about 2 to 3% of the area.

Mafic granulite is mainly distributed at the center of the area, It is massive rock of a dark greenish color, and the distribution area is estimated to be about 5%. By microscopic observations, more clinopyroxene was found than orthopyroxene, accompanied by a large amount of amphibole. The tectonic grade is as low as 0 (isogranular texture).

The representative felsic granulite, which has a pale grayish color, well-developed foliation and is fine to medium grained, is near Dekeza B. C. By microscopic observations, it was found that K-feldspar prevails with small amounts of plagioclase and garnet. Its tectonic grade is as high as 3. Felsic granulite was microscopically observed also in other places than the distribution areas of felsic granulite in the FIG. 2-4-3, but cannot be illustrated because of its small scale. The distribution area is estimated to be about 2 to 3% of the area.

Gneissose granulite is observed over the whole range of the area. It has a

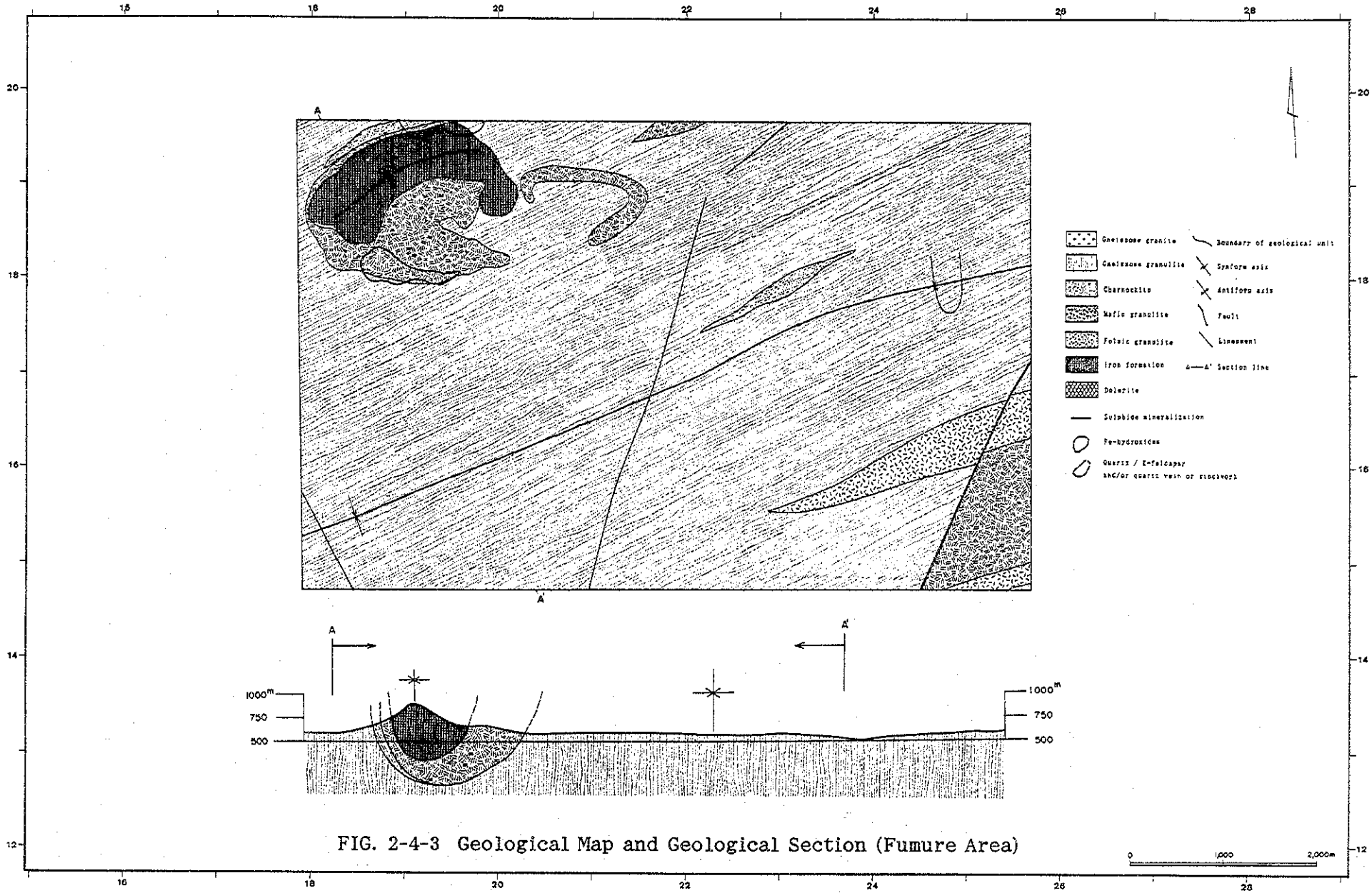

FIG. 2-4-3 Geological Map and Geological Section (Fumure Area)

grayish to brownish color, is medium grained and has a well developed foliation. By microscopic results, very small amounts of sericite and chlorite were recognized. Its distribution area is estimated to be about 90% of the area. The tectonic grade of gneissose granulite is 3, the same as felsic granulite.

Charnockite is known to be distributed in two rock bodys in the north and central of the area. It is petrologically more massive than gneissose granulite with weak foliation. It usually has a dark grayish color, and the distribution area is estimated to be about 1%. There are opaque minerals and mineral compositions in similar to enderbite containing large quantities of pyroxenes in those microscopically judged as charnockite.

4-8-2 Geological Structure

The Sazaume-Makambe tectonic line passes through the southeast of the area. This tectonic line appears to be left-lateral and the west side block of the tectonic line appears to dislocate south relative to the east side block. The anticlinal axis of an ENE-WSW system exists from the south to center of the area. It is normal in the west and becomes an overturned anticlinal axis in the east.

4-8-3 Mineralization

As mineralized signs, the distribution of Fe-hydroxides in the south of Fumure mountain (Fumure area) can be specifically mentioned. As floats containing pyrite as well as Fe-hydroxides were discovered here and geochemical anomalies by stream sediments in the Phase I were recognized in the area, the presence of Au mineralization accompanying sulphide minerals can be expected. Consequently, the district was selected as an objective zone (Fumure area) for soil geochemical survey. In samples where pyrite was recognized with the naked eye, chalcopyrite and pyrrhotite were also observed microscopically. The distribution of Fe-hydroxides was recognized also in the north of Fumure mountain, but the distribution of Fe-hydroxides is far more scattered than in the south.

Analytical results of samples collected from the Fumure area show that the contents of metal elements As and Cr are characteristically high, compared with those in other mineralized areas.

On the first survey, multiple geochemical anomalies by stream sediments were recorded in the area, and by semi-detailed geological survey, a promising mineralized sign was recorded in the Fumure area.

Although the analytical results of samples collected from the mineralized zone did not directly indicate Au mineralization, it is presumed to be a promising area according to connections with mineralized signs and Spot Mine.

4-9 NYAHONDO AREA

4-9-1 Geology

The area is located near the northwest end of the surveyed area where gneissose granulite is common. The geological units in this area are mainly felsic granulite and gneissose granulite.

Felsic granulite is distributed in the southeast of the area in an ENE-WSW system, and its distribution area is estimated to be about 15%. The lithofacies are grayish to pale brownish similar to other areas, the rocks are medium grained and have a clear foliation. They are very similar to charnockite, recognized in gneissose granulite by the naked eye and by microscope.

Gneissose granulite is most widely distributed and occupies about 85% of the area. It is usually brownish in color, coarse to medium grained, dense, hard, and has a remarkable foliation and is distributed in a NNE-SSW direction. Chlorite, epidote and sericite, considered as products due to hydrothermal alteration, were observed in gneissose granulite at the northwest end of the area.

The tectonic grade in the zone is as high as 3 to 4.

4-9-1 Geological Structure

There is geologically no specific structure, but in the Chinyamafiwa river, a NE-SW direction in the northwest end of the area, there is a foliation in this direction grows which may reflect a tectonic line. The tectonic line may be attributed to a tectonic movement after the main metamorphic episode which formed the foliation of an ENE-WSW system prevailing in the surveyed area.

4-9-1 Mineralization

Mineralized signs mainly composed of pegmatite quartz & K-feldspar (accompanied by Fe-hydroxides) are recognized in the west of the area (Nyahondo zone). These are distributed to an ENE-WSW direction matching the direction of foliation. Analytical results of samples (Fe-hydroxides) collected from the Nyahondo zone show that the contents of metal elements, As, Cu and Cr are characteristically high, compared with those in other mineralized areas.

On the first survey, multiple geochemical anomalies by stream sediments were recorded in the area, and by semi-detailed geological survey, multiple mineralized sings could be confirmed in the west of the area (Nyahondo zone).

In Nyahondo area, though the analytical results do not directly indicate Au mineralization, mineralized signs can be recognized in the west of the area, and these are mainly composed of pegmatite quartz & K-feldspar, and in some cases Fe-hydroxides. Consequently, the area was selected as a objective zone of for soil geochemical survey.

4-10 BANGALA AREA

4-10-1 Geology

The area is located in the southwestern extremity of the surveyed area, and an axis of a fold in the ENE-WSW direction is found in charnockite in the central part of the area. Major geological units are gneissose granulite and charnockite, which form monotonous distribution of geological units. Minor distribution of mafic granulite, an area about 1% of the total area, is found in the northwestern extremity of the area.

Gneissose granulite, brown-colored coarse grain rock with weak foliation, is distributed in northern and southern parts of the area. Its distribution area is estimated to be approximately 45% of the total area. In addition, charnockite is distributed within gneissose granulite. It is similar to gneissose granulite in terms of its mineral composition, containing slight amounts of orthopyroxene as shown by microscopic examination.

Charnockite with weak foliation, dark gray to gray colored, is distributed in the central part of the area forming small hills. Its distribution area is about 55% of the total area.

The tectonic grade of the area is high at 3.

4-10-2 Geological Strcture

Sazaume-Makambe tectonic line passes the northwestern extremity of the area. Although it can be estimated that the sense of the tectonic line is left-lateral, and the western block of the tectonic line is displaced to the south, no evidence was obtained in the field. On the other hand, there is a tectonic line of right-lateral sense stretching from the center of the area towards the southwest, probably by which the charnockite is displaced.

4-10-3 Mineralization

No mineralized signs was observed.

From the first year survey, some anomalies were obtained by geochemical survey of stream sediments in the area. The semi-detailed geological survey in Phase II, however, indicated no promising mineralized signs.

It is determined that this area cannot be an candidate for soil geochemical survey, because no mineralized signs, the principle object of the survey, were verified in the area.

4-11 CHIPFUNDE AREA

4-11-1 Geology

The area is located in near the central part of the area. Its major geological units are mafic granulite, felsic granulite, gneissose granulite(including charnockite), and dolerite.

Mafic granulite distributes from the north to the middle of the area, and in the ENE-WSW direction in the southern part. It is usually of dark green massive rock but sometimes shows good development of foliation. In mafic granulite with such developed foliation, it seems that a tectonic grade of augenmylonitic texture is also indicated. The distribution area of mafic granulite is estimated to be less than 10% of the total area.

Felsic granulite is distributed in the southern part of the area. It usually forms medium grain rock of a light gray color and with highly developed foliation, in common with that of other areas. Its distribution area is about 5% of the total area.

Gneissose granulite is distributed throughout the area. It is brown or gray rock of wide grain range, from fine to coarse. Its distribution area is about 85% of the total area.

Charnockite is distributed in the central part of the area as rock body stretching in an ENE-WSW direction.

The tectonic grade of each geological unit in this area is high, generally indicating 3.

4-11-2 Geological Structue

These are two tectonic lines in this area: a tectonic line which is estimated to slightly displace mafic granulite, gneissose granulite and charnockite in the central part of the area; and the Murerezi tectonic line located in the eastern part of the area. It was not revealed in the field what displacement the Murerezi tectonic line gives to the geological units in this area.

4-11-3 Mineralization

On the southern and northern edges of the area, a mineralized signs, mainly of Fe-hydroxides, was found. Other mineralized signs, probably of pegmatite quartz and K-felspar or quartz vein/stockwork, were found at one point each in the middle and south of the area. Comparing the analytical results of Fe-hydroxides samples of the Chipfunde zone with those of other areas, it is worth notice that the samples from the Chipfunde zone are higher in Cu and Ni content.

The first year survey indicated anomalies by panned samples. As a result, the above mineralized signs in the Chipfunde zone is considered to be promising.

From the analytical results of Fe-hydroxides samples, there is no strong sign of Au mineralization.

Although analytical results of Fe-hydroxides mentioned above does not provide any especially noticeable information, it can be considered that Fe-hydroxides of the Chipfunde zone accompanied with quartz/stockwork meets the criteria for selection of subject areas for soil geochemical survey.

4-12 MUSHAYA AREA

4-12-1 Geology

This area is located in the western extremity of the surveyed area, being adjacent to the north of the Fumure area. Its major geological units are mafic granulite and gneissose granulite which contains charnockite.

Mafic granulite develops mainly in the northern part of the area, in a form strongly reflecting the structure stretching in the ENE-WSW direction. Its rock is characterized by a dark green color and weak foliation common with those of other areas. Its grain is fine or medium. Mafic granulite is estimated to have a distribution area of about 10% of the total area.

Gneissose granulite containing charnockite forms the bulk of the geological structure of the area. It is a light brown, medium grain rock with highly developed foliation. It is estimated to be distributed over about 85% of the total area. In addition, charnockite, an area about 5%, is distributed in the southern part as small rock body. It contains orthopyroxene at 2-3%.

The tectonic grade is as high as 3.

4-12-2 Geology

In this area, too, geological structure in the ENE-WSW direction has clear foliation. Distribution of each geological unit is controlled in this direction. No other noteworthy tectonic line is known.

4-12-3 Mineralization

Major mineralized signs were found only in charnockite and gneissose granulite to the east of Mushaya school in the Mushaya area, appearing as pegmatite quartz and K-feldspar, or quartz vein/stockwork, which are difficult to distinguish, spreading over mafic granulite and gneissose granulite.

Although the first year survey indicated some anomalies by panned samples, it revealed no promising mineralized signs.

From the field survey, it is difficult to determine which of pegmatite quartz and K-feldspar, or quartz vein/stockwork is the origin of the mineralized signs observed in the Mushaya area.

Because of the scattered occurrence of the mineralized signs mentioned above, and because of the absence of Fe-hydroxide distribution, a sign of the relationship with sulfide which is regarded to be a feature of mineralization, it is determined that this area cannot be a candidate for soil geochemical survey.

4-13 Other AREA

4-13-1 Geology

The geology of all the above areas is summarized here, because these areas do not seem largely to affect the entire geology due to their small individual areas.

MaCdougall-SE area: This area is located in the southern extremity of the central part of the surveyed area. The majority of the area consists of felsic granulite, with minor distribution of gneissose granulite of an area only 30% of the total.

MaCdougall-N area: This area is located near the northwest of the Chirezana area. Its geology consists of felsic granulite and gneissose granulite.

Svuwure-SE area: It is located to the west of Manjirenji West area and the north of the Chipfunde area. In the area, distribution of gneissose granulite, and a minor one of mafic granulite and felsic granulite are shown.

Svuwure-NW area: This area is located in the south of the Chipfunde area. Its geology consists of gneissose granulite only.

Dabwa-SE area: This area is located in the south of the Chipfunde area. Its geology consists of felsic granulite and gneissose granulite.

Chivamba-E area: The geology of this area consists of mafic granulite and gneissose granulite which continue from the Chipfunde area located to the east of this area.

Chivamba-S area: Its geology is substantially the same as that of Chivamba-E area, except for a largely increased distribution area of mafic granulite over that of Chivamba-E area.

4-13-2 Geological Structure

MaCdougall-SE area: There is an anticlinal axis in the ENE-WSW direction near the center of the area, and its south wing seems to be a steep slope.

MaCdougall-N area: The Murerezi tectonic line passes the eastern part of the area, displacing felsic granulite and gneissose granulite in the right-lateral sense.

Svuwure-SE area: Its geological structure generally belong to the western block of the Murerezi tectonic line, in which an axis of a fold in the ENE-WSW direction is noted. This axis plunges to the east.

Svuwure-NW area: No noteworthy geological structure was found.

Dabwa-SE area: No noteworthy geological structure was found.

Chivamba-E area: In general, this area belongs to the north wing of an overfolding axis of an anticline, but no remarkable tectonic line was found.

Chivamba-S area: Its geological structure is generally the same as that of Chivamba-E area, except that this area is located nearer the axis of a fold than the Chivamba-S area.

4-13-3 Mineralization

MaCdougall-SE area: No fact indicating any mineralization was found.

MaCdougall-N area: No mineralized signs was noted.

Svuwure-SE area: It was expected to have some mineralized signs in relation of the existence of such phenomena in the Chipfunde area, but none was found.

Svuwure-NW area: Under bad outcrop conditions, no mineralized signs was found.

Dabwa-SE area: Under bad outcrop conditions, no mineralized signs was found.

Chivamba-E area: Although mafic granulite is distributed in this area in the same way as the Chipfunde area, no mineralized signs, such as existence of Fe-hydroxides, was found.

Chivamba-S area: Its geological condition is substantially the same as that of Chivamba-E area, but no noticeable mineralized signs was found.

Although anomalies were found by geochemical survey on stream sediment in the above areas, none of them could be determined to be a subject zone for soil geochemical survey from the results of the Phase II semi-detailed survey.

The above seven areas correspond to a single anomalous area found by geochemical survey on stream sediment, however, could not reveal the origin of such anomalies. This poses a problem which is also related to the evaluation of the anomalies by geochemical survey on sediment in the surveyed area.

The summary of mineralized zones are shown in TABLE 2-4-1.

TABLE 2-4-1 Summary of Mineralized Zone(Phase II)

MINERALIZED ZONE	MINERALIZED METAL	GEOLOGY	MINERALIZED SIGNS
NE-MANHANZVA	----------	Felsic Granulite Charnockite	pegmatite quartz & K-feldspar
JUWERE	Au-Bi?-Cu-Cr-Ni?	Gneissose granulite Mafic Granulite	sulphides & Fe-hydroxides
JEGEDE	Au-As-Bi?-Cu?-Zn?-Cr??	Mafic Granulite	sulphides & Fe-hydroxides
MUCHACHA	Au-As-Bi?-Zn-Ni?	Mafic Granulite	sulphides & Fe-hydroxides
CHAMBURUKIRA	----------	Felsic Granulite Gneissose Granulite	pegmatite quartz & K-feldspar
BENZI	Au-As-Bi?-Zn	Gneissose granulite Mafic Granulite	Fe-hydroxides quartz vein/stockwork pegmatite quartz & K-feldspar
RUPIRI	Au-As-Ni	Gneissose granulite Mafic Granulite	Fe-hydroxides (quartz vein/stockwork)
E-CHIPFUTI SCHOOL	----------	Felsic Granulite Gneissose Granulite	pegmatite quartz & K-feldspar
Faversham I&II	--------	Gneissose granulite Charnockite	pegmatite quartz & K-feldspar
FUMURE	As-Cr-Ni?	Mafic Granulite	sulphides & Fe-hydroxides
NYAHONDO	As-Cu-Cr	Gneissose Granulite	pegmatite quartz & K-feldspar (Fe-hydroxides)
CHIPFUNDE	As-Cu-Ni	Mafic Granulite Gneissose Granulite	Fe-hydroxides (quartz vein/stockwork)
MUSHAYA	----------	Charnockite Gneissose Granulite	pegmatite quartz & K-feldspar (&/or quartz vein/stockwork)

CHAPTER 5 SOIL GEOCHEMICAL SURVEY

In the soil geochemical survey, samples were collected checking sample collecting points, which were established previously so as to cover the survey zones by transit and tape. In nine survey zones, 10,047 soil samples were collected on the line of 100-meter line-spacing and 30-meter interval.

A sample of about 50g of -80 mesh size was collected in each place. The analytical results of these samples are shown in APPENDIX A-1 together with the geology which was determined based on the origin of each sample, collected position, etc..

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 10,047 samples collected during this survey.

In this survey, however, background and threshold values were determined on the basis of geometric mean and geometric standard deviation as same as that of phase I. The calculation was made on each geological units as possible as one can. The geological units were divided into three categories:

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

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

Threshold(1) = GM(m) + 1 geometric standard deviation(1δ)
Threshold(2) = GM(m) + 2 geometric standard deviation(2δ)
Threshold(3) = GM(m) + 3 geometric standard deviation(3δ)

5-1 JUWERE ZONE

5-1-1 Soil Sampling

Soil sampling lines were set on east-west direction due to north-south oc-

currences of Juwere mineralized zones and B-horizon soil was taken. Soil colour in the zone reflects the basement geology.
Soils taken over the mafic granulite, felsic granulite, and gneissose granulite were 82, 324, and 1,153 respectively.

5-1-2 Indicators

Two mineralized zones were found within the zone. Analytical results of the soils poorly agreed with the observations which confirmed the sulphide mineralization in the field.
The contents on geochemical indicators compared with all zones studied and Juwere zone are shown as follows;

JUWERE ZONE

ROCK CODE	Au (PPB)	Ag (PPM)	As (PPM)	Bi (PPM)	Cu (PPM)	F (PPM)	Zn (PPM)	Cr (PPM)	Ni (PPM)	Fe (%)
ALL ZONES										
R.C.3	1.73	0.63	2.25	0.06	61.57	26.42	90.47	215.97	153.32	6.89
R.C.4	0.98	0.48	0.58	0.05	8.82	23.02	40.41	30.92	11.77	1.96
R.C.5	0.93	0.53	0.66	0.05	12.86	30.30	37.45	44.07	19.23	1.90
JUWERE ZONE (SOIL)										
R.C.3	0.84	0.47	0.73	0.05	47.05	31.58	75.28	111.66	54.49	5.83
R.C.4	0.74	0.37	0.58	0.05	4.30	71.25	40.92	31.95	4.41	1.70
R.C.5	0.73	0.32	0.66	0.05	12.20	54.70	48.08	62.36	13.28	2.48

Background Geology and Indicator Content

Accordingly, geochemical characteristics for respective geological units are shown in TABLE 2-5-1. According to this table, geochemical characteristics on each indicator are summarized as follows:

Au : Geometric means(GMs) of rock code 3, rock code 4, and rock code 5 of all zones are 1.73, 0.89, and 0.93 ppb, respectively but rock code 3 in the zone has the largest value of 0.84 ppb.
A comparison on the contents of indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) was made. Au contents in the zone can be pointed out to be rather low. The maximum value in the zone is 115 ppb.

Ag : GMs of rock code 3, rock code 4, and rock code 5 of all zones are 0.63, 0.48, and 0.53 ppm, respectively but rock code 3 in Juwere zone has the largest value of 0.47 ppm.
A comparison on contents of the indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) was made. Ag contents in the zone rather high, with a maximum value of 11 ppm.

As : Since approximately 70 % of data indicated the contents below its detection limit(1.00 ppm), it is difficult to clarify its geochemical character in the zone.
Rock code 3 in the zone has the largest value of 0.73 ppm.

TABLE 2-5-1 Statistical Parameter of Indicators(Juwere Zone)

SOIL <ROCK 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(%)		THRESHOLD (PPM) Au(PPB)	Ag(PPM)	As(PPM)	Bi(PPM)	Cu(PPM)	F(PPM)	Zn(PPM)	Cr(PPM)	Ni(PPM)	Fe(%)	
													1.86	0.81	1.65	0.05	112	64	117	251	113	10.71	←g.m.+ s.d
MAFIC GRANULITE	82	0.84	0.47	0.73	0.05	47.05	31.58	75.28	111.66	54.49	5.83	←g.m.	4.12	1.40	3.73	0.05	269	129	182	565	234	19.69	←g.m.+2 s.d.
<3>		2.22	1.72	2.26	1.08	2.39	2.02	1.55	2.25	2.07	1.84	←s.d.	9.14	2.40	8.44	0.06	642	261	283	1,270	484	36.19	←g.m.+3 s.d.
													1.44	0.53	0.84	0.05	8	153	75	57	18	2.24	←g.m.+ s.d
FELSIC GRANULITE	324	0.74	0.34	0.58	0.05	4.30	71.25	40.92	31.95	4.41	1.70	←g.m.	2.78	0.82	1.22	0.06	16	329	136	103	73	2.95	←g.m.+2 s.d.
<4>		1.94	1.55	1.46	1.06	1.92	2.15	1.82	1.80	4.07	1.32	←s.d.	5.39	1.27	1.77	0.06	30	707	247	185	297	3.89	←g.m.+3 s.d.
													1.48	0.50	1.39	0.06	36	139	103	166	57	5.14	←g.m.+ s.d
GNEISSOSE GRANULITE	1,154	0.73	0.32	0.66	0.05	12.20	54.70	48.08	62.36	13.28	2.48	←g.m.	3.01	0.79	2.95	0.07	109	355	222	443	246	10.65	←g.m.+2 s.d.
<5>		2.03	1.58	2.12	1.16	2.99	2.55	2.15	2.66	4.30	2.07	←s.d.	6.11	1.25	6.24	0.08	326	903	476	1,179	1,056	22.06	←g.m.+3 s.d.

	NO. OF SAMPLE	MINIMUM VALUE (PPM) Au(PPB)	Ag(PPM)	As(PPM)	Bi(PPM)	Cu(PPM)	F(PPM)	Zn(PPM)	Cr(PPM)	Ni(PPM)	Fe(%)	MAXIMUM VALUE (PPM) Au(PPB)	Ag(PPM)	As(PPM)	Bi(PPM)	Cu(PPM)	F(PPM)	Zn(PPM)	Cr(PPM)	Ni(PPM)	Fe(%)
MAFIC GRANULITE <3>	82	0.50	0.25	0.50	0.05	10.00	10.00	18.00	18.00	10.00	1.19	8.00	1.30	46.00	0.10	287	160	198	660	206	18.88
FELSIC GRANULITE <4>	324	0.50	0.25	0.50	0.05	0.50	10.00	13.00	1.00	0.50	0.86	6.00	1.80	11.00	0.10	23	450	2,350	226	621	4.64
GNEISSOSE GRANULITE <5>	1,154	0.50	0.25	0.50	0.05	0.50	10.00	9.00	1.00	5.00	0.56	115.00	11.00	240.00	1.10	432	650	5,050	5,400	294	22.09

g.m. : geometric mean s.d. : standard deviation

ROCK CODE	Au (PPB)	Ag (PPM)	As (PPM)	Bi (PPM)	Cu (PPM)	F (PPM)	Zn (PPM)	Cr (PPM)	Ni (PPM)	Fe (%)
ALL ZONES										
R.C.3	1.73	0.63	2.25	0.06	61.57	26.42	90.47	215.97	153.32	6.89
R.C.4	0.98	0.48	0.58	0.05	8.82	23.02	40.41	30.92	11.77	1.96
R.C.5	0.93	0.53	0.66	0.05	12.86	30.30	37.45	44.07	19.23	1.90
JUWERE ZONE (SOIL)										
R.C.3	0.84	0.47	0.73	0.05	47.05	31.58	75.28	111.66	54.49	5.83
R.C.4	0.74	0.37	0.58	0.05	4.30	71.25	40.92	31.95	4.41	1.70
R.C.5	0.73	0.32	0.66	0.05	12.20	54.70	48.08	62.36	13.28	2.48

ROCK TYPE	Au (PPB)	Ag (PPM)	As (PPM)	Bi (PPM)	Cu (PPM)	F (PPM)	Zn (PPM)	Cr (PPM)	Ni (PPM)	Fe (%)
MAFIC ROCK	4.00	0.10	2.00	0.01	100	370	130	200	160	8.56
INT. ROCK	----	0.07	2.40	0.01	35	500	72	50	55	5.85
FELSIC ROCK	4.50	0.05	1.50	0.01	20	800	6	25	8	2.70
GRANITE	1.00	0.05	0.25	0.43	12	1,250	85	7	5	1.85
MICA SCHIST	----	0.30	----	----	30	----	70	70	50	4.90
					<After Flanagan(1976) & Vinogradov(1962)>					
JUWERE ZONE (ROCK)										
R.C.3	0.50	0.25	1.00	0.05	37	95	102	158	98	9.16
R.C.4	0.50	0.25	1.00	0.05	3	35	126	1	84	0.87
R.C.5	1.48	0.25	0.79	0.05	13	138	83	17	32	2.62

INT. ROCK : INTERMEDIATE ROCK
---- : NO DATA

A comparison on contents of the indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) was made. As contents of the zone is fairly low, with maximum value of 240 ppm.

Bi : Since approximately 95 % of data indicated contents below its detection limit(0.10 ppm), it is difficult to clarify its geochemical character in the zone.
A comparison on contents of the indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) was made. Bi contents in the zone is nearly the same. Maximum value in the zone is 1.10 ppm.

Cu : GMs of rock code 3, rock code 4, and rock code 5 of all zones are 61.57, 8.82, and 12.86 ppm, respectively but rock code 3 in the zone has the largest value of 47.05 ppm.
A comparison on contents of the indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) was made. Copper contents of the zone is fairly low. The maximum value in the zone is 432 ppm.

F : GMs of rock code 3, rock code 4, and rock code 5 of the zone are 26.42, 23.02, and 30.30 ppm, respectively but rock code 4 in the zone has the largest value of 71.25 ppm.
A comparison on contents of the indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) was made. F contents in the zone is fairly low, with maximum value of 650 ppm.

Zn : GMs of rock code 3,rock code 4, and rock code 5 of the zone are 90.47, 40.41, and 37.45 ppm, respectively but rock code 3 in the zone has the largest value of 75.28 ppm.
A comparison on contents of the indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) made clear that Zn contents in the zone is rather low. The maximum value in the zone is 5,050 ppm.

Cr : GMs of rock code 3, rock code 4, and rock code 5 of the zone are 215.97, 30.92, and 44.07 ppm, respectively but rock code 3 in the zone has the largest value of 111.66 ppm.
A comparison on contents of the indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) made clear that Cr contents of the zone is almost same. However, the indicator's values fluctuate greatly for rock types according to Flanagan's data. The maximum value in the zone is 5,400 ppm.

Ni : GMs of rock code 3, rock code 4, and rock code 5 of the zone are 153.32, 11.77, and 19.23 ppm but rock code 3 in the zone has the largest value of 54.49 ppm.
A comparison on contents of the indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) made clear that Ni contents of the zone is almost the same for the area compared. However, values of Flanagan's data fluctuate greatly for various rock types. The maximum value in the zone is 621

ppm.

Fe : GMs of rock code 3, rock code 4, and rock code 5 of the zone are 6.89, 1.96, and 1.90 %, respectively but rock code 3 in the zone has the largest value of 5.83 %.

A comparison on contents of the indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) made clear that Fe contents in the zone is normal. The maximum value in the zone is 22.09 %.

Determination of Threshold Values

An interpretation was conducted on the cumulative frequency curve of Au in each geological unit. The results are summarized as follows:

Rock code 3 : Au shows a kind of dual distribution as shown in FIG.2-5-1. Geochemical values principally consist of two populations, that is cumulative frequency of each population is about 70 %, and 30 %. The threshold value(GM + 2 δ)determined statistically correspond to the upper 3 % level of the second population.

Rock code 4 : Au also shows a kind of dual distribution as shown in FIG.2-5-1. Geochemical values principally consist of two populations, that is, cumulative frequency of each population is about 70 %, and 30 %. The threshold value(GM + 2 δ)determined statistically indicates near the median value(upper 5 % level) of the second population.

Rock code 5: The cumulative frequency curve shows almost same characteristics to that of rock code 4, as shown in FIG. 2-5-1.

5-1-3 Interpretation

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 2-5-2(1). General characteristics of each geological unit are summarized below:

Rock code 3 : As shown in TABLE 2-2-3(1), the contribution ratio for the first principal component to all the principal components is about 35 %, occupying one third of all. The total to the ratio of the fifth principal component amounts to 80 % 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 general small and not decisive. Each component drops gradually and does not change markedly.

Principal components intimately related to Au are as folws:

The second principal component is characterized by medium correlation of Ag

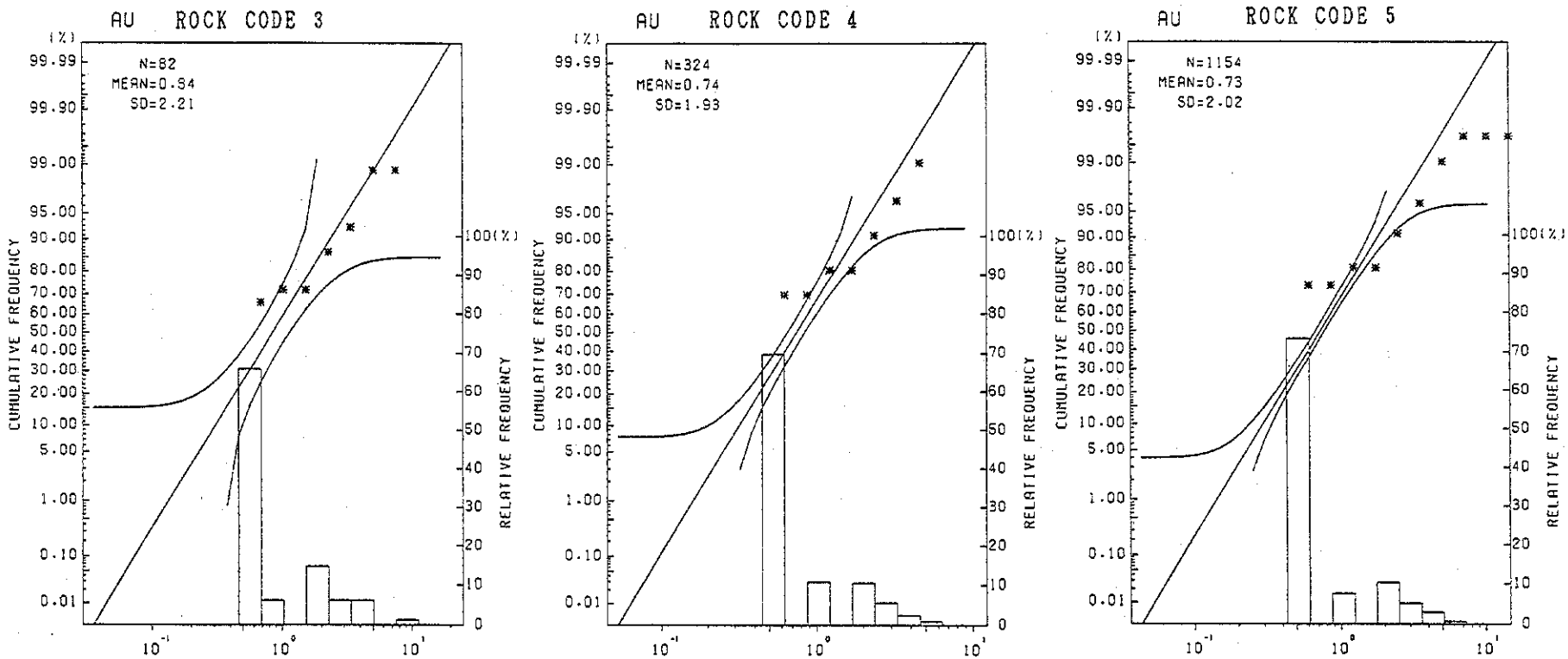

FIG. 2-5-1 Frequency Distribution and Cumulative Frequency Curve (Au;Juwere Zone)

and Cr, and negative medium correlation(-0.48~-0.52) with Au and F.

The fourth principal component shows a strong correlation(0.76) with As and a negative medium correlation(-0.53) with Au.

The fifth principal component is characterized by medium correlations(0.58~0.61) with Au and As. Therefore, the principal component is worth notice for the survey of gold, although the contribution ratio is as small as 9 %.

Rock code 4 : As shown in TABLE 2-5-2(2), the contribution ratio for the first principal component to all the principal components is about 21 %, occupying one fifth of all. The total to the ratio of the fifth principal component amounts to 70 % 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, except for the first principal component, drops gradually and does not change markedly.

Principal components intimately related to Au are as folws:

The fourth principal component is characterized by a strong correlation (0.80) with Au. The component is worth notice for the gold exploration, although the contribution ratio is as low as 10 %.

Rock code 5 : As shown in TABLE 2-5-2(3), the contribution ratio for the first principal component to all the principal components is about 26 %, occupying one fourth of all. The total to the ratio of the fifth principal component amounts to 74 % approximately, so that a greater part of the fluctuation of all the components can be explained by them. However, the contribution ratio of each component is generally small and not decisive. Each component, except for the first and second principal components, drops gradually and does not change markedly.

Principal components intimately related to Au are as folws:

The fourth principal component is characterized by strong correlation (0.94) with Au. The component is worth notice for the gold exploration, although the contribution ratio is as low as 10 %.

Au Concentration and Principal Component Scores

The concentration distribution of Au in this surveyed zone indicates that there is no anomalous zone with remarkable continuity. Since Juwere mineralized zones (I and II) have been found in this zone, as mentioned above, it was expected that an association between the zones and geochemical anomalies would be found. However, no noteworthy anomaly was found by geochemical soil survey around these mineralized zones.

No special relationship was found between geochemical anomalies and geology for mafic granulite, felsic granulite and gneissose granulite distributed in this zone.

Principal component highly related to Au were the fifth component for code 3 and the fourth component for codes 4 and 5. The score distributions of such com-

TABLE 2-5-2(1) Results of Principal Component Analysis(Juwere Zone:R.C. 3)

PRINCIPAL COMPONENT	EIGEN-VALUE	CONTRIBUTION RATIO	FACTOR LOADING										SCORE	
			Au	Ag	As	Bi	Cu	F	Zn	Cr	Ni	Fe	MAXIMUM	MINIMUM
Z1	3.5100	0.3510 (0.3510)	0.09	-0.24	0.14	0.45	0.95	-0.15	0.67	0.59	0.85	0.87	2.666	-1.650
Z2	1.4890	0.1489 (0.4999)	-0.48	0.64	-0.19	0.18	-0.06	-0.52	-0.33	0.59	0.13	-0.15	7.789	-1.149
Z3	1.0410	0.1041 (0.6040)	-0.04	0.21	-0.12	0.69	0.03	0.69	-0.11	0.00	0.03	-0.15	3.660	-2.146
Z4	1.0170	0.1017 (0.7057)	-0.53	0.21	0.76	-0.10	-0.04	0.19	0.23	-0.07	-0.06	0.05	4.564	-1.207
Z5	0.9310	0.0931 (0.7988)	0.61	0.11	0.58	0.28	-0.05	-0.25	-0.20	0.10	-0.01	-0.17	7.831	-0.629

TABLE 2-5-2(2) Results of Principal Component Analysis(Juwere Zone:R.C. 4)

PRINCIPAL COMPONENT	EIGEN-VALUE	CONTRIBUTION RATIO	FACTOR LOADING										SCORE	
			Au	Ag	As	Bi	Cu	F	Zn	Cr	Ni	Fe	MAXIMUM	MINIMUM
Z1	2.0640	0.2064 (0.2064)	-0.04	0.29	0.38	0.03	0.77	0.19	0.17	0.67	0.29	0.80	7.155	-2.416
Z2	1.4040	0.1404 (0.3468)	-0.27	0.71	-0.44	-0.05	-0.34	-0.41	0.45	0.03	-0.21	0.32	8.379	-3.409
Z3	1.2050	0.1205 (0.4673)	0.04	-0.11	-0.13	0.13	0.29	-0.54	0.25	-0.36	0.77	-0.08	10.572	-1.700
Z4	1.1050	0.1105 (0.5778)	0.80	0.12	-0.08	-0.41	-0.07	0.30	0.33	-0.23	0.07	0.13	4.238	-1.404
Z5	0.9890	0.0989 (0.6767)	0.28	-0.02	-0.23	0.88	-0.06	0.21	0.11	-0.02	-0.07	0.13	12.476	-2.210

TABLE 2-5-2(3) Results of Principal Component Analysis(Juwere Zone:R.C. 5)

PRINCIPAL COMPONENT	EIGEN-VALUE	CONTRIBUTION RATIO	FACTOR LOADING										SCORE	
			Au	Ag	As	Bi	Cu	F	Zn	Cr	Ni	Fe	MAXIMUM	MINIMUM
Z1	2.5930	0.2593 (0.2593)	0.00	0.09	-0.06	0.11	0.90	-0.11	0.34	0.26	0.84	0.92	5.765	-0.850
Z2	1.6230	0.1623 (0.4216)	0.06	0.89	0.15	0.87	-0.07	-0.17	-0.10	0.00	-0.04	-0.06	30.246	-0.593
Z3	1.1810	0.1181 (0.5397)	-0.18	0.09	-0.41	0.18	0.02	0.73	0.43	-0.46	-0.09	0.06	8.793	-11.628
Z4	1.0060	0.1006 (0.6403)	0.94	0.01	-0.05	-0.06	0.05	-0.05	0.11	-0.30	-0.04	0.03	22.313	-3.598
Z5	0.9930	0.0993 (0.7396)	-0.14	0.01	0.82	-0.10	0.07	-0.01	0.28	-0.45	-0.05	0.06	23.361	-2.941

ponents show a scattered distribution of high scores, and no promising zone could be specified.

5-2 JEGEDE ZONE

5-2-1 Soil Sampling

Soil sampling lines were set on north-south direction due to east-west occurrence of Jegede mineralized zone and B-horizon soil was taken. Soil colour in the zone reflects the basement geology.

Soils taken over the mafic granulite, felsic granulite, and gneissose granulite are 478, 139, and 658, respectively.

5-2-2 Indicators

A mineralized zone was found within the zone. Analytical results of the soils also poorly agreed with the observations which confirmed the sulphide mineralization in the field but continuous and promising Au anomalous zone was detected in the central portion of the zone.

The contents on geochemical indicators compared with all zones studied and Jegede zone are shown as follows.

JEGEDE ZONE

ROCK CODE	Au (PPB)	Ag (PPM)	As (PPM)	Bi (PPM)	Cu (PPM)	F (PPM)	Zn (PPM)	Cr (PPM)	Ni (PPM)	Fe (%)
ALL ZONES										
R.C.3	1.73	0.63	2.25	0.06	61.57	26.42	90.47	215.97	153.32	6.89
R.C.4	0.98	0.48	0.58	0.05	8.82	23.02	40.41	30.92	11.77	1.96
R.C.5	0.93	0.53	0.66	0.05	12.86	30.30	37.45	44.07	19.23	1.90
JEGEDE ZONE(SOIL)										
R.C.3	1.65	0.89	3.73	0.08	102.73	19.37	122.92	169.06	203.74	9.93
R.C.4	0.97	2.58	0.83	0.05	17.93	18.00	45.51	58.70	47.27	2.38
R.C.5	0.92	0.77	1.15	0.06	15.38	22.40	53.97	54.45	37.75	2.81

Background Geology and Indicator Content

Accordingly, geochemical characteristics for respective geological units are shown in TABLE 2-5-3. According to this table, geochemical characteristics on each indicator are summarized as follows:

Au : Geometric means(GMs) of rock code 3, rock code 4, and rock code 5 of all zones are 1.73, 0.89, and 0.93 ppb, respectively but rock code 3 in the zone has the largest value of 1.65 ppb.

A comparison on the contents of indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) was made. Au contents in the zone can be pointed out to be rather low. The maximum value in the zone is 1,490 ppb.

Ag : GMs of rock code 3, rock code 4, and rock code 5 of all zones are 0.63, 0.48, and 0.53 ppm, respectively but rock code 4 in the zone has the largest value of 2.58 ppm.

TABLE 2-5-3 Statistical Parameter of Indicators(Jegede Zone)

SOIL <ROCK 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(%)		THRESHOLD (PPM) Au(PPB)	Ag(PPM)	As(PPM)	Bi(PPM)	Cu(PPM)	F(PPM)	Zn(PPM)	Cr(PPM)	Ni(PPM)	Fe(%)	
MAFIC GRANULITE <3>	478	1.65	0.89	3.73	0.08	102.73	19.37	122.92	169.06	203.74	9.93	←g.m.	5.74	1.89	16.40	0.15	157	39	185	700	420	12.23	←g.m.+ s.d
													20.04	4.02	72.12	0.25	241	79	280	2,896	866	15.05	←g.m.+2 s.d.
		3.49	2.13	4.40	1.79	1.53	2.01	1.51	4.14	2.06	1.23	←s.d.	69.91	8.56	317.26	0.47	369	158	422	11,987	1,786	18.53	←g.m.+3 s.d.
FELSIC GRANULITE <4>	139	0.97	2.58	0.83	0.05	17.93	18.00	45.51	58.70	47.27	2.38	←g.m.	2.83	4.16	1.84	0.07	54	37	105	174	101	4.62	←g.m.+ s.d
													8.20	6.71	4.05	0.09	161	77	241	517	216	8.98	←g.m.+2 s.d.
		2.90	1.61	2.21	1.30	3.00	2.07	2.30	2.97	2.14	1.94	←s.d.	23.80	10.81	8.93	0.12	485	160	554	1,533	461	17.45	←g.m.+3 s.d.
GNEISSOSE GRANULITE <5>	658	0.92	0.77	1.15	0.06	15.38	22.40	53.97	54.45	37.75	2.81	←g.m.	2.54	2.12	4.07	0.09	73	49	125	181	160	6.96	←g.m.+ s.d
													6.97	5.82	14.40	0.14	346	106	291	599	681	17.23	←g.m.+2 s.d.
		2.75	2.75	3.54	1.54	4.74	2.18	2.32	3.32	4.25	2.48	←s.d.	19.13	16.00	51.01	0.21	1,640	232	677	1,989	2,890	42.65	←g.m.+3 s.d.

	NO. OF SAMPLE	MINIMUM VALUE (PPM) Au(PPB)	Ag(PPM)	As(PPM)	Bi(PPM)	Cu(PPM)	F(PPM)	Zn(PPM)	Cr(PPM)	Ni(PPM)	Fe(%)	MAXIMUM VALUE (PPM) Au(PPB)	Ag(PPM)	As(PPM)	Bi(PPM)	Cu(PPM)	F(PPM)	Zn(PPM)	Cr(PPM)	Ni(PPM)	Fe(%)
MAFIC GRANULITE <3>	478	0.50	0.25	0.50	0.05	10.00	10.00	19.00	1.00	27.00	1.69	854.00	9.30	200.00	0.70	401	190	774	2,240	880	14.55
FELSIC GRANULITE <4>	139	0.50	0.70	0.50	0.05	0.50	10.00	12.00	2.00	19.00	0.85	76.00	10.20	30.00	0.20	160	570	402	742	333	11.13
GNEISSOSE GRANULITE <5>	658	0.50	0.25	0.50	0.05	0.50	10.00	2.00	1.00	0.50	0.59	1,490	9.90	238.00	1.10	225	470	1,240	1,260	1,140	17.03

g.m. : geometric mean s.d. : standard deviation

ROCK CODE	Au (PPB)	Ag (PPM)	As (PPM)	Bi (PPM)	Cu (PPM)	F (PPM)	Zn (PPM)	Cr (PPM)	Ni (PPM)	Fe (%)
ALL ZONES										
R.C.3	1.73	0.63	2.25	0.06	61.57	26.42	90.47	215.97	153.32	6.89
R.C.4	0.98	0.48	0.58	0.05	8.82	23.02	40.41	30.92	11.77	1.96
R.C.5	0.93	0.53	0.66	0.05	12.86	30.30	37.45	44.07	19.23	1.90
JEGEDE ZONE (SOIL)										
R.C.3	1.65	0.89	3.73	0.08	102.73	19.37	122.92	169.06	203.74	9.93
R.C.4	0.97	2.58	0.83	0.05	17.93	18.00	45.51	58.70	47.27	2.38
R.C.5	0.92	0.77	1.15	0.06	15.38	22.40	53.97	54.45	37.75	2.81

ROCK TYPE	Au (PPB)	Ag (PPM)	As (PPM)	Bi (PPM)	Cu (PPM)	F (PPM)	Zn (PPM)	Cr (PPM)	Ni (PPM)	Fe (%)
MAFIC ROCK	4.00	0.10	2.00	0.01	100	370	130	200	160	8.56
INT. ROCK	----	0.07	2.40	0.01	35	500	72	50	55	5.85
FELSIC ROCK	4.50	0.05	1.50	0.01	20	800	6	25	8	2.70
GRANITE	1.00	0.05	0.25	0.43	12	1,250	85	7	5	1.85
MICA SCHIST	----	0.30	----	----	30	-----	70	70	50	4.90
					<After Flanagan(1976) & Vinogradov(1962)>					
JEGEDE ZONE (ROCK)										
R.C.3	0.50	0.25	1.41	0.05	132	95	54	240	138	5.42
R.C.4	2.00	0.25	0.50	0.05	5	69	46	2	15	1.13
R.C.5	0.50	0.25	1.00	0.05	10	182	54	2	19	1.60

INT. ROCK : INTERMEDIATE ROCK
---- : NO DATA

A comparison on contents of the indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) was made. Ag contents in the zone is rather high, with a maximum value of 10.20 ppm.

As : Since approximately 50 % of data indicated contents below its detection limit(1.00 ppm), it is difficult to clarify its geochemical character in the zone. Rock code 3 in the zone has the largest value of 3.73 ppm.
A comparison on contents of the indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) was made. As contents of the zone is nearly same, with maximum value of 238 ppm.

Bi : Since approximately 95 % of data indicated content below its detection limit(0.10 ppm), it is difficult to clarify its geochemical character in the zone.
A comparison on contents of the indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) was made. Bi contents in the zone is nearly the same. Maximum value in the zone is 1.10 ppm.

Cu : GMs of rock code 3, rock code 4, and rock code 5 of all zones are 61.57, 8.82, and 12.86 ppm, respectively but rock code 3 in the zone has the largest value of 102.73 ppm.
A comparison on contents of the indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) was made. Copper contents of the zone is nearly same as that of the areas compared. The maximum value in the zone is 401 ppm.

F : GMs of rock code 3, rock code 4 and rock code 5 of the zone are 26.42, 23.02, and 30.30 ppm, respectively but rock code 5 in the zone has the largest value of 22.40 ppm.
A comparison on contents of the indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) was made. F contents in the zone is fairly low, with maximum value of 570 ppm.

Zn : GMs of rock code 3, rock code 4, and rock code 5 of the zone are 90.47, 40.41, and 37.45 ppm, respectively but rock code 3 in the zone has the largest value of 122.92 ppm.
A comparison on contents of the indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) made clear that Zn contents in the zone is normal. The maximum value in the zone is 1,240 ppm.

Cr : GMs of rock code 3, rock code 4, and rock code 5 of the zone are 215.97, 30.92, and 44.07 ppm, respectively but rock code 5 in the zone has larger value of 169.06 ppm.
A comparison on contents of the indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) made clear that Cr contents of the zone is almost same. However, the indicator's values fluctuate greatly for rock types according to Flanagan's data. The maximum value in the zone is 2,240 ppm.

Ni : GMs of rock code 3, rock code 4, and rock code 5 of the zone are 153.32, 11.77, and 19.23 ppm but rock code 3 in the zone has the largest value of 203.74 ppm.

A comparison on contents of the indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) made clear that Ni contents of rock code 5 of the zone is almost the same for the area compared.

The maximum value in the zone is 1,140 ppm.

Fe : GMs of rock code 3, rock code 4, and rock code 5 of the zone are 6.89, 1.96, and 1.90 %, respectively but rock code 3 in the zone has the largest value of 9.93 %.

A comparison on contents of the indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) made clear that Fe contents in the zone is normal. The maximum value in the zone is 17.03 %.

Determination of Threshold Values

An interpretation was conducted on the cumulative frequency curve of Au in each geological unit. The results are summarized as follows:

Rock code 3 : Au shows a kind of dual distribution as shown in FIG.2-5-2. Geochemical values principally consist of two populations, that is, cumulative frequency of each population is about 40 %, and 60 %. The threshold value(GM + 2 δ)determined statistically corresponds to the upper 5 % level of the second population.

Rock code 4 : Au shows a kind of dual distribution as shown in FIG.2-5-2. Geochemical values principally consist of two populations, that is, cumulative frequency of each population is about 65 %, and 35 %. The threshold value(GM + 2 δ)determined corresponds to the upper 5 % level of the second population.

Rock code 5 : The cumulative frequency curve shows almost same characteristics to that of rock code 4 as shown in FIG.2-5-2.

However, it can be observed that the cumulative frequency curves of the second populations of 3 rock codes tend to show negative skewness.

2-2-3 Interpretation

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 2-5-4.

General characteristics of each geological unit are summarized below:

Rock code 3 : As shown in TABLE 2-5-4(1), the contribution ratio for the first principal component to all the principal components is about 25 %, occupying one

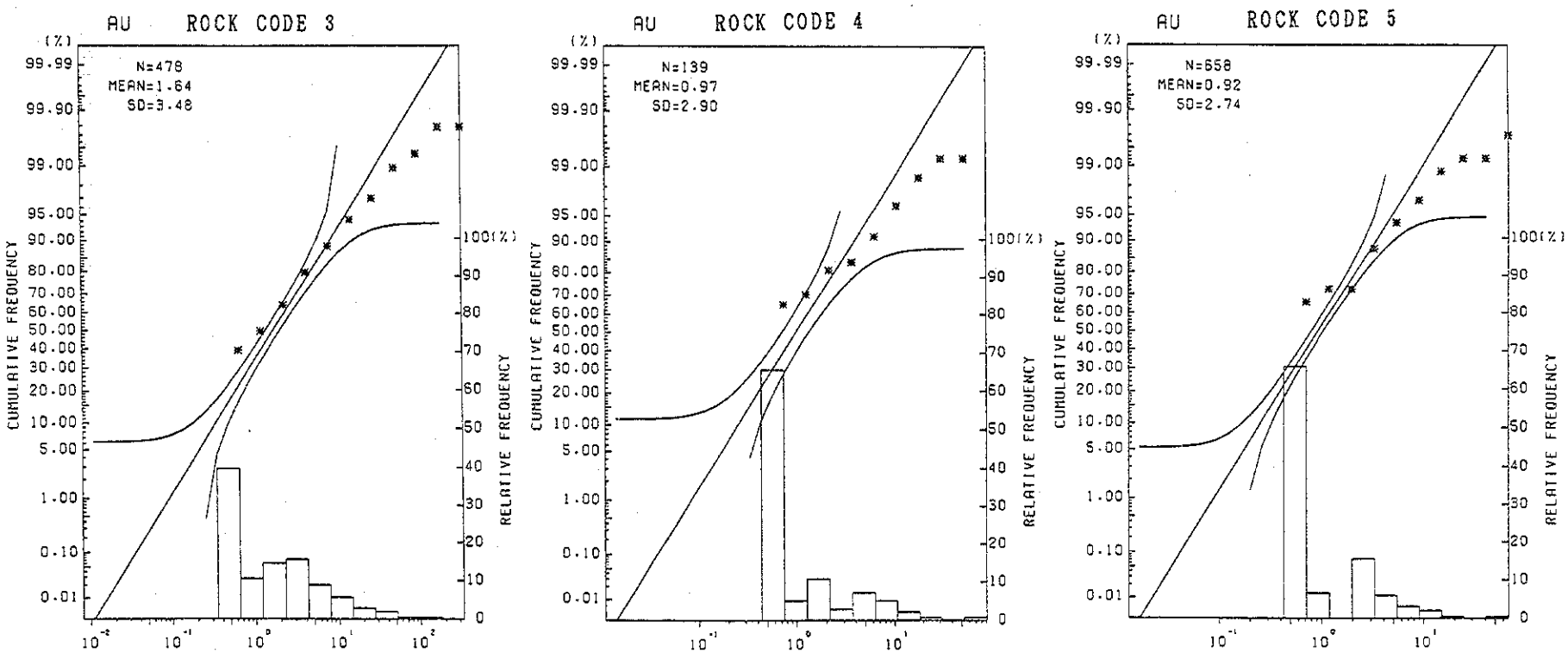

FIG. 2-5-2 Frequency Distribution and Cumulative Frequency Curve (Au;Jegede Zone)

fourth of all. The total to the ratio of the fifth principal component amounts to 74 % approximately, so that a greater part of the fluctuation of all the components can be explained by them. However, the contribution ratio of each component is general small and not decisive. Each component drops gradually and does not change markedly.

The summary of principal components intimately related to Au is as follows:

The second principal component is characterized by a strong correlation (0.71) of Au and medium correlation(0.48～0.55) with F, Zn, and Fe. Therefore, the principal component is worth notice for the exploration of gold although the contribution ratio is as small as 16 %.

The fourth principal component shows a medium correlation(0.47) with As and a negative medium correlation(-0.56) with Au.

Rock code 4 : As shown in TABLE 2-5-4(2), the contribution ratio for the first principal component to all the principal components is about 48%, occupying nearly half of all. The total to the ratio of the fifth principal component amounts to 90 % approximately, so that a greater part of the fluctuation of all the components can be explained by them. The contribution ratio of each principal is generally high. Each component, except for the first and the second components, drops gradually.

The summary of principal components intimately related to Au is as follows:

For the first principal component, Au, As, and Bi show medium correlations (0.46～0.68) and strong correlations(0.71～0.90) with Cu, Zn, Cr, and Fe. Therefore, the first principal component correlates to the indicators and reflects as high scores to the concentration of the indicators.

The second principal component is characterized by medium correlations (0.47 ～0.62) with Ag, and As. On the other hand, a negative medium correlation (-0.42) with Au. High scores and low negative scores are expected in the concentration of these indicators.

The third principal component has medium correlations(0.53～0.63) with Au, As, and Bi. Therefore, high scores are expected for the concentration of these indicators.

The fourth principal component is characterized by medium correlations (0.40 ～0.45) with Bi and F and a strong correlation(0.70) with Au. The component is worth notice for the gold exploration, although the contribution ratio is as low as 10 %.

Rock code 5 : As shown in TABLE 2-5-4(3), the contribution ratio for the first principal component to all the principal components is about 40 %. The total to the ratio of the fifth principal component amounts to 80 % approximately, to that a greater part of the fluctuation of all the components can be explained by them. However, the contribution ratio of each principal is rather high . Each component,

TABLE 2-5-4(1) Results of Principal Component Analysis(Jegede Zone:R.C. 3)

PRINCIPAL COMPONENT	EIGEN-VALUE	CONTRIBUTION RATIO	FACTOR LOADING										SCORE	
			Au	Ag	As	Bi	Cu	F	Zn	Cr	Ni	Fe	MAXIMUM	MINIMUM
Z1	2.5280	0.2528 (0.2528)	0.12	0.08	0.57	0.32	0.80	-0.36	0.59	0.62	0.72	0.25	5.511	-2.573
Z2	1.5950	0.1595 (0.4123)	0.71	-0.12	0.21	0.03	-0.03	0.55	0.54	-0.30	-0.34	0.48	5.059	-3.815
Z3	1.3900	0.1390 (0.5513)	0.02	0.77	0.16	0.59	-0.06	-0.07	0.24	-0.31	-0.20	-0.48	18.791	-0.995
Z4	1.0900	0.1090 (0.6603)	-0.56	-0.16	0.47	0.38	0.16	0.21	-0.29	-0.21	-0.20	0.38	1.975	-5.918
Z5	0.7900	0.0790 (0.7393)	-0.06	0.22	0.27	-0.17	-0.14	0.59	-0.10	0.46	0.06	-0.21	5.414	-2.181

TABLE 2-5-4(2) Results of Principal Component Analysis(Jegede Zone:R.C. 4)

PRINCIPAL COMPONENT	EIGEN-VALUE	CONTRIBUTION RATIO	FACTOR LOADING										SCORE	
			Au	Ag	As	Bi	Cu	F	Zn	Cr	Ni	Fe	MAXIMUM	MINIMUM
Z1	4.7740	0.4774 (0.4774)	0.46	-0.40	0.60	0.68	0.95	-0.01	0.73	0.71	0.91	0.90	4.679	-0.862
Z2	1.2210	0.1221 (0.5995)	-0.42	0.47	0.62	0.37	-0.09	0.19	0.39	-0.26	-0.14	-0.16	8.664	-1.909
Z3	1.0080	0.1008 (0.7003)	0.53	-0.17	0.60	0.63	-0.12	-0.21	0.01	-0.01	-0.04	-0.06	10.885	-1.132
Z4	0.9700	0.0970 (0.7973)	0.70	0.13	-0.10	0.40	0.00	0.45	-0.10	-0.23	-0.10	-0.16	5.428	-1.437
Z5	0.7820	0.0782 (0.8755)	0.02	0.72	-0.27	-0.24	0.12	0.09	0.02	0.09	0.26	0.20	10.868	-0.453

TABLE 2-5-4(3) Results of Principal Component Analysis(Jegede Zone:R.C. 5)

PRINCIPAL COMPONENT	EIGEN-VALUE	CONTRIBUTION RATIO	FACTOR LOADING										SCORE	
			Au	Ag	As	Bi	Cu	F	Zn	Cr	Ni	Fe	MAXIMUM	MINIMUM
Z1	3.9690	0.3969 (0.3969)	0.03	-0.48	0.65	0.53	0.91	0.23	0.54	0.66	0.80	0.90	4.779	-3.279
Z2	1.2930	0.1293 (0.5262)	0.13	0.50	0.53	0.56	-0.09	-0.60	-0.22	0.07	0.01	-0.13	14.615	-1.405
Z3	1.0620	0.1062 (0.6324)	0.62	-0.23	0.24	0.37	-0.11	0.47	0.07	-0.35	-0.23	-0.12	9.342	-4.121
Z4	0.9720	0.0972 (0.7296)	0.76	-0.60	-0.19	-0.36	0.07	-0.32	-0.15	0.28	0.14	0.07	14.434	-1.482
Z5	0.7970	0.0797 (0.8093)	0.13	0.36	-0.11	-0.07	0.03	-0.16	0.75	-0.22	-0.04	0.06	25.223	-1.050

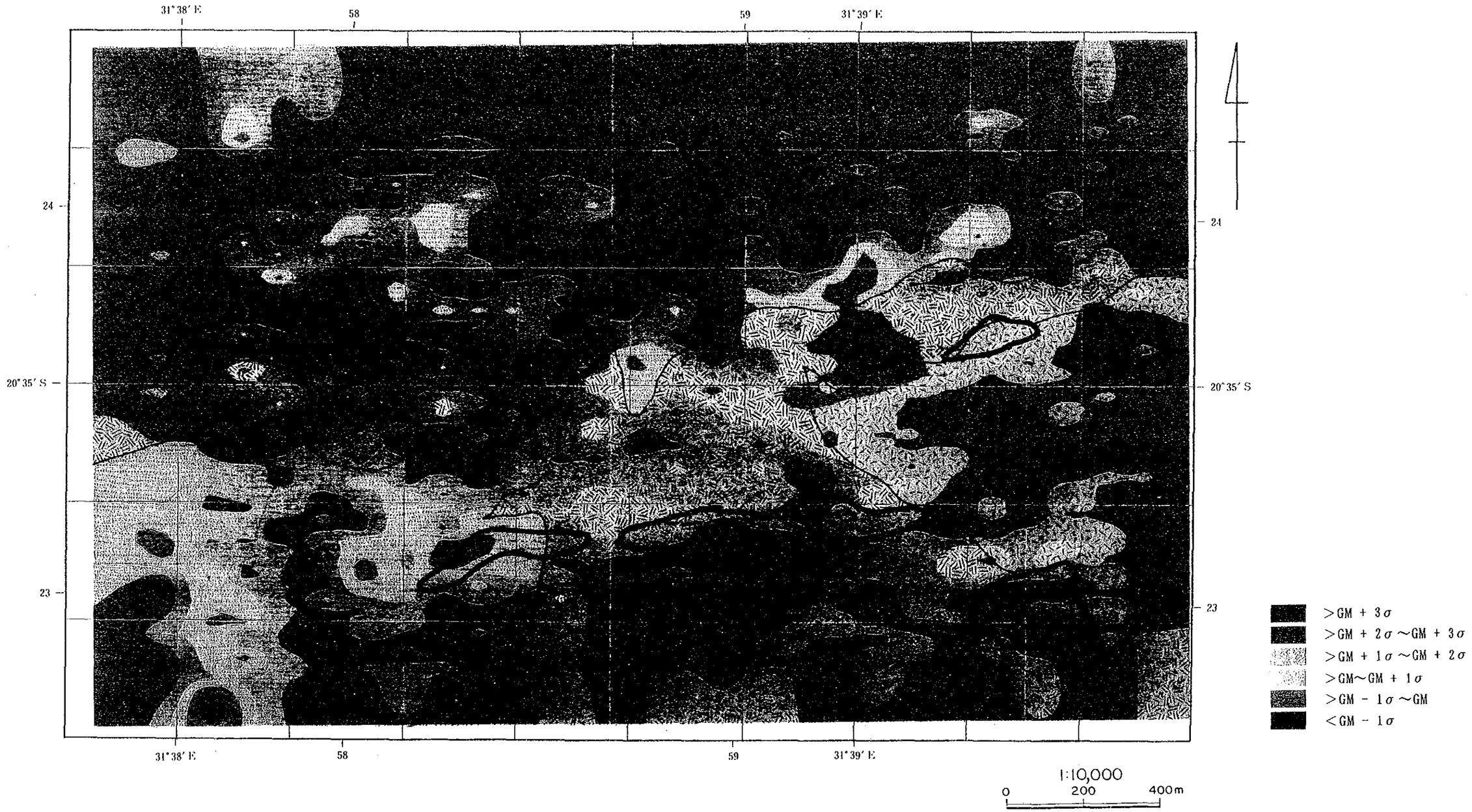

FIG. 2-5-3 Gold Distribution (Jegede Zone)

except for the first and second components, drops gradually.

The summary of principal components intimately related to Au is as follows:

The third principal component has medium correlations(0.53～0.65) with Au, and F. Therefore, high scores are expected for the concentration of these indicators.

The fourth principal component is characterized by a strong correlation (0.76) with Au, and a negative medium correlation(-0.60) with Ag. The component is worth notice for the gold exploration, although the contribution ratio is as low as 10%.

Au Concentration and Principal Component Scores

The concentration distribution of gold in this area, as shown in FIG. 2-5-3, indicates an anomalous zone (GM+ σ ～ GM+ σ 2) with good continuity in the ENE-WSW direction. As mentioned above, Jegede mineralized zone has been found in this zone, but no noteworthy anomalous zones were found in them. The center of the above anomalous zone was found to lie about 400m north of the mineralized zone. Since this anomalous zone is located geographically lower, it may be that it represents so-called hydromorphic anomalies in which Au has been transported from a higher portion, as suggested high mobility of Au by Krauskopf (1984), Mann (1984) and Webster and Mann (1984). In general, Au is stable as $Au^{\square}$ in natural conditions, but it becomes unstable in forms Au^{+} and Au^{++} forming complex compounds with $(CN)^{--}$, $(S_2 O_2)^{--}$ or carbonaceous materials. Moreover, it may be transported as a form of colloid.

From the figure showing a scattered distribution of high scores, no promising zone could be specified.

5-3 MUCHACHA ZONE

5-3-1 Soil Sampling

Soil sampling lines were set on north-south direction due to east-west occurrences of Muchacha mineralized zone and B-horizon soil was taken. Soil colour in the zone possibly reflects the basement geology.

Soils taken over the mafic granulite, felsic granulite, and gneissose granulite are 228, 56, and 622, respectively.

5-3-2 Indicators

Muchacha mineralized zone was found within the zone. Analytical results of the soils also poorly agreed with the observations which confirmed the sulphide mineralization in the field.

The contents on geochemical indicators compared with all zones studied Muchacha zone are shown as follows:

MUCHACHA ZONE

ROCK CODE	Au (PPB)	Ag (PPM)	As (PPM)	Bi (PPM)	Cu (PPM)	F (PPM)	Zn (PPM)	Cr (PPM)	Ni (PPM)	Fe (%)
ALL ZONES										
R.C.3	1.73	0.63	2.25	0.06	61.57	26.42	90.47	215.97	153.32	6.89
R.C.4	0.98	0.48	0.58	0.05	8.82	23.02	40.41	30.92	11.77	1.96
R.C.5	0.93	0.53	0.66	0.05	12.86	30.30	37.45	44.07	19.23	1.90
MUCHACHA ZONE (SOIL)										
R.C.3	1.50	0.34	5.38	0.09	33.74	25.97	59.03	163.97	75.45	5.09
R.C.4	0.69	0.33	0.58	0.05	5.74	15.24	25.48	77.32	11.48	1.55
R.C.5	0.72	0.46	0.73	0.05	6.55	20.61	22.22	53.07	21.69	1.53

Background Geology and Indicator Content

Accordingly, geochemical characteristics for respective geological units are shown in TABLE 2-5-5. According to this table, geochemical characteristics on each element are summarized as follows:

Au : Geometric means(GMs) of rock code 3, rock code 4, and rock code 5 of all zones are 1.73, 0.89, and 0.93 ppb, respectively but rock code 3 in the zone has the largest value of 1.50 ppb.

A comparison on the content of indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) was made. Au contents in the zone can be pointed out to be rather low. The maximum value in the zone is 27 ppb.

Ag : GMs of rock code 3, rock code 4, and rock code 5 of all zones are 0.63, 0.48, and 0.53 ppm, respectively but rock code 5 in the zone has the largest value of 0.46 ppm.

A comparison on contents of the indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) was made. Ag contents in the zone rather high, with a maximum value of 14.20 ppm.

As : Since approximately 60 % of data except rock code 3 indicated content below its detection limit(1.00 ppm), it is difficult to clarify its geochemical character in the zone.

Rock code 3 in the zone has the largest value of 5.38 ppm. On the other hand, the smallest GM is 0.58 ppm of rock code 4. A comparison on content of the indicator between the zone and other area based on data by Flanagan(1976) and Vinogradov (1962) was made. As contents of rock code 3 in the zone is rather high, with maximum value of 1,120 ppm.

Bi : Since approximately 90 % of data except rock code 3 indicated content below its detection limit(0.10 ppm), it is difficult to clarify its geochemical character in the zone.

A comparison on contents of the indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) was made. Bi contents in the zone is nearly the same. Maximum value in the zone is 1.00 ppm.

Cu : GMs of rock code 3, rock code 4, and rock code 5 of all zones are 61.57,

TABLE 2-5-5 Statistical Parameter of Indicators(Muchacha Zone)

SOIL <ROCK 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(%)		THRESHOLD (PPM) Au(PPB)	Ag(PPM)	As(PPM)	Bi(PPM)	Cu(PPM)	F(PPM)	Zn(PPM)	Cr(PPM)	Ni(PPM)	Fe(%)	
													4.74	0.53	41.73	0.18	155	54	197	527	349	14.70	←g.m.+ s.d
MAFIC GRANULITE	228	1.50	0.34	5.38	0.09	33.74	25.97	59.03	163.97	75.45	5.09	←g.m.	14.98	0.82	323.59	0.40	714	111	656	1,695	1,619	42.49	←g.m.+2 s.d.
<3>		3.16	1.56	7.75	2.17	4.60	2.07	3.33	3.22	4.63	2.89	←s.d.	47.36	1.27	2.509	0.87	3.284	230	2.185	5.449	7.498	——	←g.m.+3 s.d.
													1.38	0.50	0.77	0.06	11	27	78	135	19	2.31	←g.m.+ s.d
FELSIC GRANULITE	56	0.69	0.33	0.58	0.05	5.74	15.24	25.48	77.32	11.48	1.55	←g.m.	2.76	0.74	1.03	0.06	20	47	236	236	32	3.43	←g.m.+2 s.d.
<4>		2.00	1.49	1.33	1.14	1.85	1.75	3.04	1.75	1.66	1.49	←s.d.	5.52	1.10	1.37	0.07	36	82	717	413	52	5.10	←g.m.+3 s.d.
													1.42	1.10	1.36	0.07	16	41	49	173	42	2.49	←g.m.+ s.d
GNEISSOSE GRANULITE	622	0.72	0.46	0.73	0.05	6.55	20.61	22.22	53.07	21.59	1.53	←g.m.	2.80	2.64	2.54	0.09	38	83	106	562	81	4.06	←g.m.+2 s.d.
<5>		1.97	2.39	1.86	1.26	2.41	2.01	2.18	3.26	1.93	1.63	←s.d.	5.53	6.31	4.72	0.11	92	168	231	1,830	157	6.62	←g.m.+3 s.d.

	NO. OF SAMPLE	MINIMUM VALUE (PPM) Au(PPB)	Ag(PPM)	As(PPM)	Bi(PPM)	Cu(PPM)	F(PPM)	Zn(PPM)	Cr(PPM)	Ni(PPM)	Fe(%)	MAXIMUM VALUE (PPM) Au(PPB)	Ag(PPM)	As(PPM)	Bi(PPM)	Cu(PPM)	F(PPM)	Zn(PPM)	Cr(PPM)	Ni(PPM)	Fe(%)
MAFIC GRANULITE <3>	228	0.50	0.25	0.50	0.05	2.00	10.00	3.00	1.00	5.00	0.87	23.00	1.50	1,120	1.00	302	150	349	3,950	1,820	17.20
FELSIC GRANULITE <4>	56	0.50	0.25	0.50	0.05	1.00	10.00	0.50	19.00	5.00	0.67	7.00	0.80	1.00	0.10	22	68	92	310	56	2.91
GNEISSOSE GRANULITE <5>	622	0.50	0.25	0.50	0.05	0.50	10.00	0.50	0.50	5.00	0.41	27.00	14.20	15.00	0.30	149	310	159	777	372	12.08

g.m. : geometric mean s.d. : standard deviation

ROCK CODE	Au (PPB)	Ag (PPM)	As (PPM)	Bi (PPM)	Cu (PPM)	F (PPM)	Zn (PPM)	Cr (PPM)	Ni (PPM)	Fe (%)
ALL ZONES										
R.C.3	1.73	0.63	2.25	0.06	61.57	26.42	90.47	215.97	153.32	6.89
R.C.4	0.98	0.48	0.58	0.05	8.82	23.02	40.41	30.92	11.77	1.96
R.C.5	0.93	0.53	0.66	0.05	12.86	30.30	37.45	44.07	19.23	1.90
MUCHACHA ZONE (SOIL)										
R.C.3	1.50	0.34	5.38	0.09	33.74	25.97	59.03	163.97	75.45	5.09
R.C.4	0.69	0.33	0.58	0.05	5.74	15.24	25.48	77.32	11.48	1.55
R.C.5	0.72	0.46	0.73	0.05	6.55	20.61	22.22	53.07	21.69	1.53

ROCK TYPE	Au (PPB)	Ag (PPM)	As (PPM)	Bi (PPM)	Cu (PPM)	F (PPM)	Zn (PPM)	Cr (PPM)	Ni (PPM)	Fe (%)
MAFIC ROCK	4.00	0.10	2.00	0.01	100	370	130	200	160	8.56
INT. ROCK	----	0.07	2.40	0.01	35	500	72	50	55	5.85
FELSIC ROCK	4.50	0.05	1.50	0.01	20	800	6	25	8	2.70
GRANITE	1.00	0.05	0.25	0.43	12	1.250	85	7	5	1.85
MICA SCHIST	----	0.30	----	----	30	----	70	70	50	4.90
					<After Flanagan(1976) & Vinogradov(1962)>					
MUCHACHA ZONE (ROCK)										
R.C.3	0.50	0.25	2.00	0.05	123	60	63	1	84	7.33
R.C.4	1.00	0.25	2.00	0.05	4	31	21	5	12	0.32
R.C.5	0.50	0.25	1.00	0.05	14	234	79	1	39	2.67

INT. ROCK : INTERMEDIATE ROCK
---- : NO DATA

8.82, and 12.86 ppm, respectively but rock code 3 in the zone has the largest value of 33.74 ppm.

A comparison on contents of the indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) was made. Copper content in rock code 3 and rock code 5 of the zone is nearly the same as the areas compared.

The maximum value in the zone is 302 ppm.

F : GMs of rock code 3, rock code 4, and rock code 5 of all zones are 26.42, 23.02, and 30.30 ppm, respectively but rock code 3 in the zone has largest value of 25.79 ppm.

A comparison on contents of the indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) was made. F contents in the zone is fairly low, with maximum value of 310 ppm.

Zn : GMs of rock code 3, rock code 4, and rock code 5 of all zones are 90.47, 40.41, and 37.45 ppm, respectively but rock code 3 in the zone has the largest value of 59.03 ppm.

A comparison on contents of the indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) made clear that Zn contents in the zone is fairly low. The maximum value in the zone is 349 ppm.

Cr : GMs of rock code 3, rock code 4 and rock code 5 of all zones are 215.97, 30.92, and 44.07 ppm, respectively but rock code 3 in the zone has the largest value of 163.97 ppm.

A comparison on contents of the indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) made clear that Cr contents of rock code 5 of the zone is almost same. However, the indicator's values fluctuate greatly for rock types according to Flanagan's data. The maximum value in the zone is 3,950 ppm.

Ni : GMs of rock code 3, rock code 4, and rock code 5 of all zones are 153.32, 11.77, and 19.23 ppm but rock code 3 in the zone has the largest value of 75.45 ppm.

A comparison on contents of the indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) made clear that Ni contents of rock code 5 of the zone is almost the same for the area compared. However, values of Flanagan's data fluctuate greatly for various rock types. The maximum value in the zone is 1,820 ppm.

Fe : GMs of rock code 3, rock code 4, and rock code 5 of all zones are 6.89, 1.96, and 1.90 %, respectively but rock code 3 in the zone has the largest value of 5.09 %.

A comparison on contents of the indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) made clear that Fe contents in the zone is normal. The maximum value in the zone is 17.02 %.

Determination of Threshold Values

An interpretation was conducted on the cumulative frequency curve of Au in each geological unit. The results are summarized as follows:

Rock code 3 : Au shows a kind of dual distribution as shown in FIG.2-5-4. Geochemical values principally consist of two populations, that is, cumulative frequency of each population is about 55 %, and 45 %. The threshold value(GM + 2δ) determined statistically corresponds to the upper 8 % level of the second population. The cumulative frequency curve of the second population shows a tendency of positive skewness.

Rock code 4 : Au shows a kind of dual distribution as shown in FIG.2-5-4. Geochemical values consist of principally two populations, that is, cumulative frequency of each population is about 90 %, and 10 %. The threshold value(GM + 2δ) determined statistically corresponds near the median value of the second population.

Rock code 5 : The cumulative frequency curve shows almost same characteristics to that of rock code 4 as shown in FIG.2-5-4.

5-3-3 Interpretation

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 2-5-6.

General characteristics of principal components intimately related to Au are summarized below:

Rock code 3 : As shown in TABLE 2-5-6(1), the contribution ratio for the first principal component to all the principal components is about 44 %, occupying nearly half of all. The total to the ratio of the fifth principal component amounts to 90 % 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 large. Each component, except for the first component, drops gradually and this code is characterized by the large contribution ratio of the first component.

For the first principal component, Au, As, Bi, and Cr show medium correlation values of 0.57～0.68. On the other hand Cu, Zn, Ni and Fe have strong correlations of 0.86～0.92. Therefore, the first principal component is characterized by high concentration of these indicators.

The second principal component is characterized by medium correlations of Au and Bi and a strong correlation(0.72) with As. On the other hand, Cr and Ni have

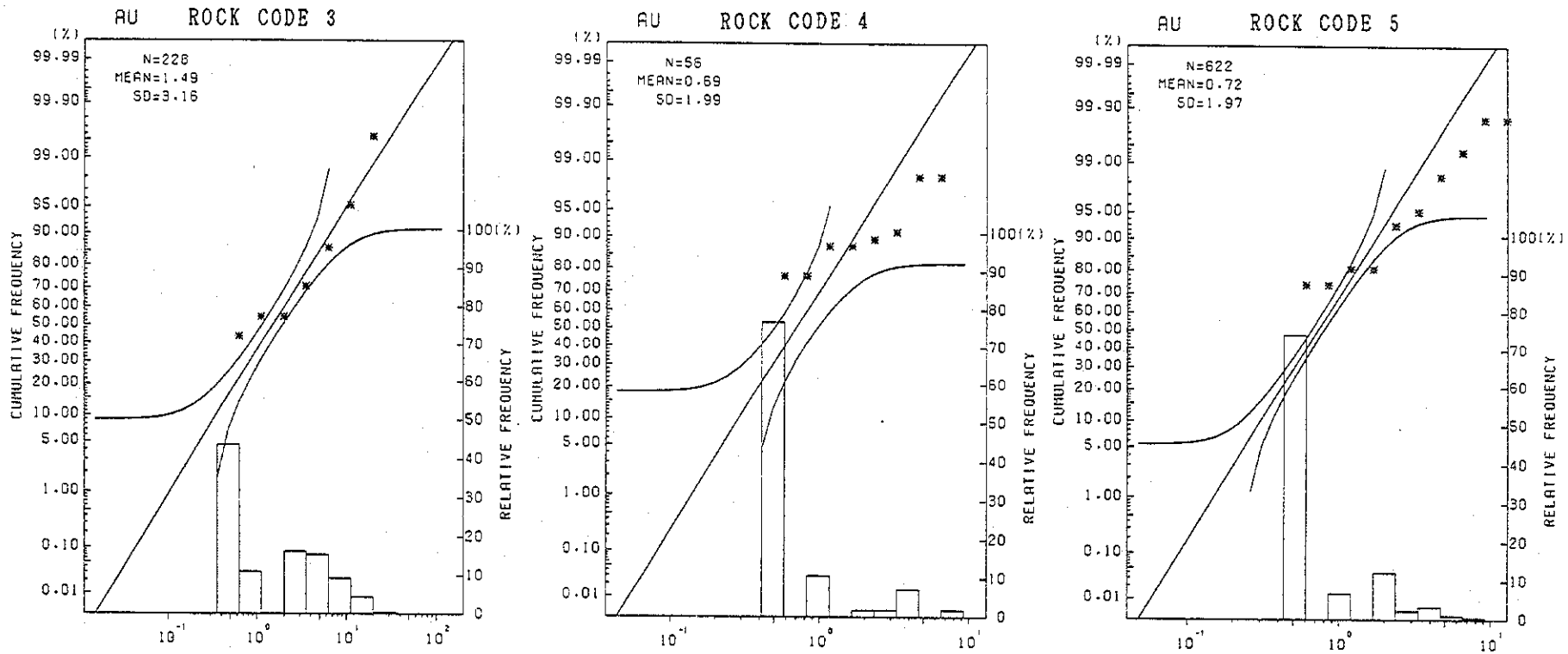

FIG. 2-5-4 Frequency Distribution and Cumulative Frequency Curve (Au;Muchacha Zone)

negative medium correlations(-0.46~-0.52) for the component.

Rock code 4 : As shown in TABLE 2-5-6(2), the contribution ratio for the first principal component to all the principal components is about 28 %, occupying less than one third of all. The total to the ratio of the fifth principal component amounts to 80 % 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 not so big and not decisive. Each component, except the first principal component, drops gradually and does not change markedly.

General characteristics of principal components intimately related to Au are summarized below:

The second principal component is characterized by medium correlations (0.43 ~0.64) with Au, Zn, and Cr. On the other hand, negative medium correlations (-0.43 ~-0.53) with As and Ni. High scores and low negative scores are expected in the concentration of these indicators.

The third principal component has medium correlations(0.58~0.59) with Au, and Bi and a negative medium correlation(-0.56) with Zn.

Rock code 5 : As shown in TABLE 2-5-6(3), the contribution ratio for the first principal component to all the principal components is about 41 %, occupying nearly half of all. The total to the ratio of the fifth principal component amounts to 84 % approximately, so that a greater part of the fluctuation of all components can be explained by them. However, the contribution ratio of each principal is rather large. Each component, except for the first principal component, drops gradually.

General characteristics of principal components intimately related to Au are summarized below:

The fifth principal component show only a strong correlation(0.77) with Au and a negative medium correlation(-0.46) with F. The component is worth notice for the gold exploration, although the contribution ratio is as low as 9 %.

Au Concentration and Principal Component Scores

The concentration distribution of Au in the surveyed zone indicates no anomalous zone with good continuity. Since a Muchacha mineralized zone has been found in this zone, it was expected that an association between this zone and geochemical anomalies would be found. However, no noteworthy anomalous zone was found by geochemical soil exploration around the mineralized zone.

No special relationship was found between geochemical anomalies and geology for mafic granulite, felsic granulite and gneissose granulite distributed in this area.

Principal components highly related to Au are the second component for code 3, the third component for code 4 and the fifth component for code 5.
From the figure showing scattered distribution of high scores, no promising zone

TABLE 2-5-6(1) Results of Principal Component Analysis(Muchacha Zone:R.C. 3)

PRINCIPAL COMPONENT	EIGEN-VALUE	CONTRIBUTION RATIO	FACTOR LOADING										SCORE	
			Au	Ag	As	Bi	Cu	F	Zn	Cr	Ni	Fe	MAXIMUM	MINIMUM
Z1	4.4120	0.4412 (0.4412)	0.57	-0.15	0.58	0.68	0.86	-0.10	0.92	0.63	0.74	0.86	2.230	-1.604
Z2	1.7200	0.1720 (0.6132)	0.52	-0.03	0.72	0.56	-0.18	0.24	-0.12	-0.46	-0.52	-0.17	8.735	-1.014
Z3	1.1280	0.1128 (0.7260)	0.26	0.74	0.02	0.00	-0.04	-0.70	0.07	0.02	-0.04	-0.15	6.815	-1.630
Z4	0.8950	0.0895 (0.8155)	-0.08	0.64	-0.06	-0.09	0.09	0.60	0.14	-0.14	-0.03	0.23	5.159	-1.027
Z5	0.7610	0.0761 (0.8916)	0.32	0.08	0.07	-0.07	-0.35	0.28	-0.11	0.53	0.25	-0.29	4.483	-1.041

TABLE 2-5-6(2) Results of Principal Component Analysis(Muchacha Zone:R.C. 4)

PRINCIPAL COMPONENT	EIGEN-VALUE	CONTRIBUTION RATIO	FACTOR LOADING										SCORE	
			Au	Ag	As	Bi	Cu	F	Zn	Cr	Ni	Fe	MAXIMUM	MINIMUM
Z1	2.7830	0.2783 (0.2783)	0.29	-0.15	0.18	0.45	0.85	0.06	0.62	0.16	0.75	0.86	3.409	-2.001
Z2	1.5490	0.1549 (0.4332)	0.53	0.14	-0.53	-0.17	-0.25	0.21	0.43	0.64	-0.43	0.23	2.114	-1.431
Z3	1.3410	0.1341 (0.5673)	0.59	-0.24	0.10	0.58	0.12	-0.21	-0.56	0.36	-0.06	-0.28	3.876	-1.180
Z4	1.2250	0.1225 (0.6898)	0.06	-0.66	0.07	0.15	-0.14	0.82	0.04	-0.23	-0.12	-0.02	2.768	-2.701
Z5	1.0130	0.1013 (0.7911)	0.29	0.58	0.50	0.28	-0.25	0.20	0.05	-0.28	-0.22	0.19	2.217	-2.474

TABLE 2-5-6(3) Results of Principal Component Analysis(Muchacha Zone:R.C. 5)

PRINCIPAL COMPONENT	EIGEN-VALUE	CONTRIBUTION RATIO	FACTOR LOADING										SCORE	
			Au	Ag	As	Bi	Cu	F	Zn	Cr	Ni	Fe	MAXIMUM	MINIMUM
Z1	4.1260	0.4126 (0.4126)	0.32	-0.03	0.59	0.36	0.95	0.07	0.83	0.53	0.89	0.94	7.649	-1.331
Z2	1.3240	0.1324 (0.5450)	0.28	0.56	0.56	0.63	-0.08	0.00	-0.09	-0.41	-0.16	-0.13	10.011	-1.488
Z3	1.0890	0.1089 (0.6539)	0.35	-0.48	-0.10	0.24	0.00	0.80	-0.03	-0.15	-0.06	-0.04	8.816	-2.862
Z4	0.9570	0.0957 (0.7496)	0.22	0.56	-0.26	-0.50	0.05	0.32	0.13	-0.33	0.15	0.15	10.168	-1.816
Z5	0.9010	0.0901 (0.8397)	0.77	-0.23	-0.05	-0.16	-0.01	-0.46	0.04	-0.08	-0.07	-0.05	16.998	-2.394

could be specified.

5-4 BENZI ZONE

5-4-1 Soil Sampling

Soil sampling lines were set on north-south direction due to east-west occurrences of mineralized signs such as Fe-hydroxide, pegmatite quartz etc. and B-horizon soils were taken. Soil colour in the zone poorly reflects the basement geology. Soils taken over the mafic granulite, felsic granulite, and gneissose granulite are 123, 157, and 448, respectively.

5-4-2 Indicators

Several mineralized signs were found within the zone. Analytical results of the soils also roughly agreed with the observations which confirmed the sulphide mineralization in the field. The contents on geochemical indicators compared with other area and all studied zone by phase II are shown as follows.

BENZI ZONE

ROCK CODE	Au (PPB)	Ag (PPM)	As (PPM)	Bi (PPM)	Cu (PPM)	F (PPM)	Zn (PPM)	Cr (PPM)	Ni (PPM)	Fe (%)
ALL ZONES										
R.C.3	1.73	0.63	2.25	0.06	61.57	26.42	90.47	215.97	153.32	6.89
R.C.4	0.98	0.48	0.58	0.05	8.82	23.02	40.41	30.92	11.77	1.96
R.C.5	0.93	0.53	0.66	0.05	12.86	30.30	37.45	44.07	19.23	1.90
BENZI ZONE(SOIL)										
R.C.3	3.24	0.57	0.60	0.06	14.88	24.05	37.17	33.32	25.12	3.10
R.C.4	2.00	1.23	0.50	0.05	11.27	26.62	65.97	15.63	12.07	3.77
R.C.5	2.06	0.79	0.59	0.06	10.90	25.27	49.53	25.99	16.16	2.65

Background Geology and Indicator Content

Accordingly, geochemical characteristics for respective geological units are shown in TABLE 2-5-7. According to this table, geochemical characteristics on each element are summarized as follows:

Au : Geometric means(GMs) of rock code 3, rock code 4, and rock code 5 of all zones are 1.73, 0.98, and 0.93 ppb, respectively but rock code 3 in the zone has the largest value of 3.24 ppb.

A comparison on the content of indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) was made. Au content in the zone can be pointed out to be rather low. The maximum value in the zone is 922 ppb.

Ag : GMs of rock code 3, rock code 4, and rock code 5 of all zones are 0.63, 0.48, and 0.53 ppm, respectively but rock code 4 in the zone has the largest value of 1.23 ppm.

A comparison on content of the indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) was made. Ag content in the zone is higher than that of the areas, with a maximum value of 5.10 ppm.

As : Since approximately 60 % of data indicated content below its detection limit(1.00 ppm), it is difficult to clarify its geochemical character in the zone.

TABLE 2-5-7 Statistical Parameter of Indicators(Benzi Zone)

SOIL <ROCK 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(%)		THRESHOLD (PPM) Au(PPB)	Ag(PPM)	As(PPM)	Bi(PPM)	Cu(PPM)	F(PPM)	Zn(PPM)	Cr(PPM)	Ni(PPM)	Fe(%)	
													22.73	0.85	0.96	0.10	28	50	64	84	51	4.14	←g.m.+ s.d
MAFIC GRANULITE	123	3.24	0.57	0.60	0.06	14.88	24.05	37.17	33.32	25.12	3.10	←g.m.	159.74	1.28	1.54	0.16	53	103	110	211	104	5.54	←g.m.+2 s.d.
<3>		7.03	1.50	1.61	1.66	1.88	2.07	1.72	2.52	2.03	1.34	←s.d.	1.122	1.92	2.46	0.26	99	214	188	532	211	7.41	←g.m.+3 s.d.
													8.56	2.08	0.53	0.05	19	59	136	48	21	5.95	←g.m.+ s.d
FELSIC GRANULITE	157	2.00	1.23	0.50	0.05	11.27	26.62	65.97	15.63	12.07	3.77	←g.m.	36.75	3.51	0.56	0.06	33	133	279	145	35	9.39	←g.m.+2 s.d.
<4>		4.29	1.69	1.06	1.06	1.72	2.23	2.06	3.05	1.74	1.58	←s.d.	157.73	5.94	0.59	0.06	57	296	573	441	63	14.83	←g.m.+3 s.d.
													9.44	1.31	0.91	0.09	19	55	87	75	32	4.14	←g.m.+ s.d
GNEISSOSE GRANULITE	448	2.06	0.79	0.59	0.06	10.90	25.27	49.53	25.99	16.16	2.65	←g.m.	43.25	2.19	1.40	0.15	34	119	152	216	64	6.49	←g.m.+2 s.d.
<5>		4.58	1.67	1.54	1.57	1.76	2.17	1.75	2.88	1.99	1.57	←s.d.	198.20	3.67	2.15	0.23	59	259	267	623	128	10.16	←g.m.+3 s.d.

	NO. OF SAMPLE	MINIMUM VALUE (PPM) Au(PPB)	Ag(PPM)	As(PPM)	Bi(PPM)	Cu(PPM)	F(PPM)	Zn(PPM)	Cr(PPM)	Ni(PPM)	Fe(%)	MAXIMUM VALUE (PPM) Au(PPB)	Ag(PPM)	As(PPM)	Bi(PPM)	Cu(PPM)	F(PPM)	Zn(PPM)	Cr(PPM)	Ni(PPM)	Fe(%)
MAFIC GRANULITE <3>	123	0.50	0.25	0.50	0.05	4.00	10.00	7.00	6.00	2.00	1.42	922.00	1.20	3.00	1.50	162	230	165	604	252	6.75
FELSIC GRANULITE <4>	157	0.50	0.25	0.50	0.05	3.00	10.00	6.00	1.00	4.00	1.10	753.00	3.20	1.00	0.10	45	240	222	193	97	8.72
GNEISSOSE GRANULITE <5>	448	0.50	0.25	0.50	0.05	2.00	10.00	6.00	1.00	3.00	0.87	848.00	5.10	3.00	0.60	51	520	287	679	258	8.64

g.m. : geometric mean s.d. : standard deviation

ROCK CODE	Au (PPB)	Ag (PPM)	As (PPM)	Bi (PPM)	Cu (PPM)	F (PPM)	Zn (PPM)	Cr (PPM)	Ni (PPM)	Fe (%)
ALL ZONES										
R.C.3	1.73	0.63	2.25	0.06	61.57	26.42	90.47	215.97	153.32	6.89
R.C.4	0.98	0.48	0.58	0.05	8.82	23.02	40.41	30.92	11.77	1.96
R.C.5	0.93	0.53	0.66	0.05	12.86	30.30	37.45	44.07	19.23	1.90
BENZI ZONE (SOIL)										
R.C.3	3.24	0.57	0.60	0.06	14.88	24.05	37.17	33.32	25.12	3.10
R.C.4	2.00	1.23	0.50	0.05	11.27	26.62	65.97	15.63	12.07	3.77
R.C.5	2.06	0.79	0.59	0.06	10.90	25.27	49.53	25.99	16.16	2.65

ROCK TYPE	Au (PPB)	Ag (PPM)	As (PPM)	Bi (PPM)	Cu (PPM)	F (PPM)	Zn (PPM)	Cr (PPM)	Ni (PPM)	Fe (%)
MAFIC ROCK	4.00	0.10	2.00	0.01	100	370	130	200	160	8.56
INT. ROCK	----	0.07	2.40	0.01	35	500	72	50	55	5.85
FELSIC ROCK	4.50	0.05	1.50	0.01	20	800	6	25	8	2.70
GRANITE	1.00	0.05	0.25	0.43	12	1,250	85	7	5	1.85
MICA SCHIST	----	0.30	----	----	30	-----	70	70	50	4.90
					<After Flanagan(1976) & Vinogradov(1962)>					
BENZI ZONE (ROCK)										
R.C.3	0.50	0.25	1.00	0.05	28	186	66	234	151	5.15
R.C.4	0.50	0.25	1.00	0.05	3	39	19	10	6	0.58
R.C.5	0.63	0.25	1.58	0.05	3	22	40	30	11	1.05

INT. ROCK : INTERMEDIATE ROCK
---- : NO DATA

Rock code 3 in the zone has the largest value of 0.60 ppm and other rock codes of the zone also have similar contents.
A comparison on content of the indicator between the zone and other area based on data by Flanagan(1976) and Vinogradov(1962) was made. Content of rock code 3 in the zone is fairly low, with maximum value of 3 ppm.

Bi : Since approximately 80 % of data indicated content below its detection limit(0.10 ppm), it is difficult to clarify its geochemical character in the zone.
GMs of all zones are 0.06, 0.05, and 0.05 ppm, respectively.
A comparison on content of the indicator between the zone and other area based on data by Flanagan(1976) and Vinogradov(1962) was made. Content in the zone is nearly the same. Maximum value in the zone is 1.50 ppm.

Cu : GMs of rock code 3, rock code 4, and rock code 5 of all zones are 61.57, 8.82, and 12.86 ppm, respectively but rock code 3 in the zone has the largest value of 14.88 ppm.
A comparison on content of the indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) was made. Copper contents of the zone are fairly low for the that of the areas compared. The maximum value in the zone is 162 ppm.

F : GMs of rock code 3, rock code 4, and rock code 5 of the zone are 26.42, 23.02, and 30.30 ppm, respectively but rock code 4 in the zone has the largest value of 26.62 ppm.
A comparison on content of the indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) was made. F content in the zone is fairly low, with maximum value of 520 ppm.

Zn : GMs of rock code 3, rock code 4, and rock code 5 of the zone are 90.47, 40.41, and 37.45 ppm, respectively but rock code 4 in the zone has the largest value of 65.97 ppm.
A comparison on content of the indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) made clear that Zn content in the zone is rather low compared with that of the areas. The maximum value in the zone is 287 ppm.

Cr : GMs of rock code 3, rock code 4, and rock code 5 of the zone are 215.97, 30.92, and 44.07 ppm, respectively but rock code 3 in the zone has the largest value of 33.32 ppm.
A comparison on content of the indicator between the zone and other areas based on data by Flanagan(1976) and Vinogradov(1962) made clear that Cr contents of the zone is rather low. However, the indicator's values fluctuate greatly for rock types according to Flanagan's data. The maximum value in the zone is 679 ppm.

Ni : GMs of rock code 3, rock code 4, and rock code 5 of the zone are 153.32, 11.77, and 19.23 ppm but rock code 3 in the zone has the largest value of 25.12