No. 34

REPORT
ON
THE COOPERATIVE MINERAL EXPLORATION
IN
THE VITI LEVU AREA,
THE REPUBLIC OF FIJI

PHASE II

FEBRUARY 1992

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

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PREFACE

In response to the request of the Government of the Republic of Fiji, the Japanese Government decided to conduct a Mineral Exploration Project in Viti Levu Area and entrusted the survey to Japan International Cooperation Agency (JICA) and Metal Mining Agency of Japan (MMAJ).

The JICA and MMAJ sent to the Republic of Fiji a survey team headed by Mr.Masaaki Sugawara from 10th June to 26th December,1991.

The team exchanged views with the officials concerned of the Government of the Republic of Fiji and conducted a field survey in the Viti Levu area. After the team returned to Japan, further studies were made and the present report has been prepared.

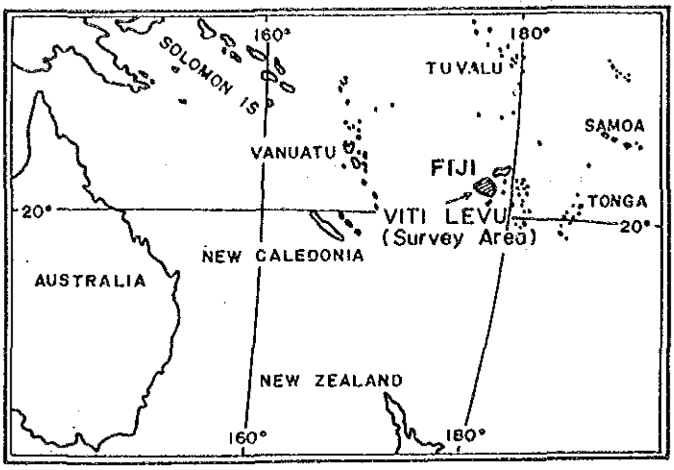
We hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

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

February, 1992

Kensuke YANAGIYA
President,
Japan International Cooperation Agency

Gen-ichi FUKUHARA
President,
Metal Mining Agency of Japan



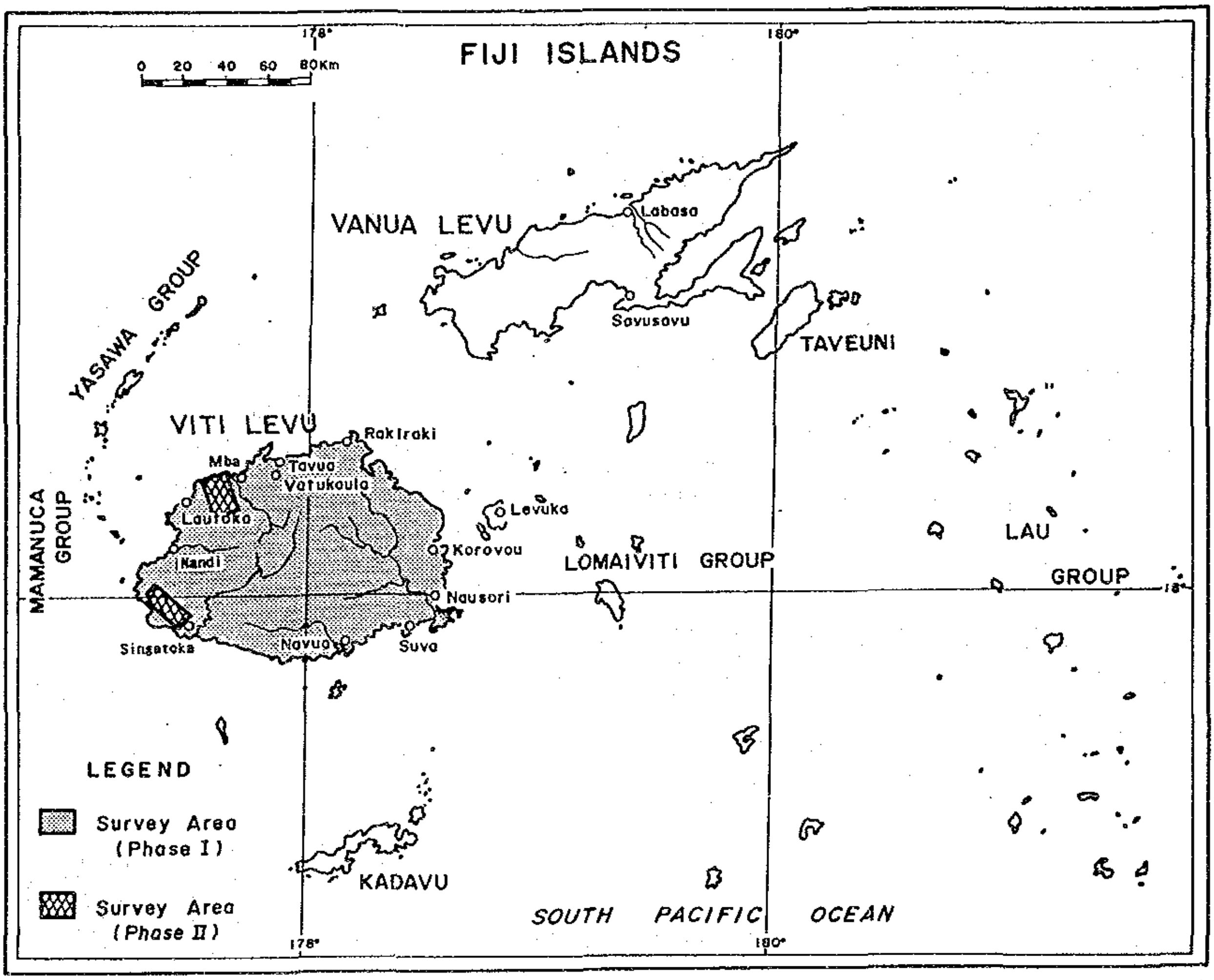


Fig. 1-1 Index Map of the Survey Area

SUMMARY

[Mba-west Area]

Photogeological analysis, geological survey, geochemical prospecting and drilling were conducted in the Mba-west area.
The results are summarized below.

(1) The photogeological analysis of the Mba-west area classified the geology into 10 geological units and extracted 95 lineaments. Also eight localities with photogeological characteristics similar to those of the known mineralized zones were extracted.

(2) The geology of the Mba-west consists of Miocene-Pliocene andesitic and basaltic volcanic products and limestone; Pliocene basalt and andesite volcanic products, sandstones, conglomerates; Holocene alluvium; and intrusive rocks penetrating the Pliocene units (monzonite, dacite, andesite, basalt). The Tertiary formations are generally superimposed and dip gently northward. Thus, on the surface the beds become younger northward.

(3) The mineralization of Mba-west area was brought about by the hydrothermal activity related to Pliocene volcanism. It is probable that high sulfidation epithermal gold mineralization exist in the inferred volcanic center directly over the small magma chamber in the relatively shallow subsurface zones, while low sulfidation type of epithermal gold mineralization exists near the inferred volcanic center of the large magma chamber in the deeper zones.

(4) Significant Au, As, Te geochemical anomalies which coincide with mineralization-alteration zones were extracted at four localities as the result of geochemical prospecting in the Mba-west. Also small geochemical anomalies not associated with mineralization-alteration were identified in several localities and the existence of shallow subsurface mineralized-altered zones are inferred.

(5) The two holes drilled in the Mba-west area, bored through basalt lava and basaltic pyroclastics of the Pliocene Namosau Volcanics and confirmed a large argillized zone with pyrite dissemination, but could not confirm Au mineralization.

(6) The geologic structure and the mineralization-alteration of Yaloku and Nalotawa-Nanuku in the southern Mba-west area closely resemble those of the vicinity of the Emperor Mine. Auriferous quartz veins (maximum grade, Au 12.1g/t 15cm wide) were discovered in the Yaloku Alteration Zone, where large geochemical

anomalies related to Au mineralization occur. The occurrence of low sulfidation type of epithermal gold veins of the Emperor type is anticipated in this area.

(7) High sulfidation type of epithermal gold mineralization is considered to have occurred in Namosau Creek Alteration Zone and Raviravi Alteration Zone in the northern Mba-west area from the geologic structures, and the mineralization - alteration.
The drilling conducted this year in the Namosau Alteration Zone suggests that the deposits have been eroded out. However, the conditions in the lower parts of the Raviravi Alteration Zone is not clear and there is still the possibility of ore deposit occurrence in these zones.

(8) There are small geochemical anomalies believed to be related to Au mineralization occur in several localities of northwest Mba-west. These are not accompanied by mineralization/alteration and the existence of blind shallow gold deposits are anticipated.

[Sigatoka Area]

Gravity survey, geological survey and geochemical prospecting were conducted in the Sigatoka Area.
The result are summarized below.

(1) The geology of Sigatoka consists of Miocene andesitic volcanic products, mudstone, and others; Pleistocene fluviatile sediments; and intrusive rocks penetrating the Miocene Series (granodiorite porphyry-diorite porphyry, granodiorite, diorite, diorite porphyry, granite, quartz porphyry, aplite, basalt, andesite, dacite, rhyolite). The Miocene Series dip southwestward and is superposed.

(2) The mineralization of the Sigatoka area is closely related to the activities of the Colo Plutonic Suite. The mineralization appear to have taken place in the fractured zone developed in the vicinity of the plutonic and porphyry bodies and, therefore, it is believed to be vein, replacement, porphyry copper and other meso- to hypothermal type mineralization.

(3) Large geochemical anomalous zones which coincide with mineralization and alteration were extracted in four localities as a result of the geochemical prospecting in Sigatoka area. Also many small geochemical anomalies were extracted. These anomalies are believed to have been formed by the activities related to the Colo Plutonic Suite which occur extensively under the present area.

(4) In the Sigatoka area, the alteration related to mineralization is mostly weak with some exceptions, and the intensities of the geochemical anomalies are also generally low. Drilling has been conducted in many of the altered and anomalous zones without success so far. There are two anomalous zones which have not been drilled and polycomponent geochemical anomalies overlap. These are noted, and if large-scale mineralization is to be expected, they probably would exist in the relatively deeper subsurface zones considering the weak surface manifestations.

[Gravity Survey]

Gravity survey was conducted in the southern part of Viti Levu Island. And analysis was carried out for the whole island from the data of the first and second phase surveys.

The results are summarized below.

(1) The gravity pattern of the Viti Levu Island is clearly grouped into the northern side and the southern side with the border at the NE-SW trending line joining Verevere in the northeast and Sigatoka in the southwest. To the northwest of this line, circular to oval shaped large high anomalies occur independently in the low gravity area. While to the southeast of the above line, high and low anomalies occur in belts with NE-SW trend.

(2) In the three areas; southwest of Mba, east of Vatukoula , and west of Rakiraki; there are large scale high gravity anomalies, and also photogeological annular structures - caldera - structures - dome structures, depressions, intrusive bodies, altered zones, and notable short-wavelength gravity anomalies occur in concentrated manner. The large gravity high, particularly, is inferred to reflect the existence of a large magma chamber in the deeper parts. These areas are considered to be promising for epithermal gold occurrences.

[Recommendation for the third phase survey]

It is recommended that the following activities be undertaken for the third phase survey.

(1) Drilling at Yaloku and Nalotawa-Nanuku Alteration Zones in the south Mba-west in order to confirm the conditions related to low sulfidation epithermal gold mineralization. These zones are located near the photogeological annular structures in south Mba-west.

(2) Drilling at Raviravi Alteration Zone in north Mba-west in order to confirm the conditions related to high sulfidation epithermal gold mineralization.

(3) Geophysical surveys in order to clarify the conditions of subsurface mineralization/alteration at several localities where small geochemical anomalies occur not related to surface mineralization/alteration. And drilling if the above geophysical survey yields promising results.

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PART I OVERVIEW

Chapter 1 Introduction

1-1 Background and Objectives

In response to the request by the Government of the Republic of Fiji to conduct mineral exploration in Viti Levu area, the Japanese Government dispatched a mission to discuss the details of the project. And as a result of the consultations between the Mineral Resources Department (MRD) of the Ministry of Lands and Mineral Resources ,and the Metal Mining Agency of Japan,an agreement was reached for cooperative exploration of the Viti Levu Island. The "Scope of Work"(SW) was signed by the representatives of both governments in August 1990. The objective of this project is to assess the mineral potential of the area through geological survey, geochemical exploration, geophysical exploration and drilling during the three year period of Fiscal 1990 to 1992.

The first phase of this project was carried out in Fiscal 1990. The objective of that phase was to clarify the geological environment and thereby understand the occurrence and conditions of ore deposits of Viti Levu Island. The work carried out included; compilation of available geological information and data concerning the whole island (areal extent 10,400 km^2), analysis and interpretation of SLAR and SPOT images together with geological survey of the whole island, gravity survey (517 stations) over an area of 2,000km^2 of Tavua area in the north, and geochemical orientation survey in the area east of the Emperor Mine.

The second phase was conducted in Fiscal 1991. The objective of this phase is to survey, in detail, the prospective areas extracted by the first phase and to clarify the geologic structure of the southern Viti Levu. The following work was carried out. Photogeological analysis and interpretation, geological survey, geochemical prospecting, and drilling of Mba-west area (areal extent 206 km^2) area; geological survey and geochemical prospecting of the Sigatoka area (160 km^2); and gravity survey of the areas (8,400 km^2) of the whole island which were not surveyed during the previous year.

1-2 Conclusions and Recommendations for the Second Phase

1-2-1 Conclusions of the first phase

During the course of the first phase of the Viti Levu Island survey, analysis and interpretation of SLAR imageries and SPOT images, field geological survey, and gravity survey were carried out with the following conclusions.

(1) Twelve geologic units were delineated by SLAR imagery interpretation and 13 units by SPOT interpretation.

(2) Anticlinal and synclinal structures extracted from SLAR imageries and SPOT images are distributed from the central to the southern part of the island.

(3) A total of 1,060 lineaments were extracted from SLAR imageries. Many of these lineaments are considered to have been formed associated with the lateral faults caused by maximum horizontal compressional stress in three main directions. Most of the mines and mineral prospects of Viti Levu, with the exception of bedded manganese, residual, placer deposits and those of the western part, occur within the zone of lineaments formed by ENE to ESE trending horizontal stress or in the vicinity.

(4) It was seen from SLAR studies, that annular structures and caldera structures occur in the vicinity of the epithermal gold deposits of the Emperor Mine, and that annular, caldera and dome structures exist near the Namosi porphyry copper deposit. These photogeologic structures were interpreted to reflect the intrusion of magma in the area. Working on this hypothesis, 15 areas which contain at least one of the SLAR annular, SLAR caldera and SLAR dome structures were selected. From these 15 areas,Rakiraki,east of Vatukoula, upper reaches of the Mba River, northeast of Nadi and South of Mba area were selected as having strong geoscientific resemblance to the area near the Emperor Mine. Also northeast of Nadi and south of Mba area were selected as areas with geologic environment very similar to the Namosi Deposit area.

(5) The geology of Viti Levu consists mainly of Late Eocene-Early Oligocene volcanic and plutonic rocks, Late Oligocene-Middle Miocene volcanic and sedimentary rocks, Middle to Late Miocene plutonic rocks, Late Miocene-Early Pleistocene volcanic, plutonic and sedimentary rocks, and Pleistocene-Holocene sediments.

(6) Large number of faults occur to the south of the Colo Plutonic Suite in the central part and near the Yavuna Group in the southwest. ENE and NW trending faults are predominant to the south of the Colo Plutonic Suite while those with ENE to NNE and NNW trend are developed in the Colo Plutonic Suite zone. Faults with various trends occur in the vicinity of the Yavuna Group.

(7) A large number of folds occur in zones of many faults. Anticlines and synclines occur parallel to the elongation of the plutonic rocks (ENE to ESE,NNE) near the Colo Plutonic Suite zone and anticlines and synclines of many trends occur in the Yavuna

Group zone in the southwest.

(8) The direction of the maximum horizontal compressional stress inferred from the lineament analysis and the distribution of the Colo Plutonic Suite is ENE to ESE during Late Miocene and after Middle Pliocene, NNW to NNE during latest Miocene-Early Pliocene, NW during Early-Middle Pliocene. It is inferred, thus, that compressional stress in the ENE to ESE direction affected the area for the longest period in geologic history resulting in the largest number of basins elongated in this direction and of deep fissures also with this trend.

(9) The locations of the centers of the volcanism of the latest Miocene - earliest Late Pliocene Mba Volcanic Group were inferred from the distribution of the volcanic rocks and the photogeologic annular, caldera and dome structures. It is considered from the above that volcanic chains existed extending in the ENE direction in northern Viti Levu and in the NW direction in the eastern part of the island. These volcanoes are believed to have formed over the deep fissure zones.

(10) Many of the lineaments formed under latest Miocene-Early Pliocene NNW to NNE compressional field are distributed in the west and northwest to southeast Viti Levu. On the other hand, NW trending deep fissures are believed to have existed from northwest to southeast Viti Levu at that time. This is inferred from the distribution of the then active volcanic rocks, locations of the volcanic centers at the time and the distribution of the above lineaments.

(11) Large scale high gravity anomalies were discovered in four localities at west of Mba, Tavua Caldera, Rakiraki and east of Nadi. It is inferred that these anomalies reflect the fact that high density rocks (amphibolite, granulite and others) occur at shallower depths at the four localities than in the surrounding areas.

(12) The zones where volcanic centers are inferred to have existed in northern Viti Levu correspond to the zones of short-wavelength high gravity anomalies related to basaltic activities. It is believed that since the contents of the magmatic chambers of that time has changed from basalt to olivin-gabbro of higher density, there are positive gravity anomalies near the altered volcanic centers. However, even in cases of Kilauea type caldera, the interior of the caldera is filled with thick compact lava which is more dense than the whole volcano and thus the center of eruption would show somewhat higher density.

(13) The Tavua Caldera whose upper parts are filled by low density formations such as andesitic pyroclastics and lacustrine sediments show short-wavelength low gravity anomaly surrounded by gravity lineaments. The SLAR annular structure zone near Rakiraki in northeast Viti Levu and the vicinity of the volcanic centers west of Mba are the zones which have Tavua Caldera type gravity structure among the possible collapse caldera zones extracted photogeologically.

(14) There are distinct differences in the magnetic anomalies of the north and south Viti Levu. The anomalies in the north have very large amplitude with small size and consequently it is believed to have been caused by strongly magnetic bodies at shallow depth. The surface is widely covered by Mba Volcanic Group and the individual magnetic anomalies could be reflecting the lithological variation in this Group.

Whereas in the south, large scale magnetic anomalies occur. The Colo Plutonic Suite and the Yavuna Group zones correspond to the magnetic high zone (over 500 γ) while the distribution of Wainimala and Medrausucu Groups correspond to the low magnetic anomalous zones with fair degree of agreement.

It is possible that Colo Plutonic Suite exist in deeper zones at the large high magnetic anomalous zone in the eastern part. Also the Yavuna Group or intrusive bodies may exist in the large magnetic high in the northwest.

(15) Vein, network dissemination, porphyry copper, replacement, skarn and sedimentary type mineralization occur in this survey area.

The vein and dissemination types are grouped into epithermal gold and meso-hypothermal base-metal mineralization. The epithermal group is further classified into adularia-sericite type and acidic sulfate type. The epithermal gold mineralized zones in the Mba and Koroimavua Volcanic Groups occur near the volcanic centers which were the source of the volcanic rocks or near the zones where these centers are inferred to have existed.

The epithermal gold mineralized zones are distributed in the ENE-WSW direction from the northern to western Viti Levu.

The porphyry copper type mineralization is classified into the plutonic and volcanic types.

The volcanic type porphyry copper mineralized zones occur within and the vicinity of the latest Miocene to Early Pliocene volcano-plutonic complex (Namosi Andesite of Medrausucu Group, Sabeto Volcanics - Navilawa Stock - Nawainiu Intrusive Complex of Koroimavua Volcanic Group).

The plutonic type porphyry copper and the meso- to hypothermal base-metal mineralized zones occur within and the vicinity of the Middle to Late Miocene Colo Plutonic Suite.

The skarn type mineralization occurs in the contact zone of the Colo Plutonic Suite and Wainimala Group limestone. The replacement type mineralization occurs in the Wainimala Group in the vicinity of the Colo Plutonic Suite.

Sedimentary mineralization is divided into massive sulfide, bedded manganese, residual and placer type concentration.

The massive sulfide mineralization is strata-bound type which occurs in pyroclastics of the Wainimala Group formed by submarine volcanic activity.

The major bedded manganese deposits are stratabound type which occur in the bedded volcano-sedimentary formations of the Wainimala Group. These also tend to occur near the replacement and skarn type mineralized zones.

The residual deposit found in Viti Levu is a small bauxite deposit formed by lateritic weathering of basaltic pyroclastics of the Ba Volcanic Group.

The placer deposits in the survey area are gold concentration in alluvium and iron oxides in deltas and sand dunes.

(16) The geologic environment necessary for the formation of epi-mesothermal deposits is the existence of magmatic heat, subsurface fractures and circulating water. The magmatic heat and the subsurface fractures are mostly likely to exist in volcanic collapsed and volcanic dome structures. The circulating water formed the mineralized and altered zones. Structures which are likely to be volcanic collapse and volcanic domes were extracted through photogeologic studies of annular, caldera and dome structures; short-wavelength gravity anomalies; and field survey. Of these zones; vicinity of Rakiraki, Tavua Caldera zone, area west of Mba to southern part, Sabeto Range, south of Lautoka and Namosi area are considered to contain high potential for locating mineralized and altered zones.

1-2-2 Recommendations for the second phase

(1) Geochemical prospecting and detailed geological survey

Of the areas extracted with anticipation of epithermal gold mineralization, that extending southward from west of Mba is relatively unexplored. This lies within a 20 km × 10 km area, extend in the NNW direction, alteration zones occur scattered inside, Balevuto Gold Prospect exists to the south, volcanic collapsed zones and volcanic domes probably exist to the south-west and north, and gravity structure similar to the Tavua Caldera exists in the northwest portion. From these features, the possibility of finding mineralization is considered to be high in this area. Promising mineral showings, however, have not been found yet. From the above reasons, geochemical prospecting and detailed geological survey for delineating promising zones in this area are recommended.

(2) Lineament analysis of aerial photographs

Close relationship between the distribution of mineralized zones and lineaments is inferred from the results of the SLAR imagery analysis. It is recommended that lineament analysis of aerial photographs be carried out and promising areas be delineated from the areas extracted as possessing high potential during the first year survey, namely vicinity of Rakiraki, Tavua Caldera southward from west of Mba, Sabeto Range south of Lautoka, and the Namosi area.

(3) Gravity survey

In the western part of Viti Levu, the Yavuna Group which forms the basement of the island is distributed and the Colo Plutonic Suite intrudes into the Wainimala Group. Alteration zones occur widely in the NW to WNW direction around the Colo Plutonic Suite and porphyry and skarn type mineralized zones are distributed within these altered zones. Epithermal gold deposit (Faddy's) of acidic sulfate type occur in the Wainimala Group in the western edge of the island, but the factors controlling the mineralization are not clear.

It is considered from the above that western Viti Levu has a relatively high mineral potential. It is, thus, recommended that gravity survey be carried out in western Viti Levu and that the basement structure, subsurface distribution of Colo Plutonic Suite, the existence of volcanic centers be clarified by geological analysis. This will also clarify the high gravity anomaly zones and high magnetic anomaly zones and the relationship between the geologic structure of the island and mineralization.

Epi-mesothermal mineralization occurs in the vicinity of the known and inferred volcanic centers. Also areas of these centers show gravimetric characteristics such as short-wavelength high gravity anomalies or short-wavelength low anomalies according to the difference of the nature of the volcanic activity. Thus, gravity survey is an extremely effective method for mineral exploration in this geologic environment and gravity survey of the entire Viti Levu with the exception of the area covered during the first year is recommended.

1-3 Outline of the Second Phase Survey

1-3-1 Survey areas (Fig.1-2)

(1) Mba-west

This area is located to the west of Mba in the northwestern part of Viti Levu. Photogeological analysis and interpretation, geological survey, soil geochemical prospecting and drilling were carried out in this area.

The area for photogeological analysis is 500 km² , bounded by the following meridians and latitudes.

Long	177° 32'E.,	177° 44'E.
Lat	17° 29'S.,	17° 42'S.

Geological survey and geochemical prospecting were carried out in an area of 206 km² bounded by the following coordinates.

	Lat	Long		Lat	Long
①	17° 30'S.,	177° 32'E.	②	17° 41'S.,	177° 35'E.
③	17° 38'S.,	177° 42'E.	④	17° 27'S.,	177° 38'E.

The sites of drilling are as follows.

	Lat	Long
MJF-1	17° 32.65'S	177° 37.45'E
MJF-2	17° 32.65'S	177° 37.45'E

(2) Sigatoka

This area is located to the west of Sigatoka in the south-western part of Viti Levu. Geological survey, soil geochemical prospecting, and gravity survey were carried out in this area.

Geological survey and geochemical work were conducted in an area bounded by the following five points.

	Lat	Long		Lat	Long
①	17° 57'S.,	177° 20'E.	②	17° 59'S.,	177° 19'E.
③	18° 02'S.,	177° 20'E.	④	18° 08'S.,	177° 28'E.
⑤	18° 04'S.,	177° 30'E.			

(3) Viti Levu South

This is a large area comprising 8,400 km² within the total of 10,400 km² for the whole island. It excludes the area where gravity survey was carried out during the first phase in Fiscal 1990. Gravity survey was carried out during the present phase.

1-3-2 Objectives of the survey

The objectives of the work carried out during the second phase of this project are as follows.

a. To clarify the relation between the geologic structure and mineralization and extract prospective zones in the Mba-west and Sigatoka areas. These two areas were considered to be promising from the results of the first phase survey.

b. To clarify the conditions of the deeper parts of the mineralized zones by drilling in parts of the most promising zone of the Mba-west area.

c. To clarify the relation between the geologic structure and mineralization by understanding the nature of gravity structure of southern Viti Levu.

1-3-3 Survey methods

The methods used during the present phase of this project are; photogeological analysis and interpretation, geological survey and geochemical prospecting, drilling, and gravity survey.

(1) Photogeology

Aerial photographs of 1/50,000 scale were studied stereoscopically, geological units classified, geologic structure interpreted and compared with the photogeologic characteristics of the area in the vicinity of known mineralized zones.

(2) Geological survey and geochemical prospecting

Base camps were established in Mba City for the Mba-west survey and in the western suburb of Sigatoka City for the survey of Sigatoka.

For field work, 1/50,000 topographic maps were enlarged to 1/10,000 scale and used for preparation of route maps. Whenever necessary, 1/2,000 scale route maps were prepared by 50 m and 100 m tapes and Brunton-type compass.

Thin sections were prepared for representative rocks and studied microscopically.

Representative mineralized and altered rock samples were analyzed chemically and by X-ray powder diffraction.

Geochemical prospecting was carried out parallel to the geological work and soil samples of A horizon were collected in Mba-west and B horizon in Sigatoka.

(3) Drilling

Two holes were drilled in the alteration zone found by the present survey in the upper reaches of the Namosau Creek in Mba-west. Drilling depth was 300 m and the dip -30°. The diameter was NQ and BQ except near the head. Full core drilling was performed, where full core was not possible, core recovery was over 80 %. Thin sections were prepared for representative parts of the cores and mineralized zones were chemically analyzed and polished sections were studied microscopically.

(4) Gravity survey

A total of 8,400 km² in the southern part of Viti Levu was covered by 838 gravity survey stations during the present phase. The gravity measurements of the first phase covered 2,000 km² by 517 stations. Bouguer anomaly map at scale of 1/250,000 was prepared for the whole Viti Levu Island using the results of the measurements of both years. The data were analyzed by power spectral analysis and long-, medium-, and short-wavelength gravity maps were prepared. Also three sections were analyzed for medium- and short-wavelength gravity anomalies.

(5) Amount of work

The work carried out during the present phase are laid out below.

Survey	Particulars	
1.Analysis of Aerial Photographs	Mba-west Area	
Areal extent	500 km²	
Number of Sheets	51	
2.Geological Survey and Geochemical Prospecting	Mba-west Area	Sigatoka Area
Areal extent	206 km²	160 km²
Length of traverse	400 km	200 km²
Laboratory work		
Thin section microscopy	14 pcs	11 pcs
X-ray diffraction analysis	152 pcs	35 pcs
Ore assey	26 pcs (7 elements)	10 pcs (6 elements)
Geochemical analysis	3,005 pcs (6 elements)	660 pcs (9 elements)
3.Drilling	Mba-west Area	
Number of Drill holes	2	
Total length drilled	602 m	
Laboratory work		
Thin section microscopy	10 pcs	
Polished section microscopy	5 pcs	
X-ray diffraction analysis	22 pcs	
Ore assey	61 pcs (7 elements)	
4.Geophysical Survey (Gravity)	Southern part of the Viti Levu	
Areal extent	8,400 km²	
Number of stations	838	
Laboratory work		
Density measurements	108 pcs	
5.Digitization of Bouguer Anomaly Map and Geological Map	Whole Viti Levu Island	
Synthetic immages of gravity and relief energy	10,400 km²	
Synthetic immages of geology and relief energy	10,400 km²	

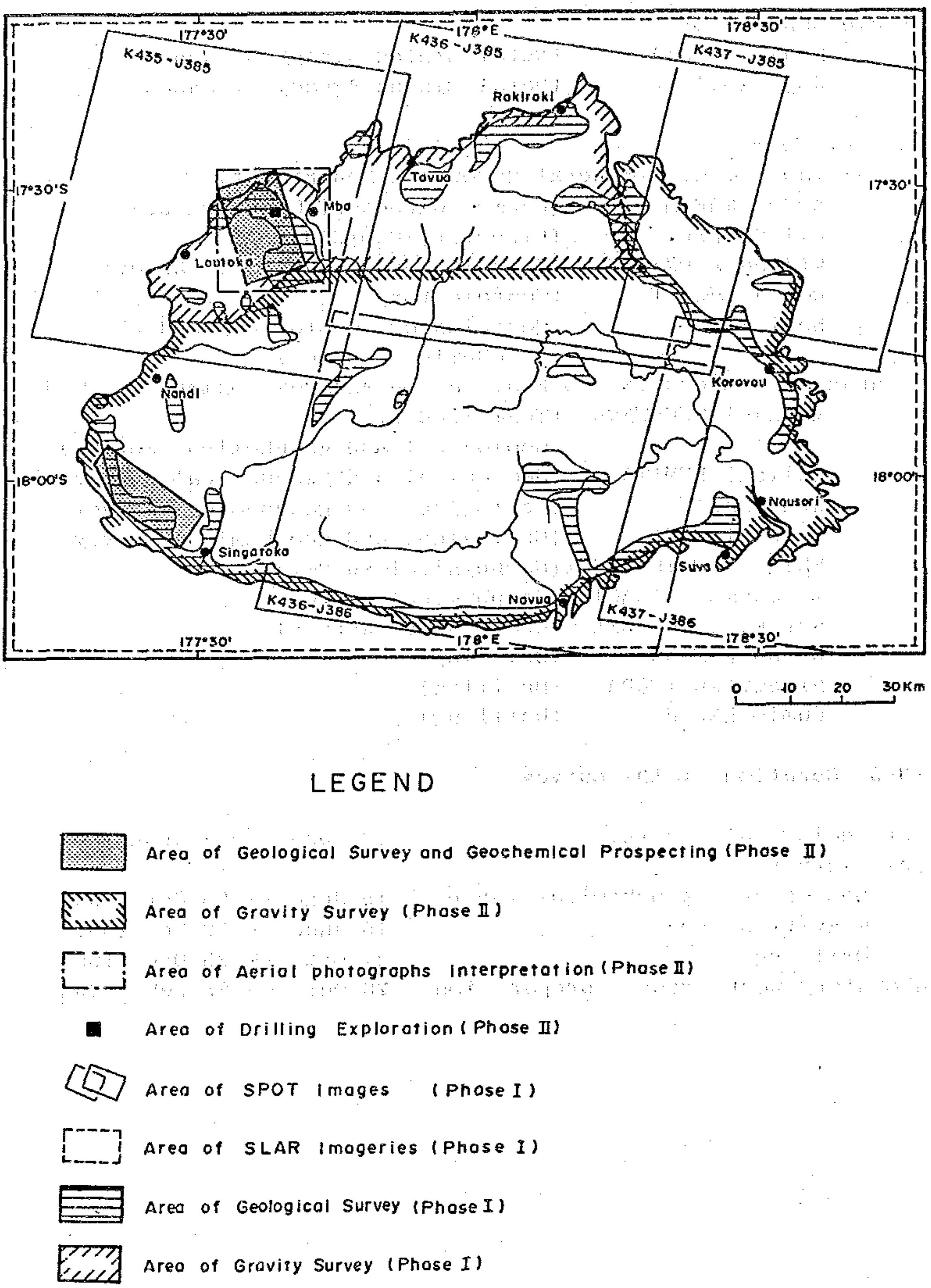


Fig. 1-2 Location Map of the Survey Area

1-3-4 Participants of the second phase survey

Field Supervisor
- Kenzo MASUTA (Metal Mining Agency of Japan)
- Koji KOIWA (Metal Mining Agency of Japan)

Survey Team

Fijian members (Mineral Resources Department)
- Abdul RAHIMAN (Former Director, Coordinator)
- Alf SIMPSON (Director, Coordinator)
- Vijendra PRASAD (Coordinator, Geophysical survey)
- Don J. FLINT (Coordinator)
- Suli NIUROU (Coordinator, Geological and geochemical survey)

Japanese members (Nikko Exploration and Development Co.,Ltd.)
- Masaaki SUGAWARA (Team leader, Geological and geochemical survey)
- Keiichi KUMITA (Geological and geochemical survey)
- Ken OBARA (Geological and geochemical survey
- Yasushi AOKI (Geological and geochemical survey)
- Shigeo MORIBAYASHI (Geophysical survey)
- Masasamu OYANAGI (Geophysical survey)
- Norikiyo SUGIURA (Geophysical survey)
- Hatuo KUMANO (Drilling)
- Hidemitsu ITODA (Drilling)
- Fumio ENDOH (Drilling)

1-3-5 Duration of the survey

Photogeological analysis	10 June -- 27 June 1991
Field survey	
Geological, geochemical survey	15 June -- 25 Oct 1991
Gravity survey	15 June -- 10 Sep 1991
Drilling	31 Oct -- 25 Dec 1991
Laboratory work, report preparation	28 Oct -- 25 Feb 1992

Chapter 2 Geography of the Survey Area

2-1 Topography and Drainage

2-1-1 Topography

(1) Topography of Viti Levu

There is a highland with an altitude of around 1,000 m in the island. There are three major systems of mountain ranges in the island. They are; in the central part, the Rairaimatuku Plateau, Korombasanga Range and other mountains extending in the N-S to ENE-WSW direction; in the northwestern part, the Mount Evans Range, Naroto Range and others extending in the NE-SW to E-W direction; and in the northeastern part, the Nakauvandra Range and Nakorotumbu Range extending in the E-W to NW-SE direction. The topography is very rugged and the highest peak is the Tomanivi (Mt. Victoria) located to the north of the central part with the elevation of 1,323 m.

Hilly zone of 150-600 m in elevation with relatively distinct relief is developed surrounding the above highland.

Alluvial plains are developed from the northern to the southwestern part of the island, also in the southeastern part, as well as along the coast and along the large rivers valleys.

Deltas are developed in many parts around the island where mangroves grow and coral reefs are developed on the outer side of these deltas.

(2) Topography of Mba-west

The southwestern margin of this area belongs to a part of the Mt. Evans Range and has a very rugged topography with elevation of around 1,000 m. The vicinity of Nalotawa, Nanuku, and Yaloku Villages in the southern part of this area corresponds to the periphery of the Mt. Evans Range and the relief is high with relative height of 300 to 500 m. The relative high zone extends northward from the south and in the north, high zone of around 450 m elevation including Mt.Koronggele forms semi-circular eastward opening. Also in the northwestern end of this area, highland of 150 to 200 m which continues westward to Mt.Koroivunatoto is distributed in a semi-circle. Gentle hills and lowland occurs along the northern coast with a width of 2 km and delta occurs in the shore zone.

(3) Topography of Sigatoka

Highlands with relatively high relief from 150 to 300 m is observed in the northwest, southeast and along the northeastern border of the survey area. Most of this area surrounded by the above highland comprises gentle hilly zone with elevation of several tens of meters.

2-1-2 Drainage

(1) Drainage of the Viti Levu Island

The drainage of the Viti Levu Island consists of the following river systems. Sigatoka River system which flows southwestward from the north-central part of the island; Rowa River system which flows southeastward from the northeastern and central part of the island; Mba River system in the northwest; Nadi River system in the west; and Navua River system in the south.

The former two river systems are the larger drainage of the island. Rewa River system is widely distributed in the eastern half of the island and comprises Wainimbuka River, Wainimala River, Waindina River; each with many tributaries.

(2) Drainage of Mba-west

Mba River meanders from the southeast to northwest in the eastern part of this area. The drainage system of this area all belong to this river system with the exception of the northwestern part and the northern coastal zone. Relatively large rivers flow in this area with fairly large discharge throughout the year, they are; Nggalinamblu Creek, and Nandrou Creek, in the south, Varathiva Creek, in the central part and Namosau Creek, in the north. The tributaries of these rivers usually have low discharge and many are underflows.

(3) Drainage of Sigatoka

The major rivers in this area meanders from the northeast to southwest. They are; Tuva River in the central part, Kumbuna River in the northwest, and Voua Creek and Nggerengere Creek in the southeast. These all have considerable flow and the Tuva is the largest river in the area. Many of the tributaries of these rivers are dry.

2-2 Climate and Vegetation

2-2-1 Climate

As Fiji belongs to the tropical rain forest climatic zone, it has two seasons, dry (May-October) and rainy (November-April). Also the country is located in the monsoon zone, and there is a southeasterly trade wind throughout the year. Since there is a highland with an altitude of around 1,000 m extending in the north-south to ENE-WSW direction in the central part of Viti Levu, precipitation is high in the southeastern side of the island - over 200 days of rain every year -, and annual precipitation reaches 5,000 mm in the Namosi district, while the northwestern side is relatively dry with the temperature often approaching 40°C.

The Mba-west and Sigatoka areas where geological and geochemical surveys were conducted, belong to the drier areas of Viti Levu, but during the wet season strong rainfall is not uncommon and heavy rain due to cyclones is observed. The annual precipitation in the southern part of Mba-west reaches 3,000 mm.

The monthly mean temperature and precipitation observed at Nadi in western Viti Levu over 30 years (1951-1980) is shown below.

	Jan.	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Average Temperature (°C)	26.6	26.6	26.3	25.7	24.6	23.8	23.0	23.2	24.0	24.8	25.6	26.2	25.0
Average Precipitation (mm)	313.8	292.5	367.4	172.3	83.7	77.9	51.9	58.1	92.9	96.9	136.4	168.9	1912.6

(Observed at: 17°45'S, 177°27'E, Elevation 18 m)

The average annual precipitation over 47 years (1942 - 1989) is 3,036 mm in Suva and 1,849 mm in Nadi.

2-2-2 Vegetation

Southeastern Viti Levu is in the tropical rain forest zone and the greater part is covered by dense jungle. In the area from the northeast to the west, on the other hand, there are dense jungle of low trees along the course of rivers, but the mountains and the ridges are often covered by 2 m high reeds or reforested pine forests. Mangroves are developed in the delta areas along the coast and there are many coconut palms near the villages along the coast.

Chapter 3 Geological Setting

The geology of Viti Levu and its vicinity was reviewed after Rodda (1989) during the first phase of this project in 1990.

The geological units constituting the Fijian Islands are all of Cenozoic Era and the oldest rock is Eocene limestone and volcanics in Viti Levu and the youngest is the effusive rocks of historical times in Taveuni Island.

Plate tectonically, The Fijian Islands form an island arc which is situated in the eastern margin of the Australia-India Plate and is a part of the Lau Ridge where it bends from ENE-WSW to N-S trend. The ENE-WSW trending left lateral Fiji Transform Fault occurs to the north of Viti Levu and there is the NE-SW trending Hunter Fracture Zone (a left lateral transform fault). Also WNW trending left lateral transform fault is considered to extend from the eastern edge of the Hunter Fracture Zone between Viti Levu and Vanua Levu (Tectonic Map of the Circum Pacific Region, Southwest Quadrant, 1991). Northern Fiji is considered to be rotating counter clockwise by the expansion of the North Fiji Basin to the west of Viti Levu and the eastern movement of the Australia-India Plate. This rotation is believed to have started during Late Miocene to Early Pliocene time.

The geologic units constituting Viti Levu are:Late Eocene-Early Oligocene Yavuna Volcanics (basaltic effusives, dacitic effusives, limestone) and tonalite; Late Oligocene-Middle Miocene Wainimala Group (basaltic effusives, dacitic effusives, limestone, sandstone, conglomerate, mudstone), Savura Volcanic Group (basaltic effusives, dacitic effusives); Middle-Late Miocene Colo Plutonic suite (tonalite, diorite, granodiorite, gabbro), Late Miocene Tuva Group (sandstone, conglomerate, andesites), Ra Sedimentary Group (sandstone, mudstone, conglomerate), Nadi Sedimentary Group (andesitic pyroclastics, sandstone marl), Navosa Sedimentary Group (conglomerate, sandstone, mudstone, andesitic effusives); Late Miocene-Early Pliocene Medrausucu Group (conglomerate, sandstone, mudstone, limestone, marl, tuff, andesitic effusives, basalt, intermediate to silicic porphyries), Koroimavua Volcanic Group (basaltic effusives, andesitic effusives, sandstone, conglomerate, monzonite), Cuvu Sedimentary Group (sandstone, siltstone, limestone, marl); latest Miocene-Early Pliocene Ba Volcanic Group (greywacke, siltstone, sandstone, basaltic effusives, andesitic effusives,monzonite, diorite, gabbro); Late Pliocene-early Pleistocene Verata Sedimentary Group (conglomerate, sandstone, siltstone, tuff); Pleistocene Limestone; Pleistocene-early Holocene fluviatile deposits; and late Pleistocene-Holocene alluvial sediments and beach sands.

The geological units of Viti Levu can be largely grouped stratigraphically into; Late Eocene-Early Oligocene volcanics, Early-Middle Miocene volcanic and sedimentary rocks and latest Miocene-Late Pliocene volcanic and sedimentary units. Usually, sedimentary formations are lacking between the above units and orogenic movements associated with intrusive activities occurred.

Vein, network dissemination, porphyry copper, replacement, skarn and sedimentary type mineralization occur in Viti Levu.

The vein and dissemination types are grouped into epithermal gold and meso-hypothermal base-metal mineralization. The epithermal group is further classified into low sulfidation (adularia-sericite) type and high sulfidation (acidic sulfate) type. The epithermal gold mineralized zones in the Ba Volcanic Group (Uppermost Miocene-Upper Pliocene) and Koroimavua Volcanic Group (Upper Miocene-Lower Pliocene) occur near the volcanic centers which were the source of the volcanic rocks or near the zones where these centers are inferred to have existed.

The epithermal gold mineralized zones are distributed in the ENE-WSW direction from the northern to western Viti Levu.

The porphyry copper type mineralization is classified into the plutonic and volcanic types.

The volcanic type porphyry copper mineralized zones occur within and the vicinity of the latest Miocene to Early Pliocene volcano-plutonic complex (Namosi Andesite of Medrausucu Group, Sabeto Volcanics - Navilawa Stock - Nawainiu Intrusive Complex of Koroimavua Volcanic Group).

The plutonic type porphyry copper and the meso to hypothermal base-metal mineralized zones occur within and the vicinity of the Middle to Late Miocene Colo Plutonic Suite.

The skarn type mineralization occurs in the contact zone of the Colo Plutonic Suite and Wainimala Group limestone. The replacement type mineralization occurs in the Wainimala Group in the vicinity of the Colo Plutonic Suite.

Sedimentary mineralization is divided into massive sulfide, bedded manganese, residual and placer type concentration.

The massive sulfide mineralization is strata-bound type which occurs in pyroclastics of the Wainimala Group formed by submarine volcanic activity.

The major bedded manganese deposits are stratabound type which occur in the bedded volcano-sedimentary formations of the Wainimala Group. These also tend to occur near the replacement and skarn type mineralized zones.

The residual deposit found in Viti Levu is a small bauxite deposit formed by lateritic weathering of basaltic pyroclastics of the Ba Volcanic Group.

The placer deposits in Viti Levu are gold concentration in alluvium and iron oxides in deltas and sand dunes.

The most important known mineralization in Viti Levu is the gold veins of low-sulfidation epithermal type of the Emperor Mine and the porphyry copper deposit of Namosi. The former occurs in the fissures at the periphery of a caldera and the latter is associated with an intrusive body. In the SLAR imageries, annular and caldera structures were identified in the area of the above two mineralized zones and dome structures were observed in the area of the Namosi deposit.

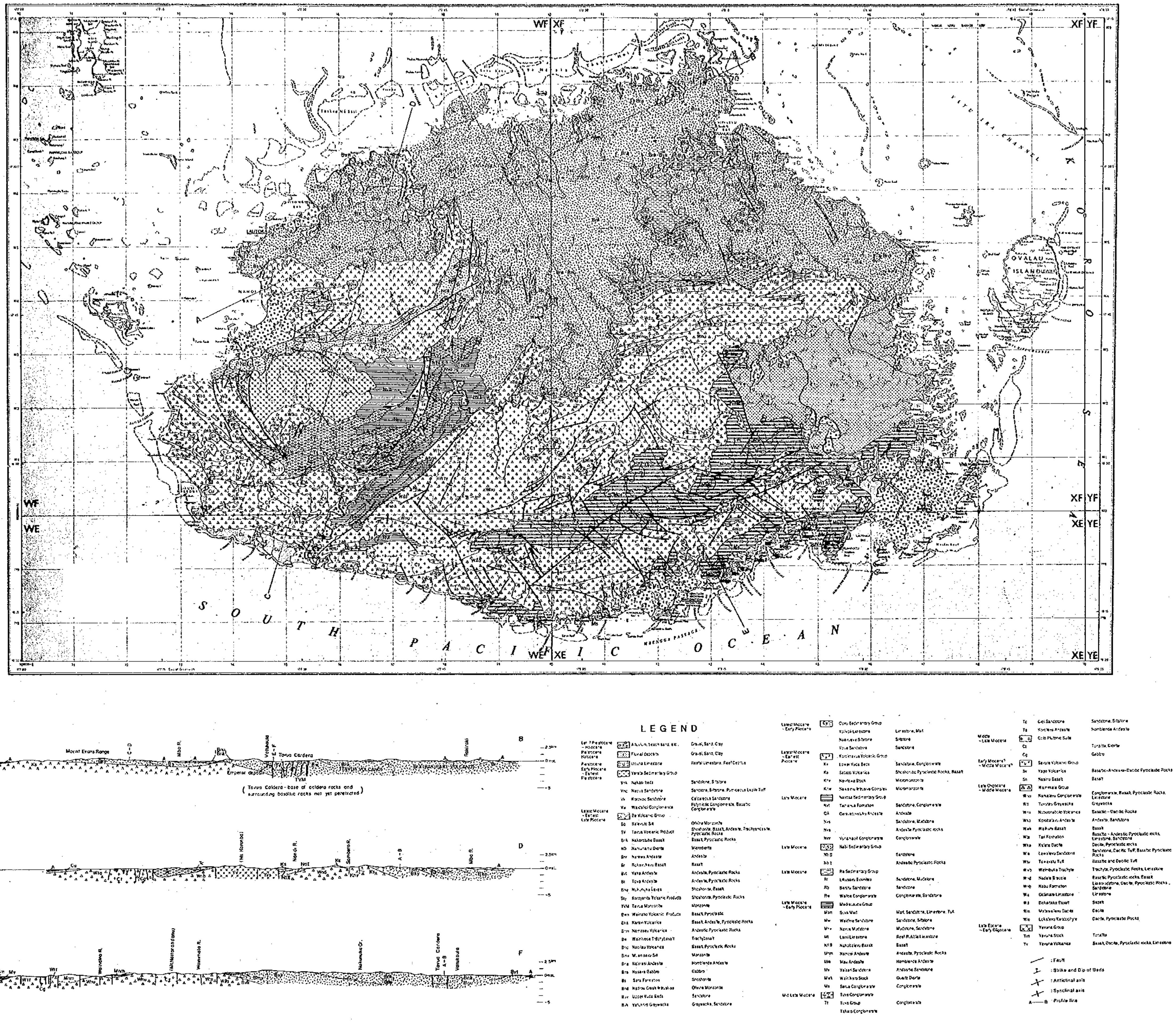


Fig.1-3 Geological Map with Geological Profiles of Viti Levu Island

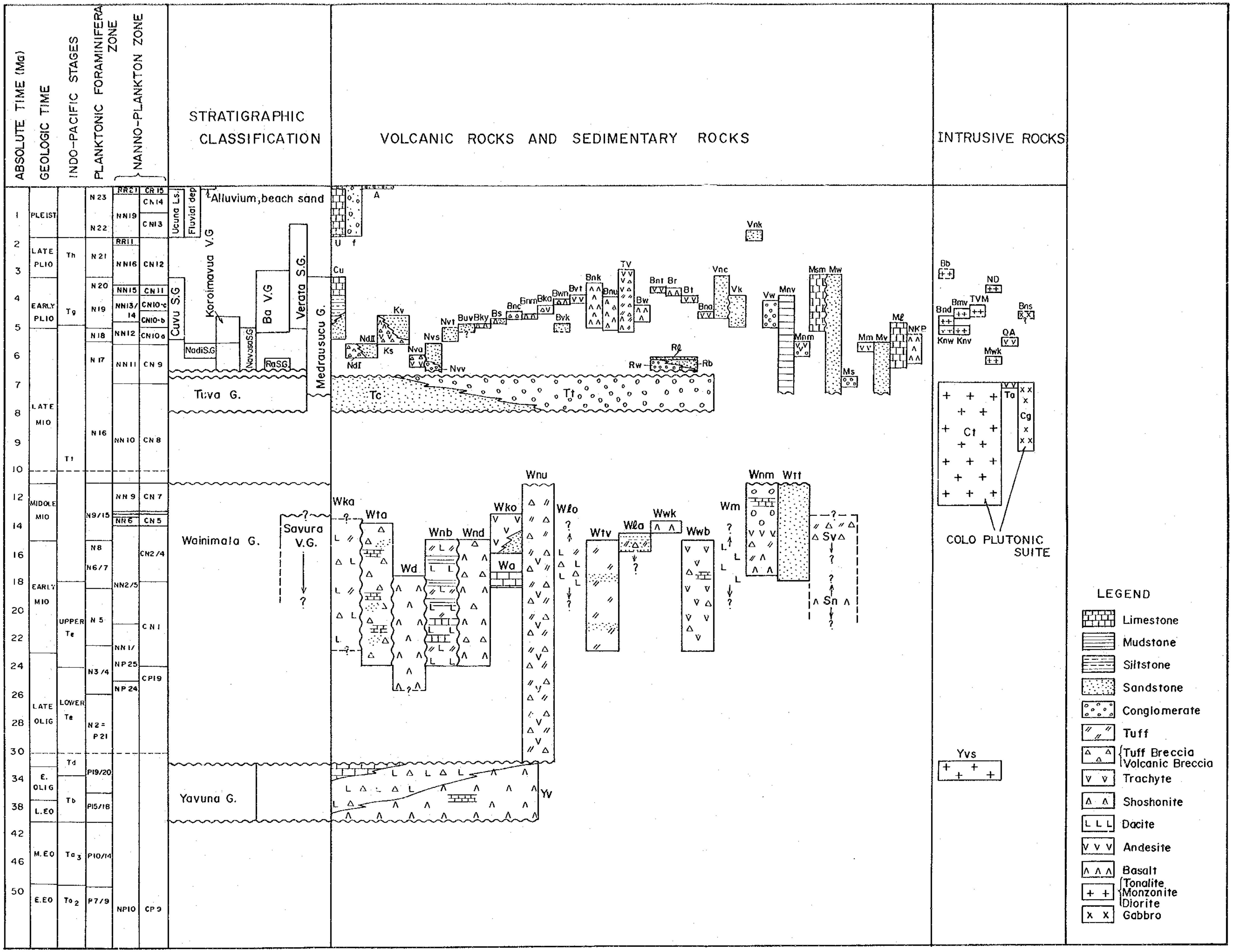


Fig.1-4 Schematic Stratigraphic Columns of Viti Levu Island

Chapter 4 Comprehensive Analysis of the Survey Results

4-1 Geologic Structure, Characteristics and Control of Mineralization

4-1-1 Mba-west

In the southern part of this area, there is a circular depression extracted photogeologically as annular structures. And basaltic Koroyanitu Volcanic Products of the Ba Volcanic Group is distributed surrounding the depression from the north. Also, intrusive rocks occur concentrated within and the periphery of the annular structure. These facts indicate that the vicinity of this structure is the center of volcanic activity which brought about the Kroyanitu Volcanic Products.

There are large scale medium-wavelength gravity high in this general region. These gravity anomalies are believed to reflect the dense rock mass (deep-seated stratified basic igneous body) formed by solidification of the magma chamber. This magma is considered to be the origin of the volcanic products (Koroimavua Volcanic Group and Ba Volcanic Group). The above annular structure is located approximately at the center of the gravity high.

The radial distribution of the dykes near this annular structure is believed to be the result of filling the fissures formed by the rise and fall of the magma below the volcano. Also a photogeologic dome structure exists within the structure, and plutonic bodies which intruded immediately following the effusion of the Koroyanitu Volcanic Products are distributed in the structure. From these evidences, the interior of the structure most probably uplifted after the effusion of the Koroyanitu Volcanic Products.

It is inferred, as above, that first collapsed structure was formed by volcanic activity, then the inner part of this structure was uplifted by the rise of the magma. This process could have erased the clear evidences of collapsed structure.

Near the above annular structure, monzonite and andesite have intruded into the basaltic volcanics and this is regarded as evidence of the differentiation of magma from basaltic to andesitic nature after the effusion of Koroyanitu Volcanic Products.

Monzonite bodies are arranged in the NNE-SSW direction. It is, thus, believed that at the time of intrusion (4.96 ± 0.30 Ma), extensional deep-seated fissures in the above direction were formed by the maximum horizontal compressional stress in that direction. This stress field agrees with that of the Early Pliocene time derived from photogeological analysis.

Regarding the lineaments of Ba-west, many of them are developed at the inferred volcanic centers in the north and southern parts and their vicinity. Lineaments with various trends are developed within the above annular structures. Also lineations parallel to the elongation of the anomaly areas are developed in the vicinity of some of the short-wavelength gravity anomalies. These indicate that differential block vertical movement occurred in association with the rise of magma resulting in the development of fractures.

Propylitized and sericitized zones are developed near the above annular structures. Au related geochemical anomalies and auriferous quartz veins partly overlap these altered zones. This mineralization is of the low sulfidation epithermal gold vein type.

Photogeologic caldera structures were extracted at three localities in the northern part of Mba-west, and volcanic products are distributed in the vicinity of these calderas. These all occur in the short-wavelength high gravity zones. From these facts, it is inferred that the photogeologic calderas are craters or volcanic collapsed structures, and also that short-wavelength high gravity reflects the high-density rock bodies in the relatively shallow subsurface zones. These dense bodies are believed to be solidified small magma chambers derived from the deep-seated large magma chamber inferred from the medium-wavelength high gravity zone mentioned above.

Acidic alteration accompanying silicified zones is developed in parts of the above caldera structure, and geochemical anomalies related to Au mineralization occur in these zones. This mineralization is of the high sulfidation epithermal gold deposit.

High sulfidation epithermal gold type alteration occurs in the short-wavelength high gravity zone in the southeastern margin of Mba-west.

It is seen from above that the mineralization of this area was brought about by the hydrothermal activities related to Pliocene volcanism. There are two types of minealization; one is the high sulfidation epithermal mineralization in the eruption center directly over the small magma chamber in the relatively shallow subsurface zones, the other is the low sulfidation epithermal gold vein mineralization near the eruption center in the large magma chamber emplaced in the deeper zones.

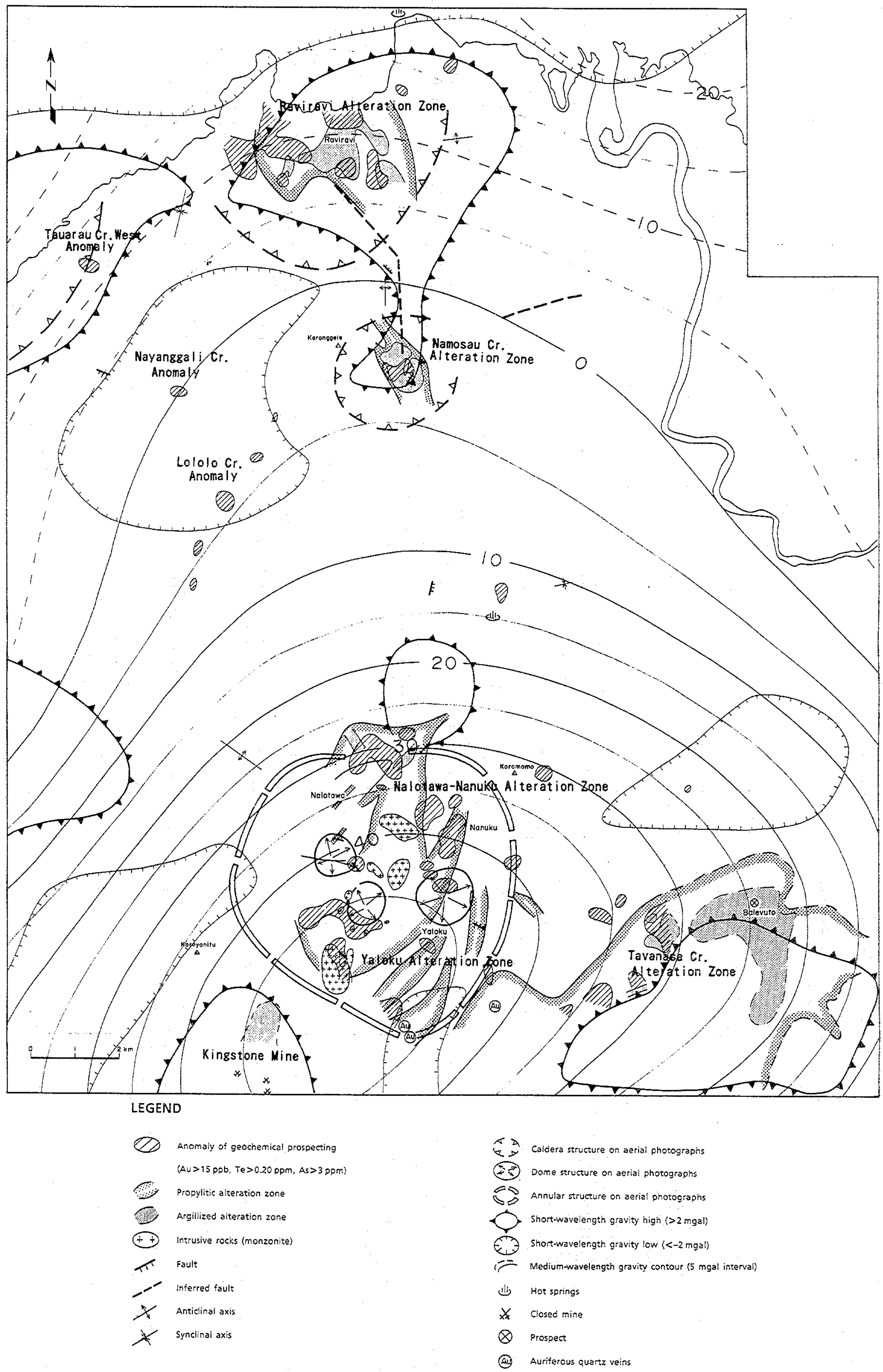


Fig. 1-5 Integrated Interpretation Map (Mba-west Area)

4-1-2 Sigatoka

Middle to Late Miocene Colo Plutonic Suite is arranged in the WNW-ESE direction within the Miocene Wainimala Group in the Sigatoka area. Dykes occur en echelon in the NW-SE and E-W directions to the south of the Colo Plutonic Suite bodies. The existence of right lateral faults is inferred.

The major faults of this area generally trend in the same direction as the Colo Plutonic Suite bodies and a few faults transect this direction. The major faults with E-W and WNW-ESE strike cuts through the relatively old porphyry bodies (10.1 ± 1.6 Ma) of the Colo rocks, and in turn is cut by the younger plutonic bodies (8.1 ± 0.3 Ma). Thus the main fault activities of this area overlap with those of the Colo Plutonic Suite.

The trends of the SLAR lineaments of this area are; NW-SE, WNW-ESE, and NE-SW. The Colo Plutonic Suite bodies are elongated in similar trend as the lineaments where the lineaments are concentrated.

The mineralized-altered zones occur at; vicinity of the above faults, periphery of Colo Plutonic Suite bodies, near SLAR lineaments, near the echelon dykes, and within the Colo Plutonic Suite bodies. The geochemical anomalies often occur overlapping the above altered zones or near them.

It is thus clear that the mineralization of Sigatoka area is closely associated with the igneous activities of the Colo Plutonic Suite. And as the deposition of the ores appear to have occurred in the fractured zones developed near the plutonic and porphyry bodies, the mineralization is believed to be of the meso to hypothermal type activity such as veins, replacement, and porphyry type concentration.

4-2 Geochemical Anomalies and Mineralization

4-2-1 Mba-west

Total of 3,005 samples of A soil horizon collected from an area of 206 km^2 were analyzed for six elements, Au, Ag, As, Sb, Hg, Te, and geochemically anomalous areas were extracted by statistical treatment.

The three elements Au, As, Te, are related to mineralization and can be used as effective path finder elements. While relation between Hg,Sb and mineralization is not understood.

Significant geochemical anomaly areas were extracted in four localities of Raviravi,Nalotawa,Nanuke-Yaloku,and Tavanasa Creek, from analysis of Au, As, Te anomalies. These all agree well with the surface distribution of mineralization/alteration.

There is also a small but notable geochemical anomaly corresponding to an altered zone at Namosau Creek.

Geochemical anomalies were confirmed at Lololo Creek, Nayanggali Creek, and Tauarau Creek-west where mineralized/altered zones do not occur on the surface. It is anticipated that blind mineralized and/or altered zones occur in the shallow subsurface parts.

There are also several Au anomalies which are considered to be singular points duc to nugget effect.

The mineralization of Mba-west is epithermal in nature and the characteristics of alteration indicate that; those of the Raviravi and Namosau Creek are of high sulfidation type, and those of the Nalotawa and Nanuke-Yaloku are of low sulfication type. With the exception of a high concentration of Te in parts of Tavanasa Creek, the distribution pattern of each component is not very different.

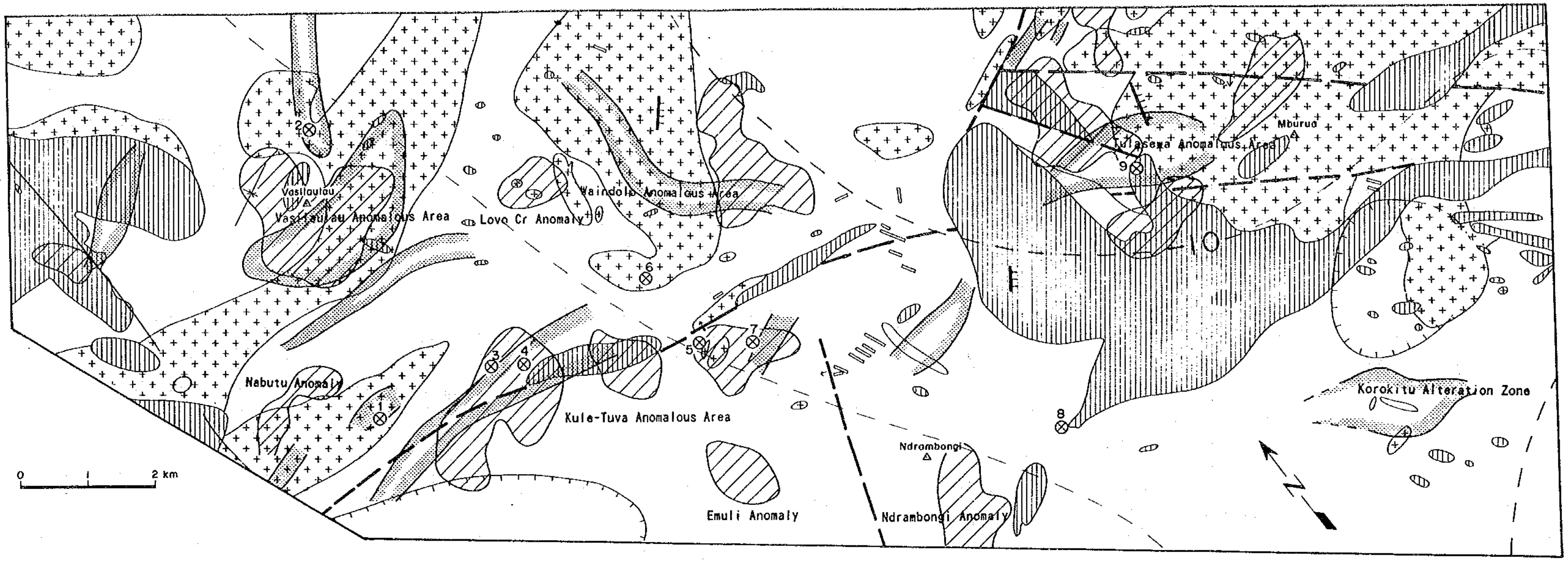
The distribution of mineralized/altered zones and geochemical anomalies largely coincide. In detail, however, the most intensely altered zones inferred from the zonal arrangement of altered minerals, do not necessarily coincide with the center of the geochemical anomalies. This probably is caused by the ease of secondary dispersion of elements in soil.

The distribution of geochemical anomalies is also related to the geologic structure. Many of the anomalies occur in photogeologic annular structures, caldera structures, and the short-wavelength high gravity zones.

Although the geochemical anomalies of this area are weaker in intensity than those in Tavua Caldera area, they reflect various geologic factors as mentioned above, and thus it is considered that they are promising targets for gold exploration. Soil geochemical prospecting is effective for extracting exploration targets and also for locating blind mineralized/altered zones. But for detailed delineation of exploration targets, detailed study of altered minerals, rock geochemical prospecting, and various geophysical survey are necessary.

4-2-2 Sigatoka

Total of 660 samples of B soil horizon collected from an area of 160 km^2 were analyzed for nine elements, Au, Cu, Pb, Zn,



LEGEND

- Anomaly of geochemical prospecting (Cu>74 ppm, Pb>5 ppm, Zn>155 ppm)
- Alteration zone
- Intrusive rocks (granodiorite porphyry-diorite porphyry)
- Intrusive rocks (granodiorite, diorite and another Colo plutonic suite)
- Intrusive rocks (dacite)
- Fault
- Inferred fault
- Synclinal axis
- Short-wavelength gravity low (< −2 mgal)
- Medium-wavelength gravity contour (5 mgal interval)

1-9 Prospect

1 Kumbuna river (Zn-Pb-Cu)
2 Nathilenga (Cu-Mo)
3 Kule (Cu)
4 Kule creek (Zn(Cu-Ag) vein)
5 Natualevu (Cu-Zn)
6 Naitaki creek (Cu-Pb-Zn)
7 Tuva river (Cu vein)
8 Voua creek (Cu-Pb-Zn)
9 Tulasewa (Zn-Cu)

Fig. 1-6 Integrated Interpretation Map (Sigatoka Area)

As, Sb, Hg, Mo, and geochemical anomalies were extracted by statistical treatment.

Relatively large anomalous areas were extracted at four localities, Tulasewa,Waindolo,Vasilaulau, and Kule-Tuva by using Cu, Pb, and Zn as the path finder elements.

Aside from the above, independent small anomalies were extracted at Navutu,Emuri,Lovo Creek, and Ndrambongi.

Many of the geochemical anomalies are developed in close association with the altered zones confirmed on the surface, but there are examples of anomalies which occur on the periphery rather than over the alteration (Tulasewa Anomalous Area) and of altered zones without notable geochemical anomalies (Korokitu altered Zone).

The extracted anomalies and anomalous areas are arranged in the WNW-ESE direction and is believed to reflect the general trend of the geologic structure of the area. A large body of the Colo Plutonic Suite are inferred to exist with WNW-ESE elongation in the subsurface parts. Those exposed on the surface are the branches from the lower main body. These are believed to have formed the mineralization, alteration, and the geochemical anomalies.

4-3 Resource Potential

4-3-1 Mba-west

The geologic structure, mineralization, and alteration in the southern Mba-west are very similar to those of the Emperor Mine area. Low sulfidation epithermal gold mineralization similar to that of the Emperor Deposit is anticipated at the Nalotawa-Nanuku and Yaloku Alteration Zones. Particularly at the Yaloku Alteration Zone, Au-Ag-Cu quartz veins were discovered during the present survey in the Nasala vein swarm. Also, although outside of the Mba-west area, the Kingston Mine, with high-grade Au-Ag-Cu veins reported previously, is located to the southwest which is the direction of Yaloku Alteration Zone elongation. Therefore, the Yaloku Alteration Zone to Kingston Mine is a noteworthy area for mineral exploration.

From the geologic, mineralization, alteration characteristics of northern Mba-west, it is believed that high sulfidation epithermal gold mineralization occurred in the Raviravi and Namosau Creek Alteration Zones. This type of mineralization is considered to generally occur in shallower zones than the low sulfidation type. And the results of drillings conducted this year at Namosau Creek indicate that the mineralized zones have been eroded out. The conditions of the lower part of Raviravi Alteration Zone is not clear and the possibility of deposit occurrence still exist.

Geochemical anomalies have been found in several localities at northwest Mba-west although mineralization/alteration have not been confirmed on the surface. There are possibilities that blind deposits occur in the shallow subsurface zones in these localities. Anticipated mineralization types are; high sulfidation epithermal gold in the Tauarau Creek-west anomaly which was probably located close to the center of volcanic activity, and low sulfidation type at Lololo Creek and Nayanggali Creek anomalies which probably were at a distance from the volcanic center.

At the Tavanasa Creek Alteration Zone in southeastern Mba-west, central parts of alteration were drilled by the private sector without notable results. The possibility of locating deposits in this part is considered to be low.

4-3-2 Sigatoka

In this area, many small mineral showings of base metals have been reported. But now, almost none of them could be observed by surface survey. During the course of the present survey, however, altered zones and/or geochemical anomalies were found in the vicinity of these showings and they were considered to have been formed by meso- to hypothermal activity related to plutonism of the Colo Plutonic Suite. This indicates the possibility of veins, replacement, porphyry, and other types of deposits in this area. But the alteration is mostly weak and the geochemical anomalies are of low level. Also many of the altered zones and geochemical anomalies have been drilled without noteworthy results. Vasilaulau and Waindolo Anomalous Zones have overlap of multicomponent anomalies and are considered to be worth notice among those not drilled so far. If large deposits do occur in this area, the weak surface manifestations indicate deep-seated mineralization.

4-3-3 Prospective areas of Viti Levu

All relevant data concerning; altered zones, mines, mineral showings, various SLAR structures, high magnetic anomaly distribution, medium-wavelength gravity contours with 10 mgal intervals, short-wavelength gravity lows and highs, and gravity faults of the whole Viti Levu Island were examined and the prospectivity of areas studied (Fig. 2-4-23).

The gravity pattern of Viti Levu is clearly divided by medium-wavelength gravity features into two areas by a line extending in the NE-SW direction joining Verevere in the northeast and Sigatoka in the southwest. Large scale gravity highs occur isolated within a region of low gravity to the northwest of the line, while to the southeast, high and low anomalies occur as parallel belts with NE-SW trend.

In the area north of the above line, marked medium-wavelength gravity high were confirmed at four localities, to the southeast of Nadi, southwest of Mba, east of Vatukoula, and west of Rakiraki. In all of these anomalies, with the exception of the Nadi southwest, altered zones occur in the central part and have "collapsed structure" or "photogeologic structure indicating collapsed structure - resurgent caldera" and plutonic bodies intruded into Ba Volcanic Group at about the same time. Also at the centers of the gravity highs at southwest of Mba and east of Vatukoula, lies the Kingston and Emperor Deposits respectively, and auriferous quartz veins have been discovered by private sector in the gravity high to the west of Rakiraki.

The high anomalies at the three localities are located at inferred volcanic centers and have circular to oval shape. These facts are interpreted to reflect the existence of high density igneous bodies formed by the solidification of magma chambers. Convection cells are believed to be formed inside large magma chambers, and the crystallized minerals are deposited in the bottom of the convection cells and form mafic stratified igneous bodies. These bodies should have very high density. Basaltic activities were predominant in the Mba and Koroimavua Volcanic Groups which are widely distributed in the above three areas, but andesite became significant towards the latter part of the volcanism. This supports the view that magmatic differentiation occurred simultaneously with the basaltic volcanism and enriched SiO_2 in the upper parts of the magma chambers.

When the magma was in molten state, volcanism was most active at the surface immediately above the chamber. Volcano itself, collapsed structures, domes, and many fractures and fissures, which would later become the place of ore emplacement, were formed at that time. The Emperor Deposit is located at the margin of a collapsed structure and is emplaced in the fissures which most probably were formed by the volcanic process. It is, therefore, reasonable to consider the possibility of epithermal gold deposits, similar to those of the Emperor Mine, at the centers of the medium-wavelength anomalies at the three localities. Considering the distribution of altered zones, medium-wavelength high gravity zone over 20 mgal would be the targets for all three localities.

Aside from the above three localities northwest of the Verevere - Sigatoka Line; altered zones, SLAR structures, and short-wavelength anomalies overlap at northwest of Mba and Sambeto south of Lautoka. Both localities are situated at the periphery of the medium-wavelength gravity high to the southwest of Mba and inferred volcanic center is in or near the structures. And the alteration and the SLAR structures are considered to be related to the activities of the small magmatic chambers which branched out from the large magma chamber inferred from the gravity high to the southwest of Mba. Both localities have epithermal gold potentials.

Sigatoka is located to the northwest of the Verevere - Sigatoka Line, but Wainimala Group and Colo Plutonic Suite are predominant and the geology is similar to that of southeast. The potential of mineralization would be porphyry type associated with the Colo Plutonics. As the density contrast between the Colo and the Wainimala is negligible, it was not possible to clarify the shape of the Colo body by gravity survey.

The mineralization southeast of the above Line includes; volcanic type porphyry copper Namosi Deposit in Medrausucu Group, plutonic type porphyry mineralization in Colo Plutonic Suite or its vicinity, skarn mineralization in the contact between Colo Plutonic Suite and limestone of the Wainimala Group, replacement mineralization in Wainimala Group near the Colo Plutonic Suite, bedded manganese in stratified volcano-sedimentary formations of the Wainimala Group, and gold and iron placers. These, however, do not show characteristic gravity anomalies. This probably is due to the lack of density contrast between the andesite of Medrausucu Group and porphyries of Medrausucu and Wainimala Group or between Colo Plutonic Suite and Wainimala Group. This is similar to the case of Sigatoka and it is difficult to extract promising zones from gravity data.

Chapter 5 Conclusions and Recommendations

5 - 1 Conclusions

[Mba-west Area]

Photogeological analysis, geological survey, geochemical prospecting and drilling were carried out.

The following conclusions were obtained.

(1) The Mba-west area was photogeologically analyzed. The geology was classified into 10 units and gently northward dipping general structure was identified.

(2) Total of ninety five lineaments were extracted photogeologically in the Mba-west. Many of these are concentrated in the southern and northern parts of the area. The directions of the maximum horizontal compressional stress axes were inferred to be NNW to NNE and ENE to ESE from the en echelon arrangement of the lineaments.

(3) The photogeological characteristics of the known mineral prospects of Mba-west were identified to be low resistance and low relief. Eight localities with these features were delineated.

(4) The geology of Mba-west consists mostly of; Miocene-Pliocene andesitic/basaltic volcanic products and limestone; Pliocene basaltic/andesitic volcanic products, sandstone, and conglomerates; Holocene alluvium; and intrusive rocks (monzonite, dacite, andesite, basalt) penetrating the Pliocene formations. The Miocene and Pliocene formations largely dip northward at low angles and are superposed. Thus the strata become younger northward.

(5) The following characteristics are noted in the intrusive bodies of Mba-west.

Monzonite is arranged in the NNE-SSW direction within the photogeological annular structures in the southern part.

Andesite and basalt dykes occur mostly in the south and north. They are particularly dominant in the south.

Many of the dykes in the south and some of the northern dykes are arranged radially.

In the south, andesite is distributed mainly within the photogeological annular structures and extend northward and southeastward from these structures. Basalt is distributed in the periphery of the andesite area.

(6) Marked Au, As, Te geochemical anomaly zones which coincide

with the altered/mineralized zones on the surface were extracted at four localities in Mba-west area. Aside from the above, small geochemical anomalies not associated with alteration/mineralization were confirmed at several localities and blind buried altered/mineralized zones were anticipated to occur in shallow subsurface parts.

(7) Two holes drilled in Mba-west area penetrated through basalt lava and basaltic pyroclastics of the Pliocene Namosau Volcanics and confirmed wide argillized zone accompanied by pyrite dissemination, but promising Au mineralization could not be confirmed.

(8) The circular depression extracted in southern Mba-west as photogeological annular structure is believed to have been the center of volcanic activity from the distribution of the volcanic products and intrusive bodies. A large scale medium-wavelength gravity high is distributed throughout this area. This gravity high is believed to reflect high density rock bodies (deep-seated bedded basic intrusive bodies) formed by the solidification of the magma chamber which supplied the volcanic products of this area. The above annular structure is located near the center of this high gravity anomaly.

(9) There is a photogeological dome structure. Plutonic monzonite and the dome occur within the annular structure in southern Mba-west, this is considered to be the evidence of uplift of the structure after the effusion of the volcanic products. The process of formation of this structure is inferred as follows. First, volcanic collapsed structure was formed in relation to the effusion of volcanic material. Subsequently the depressed structure was uplifted by the rise of magma, resulting in the extinction of the clear collapsed structure.

(10) Monzonite and andesite intruded into basaltic volcanic products near the above annular structure in southern Mba-west. This is believed to indicate the differentiation from basaltic to andesitic magma in the magma chamber after the effusion of the volcanic products.

(11) The monzonite bodies are arranged in the NNE-SSW direction in southern Mba-west, and thus it is inferred that, at the time of the intrusion (4.96 $\pm$ 0.30 Ma), extensional deep fractures were formed in that direction by maximum horizontal compressional stress. This inferred stress field coincides with that of Pliocene obtained by photogeological analysis.

(12) Many lineaments of Mba-west are developed near the inferred volcanic centers in north and south, also lineaments with various

trends are developed within the photogeologic annular structures. Also in short-wavelength low gravity zones and in parts of the short-wavelength high gravity zones, lineaments parallel to the elongation of the zones are developed in and near the zones. This is interpreted as reflecting fractures which were developed as the result of the vertical block movement accompanying the rise of magma.

(13) Propylitized zones and sericitized zones are developed near the southern photogeological annular structures, and geochemical anomalies related to Au mineralization and auriferous quartz veins occur overlapping some of these altered zones. These features regarding geologic structure and mineralization/alteration are very similar to those of the Emperor Mine area. It is anticipated that low sulfidation epithermal gold mineralization akin to that of the Emperor Mine would exist in this area.

(14) Photogeological caldera structures are extracted at three localities in northern Mba-west and volcanic products are distributed in the vicinity. These calderas all occur in short-wavelength high gravity zones. This reflects the fact that these calderas are crater and/or volcanic collapsed structures and that the short-wavelength highs are caused by shallow high density rocks. These shallow bodies are considered to be small magma chambers formed as offshoots of the large, deeper chamber whose existence is inferred from medium-wavelength gravity high.

(15) Acidic alteration zones accompanied by silicification are developed in some of the photogeological calderas in northern Mba-west. Geochemical anomalies related to Au mineralization occur overlapping these altered zones. This is of the high sulfidation epithermal gold mineralization. This type is considered to form under shallower environment than the low sulfidation type. The results of drilling at Namosau Alteration Zone of this year, showed that the deposits could have been eroded out. But the conditions of the lower parts of the Raviravi Alteration Zone is not clear, and the possibility of the occurrence of gold deposits has not died.

The high sulfidation type mineralization/alteration also occur in short-wavelength high gravity zone at the southeastern border of Mba-west.

(16) The mineralization of Mba-west was brought about by hydrothermal activities related to Pliocene volcanism. And it is considered that high sulfidation type epithermal gold mineralization occurred above the shallow small magma chamber while low sulfidation type occurred near the volcanic center in the central part of the deep and large scale chamber.

[Sigatoka Area]

Gravity survey, geological survey and geochemical prospecting were carried out.

The following conclusions were obtained.

(1) The geology of Sigatoka consists of; Miocene basaltic and/or andesitic volcanic products, and detrital sediments; Pleistocene (?) fluviatile sediments; and intrusive bodies (granodiorite-porphyry-diorite porphyry bodies, granodiorite, diorite, diorite porphyry, quartz porphyry, aplite, basalt, andesite, dacite, and rhyolite) penetrating Miocene Series. The Miocene units largely dip southwestward are superposed.

(2) The major faults of Sigatoka area have trends (E-W to WNW-ESE) similar to the direction of the arrangement of the Colo Plutonic Suite (WNW-ESE), and there are a few which intersect them at oblique angles. The major faults transect the relatively old porphyry bodies (10.1 ± 1.6 Ma) of Colo Plutonic Suite bodies, and, in turn, is transected by younger plutonic bodies (8.1 ± 0.3 Ma). This indicates that the activities of the fault and the Colo Plutonism overlap.

To the south of Colo Plutonic Suite, dykes are arranged en echelon in the NW-SE to E-W direction and the existence of right lateral faults are inferred.

(3) The trends of the SLAR lineaments of Sigatoka are NW-SE, WNW-ESE, and NE-SW. There are Colo Plutonic Suite bodies with elongation similar to these lineaments in respective areas.

(4) Most of the mineralized/altered zones occur in either near the above faults, near the Colo Plutonic Suite bodies, near the SLAR lineaments, and near the en echelon dykes. Also some of them occur within the Colo Plutonic Suite bodies.

(5) Four large geochemical anomalous zones were extracted in the Sigatoka area. These four zones coincide with the surface mineralized/altered zones, and many other small anomalies were also extracted. These are believed to be anomalies related to the activities of the Colo Plutonic Suite which occur extensively below.

(6) The mineralization of the Sigatoka area is closely related to the activities of the Colo Plutonic Suite and they are emplaced in fractured zones in the vicinity of the plutonic and porphyry bodies, thus, it is considered that the mineralization took the form of veins, replacement, porphyry, and other types of meso- to

hypothermal activity.

(7) The intensity of the mineralization/alteration is weak with some exceptions. The intensity of the geochemical anomalies is also generally low. Many of the altered zones and anomalies have been drilled without significant success. There are two undrilled localities where multi-component anomalies are noted. If large deposits are to be anticipated, the weak surface manifestation indicates deep occurrences.

[Gravity Survey]

Gravity survey was conducted in the southern part of Viti Levu Island, and analysis was carried out from the data of the first and second phase surveys.
The following conclusions are obtained.

(1) Medium-wavelength gravity features indicate that to the north of the NE-SW trending line joining Verevere in the north-east and Sigatoka in the southwest, large scale gravity highs with circular to oval shape occur isolated in a generally low gravity area, while to the southeast of the line, high and low anomalies elongated in the NE-SW direction in belt-form are distributed alternating each other. Thus the gravity features of the two areas are clearly different. The westernmost high anomaly southeast of Nadi in the northwestern part coincides well with the distribution of the Yavuna Group, but the other three highs cannot be correlated with surface geology. The zonal distribution of the high and low anomalies in the southeast more or less coincides with the distribution of the "Wainimala Group - Colo Plutonic Suite" and "Medrausucu Group - Verata Sedimentary Group".

(2) There are large medium-wavelength gravity high at three localities, southwest of Mba, east of Vatukoula, and west of Rakiraki. Annular, caldera, dome structures identified photo-geologically and collapsed structures ,intrusive bodies, altered zones, and marked short-wavelength gravity anomalies are concentrated in the centers of these medium-wavelength gravity highs. The gravity gradient of the peripheral parts of these medium-wavelength highs is steep and the shape of these anomalies is circular to oval. These are considered to indicate the existence of subsurface high density igneous body and is inferred that there was a large magma chamber in the deeper parts.

(3) The Emperor Mine is situated at the periphery of the collapsed structure in the center of the medium-wavelength gravity

high to the east of Vatukoula, the Kingston Mine in the center of the medium-wavelength gravity high to the southwest of Mba. Together with the high west of Rakiraki, the centers of these three medium-wavelength gravity highs are considered to be the localities where active volcanism occurred repeatedly. Therefore, these are listed as promising for epithermal gold exploration. The anomalies in the northern Mba-west are on the northern extension of the medium-wavelength gravity high to the southwest of Mba, and with the coincidence of SLAR annular and caldera structures and the short-wavelength gravity highs, it is believed that the northern Mba-west was the place of activity of small magma branched out from large magma chamber. The area is listed as a promising for epithermal gold deposit occurrence.

5 - 2 Recommendations for the Third Phase Survey

It is recommended that the following activities be undertaken for the third phase survey.

(1) Drilling at Yaloku and Nalotawa-Nanuku Alteration Zones in south Mba-west in order to confirm the conditions related to low sulfidation epithermal gold mineralization. These zones are located near the photogeological annular structures in south Mba-west.

(2) Drilling at Raviravi Alteration Zone in north Mba-west in order to confirm the conditions related to high sulfidation epithermal gold mineralization.

(3) Geophysical surveys in order to clarify the conditions of subsurface mineralization/alteration at several localities where small geochemical anomalies not related to surface mineralization/alteration. And drilling if the above geophysical survey provides promising results.

PART II DETAILED DISCUSSIONS

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Chapter 1 Photogeological Interpretation

1-1 Outline

1-1-1 Objectives

This work was carried out in order to understand the relation between the regional geology, geologic structure and mineralization of the Mba-west area through photogeological interpretation.

1-1-2 Area

Mba-west area is located in the northwestern part of Viti Levu and an areal extent of 500km² (21km in E-W and 24km in N-S directions) was analyzed (Fig.1-2).

1-1-3 Aerial Photographs Used

The aerial photographs used were the monochrome photographs provided by the MRD. They are:

Course No.	Photo No.	Number of Sheets	Scale	Cloud Cover	Photo date
RAAF3365	58- 70	13	Approx. 1:50000	0 %	June/1986
RAAF3365	105-117	13			
RAAF3365	137	1			
RAAF3370	49- 59	11			
RAAF3370	194-206	13			
Total		51			

1-1-4 Method of Interpretation

First, the regional geologic structure and lithologic distribution were clarified by photogeological interpretation. Then the photogeological characteristics of the vicinity of the known mineral prospects were identified and finally the relation between the mineralization of this area and the geology was deduced.

1-1-5 Criteria for Interpretation

(1) Geologic units

The standards used for delineating geologic units are as follows.

a. Photographic characteristics

Tone; indicating the brightness by light, medium, dark.
Texture; very fine, fine, medium, coarse.

b. Morphologic elements

Drainage pattern; dendritic, parallel, radial inward, radial outward, meandering.

Drainage density; high, medium, low.

Rock resistance; very high, high, medium, low, very low.

Morphology of ridges and valleys; cross sections.

Development of bedding; good, poor.

Development of lineament; good, medium, poor.

(2) Geologic structure

The standard used for interpreting the geologic structure are as follows.

a. Folds

Folds are identified by considering the distribution of geologic units, bends in the drainage pattern, trace of cuesta topography, extraction of dip of the geologic units and other factors.

b. Lineaments

Lineaments indicate the existence of fractures on the surface or at shallow subsurface regions. Only those features considered to be geologically significant were extracted as lineaments. Those in the present area were not very clear and are shown by broken lines in the map.

The major morphological features used for identifying lineaments are as follows.

① Existence of fault scarps.
② Existence of linear fault valleys.
③ Notably linear flow of rivers.
④ Existence of kerncols and kernbuts.
⑤ Linear continuation of break points of slopes.

The above features vary in accordance with the geology, geologic structure and other factors of the area. However, empirically it can be safely considered that most of the lineaments can be explained by the above morphological features.

(3) Annular and dome structures

The morphological features for identifying annular structures are; ① inward radial or semi-inward radial drainage patterns, ② circular or arc shaped depressions with similarly shaped marginal ridges.

In the structural feature mentioned in ② , it strongly suggests the existence of eroding calderas where there are sharp continuous scarps along the inner sides of the marginal ridges. These are called caldera structures (in the interpretation map