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REPORT ON THE MINERAL EXPLORATION IN THE HOMA BAY AREA REPUBLIC OF KENYA

CONSOLIDATED REPORT

MARCH 1990

JAPAN INTERNATIONAL COOPERATION AGENCY

METAL MINING AGENCY OF JAPAN

PREFACE

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

The JICA and MMAJ sent a survey team, headed by Mr. Haruo Watanabe, to the Republic of Kenya and the survey was conducted for three years from fiscal 1987 to 1989.

The team exchanged views with the officials concerned of the Government of the Republic of Kenya and conducted a field survey in the Homa Bay Area. After the team returned to Japan, further studies were made and the present compilation report of the whole survey 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 Kenya for their close cooperation extended to the team.

February, 1990

Kensuke Yanagiya

Kensuke Yanagiya.
President,
Japan International Cooperation Agency.

Genichi Fukuhara.
President,
Metal Mining Agency of Japan.

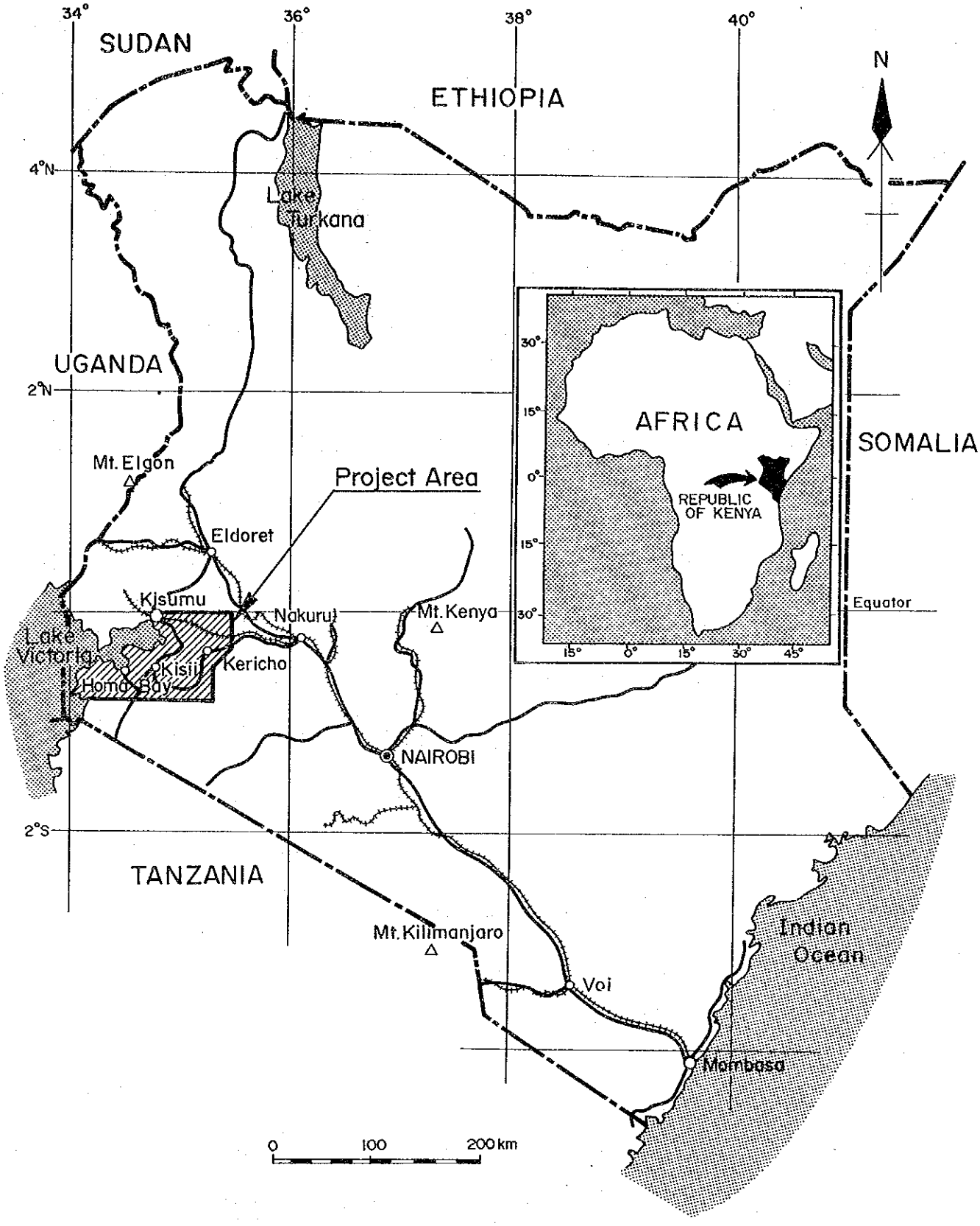

Fig. 1 Location Map of the Project Area

ABSTRACT

The Cooperative Mineral Exploration Project in the Homa Bay Area in Nyanza Province, Republic of Kenya, was carried out in a three-year period from 1987 to 1989, and covered an area of 10,000 square kilometres.

The main purpose of the Homa Bay Project was to assess the mineral deposits that are related to carbonatite by an elucidation of the geology of the area.

The exploration works that were carried out were composed of: a Regional geological survey of the carbonatite-bearing area of an area covering approximately 2,750 square kilometres; Semi-detailed geological and geochemical survey of the selected ten (10) localities of carbonatite-related mineral ore bodies, covering a total of 190 square kilometres; and Detailed surveys that included diamond drill operations of three (3) selected mineralized targets, covering a total of 3.74 square kilometres.

Regional geological survey: The results of this survey are summarized as follows; The regional geology of the area was found to conform with the existing geological maps, however, small carbonatite bodies were newly located, while, the existing ones were mapped out in some details. Copper showing were noted in several localities, however, were of limited extents and indicated weak mineralization. Gold occurrences were found in some localities and in some of these, local people have small-scale operations. It is to be noted here that the survey area is in the Nyanzian greenstone belt, and Greenstone Belts are known world-wide to be associated with gold fields. Migori Gold Field is in the proximity to the south of the survey area. There may be a possibility of locating new gold potential areas by carring out systematic exploration works in the area, especially the northeastern and southeastern parts of the survey area, including the Homa Mountain gold showings.

Semi-detailed and detailed survey: Three areas, Buru Hill, Kuge-Lwala and North and South Ruri Hills were selected from the ten (10) original target areas for rare earths elements and niobium. Results of detailed survey are as follows:

(1) Buru Hill

A detailed geological mapping and a drill operation, comprising 30 holes with total lengths of 1,750 m were carried during the last two-year period.

The Buru Hill consists of a mass of carbonatite intrusion surrounded by basement gneisses. The carbonatite mass carries rare earths elements and can be vertically separated into two zones, the Upper Oxidized (or weathered) and the Lower Reduced (or primary) zones. The Upper Oxidized Zone is secondarily enriched in rare earths elements, relative to the Lower Reduced Zone and form a rare earth ore body The inferred geological ore reserves are estimated to be approximately 10.7 millions tonnes of crude ore with average ore grades of 2.07% in light rare earths elements (La + Ce + Nd), 370 ppm of middle (Sm + Eu + Tb) and 38 ppm of heavy (Yb +

Lu), or at approximately 280 thousands tonnes of contained total rare earths oxides (TREO) with the average grade of 2.63% TREO. The average grade of TREO is low compared with those of the rare earths ore deposits being mined elsewhere in the world and may be so low to commercially develop this ore deposit at present time. However, the deposit is with a favourable configuration for a facile applicability of open pit mining operation and with a favourable accessibility. It is presumed that the ore body may be warrantedly examined with some economical possibility in a future when more detailed ore reserves are established and an applicable mineral processing technology is developed.

(2) Kuge-Lwala Area

The occurrence of the ferrocarbonatite body in the Kuga-Lwala Area was elucidated by the detailed geological and geochemical surveys as well as by diamond drills, comprising 6 holes with a total length of 360 m. The ore body is associated with a number of ferrocarbonatite dikes and extends for about 600 m in the north-south direction with the maximum width of approximately 60 m or the average width of 30 to 40 m, terminating toward north and south. The average ore grades are 1.57% of light rare earths elements (La + Ce + Nd), 198 ppm of middle (Sm + Eu + Tb), 18 ppm of heavy (Yb + Lu) and 0.06% of Nb. These values are much lower than those of the Buru Hill ore body and it may be concluded that the Kuge-Lwala ore body is unfeasible for commercial development.

(3) North and South Ruri Hills Areas

Detailed geological and geochemical surveys were carried out in three areas that were considered then as encouraging. The survey elucidated a concentration of rare earths elements in masses of ferrocarbonatite and located a number of geochemically anomalous zones. However, the zones are very limitedly extended and poor in mineralization. None of them warrant any further exploration.

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Geological Map of the Homa Bay Area, Summarizing the Results of Mineral Exploration 1987-1989

PART I GENERAL

CHAPTER 1 OUTLINE OF SURVEY WORK

1-1 Area covered

The area of the Cooperative Mineral Exploration Project, Homa Bay Area in Nyanza Province, Republic of Kenya, occupies an area covering 10,000 square kilometres, which is located in eastern district of Lake Victoria.

Three types of exploration work have been carried out for the project; reconnaissance type regional geological mapping for an area covering approximately 2750 sq.km (Regional Survey), Semi-detailed Survey for selected 10 known carbonatitic occurrences totalling about 190 sq.km and Detailed Survey for three areas selected from the Semi-detailed Survey. The project areas are shown in Figs. 1 and 2.

The names of each survey area and the covered area are listed in Table I-1-1.

Table I-1-1 Project areas

Name of Area	Area (sq.km)
REGIONAL SURVEY	2,750
SEMI-DETAILED SURVEY	
Rangwa	26.50
Sagarume-Nyamgurka	9.75
South Ruri	20.00
North Ruri	15.00
Kuge, Lwala	6.25
Ngou, Kuwor	0.60
Ugongo, Uyi, Kiyanya, Sokolo	8.40
Homa Mountain	69.80
Buru Hill	4.00
Legetet Hill	30.00
	TOTAL 190
DETAILED SURVEY	
Buru Hill	0.96
Kuge-Lwala	1.10
North & South Ruri Hill	1.68
	TOTAL 3.74

1-2 Purpose of the Survey

The main objective of the Survey is to explore and to assess the mineral potential of the Survey Area, as designated in the Scope of Work for the Mineral Exploration in the Homa Bay Area. The Scope of Work was agreed in July 1987 between the Government of Kenya through the Ministry of Environment and Natural Resources (MENR), and the Japan International Cooperation Agency (JICA) and the Metal Mining Agency of Japan (MMAJ).

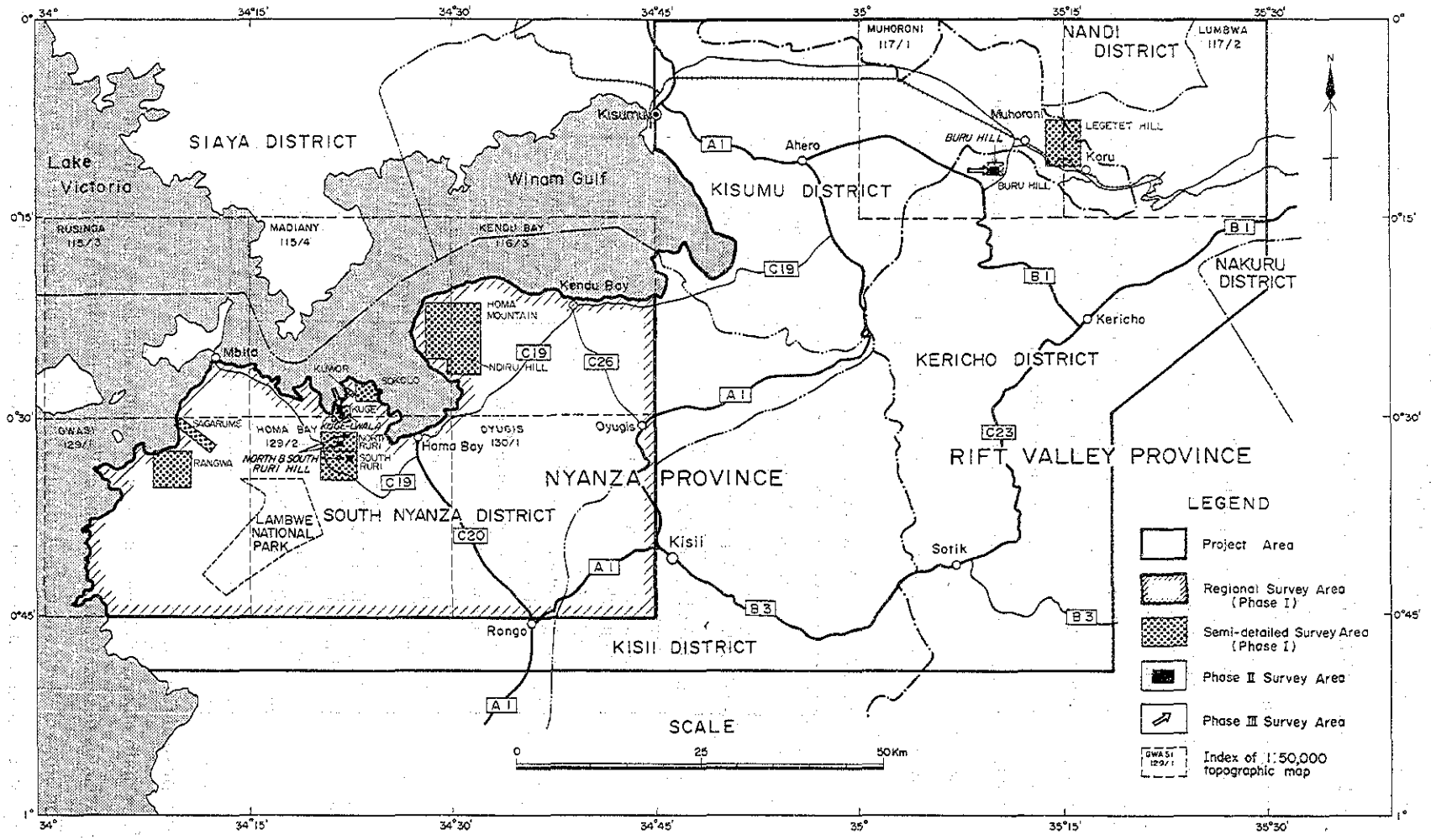


Fig. 2 Location Map of the Survey Areas

1-3 Methods and Contents of the Survey

The current Survey is a three-year project commenced in the fiscal year of 1987.

The survey of the first year includes a reconnaissance geological survey (Regional Survey) for an area of about 2,750 km^2, and geological and geochemical surveys (Semi-detailed Survey) for 10 known occurrences of carbonatite (190 km^2 in total). The major targets for both surveys are rare earths (REE) and so-called rare metals.

The survey of the second year includes a detailed geological survey followed by diamond drill explorations (17 holes, 1,000 m in total length) in the Buru Hill Area (an area of 0.96 km^2), and detailed geological and geochemical explorations in the North & South Ruri Hill Area (an area of 1.68 km^2) and the Kuge-Lwala Area (an area of 1.10 km^2).

The survey of the third year includes diamond drill explorations in the Buru Hill and Kuge Hill areas (19 holes, 1,110 m in total length).

All the works carried out by the current survey are listed in Table I-1-2.

1-4 Periods of Work

Periods of the work required for each year's programme are also listed in Table I-1-2.

1-5 Organization

Organization of negotiating team and field survey team in Phase I to III are summarized in Tables I-1-3 and I-1-4.

Table I-1-2 Content and Quantity of Field Work, and Outline of Laboratory Tests

	Phase I (1987)	Phase II (1988)	Phase III (1989)
Period of work	Oct. 1987 ~ Feb. 1988	July 1988 ~ Feb. 1989	July 1989 ~ Feb. 1989
Geological Survey Regional survey	2,750 km^2 Scale 1: 50,000		
Semi-detailed survey	190 km^2 Scale 1: 10,000 (10 Areas)		
Detailed survey		3.74 km^2 (3 Areas) Scale: 1; 5,000 1; 2,000	

Table I-1-2 Content and Quantity of Field Work, and Outline of Laboratory Tests – cont'd.

	Phase I (1987)	Phase II (1988)	Phase III (1989)
Period of work	Oct. 1987 ~ Feb. 1988	July 1988 ~ Feb. 1989	July 1989 ~ Feb. 1989
Geochemical Exploration Semi-detailed survey	10 Areas, 190 km^2 1509 Samples x 17 Elements (U, Th, La, Ce, Nd, Sm, Eu, Gd, Tb, Tm, Yb, Lu, Nb, Sr, Y, Ba, P)		
Detailed survey		3 Areas, 5.80 km^2 590 Samples x 15 Elements (U, Th, La, Ce, Nd, Sm, Eu, Tb, Yb, Lu, Nb, Sr, Y, Ba, P)	
Diamond Drill Exploration		Buru Hill Area 17 Holes, 1005.7m 210 Ore samples x 15 Elements (U, Th, La, Ce, Nd, Sm, Eu, Tb, Yb, Lu, Nb, Sr, Y, Ba, Au)	Buru Hill Area 13 Holes, 755.70m 162 Ore samples x 15 Elements (U, Th, La, Ce, Nd, Sm, Eu, Tb, Yb, Lu, Nb, Sr, Y, Ba, P) Kuge-Lwal Area 6 Holes, 360.60m 81 Ore samples x 15 Elements (Same as Buru Hill Area)
Laboratory Work			
Thin section	52	20	20
Polished section	15		
Polished thin section		12	20
Whole rock analysis	43	40	12
Trace element analysis	22		10
X-ray diffractometry	10		
K-Ar dating	5		1
EPMA Test		10	10
Size measurement of Minerals			10
Oxygen isotope measurement			10

Table I-1-3 Member List of Negotiating Team

	JAPANESE SIDE		KENYAN SIDE	
Phase I (1987)	Mr. Hiroaki Yokoi	MITI	Mr. A.C. arap Lang'at	MENR
	Mr. Yoshio Matsukawa	MMAJ	Mr. C. Mbindyo	MF
	Mr. Toshihiko Hayashi	MMAJ	Mr. W.K. Maluki	MENR
			Mr. F.G. Theuri	MGD
Phase II (1988)	Mr. Toshihiko Hayashi	MMAJ	Mr. J.K. Wachira	MGD
			Mr. F.K. Muruga	MGD
			Mr. Isaac Onuonga	MGD
Phase III (1989)	Dr. Masatsugu Ogasawara	GSJ	Mr. S. Abiud Wasike	MENR
	Dr. Hideo Hirano	MMAJ	Mr. C.Y.O. Owayo	MGD
	Mr. Hiroshi Shimotori	MMAJ	Mr. J.K. Wachira	MGD
			Mr. F.K. Muruga	MGD
			Mr. Isaac Onuonga	MGD

MITI: Ministry of International Trade and Industry of Japan

GSJ: Geological Survey of Japan

MMAJ: Metal Mining Agency of Japan

MF: Ministry of Finance of Kenya

MENR: Ministry of Environment and Natural Resources of Kenya

MGD: Mines and Geological Department of Kenya

Table I-1-4 Member List of Field Team

	JAPANESE SIDE		KENYAN SIDE	
Phase I (1987)	Dr. Kinsuke Uchida Leader	MMAJ	Mr. Isaac Onuonga Co-leader	MGD
	Mr. Haruo Watanabe	MMAJ	Mr. Peter Ongaga	MGD
	Mr. Hidetoshi Takaoka	MMAJ	Mr. John Kibe	MGD
	Mr. Atsumu Nonami	MMAJ		
Phase II (1988)	Mr. Haruo Watanabe Leader	MMAJ	Mr. Isaac Onuonga Co-leader	MGD
	Mr. Takumi Onuma	MMAJ	Mr. William Okech	MGD
	Mr. Katsuei Narita	MMAJ	Mr. Haron Onsomu Maragia	MGD
	Mr. Takehiro Manabe	MMAJ	Mr. Adipo Komo	MGD
	Mr. Masaaki Fujita	MMAJ	Mr. E. Likhaya	MGD
			Mr. Peter Obiero	MGD
			Mr. Joseph Ango	MGD
			Mr. Chambege Sembe	MGD
Phase III (1989)	Mr. Haruo Watanabe Leader	MMAJ	Mr. Isaac Onuonga Co-leader	MGD
	Mr. Katsuei Narita	MMAJ	Mr. William Okech	MGD
	Mr. Takehiro Manabe	MMAJ	Mr. Haron Onsomu Maragia	MGD
	Mr. Masaaki Fujita	MMAJ	Mr. Albert Mahaja	MGD
			Mr. Adipo Komo	MGD
			Mr. E. Likhaya	MGD
			Mr. Peter Obiero	MGD
			Mr. Joseph Ango	MGD
			Mr. Chambege Sembe	MGD

CHAPTER 2 GEOGRAPHICAL BACKGROUND

2-1 Location and Communication

(1) Location

The project area is located in western part of the Republic of Kenya (Fig. 1). The whole target area of the Regional Survey of the current work is situated in two districts in Nyanza Province, i.e., Kisii and South Nyanza. Eight of ten Semi-detailed Survey areas are included in the Regional Survey area, while the rest is locted in theKericho district of the Rift Valley Province (Fig. 2). All the areas are included in the Lake Basin Development Authority Area.

(2) Communication

An overland route access from Nairobi, the capital of the Republic of Kenya, to Kericho-the major local city in the survey area - and to Homa Bay - the local town located in central portion of the survey area - is approximately made by 270 kilometres and 400 kilometres, respectively. Nairobi and Kericho is connected through Nakuru, the major city in Kenya, by the Kenyan National Trunk Roads, A-104 and B-1. Kericho and Homa Bay is connected by the National Roads C-23, B-3, A-1 and C-20, which are fully sealed to be of all-weather type. It is 4 hours and 7 hours from Nairobi to Kericho and Homa Bay, respectively, by an easy accessibility by car driving.

Kericho and Buru Hill / Legetet Hill, outside of the survey area, is connected by the National Roads B-3 and C-35, by which an accessibility is made very easily.

The general traffic situations in the area, where Regional Geological Survey by the current investigation programme was implemented, is well-developed by abundant local road networks, car-accessible and mostly unsealed, due to that the area is included in one of the densely populated district in the Republic of Kenya. Easy accessibilities to the Semi-detailed Survey Area are also available.

Railway service is available between Nairobi and Kisumu through Muhoroni, adjacent to Buru Hill and Legetet Hill in the Semi-detailed Survey Area, and to Koru. The service is unavailable in the Regional Geological Survey area.

Route coach bus services, including long distance service, i.e., to Nairobi, are very well-organized for the purpose to common traffic availabilities. Autobus services, called Matatu, which is a refurbished small lorry, are also available in short distance communications.

2-2 Physical Features of the Survey Area

The Regional Survey area including 8 semi-detailed areas may physiographically be devided into three units reflecting the underlying geology, as it straddles the southeastern boundary faults of the Kavirondo Rift, which is regarded as a sideshoot of the East Africa Rift

Valley (cf. 3-2, and Fig. I-1-3). One of the most conspicuous surficial expression of the faults is the Kaniamwia Escarpment in the southwestern part of the area.

The first unit is the southeastern part of the boundary faults, where low-relieved rolling hills, with gradual increase in an altitude towards southeastern corner of the area, are configured. It is 1,850 m high above sea level at the corner.

The second is the plain between the boundary faults and Lake Victoria (sl. 1136m), where alluvial sediments cover the surface (less than 100m high above the lake water level).

The third is highly relieved hills of carbonatite-alkaline complexes such as Gwasi Hill (2272m), Gembe Hill (1900m), Ruri Hills (1706m), Homa Mountain (1750m) and etc.. These are located within the area of the second feature the above and their ring-shaped scarp features are impressive, as well as cone-shaped small plugs of phonolitic rocks. Among these, the double-ring structure of the Tertiary Kisingiri volcano, the outer ring of which is expressed by a ridge connecting Gwasi and Gembe hills and the inner ring by the ridges of Rangwa, is noteworthy.

The two isolated Semi-detailed areas, Buru and Legetet Hills, are located close to the northeast corner of the Kavirondo Rift, where the Quaternary volcanics from the East Africa Rift Valley cover the graben (Fig. II-1-1). Buru Hill forms a small discrete hill and Legetet Hill forms a parasite hill at the foot of the huge dissected Tertiary Tinderet volcano.

There are only a few permanent rivers within the Regional Survey area, however, in the vicinity of Buru and Legetet Hills, there are permanent water flows in the upstreams of the Nyando River.

2-3 Climate and Vegetation

(1) Climate

The climate in the project area is of semi-arid with an annual precipitation of about 1000 to 1200mm and humidity of about 60%. There are two rainy seasons; long rains from March to May or June, and short rains in November and December. The air temperature changes little throughout a year, averaging 24°C, but sometimes rising up to 40°C (LeBas 1977).

(2) Vegetation

In general, the natural vegetation of the project area is rather poor, as its climate is semi-arid, belonging to savanna, and as the area is heavily inhibited.

The plains in the Regional Survey area are more or less covered with fields of maize, millet, cassava, and cotton. These are often fringed by sisal (Agave sisalana). However, the lands seem to be infertile. Inversely, a small fraction at the southeastern corner of the area, which belongs to the Kisii district, is fertile and is used as fields for vegetables as well as maize. Also the flat lands in the proximity of Legetet and Buru Hills are fully utilized for a large scale sugar cane plantation.

Most of the hilly carbonatite-alkaline centers are open grass land, with scattered acacia trees (Acacia drepanolobium and other species), Cactus Euphorbia (Euphorbia ingens), thorn bush, and etc..

CHAPTER 3 PREVIOUS GEOLOGICAL WORK

There are a number of previous researches on the Rift Valley and carbonatite of either Eastern Africa or Kenya, among which books by Heinrich (1966), Tuttle and Gittins (ed. 1966) and LeBas (ed. 1977) are very informative. Especially, the work by LeBas and others deals with most of the Semi-detailed areas of the current works comprehensively and in detail, and is very useful.

The quadrangle geologic maps that cover the current project areas are Kericho (Binge 1962) Kisumu (Saggerson, 1952), Kisii (Huddieston, 1951) and Gwasi (McCall 1958). These provide the basic informations for the compilation of the geologic map of the Regional Survey Area.

Mineral exploration activities for limited commodities and area have intermittently been carried out within the current project area either by private sectors or foreign governmental organizations in the form of international cooperation. Among these, the projects, reports of which are so far available, are listed in Table I-3-1.

Table I-3-1 Major previous mineral exploration works in project area

Area/Prospect *1	Commodities	Organization	Period	Reference/Remarks
Buru Hill	Nb (pyrochlore & manazite)	New Consolidated Gold Fields Ltd.	6/'56-/'58	Cluver (1958)
Buru Hill, Legetet Hill, etc.	Rare earths	Metal Mining Agency of Japan		MMAJ (1981) (in Jpn.) Primary aim was ground truth of LANDSAT imagery
Oyugis (Wire Hill)	Base-metal, (massive sulphide)	United Nations Revolving Fund	11/'80-01/'84	UN Revolv. F. (1978) Final Report, Part I
Koru (and Songhor)	Cement raw materials	Geological Survey of Finland		Alviola et al. (1985)
Most of Semi-detailed areas of current work	P and Nb	Geological Survey of Finland		Idman and Mulaha (1986)
Ndiru Hill	P and Nb	Geological Survey of Finland		Mulaha (1986)

*1: Areas or prospects, that are in the current project area, are described.

CHAPTER 4 GEOLOGY OF THE HOMA BAY AREA

The current project area is located at the southwestern corner of Kenya, some 50 to 120km west from the western margin of the East Africa Rift Valley and includes the southwestern part of the Kavirondo Rift. The latter is considered to be a sideshoot of the former, and the faults that limit the southeastern boundary of the Kavirondo Rift run diagonally in the ENE-WSW direction in the Regional Survey area. Among the boundary faults, the Kaniamwia and Kendu Bay faults are physiographically prominent, and northwestern part of these faults forms a graben (Fig. II-1-1).

The project area is mainly underlain by Pre-Cambrian rocks; granites, the Nyanzian greenstone belt system, and possible Kavirondian conglomerates and grits. They are intruded by several granitic plutons. Gneisses of the so-called Basement System (the Mozambique Metamorphic Rocks) occur only in some limited areas at the northeastern corner of the graben, such as in the vicinity of Buru Hill.

Carbonatite-alkaline ring complexes of the Tertiary and/or later occur mainly in the graben, forming discrete hills, such as Gwasi Hill, Ruri Hills, Homa Mountain and etc.. Most of these are selected as the Semi-detailed areas of the first Phase. The Quaternary sediments occur covering a lowland of the graben.

The major known mineral occurrences in the project area are gold veins in the Nyanzian greenstone belt and their derivative placer, base metals of volcanogenic massive sulfides in the Nyanzian greenstone belt, hematite-magnetite, niobium, phosphorous, and rare-earths related with carbonatite complexes. More detailed description on mineral occurrences is shown in PART II.

CHAPTER 5 CONCLUSION AND RECOMMENDATION

5-1 Regional Survey Area

Regional Geological Survey of the Homa Bay Project was implemented as the first-year programme in 1987, for the purpose to elucidate the general geology in the carbonatite-bearing zone including known carbonatite localities, which covers an area of 2750 square kilometres approximately.

5-1-1 Conclusion

General geology in the area is comprised of Precambian System, Tertiary and Quaternary Systems.

The Precambrian System is composed of Nyanzian System, Post Nyanzian Intrusives, Kavirondian System, Post Kavirondian Intrusives and Bukoban System in ascending order. Nyanzian System, mainly consists of piles of volcanic rocks, majorly of basalt and rhyolite, and sediments, is to be correlated to Archaean Geenstone Belt, which is world-widely well-known as one of the major gold producers.

Tertiary and Quaternary Systems are majorly composed of the products by alkaline plutonic and eruptive rock activities on early stage of Tertiary age. Intrusive to eruptive carbonatitic bodies, volcanic centres of nephelinite-phonolite and intrusive ijolite complexes are observed in ten known localities, the above. Semi-detailed survey works, covering an area of 190 square kilometres, including ten known carbonatite occurrences, were implemented targeted for REE minerals, phosphorus, niobium and etc. in 1987, concurrently with the Regional geological survey work.

The results of the survey are summarized to be that the regional geology of the area was found to be conformable with the existing geological informations, however, small carbonatite bodies were newly located in four localities, meanwhile, the existing geological maps were revised in some details. Copper showings were observed in two localities, however, were of limited extents and indicated weak mineralization. Gold ore operations were observed in three localities and in some of these, local people have small-scale operations.

Newly located small carbonatite intrusive bodies in four localities are estimated to be unlikely encourging to warrant further investigation works due to on limited areal extents.

Copper showings in the area are estimated to be unlikely encouraging to warrant further investigation works due to on limited areal extents and qualities.

The regional geological survey area is located in the Nyanzian greenstone belt and Greenstone Belts are known world-wide to be associated with gold fields. Migori Gold Field is in the proximity to the south of the survey area. There may be a possibility of locating new gold potential areas by carrying out systematic exploration works in the area.

5-1-2 Recommendation

It is estimated that the exploration progamme in the area in future should be targeted on gold properly. The area, ocuppied by post Nyanzian Granite (G2) and surrounding Nyanzian System, should be selected for a favourable target.

5-2 Areas of Rangwa, Sagarume-Nyamgurka, Ngou-Kuwor, Ugong-Uyi-Kianya-Sokolo, Homa Mountains and Legetet Hill

5-2-1 Conclusion

Semi-detailed survey works of carbonatitic rock bodies in ten (10) occurrences, Rangwa, Sagarume-Nyamgurka, North Ruri, South Ruri, Kuge-Lwala, Ngou-Kuwor, Ugong-Uyi-Kiyanya-Sokolo, Homa Mountain, Buru Hill and Legetet Hill, covering an area of 190 square kilometres, were implemented in 1987 concurrently with the Regional geological survey work. Semi-detailed geological mapping and geochemical research works for REE, yttrium, niobium, phosphorus, etc., associated with carbonatitic bodies, were carried out.

The major results by geology, soil and rock geochemistry in areas, six (6) among the above, other than North Ruri, South Ruri, Kuge-Lwala and Buru Hill show limited areal extents of carbonatite bodies or limited encouraging geochemical showings of REE, etc.

Several quartz veins, with gold showings, were observed in Nyanzian volcanic rock in Homa Mountain.

5-2-2 Recommendation

Further exploration works for REE minerals associated with carbonititic bodies in six localities, the above, are unlikely warranted in future in the areas.

Several quartz vein showings in Homa Mountain should be noted as one of the exploration programmes of gold in a future.

5-3 North Ruri Hill and South Ruri Hill Areas

5-3-1 Conclusion

Detailed geological and geochemical surveys were carried out in 3 sectors, then were considered encouraging. The survey elucidated a concentration of rare earth elements in masses of ferrocarbonatite and located geochemically anomalous zones. However, the zones are observed areally limited and are poor in mineralization.

The three sectors where geological survey and geochemical exploration were conducted are situated in the marginal parts and in the peripheries of the carbonatite complexes of Ruri Hill, and the geology comprises basement Nyanzian metabasalt and carbonatitic rocks which have intruded the former. From geochemical explorations, it has turned out that REE and Y concentrate in ferrocarbonatite, inversely, high values of Nb are randomly

spread in the sectors and are independently distributed to any particular type of rock of carbonatites.

North Ruri Hill North Sector

The body of ferrocarbonatitic breccia is distributed in the center of sector, occupying an area of 0.03 km^2 trending E-W direction. The rocks are heterogeneous in chemical contents and strongly weathered. Geochemically anomalous zones of REE and Y are distriuted mostly in the same area covering the body and the immediate periphery. The anomalous zone has low contents parts of these elements, by what a hetergeneous character of the body is suggested. The small size of the anomalous zone and the heteogeneous character of the rocks unlikely warrant any further exploration.

North Ruri Hill South Sector

Ferrocarbonatites are mainly distributed in the south of sector in an area of 0.03 km^2 as dyke swarms, size of which are usually several centimetres to 1 m in width and several to several tens of metres in length.

Major geochemically anomalous zones are of Y, Th. and La+Ce+Nd, covering the zone of dyke-swarms of ferrocarbonatite and trending in E-W direction. The anomalous zone has an area of 0.06 km^2.

From the results of geology and geochemistry, the anomalous zone is unlikely of a potential target area for REE and Y, even though the area is larger than other two sectors.

South Ruri Hill Sector

Ferrocarbonatites in the sector occur as dykes or small dyke swarms and the majority occurs in the central to northwest part of the sector.

Major geochemically anomalous zone of the sector is observed only for La+Ce+Nd, covering the zone of dyke swarms of ferrocarbonatite.

Results of geological and geochemical explorations likely show a limited potentiality for a concentration of REE and Y in the sector.

5-3-2 Recommendation

Limited areal extents and qualities of geochemically anomalous zones in North Ruri and South Ruri are unlikely estimated to warrant further exploration works.

5-4 Kuge-Lwala Area

5-4-1 Conclusion

Geological and geochemical research works, and diamond drill operations of six (6) holes, with total depths of 360 metres for a 1989-programmes, were implemented during the term 1987 to 1989 as a part of the Homa Bay Project, Nyanza Province, Republic of Kenya.

In accordance with the results of the above works, the Kuge Hill area is geologically elucidated to be majorly composed of the dykes of ferrocarbonatite and carbonatite, which as an intermediate petrological character of ferrocarbonatite and alvikite. The general occurrence of the dykes in the area is observed in an extension of 600 metres long, 30 metres to 40 metres wide in average, 60 metres in maximum, and is extended north-southerly, dips 60 degrees to 80 degrees westerly. The results of diamund drill works by the current programme show that the oxydation zone in Kuge Hill area is insufficiently developed, resultant in that the concentration of REE minerals, associated with carbonititec dykes, is very limitedly formed. In accordance with the chemical research works of drill cores by the current works, the average grade of ore in the area shows 1.57 percent of La + Ce + Nd, which is approximate to that of the primarily mineralized zone in Buru Hill, that is 1.5 percent. However, the ore body is with a limited quantity and quality, which are with less extension and less high concentration of REE. Consequently, it is to be concluded that the REE mineralization in Kuge Hill area is less economical.

5-4-2 Recommendation

Future examinations of exploration programming for an industrial/economical development of the REE minerals in Kuge Hill area are to be unlikely warranted in accordance with the conclusion, the above.

5-5 Buru Hill

5-5-1 Conclusion

Geological and geochemical research works, and diamond drill operations of thirty (30) holes, with total depths of 1,750 metres for two-year programmes, were implemented during the term from 1987 to 1989 as a part of the Homa Bay Project, Nyanza Province, Republic of Kenya.

In accordance with the results of the above works, the Buru Hill area is geologically elucidated to be majorly composed of massive intrusive carbonatite bodies, associated with the REE minerals, and is to be surrounded by granitoid gneiss of the basement rock in the area. The carbonatite itself is zonally divided to two zone; i.e., the upper zone of oxydized-weathered part and the lower zone of reduction part.

Concentrations of REE minerals by the supergene enrichment form an ore body in upper zone of the carbonatite body. Bastnaésite is the main REE mineral of the carbonatite ore body in the Buru Hill.

The inferred geological ore reserves are estimated to be of 10,700,000 tonnes of crude ore, the average grade is La + Ce + Nd: 2.07 percent, Sm + Eu + Tb: 370 parts per million, Yb + Lu: 38 parts per million, to be re-calculated to be of Total REO: 2.63 percent, and 280,000 tonnes of Total Rare Earths Oxides.

The mineral contents in the Buru Hill ore body is inevitably estimated to be low-graded for the industrial/economical production under the current economical backgrounds in world-wide comparisons with other REE mines in operations. However, the Buru Hill ore body is with a favourable configuration for a facile applicability of open pit mining operation and with a favourable accessibility. It is also presumed that the ore body should be warrantedly examined with some economical possibility in a future when sufficient ore reserves and ore-grade values for the mining operation will be ameliorated by additional exploration activities and when an industrially favourable extration technology of REE minerals will be developed.

5-5-2 Recommendation

It should be pointed out that the followings are the major factors to be examined in compliance with a future consideration to establish an industrial/economical estimation of economical possibility of the mining development of Buru Hill ore body, those are;

1) To establish a more reliable estimation of ore reserves and ore grade based on the results by sufficient quantities of diamond drills.
2) To establish a favourable extraction technology of REE minerals by feasible crushing and metallurgical tests.
3) To estimate reasonable capital and operation costs based on the programmes related to mine development, plant construction and mining/mineral processing operations.
4) To establish infrastructural and environmental researches related to the social impacts and associated terms.

For a further reliable establishment of the re-estimation of ore reserves and ore grade, the diamond drill operations on the modes of 50 metre-interval on grid-patterns covering the mineralized zone should be appropriately operated.

The Buru Hill mineralized zone has been intersected by twenty (20) diamond drill holes among thirty (30) on approximately 100 metres to 120 metres intervals by the current works. The drill exploration programme in future considerations, to be reached down to the lowermost elevation of the oxidized zone, some 1,295 metres high above sea level, are presumed to be fixed to an aim of an extent of some additional forty (40) holes, totaling 2,000 metres.

The recovered drill cores are to be quarter-splitted in every 2 metres to 3 metres section to produce the samples for tests as that the first quarter is to be for chemical assays, the second quarter is for a preservation for spare and a remaining half is for metallurgical test.

The chemical assay of ores and mineralized materials are to be made on 14 rare earths elements, such as, lanthanum, cerium, praseodymium, neodymium, samarium, europium, gadolinium, telbium, dysprosium, holmium, erbium, thulium, ytterbium and lutecium, and with yttrium and thorium. Neutron activation analysis, X-ray fluorescene analysis and

Inductively coupled plazma are usually recommended for the analysis technology and further an application of Inductively coupled plazma-Mass spectrometry of high accuracy is to be examined.

The value of specific gravity of ore is to be determined by using the representative specimen of drill cores of the ore body itself. The value is to be determined under the air-dried, dried and wet conditions. The distribution frequency of cavities in the ore body is also to be estimated to make a correction of the specific gravity value of ore in over-whole, if it is required.

PART II DETAILS OF SURVEY WORK

CHAPTER 1 REGIONAL SURVEY AREA

1. Regional Survey Area

1-1 General Features

The geology of the Regional Survey area consists of green rocks and sediments intruded by granitoids of alkaline plutonics of Precambrian age, nephelinites-phonolite volcanics and carbonatites, having been produced by alkaline plutonisms and volcanism, which initiated in early Tertiary and then continued to Quarternary.

The Survey area, being located to the north of Migori, which has been known as one of the gold belts in western Kenya, includes minor gold deposits of a vein type around granitoids, some of which are being mined in small scale. An investigation was recently carried out for an examination of possible commercial mineralization of phosphorus and rare earths associated with carbonatite.

1-2 Geology and Stratigraphy

(1) General Geology

The geological map of the project area is presented in Fig. II-1-1, the geological columnar section is in Fig. II-1-2 and the summarized geological map, on 1:10,000 scale is in attached plate.

The Survey area is bisected by a major fault (Kaniamwia), trending NE-SW directionally. This fault bounds the southeastern side of the Kavirondo Rift, which branches off westerly from the centre of the Kenya Rift. Plutonic and volcanic rocks of carbonatite-nephelinite series of Tertiary and Quarternary ages, basement granitoid inliers within volcanics and Quarternary alluvials to the northwest of the fault, while the rocks to the southeast of the fault comprise Archean greenstones and sediments (Nyanzian and Kavirondian Systems), intrusions and nephelinitic volcanics overlying the Precambrian, are observed in the area.

The stratigraphy of the Precambrian and the sequence of alkaline plutonisms and volcanisms of Tertiary and Quarternary ages are presented in Table II-1-1 and Table II-1-2, according to LeBas (1977).

(2) Precambrian

(A) Nyanzian System

The Nyanzian System is the earliest of all the systems in the regionl area and is distributed in Ruri, Kuge, and Homa Mountain areas, and also in an area to the east of the town of Homa Bay (in Kendu Bay and Oyugis Maps).

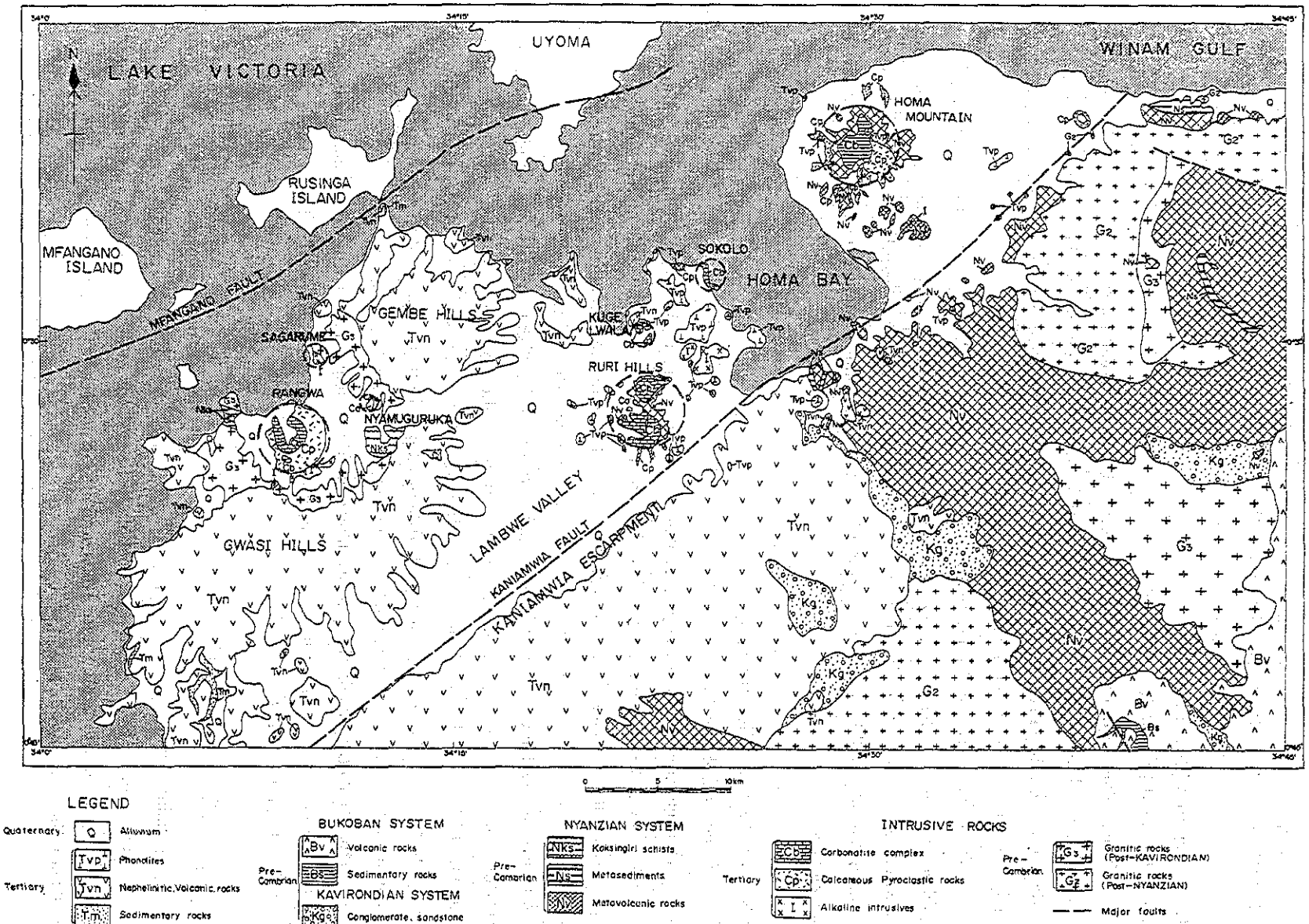


Fig. II–1–1 Geological Map of the Homa Bay Area

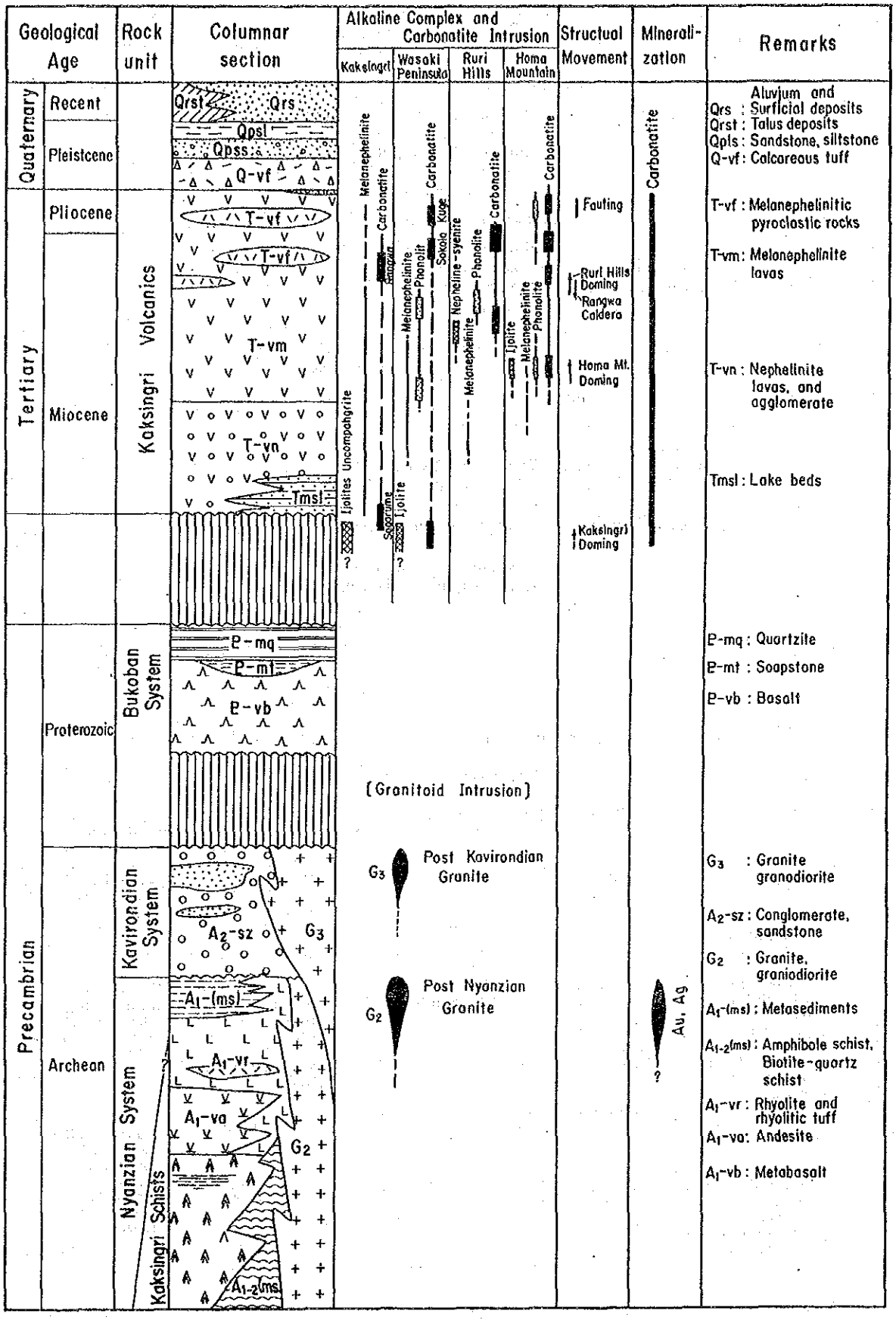


Fig. II–1–2 Generalized Geological Columnar Section of the Homa Bay Area

Table II–1–1 Precambrian Formations in the Homa Bay Area

(After LeBas, 1977)

Tertiary volcanics		
	unconformity	
Bukoban (?) (Kisii Series)	BA	Andesites, felsites and rhyolites
	BQ	Quartzites and cherts
	BB	Basalts (906 ± 35, 964 ± 35 m.y. (Briden *et al.*, 1971))
	BBP	Porphyritic basalts
	unconformity	
Post-Kavirondian intrusions (~2500 m.y.)		Kaksingiri granodiorite and adamellite
	G_3	Wanjare granite
		Nyagongo granite
Kavirondian	K	Conglomerates and grits (and volcanics in adjacent areas)
	unconformity	
Post-Nyanzian intrusions (~2800 m.y.)	G_2	Kitere granite
	G_2	Oyugis granite
	G_2P	Wasaki porphyrite
	D	Minor dolerites and diorites
Nyanzian	NR	Banded ironstones, cherts and shales; Rhyolites, tuffs and agglomerates
	NA	Andesites, dacites and shales
	NB	Basalts

Table II–1–2 Summary of Events of Alkaline Plutonism and Volcanism of Homa Bay Area (After LeBas, 1977)

m.y.	1. Kisingiri	2. Wasaki Peninsula	3. Ruri Hills	4. Homa Mountain	Associated events
1				Chiewo carbonatite.	Lake Simbi crater.
2				Phonolites.	Samanga fault phonolites.
3		Okuge carbonatite.	Cone-sheet	Melilitites.	Formation of Kavirondo
4			and	Cone-sheet	Lake (present Gulf).
5		Sokolo carbonatite.	later	and later	
6			carbonatites.	carbonatites.	Doming of 4.
7	Ekiojango and				
8	Kinyamungu		Pyroclastic activity	Sövite.	
9	carbonatities.		Phonolite plugs.		Doming of 3.
10	Rangwa caldera.	Phonolite plugs.	Sövite.		Kaniamwia and
11	Melanephelinite		Nepheline–syenite.	Breccia.	Mfanganu faults.
12	lavas and			Sövite.	Doming of 4.
13	agglomerates of	Central and fissure		Phonolite and ijolite.	Kericho flood phonolites.
14	Gembe, Gwasi,	eruption of			
15	Kaniamwia, Uyoma,	Nyamaji phonolites.		Melanephelinite	
16	Mfanganu and	Melanephelinite	Melanephelinite	lavas.	
17	Rusinga.	lavas.	lavas.		
18		Tuffs and agglomerates.			
19					Rusinga and Karungu
20	erosion	erosion			deposits in Lower
21					Miocene Lake of
22					Nyanza.
>22	Rukungu vent and crater.	Usaki ijolite.			Doming of 1 and 2.
	Kiyako and Nyamgurka	Wasaki carbonatite.			Lower Miocene erosion
	carbonatites.	Uyi/Angalo ijolite.			surface.
	Sagurume ijolites				
	and uncompahgrite.				

The system is mainly composed of volcanic rocks, which are stratigraphically classified into metabasalt, andesites and metasediments, rhyolites and porphyritic rhyolite in ascending order, according to McCall (1958) and LeBas (1977).

However, their stratigraphic relations are frequently obscure due to deformations by severe tectonism.

Metabasalt (Al-vb): The unit is distributed in Ruri Hills, Kuge and the eastern part of the Survey area. The rocks in Ruri Hills and Kuge are bluish green or dark green, hard, compact, fine grained and mostly aphanitic. The green colour is possibly due to chloritizeration of mafic minerals. These rocks are extremely shattered by an intrusion of the carbonatite complexes in Ruri Hills and Kuge and are very fragmental on outsrops.

Those in the eastern part alternate with rhyolitic rocks are arranged in the E-W or the NW-SE directionn. They are bluish green, generally masive but occasionally schistose; porphyritic and often vesicular or amygdaloidal. Dolerite dikes also occur in association with these rocks and are considered to be intrusions brought by the same volcanisms that have extruded the basalt.

Metasediments (Al-(ms)): This is a unit distributed in three localities, in association with basalt and rhyolite, to the east of the town of Homa Bay, to the east of Kendu Bay and around Wire Hill to the north of the Oyugis.

The rocks comprise light brown or grey tuffaceous siltstones, shales and charty shales. Beddings are generally clear, often with a development of finely layered structures.

Micaceous schists are observed to the west of Wire Hill and to the east of Oyugis, where the rock are well developed with schistosity.

Andesitic Rocks (Al-va): The unit occurs in the belts trending E-W directionally in the central eastern part of the Survey area (in Oyugis Map), and is also distributed in Homa Mountain area. The rocks in the central eastern part are greyish green or light green and porphyritic or vitreous. It is occasionally difficult to distinguish the rocks from the metabasalt, however, they are characteristically poor in mafic minerals and are rare in amygdaloids or in cavities.

Those in Homa Mountain area occur in association with rhyolites or dacite. It is very difficult to distinguish these rocks from rhyolites or dacites because they are extremely shattered. Chloritized pyroxenes and feldspars are observed in weakly altered portions.

Rhyolitic Rocks (Al-vr): The rocks are distributed widely in eastern part of the Survey area (in Oyugis and Kendu Bay Maps), and also in Homa Mountain area.

They comporise two facies, lavas and tuffs, which show geological alternations, although the lavas are highly predominated by tuffs. The lavas show variegated colours, such as grey white, light brown, yellowish white, light red and others, which often form layering appearences. They are generally siliceous and are porphyritic and/or aphanitic. The porphyritic rhyolite contaiins numerous phenocrysts of quartz and feldspars up to 3 mm across in vitreous groundmass. These rocks form a number of oval shaped small hills with long axes ranging from 1

to 2 km, and short axes ranging from several hundreds metres to 1 km, which stand out several tens metres above the surrounding plains. These small hills are observed in a jutting configuration with its southern rim running NW-SE directionally and its northern rim E-W directionally. This peculiar appearance may indicate positions of rhyolite extrusions (volcanic necks) or of anticlines of folded structures. Aphanitic, vitreous rhyolitic rocks occur in interspaces of the hills.

The tuffs distribute in limited areas to the south of Oyugis. The rocks are milky white or light grey, fine grained with fine layering textures.

Porphyritic Rhyolite (Al-vrp): The unit forms a large body wiht an extension of 4 km, a width of 2 km and a relative height of 250 m, forming Wire Hill to the north of Oyugis. The nature of the rocks are similar to that of rhyolitic rocks above described, the pophyritic facies in particular. However, they are distinguished in the geological maps because gossans, possibly derived from sulphides, are distributed particularly in the body of this unit.

(B) Kaksingri Schists

The Kaksingri Schist unit is distributed symmetrically to west northwest and to east southeast of the Rangwa Carbonatite Complex in western part of the Survey area with the Complex between, apart from each other for about 10 km. Both of the areas, distributed by the schist unit, are extended in a direction of WNW-ESE and appear to be linearly aligned.

The rocks of this unit are intruded by granitoids and are found in fragments of the Kavirondian rocks. Their age is presumed to be equal to that of the Nyanzian System (LeBas 1977).

The unit are divided into two facies, hornblende schist and biotite-quartz schist.

Hornblende Schist (Al-mh): The rocks are dark green or dark brown, fine grained and schistose. Hornblendes and feldspars are megascopically observed and are observed in a finely layered occurrence.

A sample collected from west-northwest of Rangwa consists primarily of hornblendes and feldspars with minor amounts of quartz and opaques under the microscope.

Biotite-Quartz Schist (Al-ms bq): The rocks are dark grey, hard, compact and extremely schistose. Quartz and feldspar are abundantly observed and micas are distributed along schistosities magascopically. A sample collected from west northwest of Rangwa consists primarily of quartz, feldspars, biotite and muscovite, accompanied with apatite, tourmaline and zircon under the microscope.

(C) Kavirondian System

The system distributes in central southern part and in south-eastern corner of the Survey area, unconformably overlying Nyanzian System and post-Nyanzian Granitoids and being overlain by Bukoban System and Tertiary Volcanics.

The system comprises sandstones and conglomerates, meanwhile, conglomerates are predominant to sandstone in central southern part and sandstones are solely distributed in southeastern corner.

Conglomerates, Sandstones (Al-sz): Conglomerates contain rounded fragments up to 1 m across in coarse grit metrices. The rounded fragments are of post-Nyanzian granite or granodiorite and Nyanzian rocks mainly andesites and rhyolites, and are characteristically rounded off. These fragments are extremely variable in sizes and poorly sorted. Some facies are abundant in fragments and others are poor grading into sandstones. The matrices of conglomerates are grey, greyish brown or bluish grey and hard, and consists of coarse feldspathic sands or fine lithic fragments.

The matrices of sandstones show a similar nature to that of conglomerates.

These conglomerates and the sandstones show a massive appearance with none of the development of bedding texture.

(D) Bukoban System

The system occupies the northwestern end of the Kisii Series, being widely distributed in southeastern part of the Survey area and is arbitrarily correlated to the Bukoban Series. It overlies Nyanzian ad Kavirondian Systems and also post-Kavirondian granite in south-eastern end of the Survey area.

The Bukoban System in this area consists primarily of basalt interbedded with quartzites in places and is occasionally developed with soap stones (called Kishii stone) underneath quartzite. These rocks, different from basalts of the Nyanzian System, form a open-folded structures, but lie flat in general.

Basalt (P-vb): The rocks are dark grey or dark green, fine grained and aphanitic or porphyritic. It is easy to identify the rocks of the Nyanzian basalt because of their weak alteration. Fine grained compact facies are predominated, however, the rocks contain phenocrysts of feldspars and pyroxenes or commonly carry amigdaloidal textures. They are generally weathered extremely and often turn into reddish soils.

Kishii Soapstone (P-mt): The rocks are distributed partially in southwestern hills of the Bukoban System, and are formed interlayered in basalts underneath quartzite as described above. However, it has not yet been cleared if the rocks are of alteration products of basalt or not.

They are slightly greyish brown, massive and soft, and consist primarily of sericite and kaolinite with subordinate amounts of chlorite, epidote and quartz in variable proportions.

Quartzite (P-mq): The rocks are distributed in a limited area in the hills of southwestern part of the Bukoban System. They are light grey or white, fine grained, thinly layerd and are occasionally interbedded with thin beds of greywacke. They occupy the roofs of the hill and form open-folded structures with axes trending N-S and WNW-ESE directionally.

(3) Precambrian-Intrusive rocks

(A) Post-Nyanzian Intrusives

The intrusives are observed in Nyanzian System and are unconformably overlain by Kavirondian System. They include granitic batholiths in central south (Kitere Granite) and the northeast (Oyugis Granite) of the Survey area, and dioritic and doleritic intrusions (dikes) of small scale. These small intrusions are indistinguishable from those of the post-Kavirondian intrusives and are shown on the geological maps as minor intrusions.

Kitere Granite (G2): The batholith occupies an area of approximately 110 sq.km in the Survey area and extends southwards out of the area. The rocks comprise primarily grey, to light red and fine to medium grained hornblende-biotite granite and granodiorite accompanied by red biotite granite. Hornblende dominates to biotite in granodiorite and inversely biotite to hornblende in granite. These mafic minerals are partly altered to chlorite or epidote. The rocks are homogeneous in appearances and has no foliated structures.

It is considered that the gold mineralization of the Migori Gold Belt have been generated in relation with intrusive activities of the Kitere granite.

Oyugis Granite (G2): The batholith, with a similar size to Kitere batholith, occupies an area of approximately 120 sq.km and extends eastwards out of the Survey area. However, its distribution is limited to the southeast side of Kaniamwia fault.

The rocks are mostly of hornblende biotite granite, which is light red due to abundant contents of potash feldspar, and are generally medium and partly coarse grained. But biotite-hornblende granodiorite also occurs subordinately in southern part of the batholith with forming an extended body in E-W direction for a length of 1 to 2 km. Hornblende in both the granite and the granodiorite is generally chloritized. The rocks are often well developed with schistosites near the contact to intruded Nyanzian System or adjacent to Kaniamwia fault.

(B) Post-Kavirodian Intrusives (G3):

The intrusives comprise granitic rocks around Rangwa (Kaksingri Granodiorite Complex) in western part of the Survey area, the batholithic body (Wanjare Granite) in the southeastern stock elongated N-S directionally in northeastern part and diorite dikes and stocks of small scale.

Kaksingri Granodiorite Complex: The complex surrounds a circular area with a diameter of approximately 14 km, which includes Rangwa carbonatite complex in the centre, and forms a circular inlier, 2 to 3 km wide, within Kaksingri Volcanics. It is situated in the periphery of the zone up-lifted by an intrusion of the carbonatite-alkaline rock complex of Tertiary age in Rangwa area. The rocks are mostly medium to coarse grained granodiorite and fine to coarse grained leucocratic rock (granite or adamellite), accompanied by aplite and diorite.

Grey granodiorite contains either horblende or biotite or both and megacrysts of plagioclase exceeding 10 mm in length particularly in coarse-grained portions.

Leucocratic granite or adamellite is white to light red, occasionally light green due to alteration, and poor in mafics. Judging from the variation in quartz contents, both of granite and adamellite are included in this type of rocks. The potash feldspar in the rocks are mostly microcline, according to McCall (1958) and LeBas (1977).

Both of granodiorite and leucocratic rocks are often schistose and granulated possibly due to decomposition and deformation.

Wanjare Granite: The batholith occupies a massive area of approximately 100 sq.km. The rocks are homogeneous in nature, and are mostly light red, medium grained and poor in mafic minerals. Fine grained and coare grained facies are observed respectively in the periphery and inside of the batholith.

A sample of fine grained granite, collected at the northwestern end of the batholith, contains quartz, perthite, plagioclase and a minor amount of biotite under the microscope as shown in APX-2.

Stocks extended N-S directionally in northeastern part of Survey Area: Stocks are located between G2 granite and Nyanzian volcanics. The rocks are light red or occasionally light green due to alteration, rich in potash feldspar and poor in quartz and mafic minerals. Their compositions range from granite to quartz monzonite. A very minor amount of mafic minerals, comprising hornblende and biotite, are generally altered to epidote or chlorite. The rocks are disseminated by iron oxide minerals and stained in appearances. Schistosities are well developed in the direction parallel to the extension (NNE-SSW directional) of the stock.

Diorite (D): The rocks are distributed in southeastern part (in Oyugis Map) of the Survey area in the forms of dykes and stocks of small scale. The intrusions trend in NW-SE or E-W direction in general and show two types of facies: the one is dark greyish green, fine or partly medium grained and equigranular, and the other is of characteristic association with feldspar phenocrysts.

Fenitized Granitic Rocks (P-mf): Kitere Granite is intensively fenitized near the contacts to Tertiary alkaline intrusives. Fenitized granitic rocks have undergone mylonitization in variable degrees and characteristically contain minerals rich in sodium and/or potash. The most intensive fenitization is observed in Sagarume-Nyamgurka area, a part of the semi-detailed survey areas.

(4) Tertiary System

Tertiary system in the Survey area comprises lacustrine sediments, nephelinitic volcanics, phonolite, carbonatitic rocks and alkaline plutonics and dykes.

Those, which are distributed only in the semi-detailed survey areas, are excluded from the description hereunder.

(A) Lacustrine Sediments (Tmsl)

The sediments are distributed horizontally near the southeastern end and around Mbita point in northwestern part of the Survey area.

The sediments consist of light brown, calcareous and tuffaceous sandstones, which are massive or weakly bedded and contain well rounded nephelinite fragments. Sandstones are occasionally interbedded with calcareous pebble sandstone layers. Tuffaceous sandstones are generally heterogeneous and often contain boulders of nephelinite and wood fragments replaced by carbonate minerals.

The sediments are of early Miocene and the earliest of the Tertiary system in the area.

(B) Nephelinitic Volcanics

Kaksingri Volcano, in the centre of Rangwa, is the largest stratovolcano in western Kenya, which have extruded nephelinitic volcanics in an extensive area of exceeding 2,000 sq.km. The western half of the Survey area is largely occupied by the volcanics.

Nephelinitic volcanics comprise nephelinitic agglomerates, melanephelinite or melilitite, and mela-nephelinitic pyroclastics.

Nephelinitic Agglomerates and Pyroclastics (T-vn): The rocks are distributed near the coast of Lake Victoria in southwestern part of the Survey area, and are located at the bottom of the Kaksingri volcano.

They contain dark brown, angular or rounded fragments of nephelinite lavas in tuffaceous matrices, which show variegated colour such as brown, yellowish brown, light brown and etc.. Sizes and amounts of fragments are also variable and facies change from lapilli tuffs to volcanic breccias or agglomerate.

This unit, exceeding 300 m in thickness, is considered to have been extruded from the Rangwa crater, according to McCall (1958).

Melanephelinite or Melilitite (T-vm): This unit comprise the major part of the Kaksingri volcanics and is distriubutes in Gwasi and Gembe Hills around Rangwa and in central part of the Survey area to the southeast of the Kaniamwia fault. The unit forms a flat plain slightly dipping southeastwards in central part of the Survey area.

The melanephelinite and the melilitite are mostly indistinguishable megascopically. They are commonly black, dark grey or dark green and generally coarse in textures, containing phenocrysts heterogeneously. They show considerably variable facies, fine grained, compact or abundant in coarse grained phenocrysts, dark green pyroxene mostly and nepheline sparsely. The rocks are strongly magnetic and are considered to be containing a large amount of magnetite.

Samples collected in southwestern Gembe Hill and in northern Gwasi Hill were examined under the micrscope and chemically analyzed. Both of the samples contain abundant melitite and are examined to be of melilitite. Their normative compositions are plotted in the melanephelinite domain in the diagrams.

The results of the K-Ar age dterminations for these samples are presented in Apx. 2. The result for the sample from Gwasi Hill indicates the rock to be of 14.4 ± 0.8 Ma in the K-Ar age, which supports the LeBas's view (1977), while the other sample from Gembe Hill is determined to be of 4.5 ± 0.5 Ma, which is significantly different from the past views. This discrepancy is left to be solved in the future.

Melanephelinitic pyroclastics (T-vf): The above unite is often accompanied by pyroclastic facies. The portions relatively dominated by pyroclastics are distinguished as a delineative unit. The rocks distribute mostly on the ridge of Gwasi Hill and in Gembe Hill, and vary in facies from tuffs to volcanic breccias.

(C) Phonolite (T-vp):

A total number of more than 80 phonolite bodies are located in the Survey area; more than 60 bodies of large and small sizes are located in an area of approximately 150 sq. km, including Ruri Hills, Wasaki peninsula and environs, about 20 bodies in Homa Mountain and adjacent area, and one in Asago Mountain in the suburbs of the Homa Bay town. The majority of them is distributed in the Kavirondo Rift to the northwest of Kaniamwia fault, and only a few are situated near and to the southeast of the fault. They are circular, oval or twin-circular in plan and cone-shaped. Their sizes range ordinarily from 50 m to 1,000 m in diameters and their relative hights from several tens or up to about 100 m. However, the one near Nyamaji to the northwest of North Ruri Hill is exceptionally large in its size, having a long axis of 3 km, a short axis of 1.5 km and a relative height of 300 m. Most of the phonolite bodies form cones with their rounded tops and show peculiar topographic features. They are possibly considered to be of volcanic necks or of lava domes in an occasion of wide-spread occurrences. Other than these, phonolite dykes also occur in the South Ruri Hill area, one of the semi-detailed survey areas.

The phonolite is grey or greenish grey, generally vitreous, and contains nepheline, potash feldspar, pyroxene and sparsely phlogopite. Small bodies are wholly aphanitic and large bodies are aphanitic in their peripheries and porphyritic in their inner portion in most cases.

(D) Carbonatitic Rocks

So-called carbonatitic rocks of the Survey area comprise (i) carbonatite proper, including sövite, alvikite, ferrocarbonatite and their breccias (ii) carbonititic or calcareous pyroclastics of the same origin, (iii) brecias containing angular fragments of carbonatites and (iv) breccias occur in close association with carbonatites. Most of these rocks are distributed in the semi-detailed Survey areas and are reported in the semi-detailed survey section. Accordingly, the carbonatitic rocks additionally observed by the current Regional Survey are shown below:

Carbonatite 3 km northwest of the Top of Gwasi Hill: The carbonatite associated with a melanephelinite lava covering Gwasi hill is brown, fine-grained alvikite dyke with a width of about 5 m located in post-Kavirondian granite towards its contact. Ferrocarbonatite dikelets

intersect the alvikite dykes, adjacent to which small stocks of ijolite are exposed. Alvikite contains carbonate minerals, apatite and opaques under the microscope.

Carbonatite 5 km southeast of the town of Sindo facing toKaksingri Bay: The carbonatite forms an isolated body with a diametre exceeding 5 m across in the area, associated with hornblende schists (Kaksingri schist) and schistose granite to the east of Rangwa. Carbonatite is light-green and consists of aggregates of fine and coarse grained carbonate minerals. It contains calcite, dolomite, apatite, chlorite, microcline and very minor opaques under the microscope.

Carbonatites at 2 localities in the vicinity of the town of Homa Bay: Alvikitic carbonate rocks are located near the coast of Lake Victoria, 8 km northeast of the town of Homa Bay, where metavolcanics of the Nyanzian System are distributed. The rocks are strongly weathered, brown to white, and are highly developed with banded structures.

Alvikitic carbonate rocks, white, fine grained and banded form a group of float in a tiny area less than 0.5 m across in diameter at a location 2.5 km east northeast of Asego Mountain to the east of the town of Homa Bay. The floats occur being mixed with those of the Nyanzian metavolcanics.

(E) Alkaline Plutonic Rocks

Alkaline plutonic rocks include ijolite, uncompahgrite, pyroxenite and nepheline syenite. Among these, only the ijolite body, 4 km northeast of North Ruri Hill (Usaki Ijolite Complex, LeBas 1977), is located outside of the semi-detailed survey areas.

Usaki Ijolite Complex (I): The complex, partly covered by alluvials and occupies an area 3.5 km long and 2 km wide, comprises coarse grained ijolite, microijolite and pyroxinite. The rocks are developed with banded, breccia and other structures. LeBas (1977) has divided the complex into pyroxinite rich in diopside, microijolite and urtite in the order of intrusion.

A sample of ijolite collected in southern part of the complex was examined under the microscope and was analysed chemically. The normative composition is plotted on a trianglar diagram for the classification of alkaline plutonic rocks. The K-Ar age determination was also made for the sample and the result indicates the K-Ar age of 16.2 $\pm$ 0.8 Ma. as shown in Apx. 2. The age is to be correlated to the middle-Miocene and differs from the LeBas's view (1977), which placed the age of the intrusion on the stage of earlier than Miocene.

(F) Dikes (D)

Small dikes of phonolite, nephelinite, pyroxenite, dolerite gabbro and quartz porphyry are locally distributed. The former three are of intrusions of Tertiary age and the latter two are those of Pre-cambrian.

(5) Quartenary

(A) Lacustrine sediments (Qpsl)

The sediments are distributed widely from the outskirt of the Homa Mountain to the lake side. The sediments are nearly flat-bedded and consists of calcareous tuffs, which are light yellow or light grey and well-developed with beddings. The sediments form 20 m high cliffs facing to the lake and are thinly covered by surface deposits towards the inland with sporadic exposure.

(B) Surficial Deposits and Aluvials (Ors)

Surficial deposit and alluvials are extensively developed in the Kavirondo Rift to the northwest of the Kaniamwia fault. They are distributed mainly in Lambwe valley, the outskirt of the Rangwa carbonatite centre and around Homa Bay.

1-3 Mineralization

The records on a history of exploitation work on metalliferous ore deposits in the Survey Area are unavailable. Mineral occurrences located by the current survey are shown below (Table II-1-3):

(1) Carbonatite

Small outcrops of carbonatitic rocks are additionally found at 4 localities, excluding those in the semi-detailed survey areas. Two bodies are located around Rangwa and others are to the east northeast of the town of Homa Bay. They occur in a form of dykes of small scale.

(2) Gold Ore Vein

Gold mining sites are observed in three localities in the eastern part of the Survey Area. Quartz veins in Nyanzian metavolcanics are being mined at two localities. Panning operation is observed, however, gold ore occurrence is still unknown.

A white quartz vein, ranging from 5 to 10 cm wide, occurs in schistosed Nyanzian metavolcanics (basic schist) and is being mined. A total number of about 30 local people are engaged in mining, crushing and panning operations. A sample collected from the quartz vein was assayed at 3.3 g/t Au and 2.0 g/t Ag.

The Survey Area is located adjacent to the Migori gold belt, which is one of the gold productive area in western Kenya. A sample of a quartz vein in Homa Mountain of the semi-detailed survey area was also assayed at 31.3 g/t Au and 5.0 g/t Ag. It should be deserved to pay remarks on the gold ore occurrences for a future consideration.

(3) Copper Mineralization

An occurrence of copper mineralization was found for the first time at 7 km north-east of Kendu Bay. Another occurrence ever known is a massive sulphide deposits at Wire Hill, 4 km

north of Oyugis. The deposit has ever been investigated by the United Nations Revolving Funds for Natural Resources Exploration.

The former occurrence is of green copper-oxide stains, possibly malachite, along fractures in granite rich in potash feldspar. However, the copper content is estimated to be less than 0.10% and its extention is also to be very limited. The occurrence is too small and weak in mineralization to warrant a further exploration.

At the latter occurrence in Wire Hill, a massive iron-oxide gossan hosted in rhyolitic rocks is located, being approximately 30 m long, along a newly opened road cut facing. However, no copper minerals are identified by the current survey. The exploration by UNRFNRE concluded that the occurrence would be of a possible Kuroko type and should be carefully investigated.

Table II-1-3 Summary of Findings in the Regional Survey Area

Locality	Sample Number	Rock type/ Mineralization	Wd or Thkn	Length &/ or Area	Remarks
ca. 3km NW of Gwasi	WR-108	CARBONATITIC ROCKS	ca. 5m		Mt-bearing brown ALV & dark FCB intrude with IJL basement granites.
5km SE OF Sindo	RT-46		ca. 5m		Fenitized sovite intrudes schists & granites of basement.
WNW of Asego H.	RT-60				Brownish, fine, with weak foliation. ALV or meta-LS.
8km NE Homa Bay	RT-99		ca. 5m		Light brown, well-bedded sinter like ALV or Calcareous TF.
SE Kendu Bay	RT-83	Secondary Cu mineral			Disseminated & fracture-filling MALC in red QMZ on ridge.
Wire Hill prospect 4 to 5km NW of Oyugis		Volc. genc. massive sulfides		Limonit'zd OP over 30 m along Rd	Explored by UN Revolving Fund. (UN Revolving Fund: 1978 Final Report).

GOLD MINERALIZATION					Au g/t	Ag g/t	Remarks
S of Wire Hill	RT-90	Quartz veins	5 ~ 10cm		3.3	2.0	Being mined. Occur in meta-BAS.
25km SSW of Oyugis	RT-105	Quratz veins	3.0m	OP & FL scattered over 5km	tr	1.0	Sample taken at RD side of A-1. S-end of a large QV
S Rongo OUTSIDE OF AREA	REFERECE SAMPLE	Flectrum-bearing QV	??		849	59.0	Being mined. Within Migori Gold Field
Homa Mountain Area of SEMI-DETAILED SURVEY AREAS	100205G 100206G 100207G 100208G	Quartz veins with float zone	5m+	ca. 500m judged from float distribution.	2.0 31.3	5.0 4.0	2.5 ~ 3.3km E of Summit of Homa Mtn Aduralia-bearing white QV in Nyanzian meta-volcanic rocks.
	100209G	QV OP			0.7	1.0	
	100222G 100224G	QV FL QV FL	D=15cm D=20cm	?? ??	tr tr	1.0 1.0	Both are different veins from above.

*1 Gold localities include those from "Semi-deatailed areas" and outside of the the present project areas.

* ABBRIVIATION: ALV=alvikite. BAS=basalt. ca.=about. D=diameter. FCB=ferro-carbonatite, FL=foat. IJ=ijolite. Limonit'zd=limonitized. LS=limestone. MALC=malachite. MT=magnetite. OP=outcrop. RD=road. QMZ=quartz monzonite. QV=quartz vein. TF=tuff. Thk=thickness. Volc.genc.=volcanogenic. Wd.=width.

CHAPTER 2 RANGWA AREA

2-1 General geology

The Rangwa is a cone-shaped hill located in central part of the Kisingri volcano, which occupies an extensive area of more than 2000 km^2 on the southern coast of Winamu in Lake Victoria.

The Kisingri volcano, one of the largest carbonatite-alkaline rock complexes, has a caldera structure which was formed by eruptions of large scale and is a well-known field for gelogists to comprehend the modes of intrusion and extrusion as its whole structure is well exposed due to erosion.

2-2 Results of geological survey

(1) Geology

The geological plan and profiles are shown in Fig. II-2-4.

The geology of this area comprises granitoids of the basement, pyroclastics, carbonatites, carbonatitic breccias, terrace deposits, alluvials and surface soils.

(2) Geological structure

The original cone-shaped configuration of the volcano has been deformed due to erosion, and only eastern half of the caldera wall, approximately 4 km across, remains at presnt time.

The Carbonatite Centre, located within the caldera, consits of carbonatite intrusions distributed in a concentric occurrence, the outer diameter of which reaches approximately 2 km.

The outer rims of the caldera and the Carbonatite Centre dip vertically.

The pyroclastics within the caldera dip toward the carbonatite centre by 20 to 30 degrees.

2-3 Results of geochemical survey

(1) Sampling

Survey lines were mainly allocated on ridges covering a whole area of the Rangwa body, and 211 rock samples including all facies of rock in the area were collected. In addition to rock samples, 27 soil samples were collected in a flat area along the central valley of Rangwa to investigate a secondary enrichment of the elements from rock into soil.

(2) Interpretations of geochemical anomaly

Geochemical anomalies in the area are plotted in Fig. II-2-2.

Rock geochemistry; There are many samples which have anomalous values for P, Ba, Nb, LREE and HREE, and most of values are shown in the Carbonatite Centre of Rangwa. However, the number of samples, which shows anomalous value for the element, other than P and Nb, does not occupy a major portion of the total number of samples.

The number of samples with anomalous value of P exceed 25% of the total, however, only two samples show highly anomalous value, resulting in to form none of anomaly of P in the area. In case of Nb, the behaviour is similar to that of P. The highly anomalous value of Nb was not detected by the current survey.

Soil geochemistry: The average values of each element, other than Sr, show 2 to 10 times of rock chemistry, almost equal to m + 1 s values by soil geochemistry in the entire Semi-detailed area. Soil samples are mainly derived from carbonatite of the Rangwa carbonatite centre and a concentration of the elements from carbonatite body in soil is obvious. A concentration of Nb, which is 1,010 ppm average-valued and is higher than that in Buru Hill -688 ppm average-valued, is notably remarked. The highest value of Nb, 6,300 ppm, is detected in the soil, collected from the location directly overlying ferrocarbonatite dyke.

2-4 Mineralization

Through the geological and geochemical works, Rangwa carbonatite body is considered to be eroded more deeply than that in Ruri Hills and Homa Mountain. Consequently, highly concentrated contents of elements, such as Nb and P, are considered to represent that those are derived from a deeper section of intrusive carbonatite body.

Rock and Soil geochemistry in Rangwa Area provide a limited number of highly anomalous values that form an anomaly zone, therefore, the exploration target for future considerations in the area is estimated to be unlikely selected by the current works.

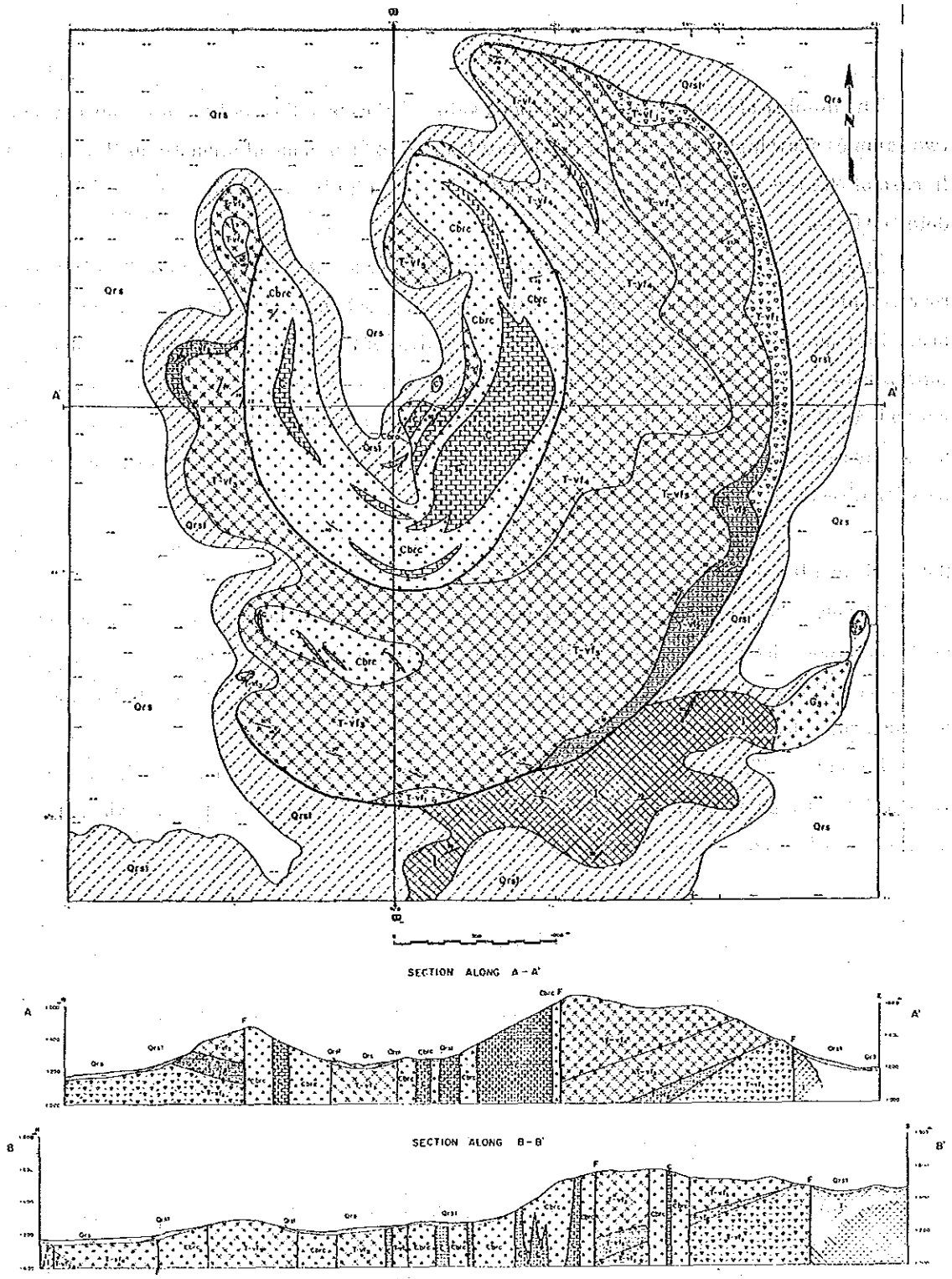
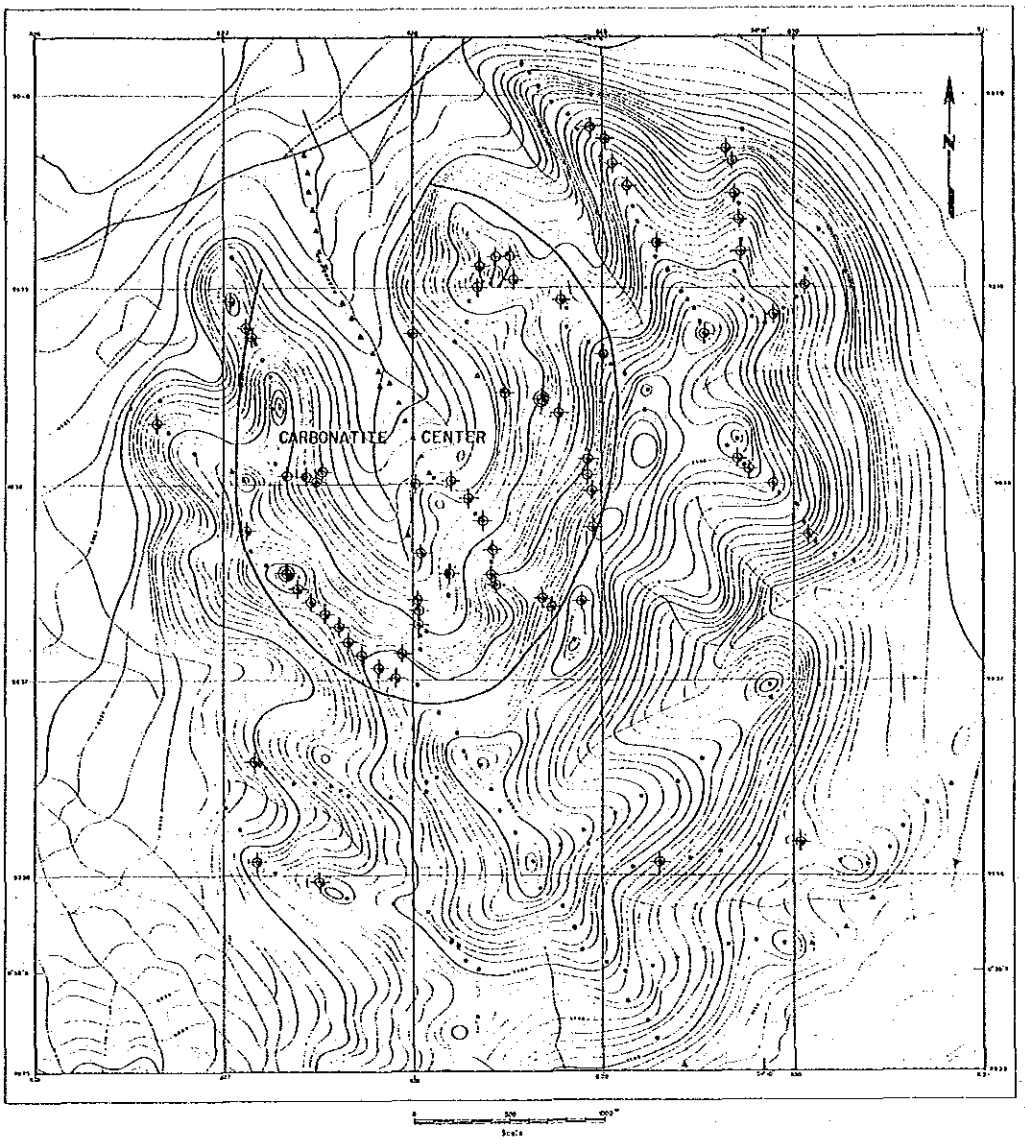


Fig. II–2–1 Geological Map of the Rangwa Area



LEGEND

- Non anomalous sample
- Anomalous sample (≧ m + 1S , <m+2S)
- Highly anomalous sample (≧ m +2S)
- Soil sample

Classification

Element	Anomalous, ≧ m+1S, <m+2S	Highly anomalous ≧ m + 2S
La ppm	≧ 767 , < 3,300	≧ 3,300
Y ppm	≧ 148 , < 344	≧ 344
Nb ppm	≧ 620 , < 2,600	≧ 2,600
P %	≧ 061 , < 217	≧ 217

m : mean , S : standard deviation

Figures are of 1325 rock samples from all the Semi-detailed Survey Areas other than the grid-sampled areas in the Buru and Ndiru Hills.

Fig. II–2–2 Geochemical Interpretation Map of the Rangwa Area

CHAPTER 3 SAGARUME - NYAMGURKA AREA

3-1 General geology

Prior to the eruptin of the Kaksingri volcano, in the centre of Rangwa Area, the basement rock was up-lifted due to an intrusion of alkaline plutons.

The Sagarume-Nyamguruka Area is located at the northeastern edge of the basement uplift zone, several tens kilometres across in diameter, in the centre of Rangwa Area, and is distributed by basement granitoids, alkaline rocks and minor carbonatites.

The basement granitoids, intruded by the alkaline rocks and the carbonatite, are fenitized.

3-2 Results of geological survey

(1) Geology

The geological plan and profiles are presented in Fig. II-2-3.

The geology of the Area comprises granitoids (G3), fenitized granitoids (P-mf), ijolites (I), micro-ijolites and pyroxenites (ImP), dolerites (D), gabbros (B), siliceous breccias (Brc), alvikite (Ca) and soils and surface deposits.

(2) Geological structure

The Area is located at the northeastern end of the circular up-lifted zone of basement rock, formed by intrusions of ijolites-syenites.

Zones of various degrees of fenitization are distributed in a concentric occurrence in Sagarume Area.

Intrusive bodies of ijolite are not observed on ground surface in Nyamguruka Area, however, are presumed to be deeply seated underneath of fenitized granitoid.

3-3 Results of geochemical survey

(1) Sampling

Rock samples were collected on a group of hills aligning in NW-SE direction only where exposure of rocks are observed in the area. The other area forms colluvial slope of Gembe Hill which is composed of melanephelinetic volcanic rocks. Carbonatitic rocks in the area are limitedly distributed in small areas, so that 22 samples of carbonatite among 76 were collected. Remaining 54 samples include fenite, ijolite and granitic rocks.

(2) Interpretations of geochemical anomaly

Interpretation result of geochemical anomaly in the area is shown in Fig. II-2-4.

In the Sagarume area which is located in the northwestern part of the area, only two samples show anomalous values of P or Y and Sm, and others are not amomalous at all. None of anomaly zone is revealed in the area.

In Nyamgurka area located in the central and southeastern part of the area, anomalous values of P, La, Ce, Nd, Sm and Eu were detected from some carbonatites which occur as small dykes of massive bodies. However, none of samples which have highly anomalous value were detected from those carbonatites. The fact that the sample has no anomalous value of REE except Lu (3.2 ppm), and has pretty high value of Sr (9930 ppm) may indicate a limitedly local mineralizations with P and Sr, and very minor REE.

3-4 Mineralization

Through geological survey, it turnes out that this area provides very minor occurrence of carbonatite, especially ferrocarbonatite which is considered to have a close relation with mineralization of REE.

Through geochemical survey, inversely, none of anomaly was found in this area, however, there are a few alvikite which has anomalous values of P, Y and REE.

Samples of ijolites and fenites, which are frequently observed in this area, do not show any anomalous value, other than only one sample, which is highly anomalous for P.

Consequently, it is presumed that a further detailed work in the area is unlikely warranted.

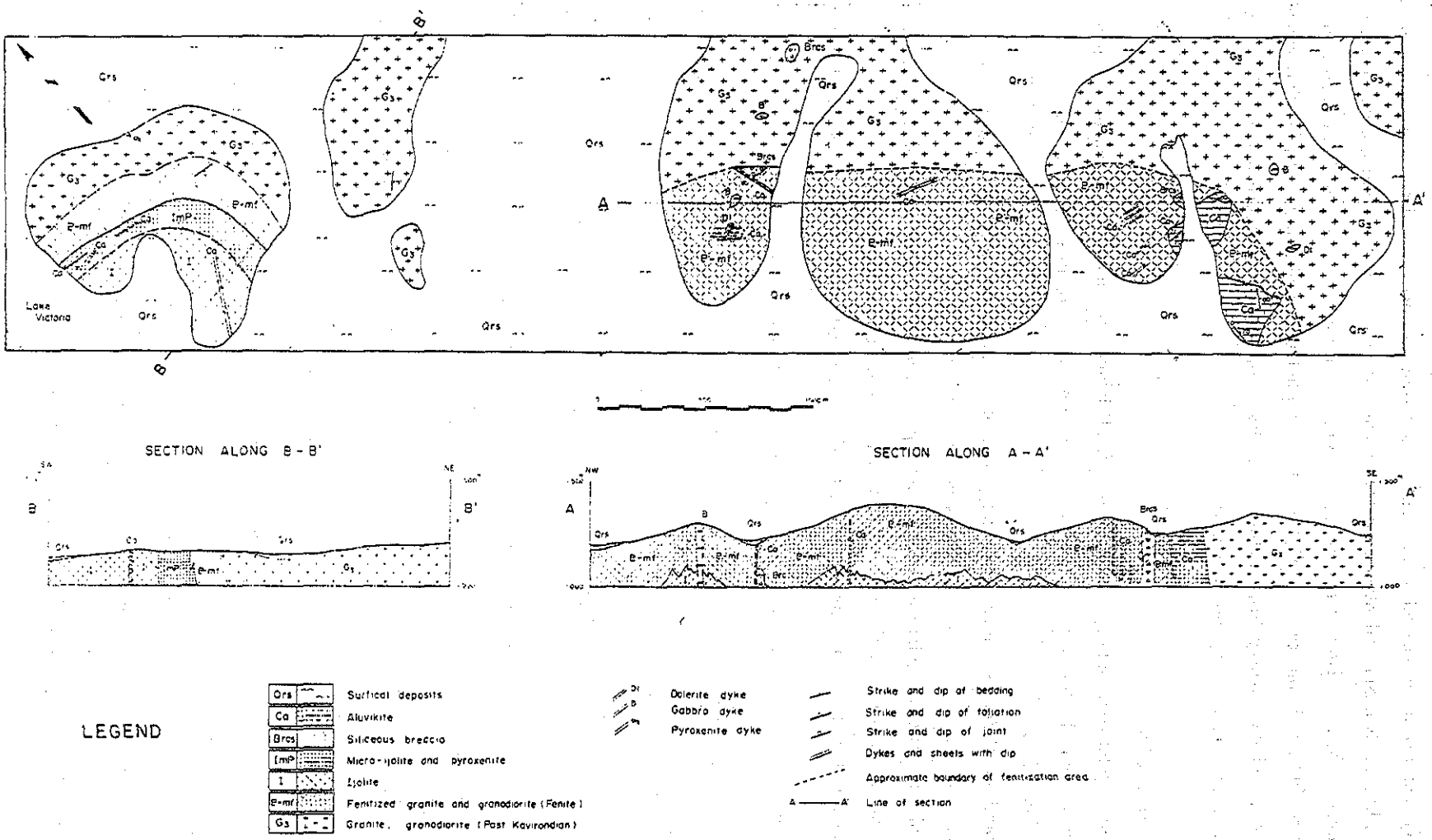
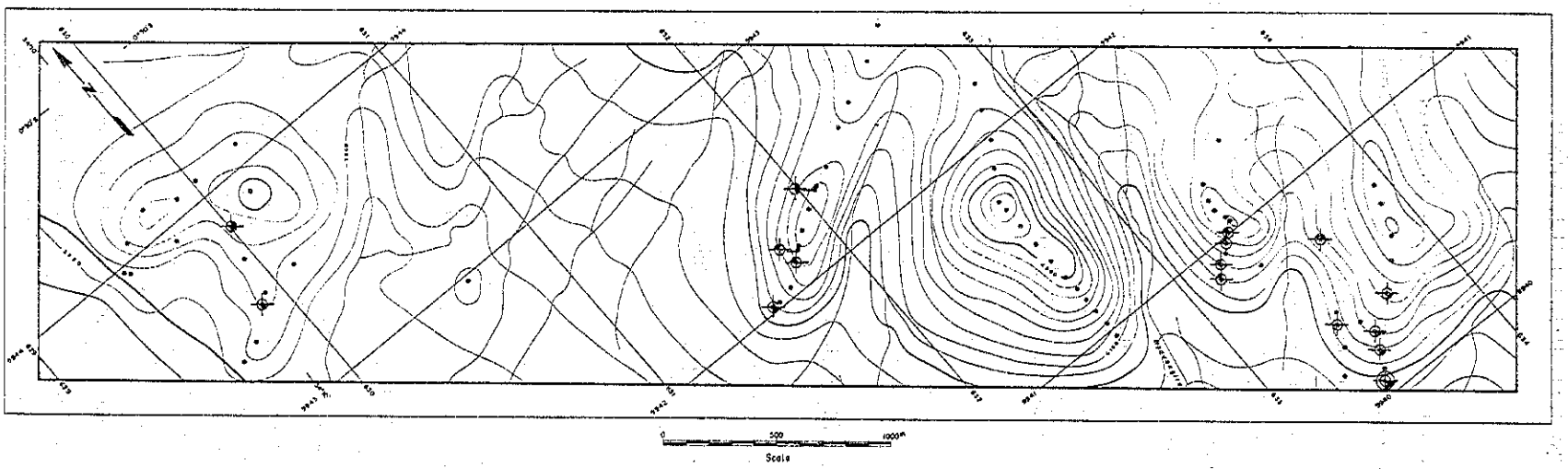


Fig. II–3–1 Geological Map of the Sagarume – Nyamgurka Area



LEGEND

Non anomalous sample

Anomalous sample
(≧ m + 1S , < m + 2S)

Highly anomalous sample
(≧ m + 2S)

Classification

Element	Anomalous, ≧ m+1S, <m+2S	Highly anomalous ≧ m + 2S
La ppm	≧ 767 , < 3,300	≧ 3,300
Y ppm	≧ 148 , < 344	≧ 344
Nb ppm	≧ 620 , < 2,600	≧ 2,600
P %	≧ 061 , < 217	≧ 217

m : mean , S : standard deviation

Figures are of 1325 rock samples from all the Semi-detailed Survey Areas other than the grid-sampled areas in the Buru and Ndiru Hills.

Fig. II–3–2 Geochemical Interpretation Map of the Sagarume – Nyamgurka Area

CHAPTER 4 NORTH RURI HILL AREA and SOUTH RURI HILL AREA

4-1 General geology

North Ruri Hill and South Ruri Hill (called Ruri Hills collectively) are formed of one of the three largest carbonatite-alkaline rock complex units and are a pair of hills which stand out above the surrounding alluvial plain and are composed of two typical cone-sheets.

North Ruri Hill is formed of a cone-sheet of carbonatites that lacks the SE part at the surface. Basement rocks occur in the central part of the Hill. The carbonatites comprises mainly alvikite with some carbonatitic breccia, sövite and ferrocarbonatite. Ferrocarbonatite is mostly distributed as ring dykes in the peripheral zone of the complex.

South Ruri Hill is of a cylindrical massive cabonatite complex (diameter is 2.5 km), which is the largest single carbonatitic body in the Homa Bay area. It comprises alvikite, sövite, carbonatitic breccia, and ferrocarbonatite. Ferrocarbonatites occur as dykes in the peripheral zones of the complex.

4-2 Results of geological survey

(1) Geology

The geological plan and profiles are presented in Fig. II-4-1 and the geological columnar section is in Fig. II-4-2.

The geology of this area comprises 11 units; Nyanzian Metabasalt, Intensively shattered Metabasalt associated with Carbonatite Sheets, Nepheline Syenite, Phonolite, Sövite, Alvikite, Ferrocarbonatite, Carbonatite Breccia, Calcareous tuffs and Tuff Breccias, Phonolitic Vent Brecca, and Soils and Surficial Deposits.

(2) Geological structure

Both the North and the South Ruri Hills have domal structures.

The central carbonatite complexes occupy a roof of the domes and the outer contact dip steeply outwards.

The surrounding basement has steep dips near the contact to the carbonatite intrusions, however, gently dips away from the intrusions in general.

These structural features may have been formed by the intrusive activities of the ijolite and subsequent carbonatite.

The carbonatite complexes show a cone sheet strucuture.

In the North Ruri Hill in particular, it is clearly observed that numerous sheets of carbonatite dip towards the centre of the complex with angles ranging from 40 to 60 degrees.

The basement metabasalt is left as a roof pendant on the top of the North Ruri Hill at an elevation of 1,600 m above sea level.

In the South Ruri Hill, the metabasalt distributes up to an elevatio of 1,450 m above sea level, however, roof pendant is not left on the top of the Hill.

A number of the phonolite volcanic necks are distributed in the South Ruri Hill Area, inversely, only a few in the North Ruri Hill Area.

The vent breccia at the centre of the North Ruri Hill appears to grade into a volcanic vent toward the depth.

In summary, the North Ruri Hill Carbonatite Complex may represent a shallow facies, compared with the South Ruri Hill Carbonatite Complex.

The North Ruri Hill Complex is smaller in scale than that of the South Ruri Hills.

(3) Detailed geology

Three sectors in the area were investigated in details.

NorthRuri Hill North Sector

This sector is situated in the northern slope of North Ruri Hill Carbonatite Complex (Fig. II-4-1).

The geology of the sector comprises the basement Nyanzian metabasalt and carbonatitic rocks, composed of alvikite and ferrocarbonatite which have intruded the basement.

The geological plan of the sector is presented in Fig. II-4-4.

- Ferrocarbonatite breccia

The unit is distributed in the middle of northern half of the sector, in an area of about 300x100 m trending in E-W direction. The location is in northern marginal part of North Ruri Hill Carbonatite Complex and the unit makes a contact with Nyanzian Metabasalt.

The rocks of the unit show variable colours such as brown, dark brown and reddish brown, what is mainly caused by oxidation of iron bearing minerals. The rocks are heterogeneous both in amount and size of breccias, and show a banded structure in some place where the amount of breccias is very small.

The rocks have been intruded by small dykes and network veinlets of brown to black ferrocarbonatites, which are estimated to be of the products of the latest stage of intrusion of the North Ruri Hill Carbonatite Complex.

North Ruri Hill South Sector

This sector is situated in the west of the southern slope of South Ruri Hill (Fig. II-4-1).

The geology of the sector comprises the basement Nyanzian metabasalts, calcareous pyroclastic rock, alvikite, sövite, ferrocarbonatite and carbonatite breccias.

The geological plan and profiles are presented in Fig. II-4-5.

- Ferrocarbonatite

The unit is distributed as a group of small dykes in the southern part of the sector and as dykes in the west and southwest of the sector.

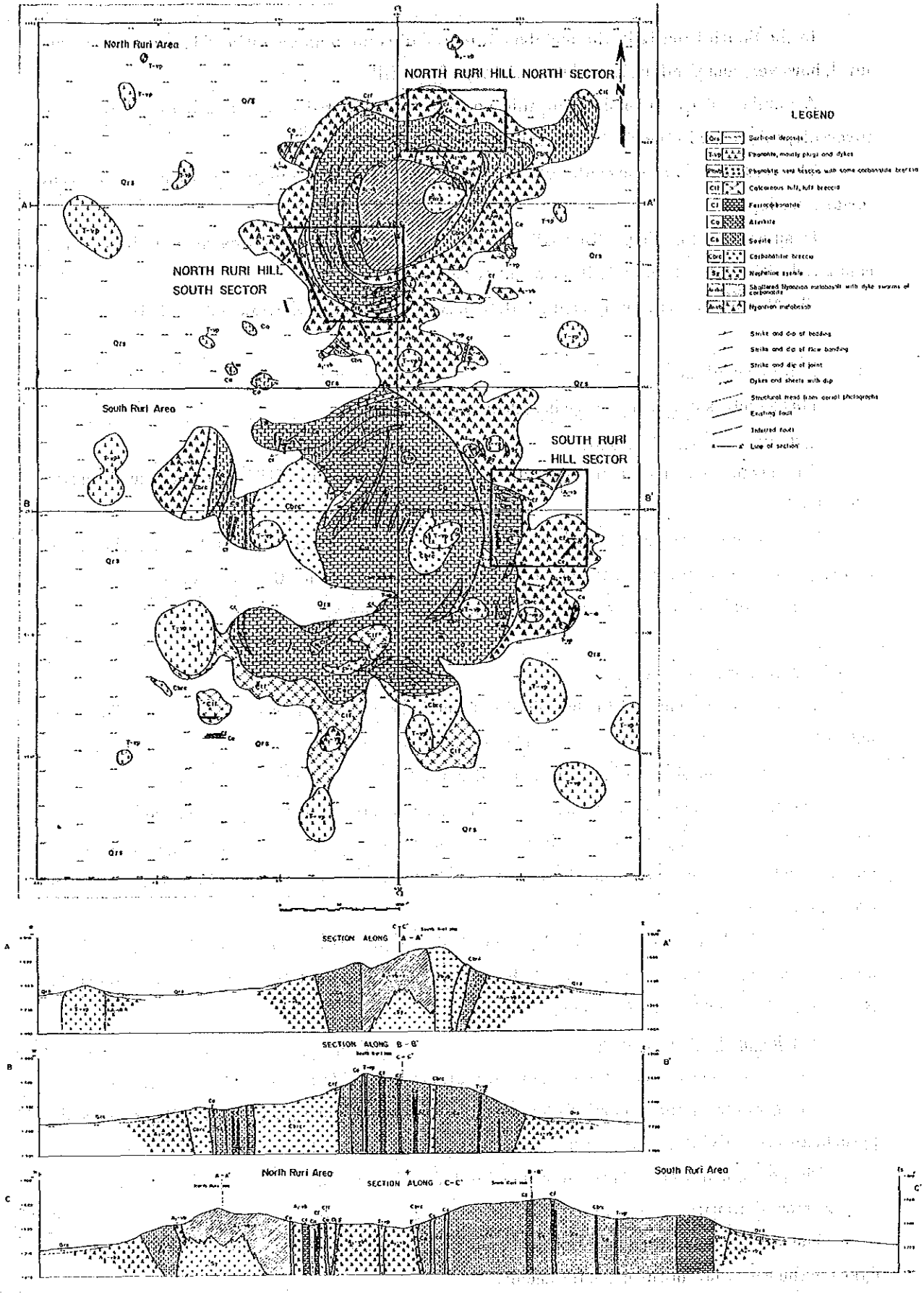


Fig. II–4–1 Geological Map of the North Ruri Hill Area and South Ruri Hill Area

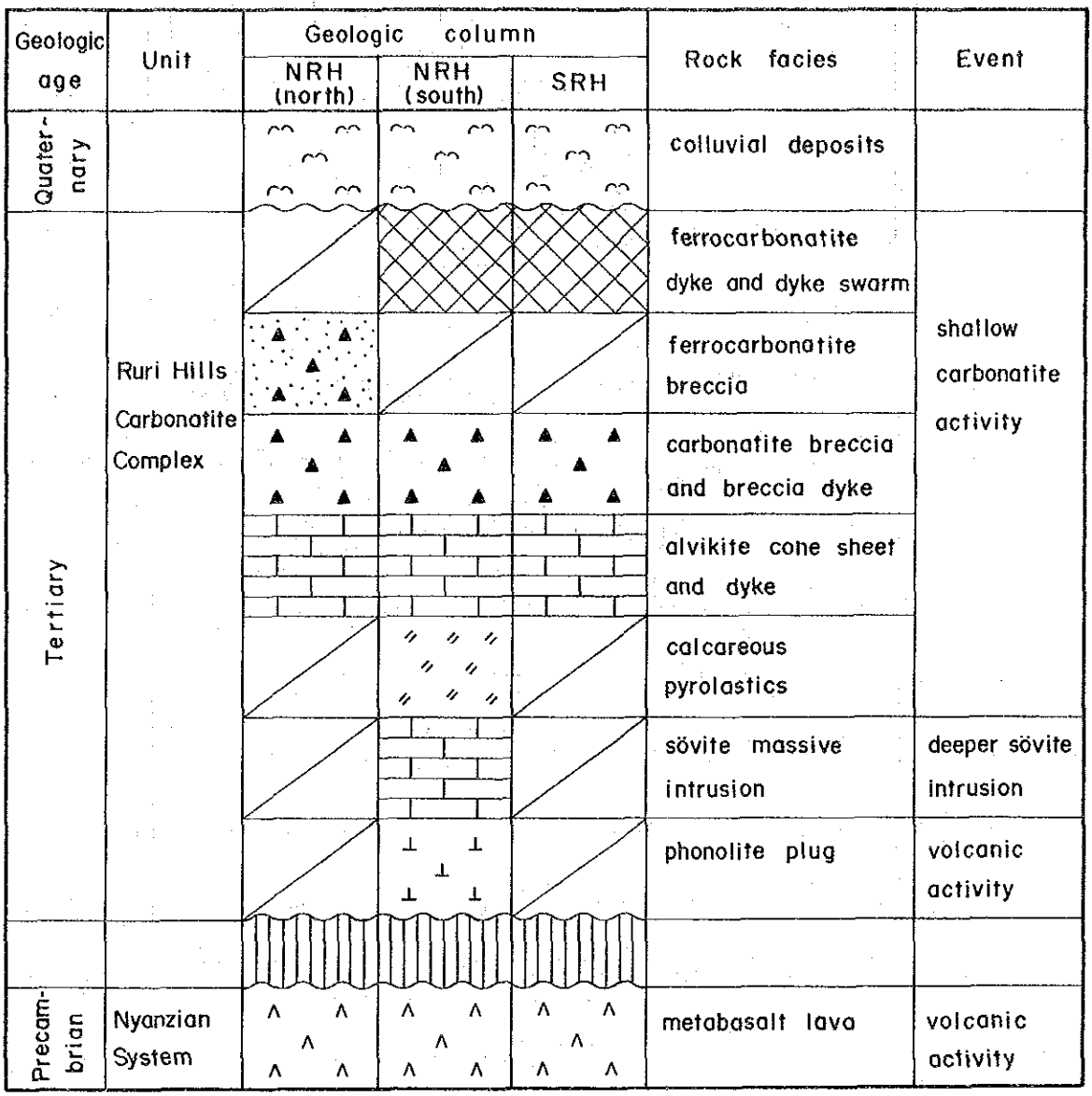
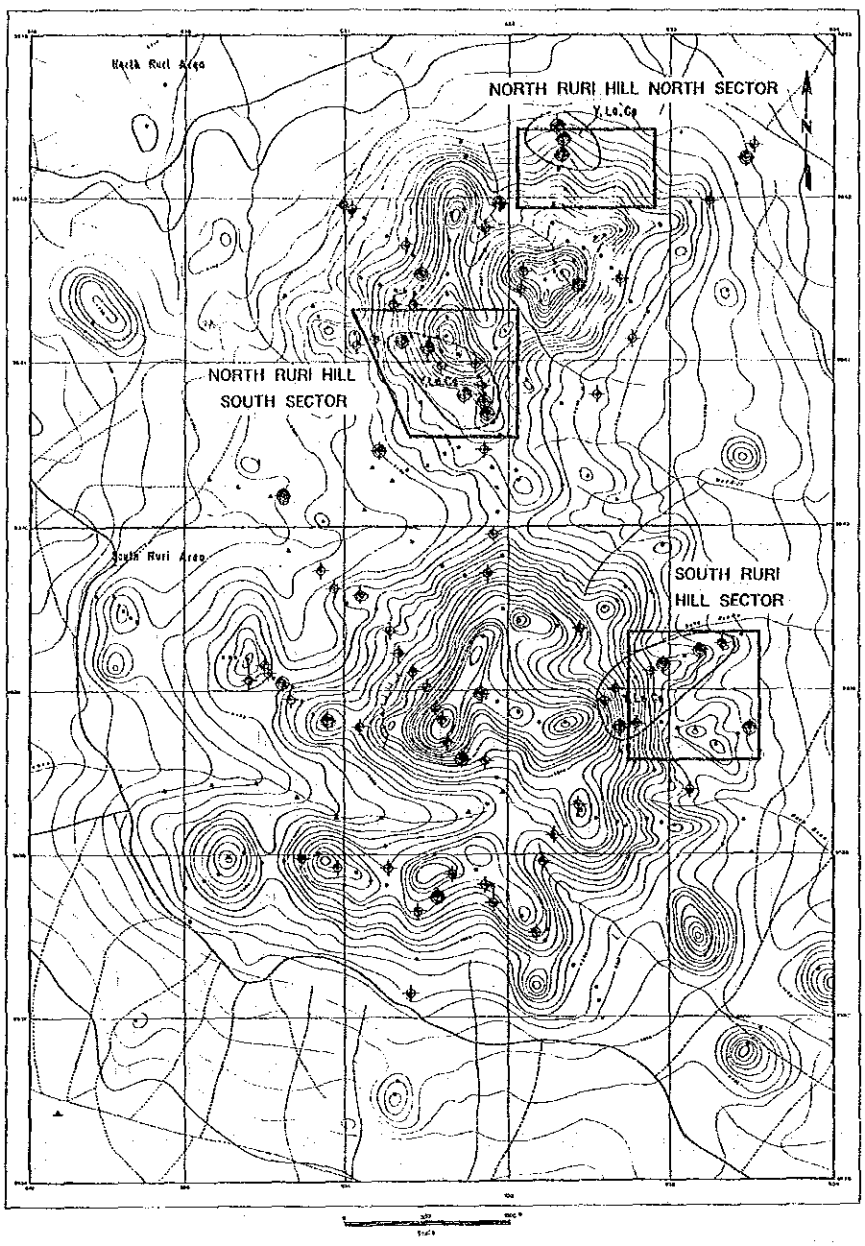


Fig. II–4–2 Geological Columnar Sections in the Ruri Hill Area



LEGEND

- Non anomalous sample
- Anomalous sample (≧ m+1S , <m+2S)
- Highly anomalous sample (≧ m+2S)
- Geochemicaly anomalous zone (Target area)
- Soil sample

Classification

Element	Anomalous, ≧ m+1S, <m+2S	Highly anomalous ≧ m+2S
La ppm	≧ 767 , < 3,300	≧ 3,300
Y ppm	≧ 148 , < 344	≧ 344
Nb ppm	≧ 620 , < 2,600	≧ 2,600
P %	≧ 061 , < 217	≧ 217

m : mean , S : standard deviation

Figures are of 1325 rock samples from all the Semi-detailed Survey Areas other than the grid-sampled areas in the Buru and Ndiru Hills.

Fig. II–4–3 Geochemical Interpretation Map of the North Ruri Hill and South Ruri Hill Area

The sizes of dykes are several centimetres to 1 metre in width, several metres to several tens of metres in length in the dyke swarm zone and several to twenty metres in width and 250 m in maximum length in the west and southwest of the sector.

The rocks shows dark grey, dark brownish grey, dark brown and pale brown. The facies are very variable in texture and mineral composition. It occasionally shows a banded structure and a brecciated structure. A large amount of magnetite is occasionally included.

The rocks comprises mainly carbonate minerals and goetite by weathering of iron oxide minerals.

South Ruri Hill Sector

This sector is situated in eastern slope of the South Ruri Hill (Fig. II-4-1).

The geology of the sector comprises basement Nyanzian metabasalt, alvikite, ferrocarbonatite, carbonatitic breccia and phonolite.

The geological plan and profiles are presented in Fig. II-4-6.

● Ferrocarbonatite

The unit is distributed in northern part of the sector as a group of small dykes (dyke swarm) and as separate dykes in the middle to the east of sector. The sizes of dykes of the former are usually several tens of centimeter in width and several to ten meters in length. The later is also small in size, and the maximum one confined is 100 m long and 3 m wide.

These dykes occur in the peripheral zone of the South Ruri Carbonatite Complex in a macroscopic view and the relation is same as the case of the North Ruri Hill South Sector.

The rocks have undergone strong weathering and contamination by oxidation of iron oxide minerals, resulting in brown to dark brown, reddish brown and block stainings. Magnetites sometimes forming a banded structure have mostly been changed to ferric iron oxide.

4-3 Results of geochemical survey (Semi-detailed survey)

(1) Sampling

Both rocks and soils were sampled in the area.

Rock samples were collected in Ruri Hills being composed mainly of carbonatites, and in the surrounding piedmont where Nyanzian rocks and carbonatitic pyroclastics were exposed. The number of samples is 136 in the South Ruri and 122 in the North Ruri, totaling 258.

Soil samples were collected in a flat area along a valley running westward from just south of the South Ruri Peak, and western piedmont of the North Ruri where scattered exposures of carbonatite were observed. The number of samples in the former is 9, and the later 10, totaling 19.

(2) Interpretations of geochemical anomaly

Geochemical anomialies in the area are shown in Plate 20 and Fig. II-4-3.

In rock geochemistry, anomalous values are frequently shown in Sr and REE, and highly anomalous values in Y, Th, Ce, Yb and Lu.

Samples having anomalous values are usually distributed in the carbonatite zone widely, however, prominent concentration is unobserved.

Highly anomalous samples, inversely, are distributed in the marginal zones of carbonatite cone sheets of Ruri Hills, and a type of these sample is entirely of ferrocarbonatite.

Consequently, following three geochemical anomalies were revealed.

Anomaly located at 0.8 km north of North Ruri Peak

This anomaly is located on the contact zone of Nyanzian metabasalt and carbonatite cone sheet of North Ruri, where ferrocarbonatites occur as swarms of dykes or veinlets network in alvikites and metabasalts.

Anomaly located at 0.9 km southwest of North Ruri Peak

This anomaly is located in southwest part of North Ruri carbonatite cone sheet, where alvikites and metabasalts are distributed irregularly and swarms of ferrocarbonatite have intruded them.

Anomaly located at 1.5 km east-northeast of South Ruri Peak

This anomaly is on the marginal zone of carbonatite cone sheet of South Ruri and Nyanzian metabasalt, where massive alvikites and metabasalts are intruded by abundant small ferrocarbonatite dykes.

In soil geochemistry, the sample which shows highly anomalous value of any elements was undetected. Secondary enrichment is considered to be made to some degree in soil, however, their contents are not so high that forming an anomaly.

4-4 Results of geochemical survey (Detailed survey)

(1) Sampling

Geochemical sampling was carried out in accordance with geological mapping. Sampling locations were at a 100x50 m grid by uisng 50 to 100m vinyl tapes and compasses.

Rock samples from outcrops were usually taken for geochemical purpose, but float samples, which were estimated to be in situ, were also taken where no outcrop was observed.

Sampling was not made in those places, where no flats in situ were found or a soil cover was thick.

The total number of samples is of 81 in North Ruri Hill North Sector, 150 in North Ruri Hill South Sector and 93 in South Ruri Hill Sector.

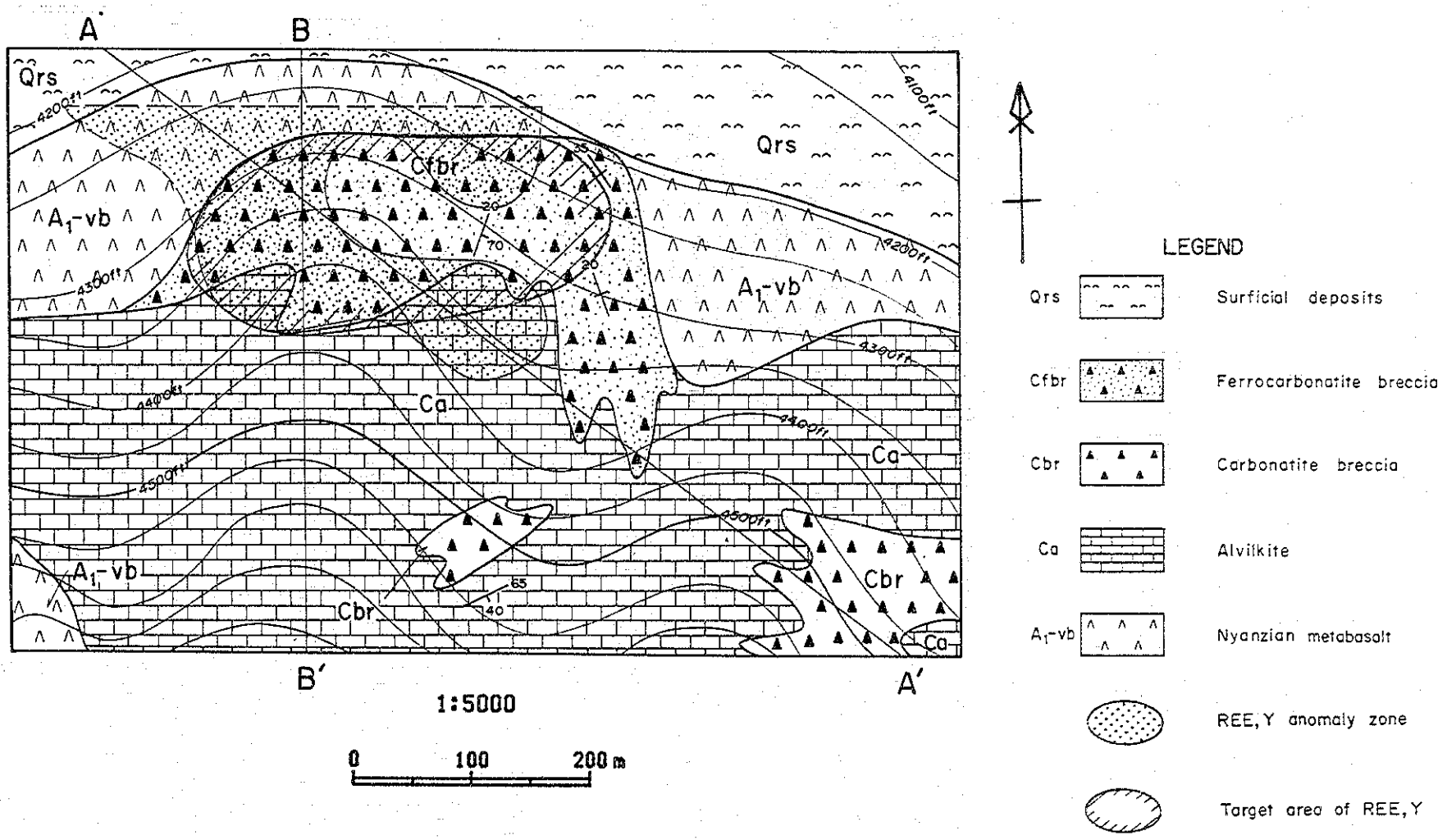


Fig. II–4–4 Geochemical Interpretation Map of the North Ruri Hill North Sector

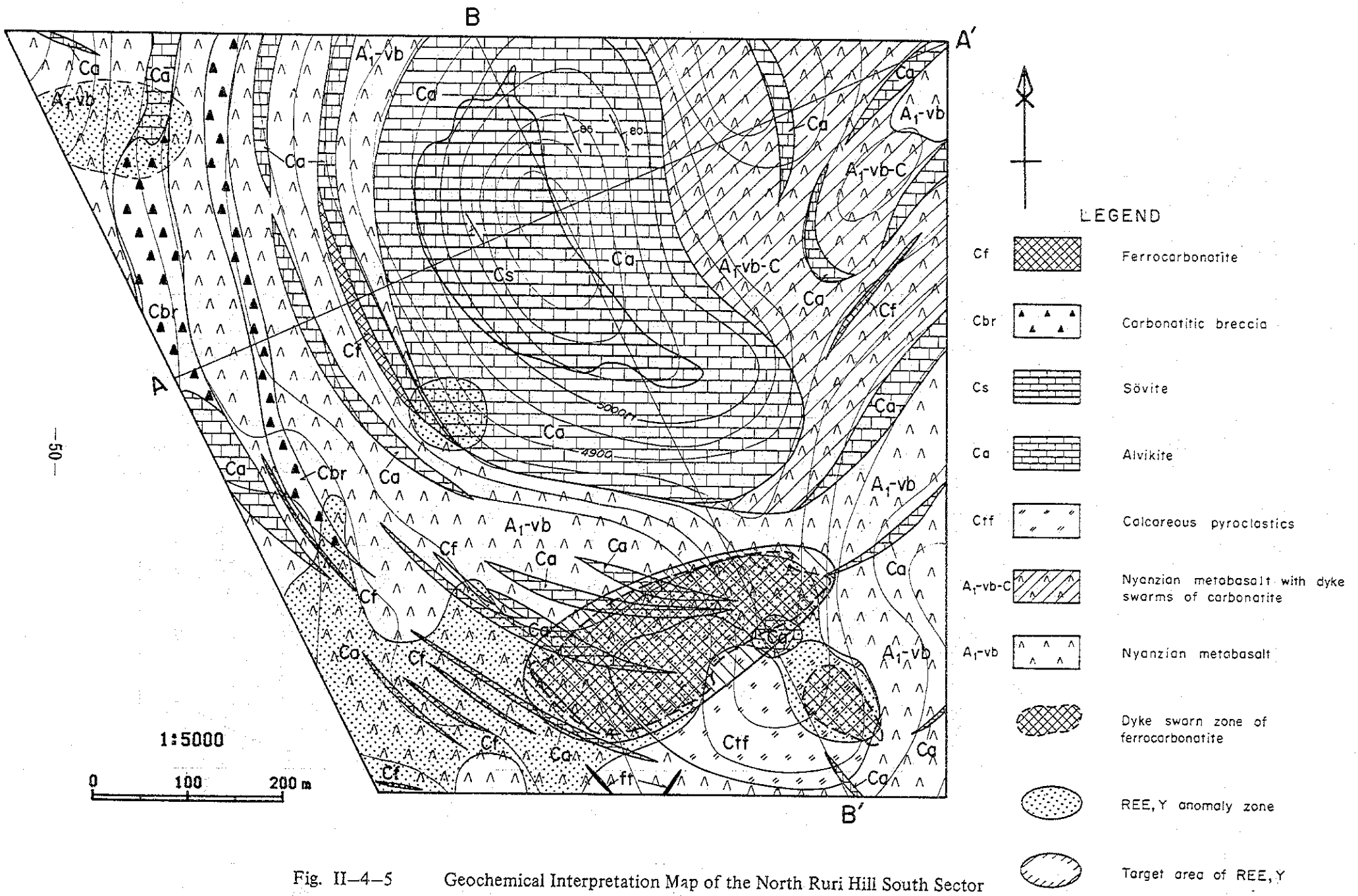


Fig. II–4–5 Geochemical Interpretation Map of the North Ruri Hill South Sector

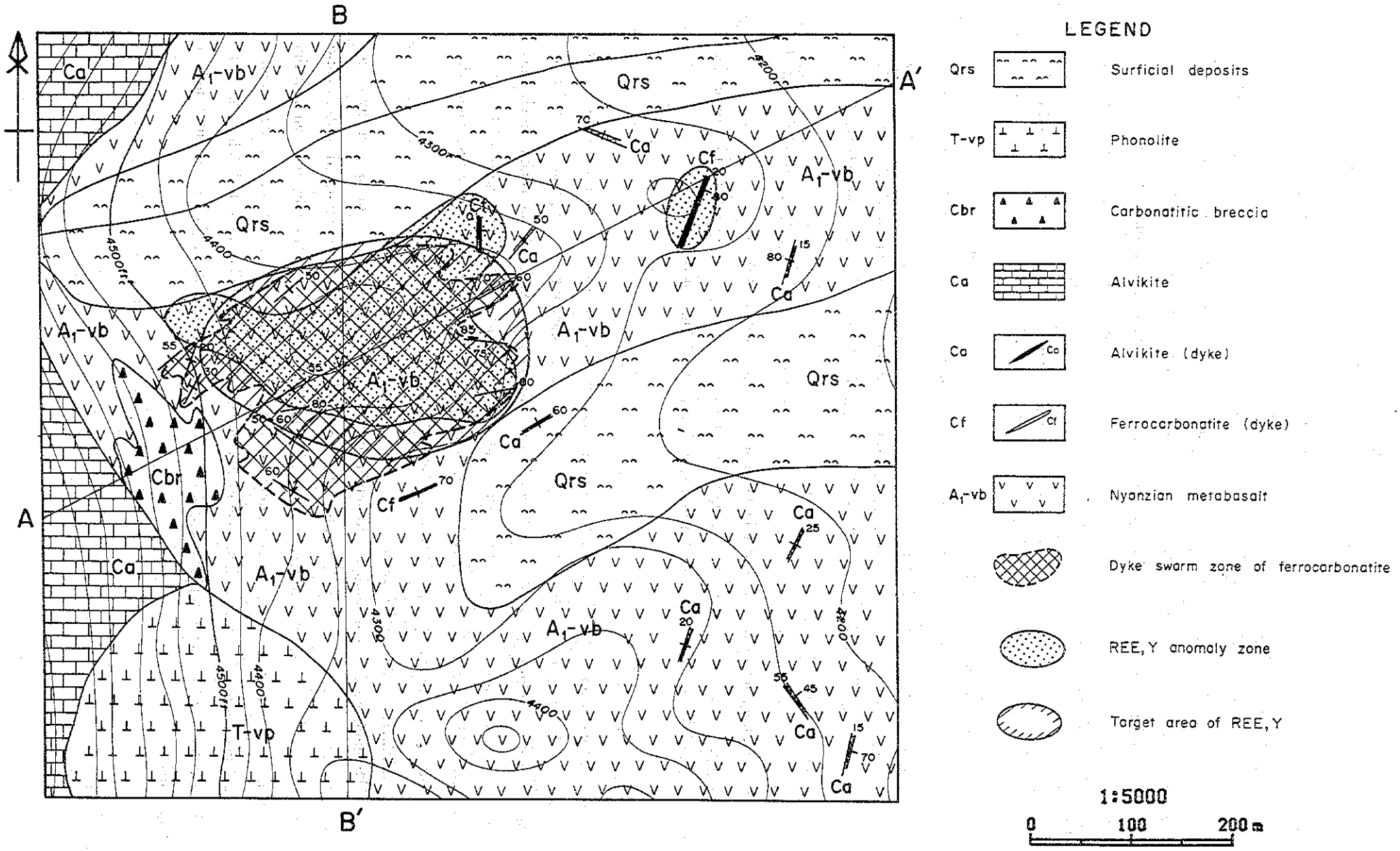


Fig. II–4–6 Geochemical Interpretation Map of the South Ruri Hill Sector

(2) Interpretations of geochemical anomaly

North Ruri Hill North Sector

In general, the rocks in the sector show higher values of 9 elements among 16 than that in other sectors, and the tendency is much strong in REE, particularly in Tb, Yb and Lu.

The major anomaly zone of these elements covers the ferrocarbonatite body and the periphery located in the north of sector, by what the body is selected to be a main target area of REE (Fig. II-4-4).

The chondrite-normalized REE patterns show that the concentration of MREE and HREE (Tb, Yb, Lu) is higher thanthat of LREE (La, Ce).

North Ruri Hill South Sector

High contents of Sr and P are considered to be caused by an occurrence of sövite body and La and Ce are by ferrocarbonatites.

The main anomalous zone of REE, Ba, Y and Th is situated in the south of sector, where dyke swarms of ferrocarbonatite to be the main target area of the sector are observed (Fig. II-4-5).

South Ruri Hill Sector

The major anomalous zones related to the minaralization of carbonatite are mostly limited in the central part of the area, where dyke swarms of carbonatite are observed.

From the comprehensive study of geology and geochemistry of the sector, only the major anomalous zone is considered to be a target area of the sector (Fig. II-4-6).

4-5 Mineralization

The three sectors where geological survey and geochemical exploration were conducted are situated in the marginal parts and in the peripheries of the carbonatite complexes of Ruri Hill, and the geology comprises basement Nyanzian metabasalt and carbonatitic rocks which have intruded the former. From geochemical explorations, it has turned out that REE and Y concentrate in ferrocarbonatite, inversely, high values of Nb are randomly spread in the sectors and are independently distributed to any particular type of rock of carbonatites.

North Ruri Hill North Sector

The body of ferrocarbonatitic breccia is distributed in the center of sector, occupying an area of 0.03 km^2 trending E-W direction. The rocks are heterogeneous in chemical contents and strongly weathered. Geochemically anomalous zones of REE and Y are distributed mostly in the same area covering the body and the immediate periphery. The anomalous zone has low contents parts of these elements, by what a hetergeneous character of the body is suggested. The small size of the anomalous zone and the heteogeneous character of the rocks unlikely warrant any further exploration.

North Ruri Hill South Sector

Ferrocarbonatites are mainly distributed in the south of sector in an area of 0.03 km^2 as dyke swarms, size of which are usually several centimetres to 1 m in width and several to several tens of metres in length.

Major geochemically anomalous zones are of Y, Th. and La+Ce+Nd, covering the zone of dyke-swarms of ferrocarbonatite and trending in E-W direction. The anomalous zone has an area of 0.06 km^2.

From the results of geology and geochemistry, the anomalous zone is unlikely of a potential target area for REE and Y, even though the area is larger than other two sectors.

South Ruri Hill Sector

Ferrocarbonatites in the sector occur as dykes or small dyke swarms and the majority occurs in the central to northwest part of the sector.

Major geochemically anomalous zone of the sector is observed only for La+Ce+Nd, covering the zone of dyke swarms of ferrocarbonatite.

Results of geological and geochemical explorations likely show a limited potentiality for a concentration of REE and Y in the sector.