REPORT
ON
THE MINERAL EXPLORATION
IN
THE MOMBASA AREA
REPUBLIC OF KENYA

CONSOLIDATED REPORT

MARCH 1993

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 formulate a Cooperative Mineral Exploration Project, comprised of geological, geochemical and diamond drill explorations of mineral survey, for an objective to evaluate a possibility of mineral occurrences in Mombasa Area, which is situated in coastal district of Kenya. The Japanese Government entrusted the work implementations to the Japan International Cooperation Agency (JICA), then, the JICA further assigned the implementations to the Metal Mining Agency of Japan (MMAJ), who is specializedly in charge of the survey work administrations concerning to the fields of geology and mineral resources industry.

The current works have been implemented in three years of period during the term from 1990 to 1992 to achieve a successful accomplishment of the works, as time-scheduled, under the full supports given by the governmental organizations of Kenya and the Mines and Geological Department of the Ministry of Environment and Natural Resources of Kenya.

This is the summary report on the current survey work results in three years of period.

Finally, we wish to express our deepest appreciations to the officials concerned of the governmental organizations of the Republic of Kenya and the Ministry of Foreign Affairs, the Ministry of International Trade and Industry of Japan, and the Japanese Embassy to Kenya.

March 1993

Kensuke Yanagiya

Kensuke Yanagiya
President,
Japan International Cooperation Agency

Takashi Ishikawa

Takashi Ishikawa
President,
Metal Mining Agency of Japan

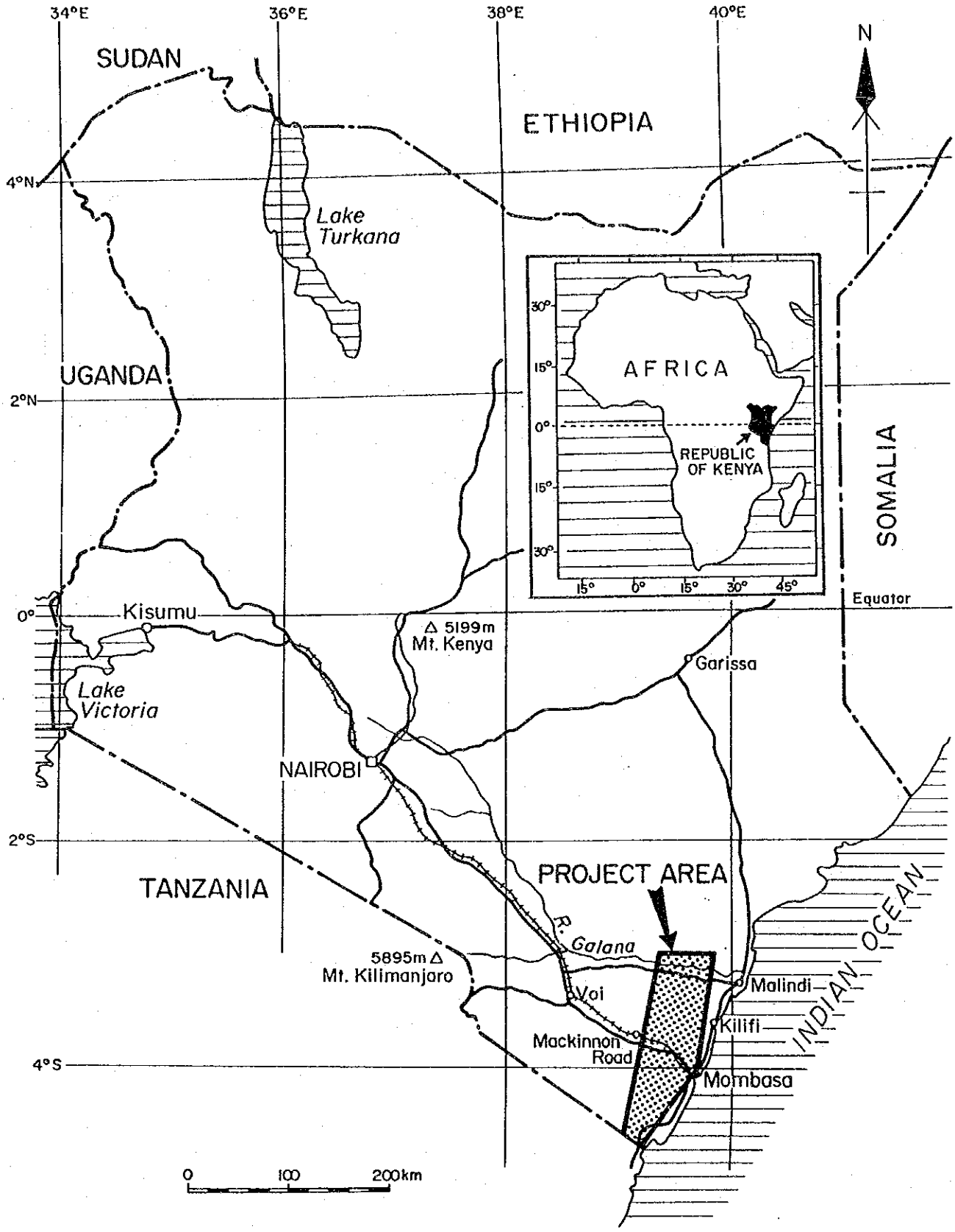

Figure 1 Index Map of Kenya Showing Location of the Mombasa Area

SUMMARY

The Cooperative Mineral Exploration Project Works in Mombasa Area of the Republic of Kenya, to cover an area of 9,000 square kilometres, were carried in three years of period from 1990 to 1992 as shown below.

The major objectives of Mombasa Project Works are to specify ore mineral occurrences of precious and base metals, niobium/rare earths elements and etc. through an establishment of the elucidations of geology in the project Area and to facilitate a geoscientific technical transfer to the counterpart organizations.

First-year programme in 1990 : Studies of existing informations, implementations of the outlined work of geological reconnaissance and geochemistry to cover the entire Area of 9,000 sq.km.

Second-year programme in 1991 : Implementations of the Semi-detailed work of geological reconnaissance and geochemistry in five Areas to cover an area of 620 sq.km.

Third-year programme in 1992 : Implementations of the Detailed work of geochemistry in two areas to cover an area of 6 sq.km and diamond drill exploration, nine holes, 1250 metres deep in total, in four ore showings in three Areas.

By the first-year work, such five Areas, as Ganze, Jibana, Ribe, Mkangombe and Mrima-Jombo, were selected to consecutively carry out Semi-detailed Work.

By the second-year work, a detailed geological representation of Jibana Mineralized Zone in Jibana Area, a new elucidationof Ribe Mineralized Zone in Ribe Area, a detailed geological representation of base metal-quartz ore veining mineralizations of Mkangombe North Ore Showing in Mkangombe Area and a new representation of niobium/rare earths elements of Kiruku Hill area in Mrima-Jombo Area, have been reputably accomplished.

By the third-year work, deep underground extensions of the ore showings and mineralized zones in Jibana, Ribe and Mkangombe Areas have been examined by diamond drill operations. An encouraging result in Mkangombe North Ore Showing has been concluded. Niobium/rare earths elements mineralizations, associated with wall rock silicification in Kiruku Hill area in Mrima-Jombo Area has been examined in comparison with those, associated with carbonatite occurrence in Mrima Hill.

Major exploration results by Semi-detailed and Detailed Works by the current programme in respective five Areas are stated below:

(1) Ganze Area by Semi-detailed Work.

Mineral showing and geochemical anomalous zones, to be deserved to warrant

further future work, are unlikely evaluated to be encouraging.

(2) Jibana Area by Semi-detailed and Detailed works with diamond drill operations.

The occurrence of Jibana Mineralized Zone, 100 m wide and 2 km long approximately, has been studied. Remarkable accumulative occurrence of metallic mineral of significance on ground surface in gossanous materials and soils in Jibana Mineralized Zone has not yet been shown by chemical assay results. Three diamond holes, 450 m deep in total, which were targeted on examinations of underground extensions of gossans and geochemical lead-anomalies in Jibana Mineralized Zone were operated, however, the operation results with an absence of remarkable mineralization occurrence are unlikely evaluated to further a future work programming to be deserved to warrant.

(3) Ribe Area by Semi-detailed and Detailed Works with diamond drill operations.

Ribe Area and environs had been evaluated to be possibly mineral-potential since of the geological structural situations in the Area and of the occurrences of ever-known Kinagoni Ore Body nearby and mineral showing. One diamond drill hole, 150 m deep, was operated in ever-known Chiume Hill Mineralized Zone, meanwhile, three diamond drill holes, 450 m deep in total, were operate in Ribe Mineralized Zone, which has been newly discovered by the current programme.

By the results, Chiume Hill Minearlized Zone is likely evaluated to be limitedly extended in deep underground with little significance. Ribe Mineralized Zone is likely estimated to extendedly form a barren silicified zone in deep underground, associated with limited occurrences of barite fine veins in silicified rocks.

However, further strenuous efforts to wagingly attain a new eventual mineral potential are considered to be consecutively made in Ribe and also in Jibana Areas overall, where faultings of geological significance and wall rock alterations are remarkably observed.

(4) Mkangombe Area by Semi-detailed and Detailed Works with diamond drill operations.

The Mkangombe North Ore Showing, comprised of copper-lead-zinc-quartz ore veining mineralization, more than 300 m long and 0.2 to 1.5 m wide, striking N25° to 30° E and dipping 55° to 70° toward southeast, in Mkangombe Area is estimated to have been formed under a fault-structural control. Two diamond holes, 200 m deep in total, were operated to examine underground extensions of the above showing.

By the results, Hole MJKM-8 has successfully intersected an underground occurrence of a massive sphalerite ore vein, 24 cm wide, to provide a geological possibility that quality and scale of ore mineralization in deep underground could eventually be improvedly higher than those on ground surface showing and further to lead to an eventual possibility of an occurrence of ore mineralization of economical significance in the vicinity.

Abundant occurrences of quartz veins outcrops and floats, N45° E directional, are observed to form a quartz veining ore mineralized zone, more than 10 km long, in an area between Mkangombe North and Mkangombe South Ore Showings. Outcrops and floats of quartz veinings, associated with copper minerals, have newly been discovered in the vicinity of Mkangombe South Ore Showing. Those are likely evaluated to pose a geological possibility of an occurrence of ore mineralization of significance in quartz veining mineralized zone.

Further implementations of diamond drill operations in future are considered to be required to examine the ore mineralization occurrences in deeper portions underground on an entire extension of Mkangombe North Ore Showing.

Further implementation of detailed geological reconnaissance works in quartz veining mineralized zones to thoroughly cover never-examined spots are also considered to be required.

(5) Mrima-Jombo Area by Semi-detailed and Detailed Works.

It has been clarified that the occurrences of niobium/rare earths elements (REE) are observed not only in ever-known Mrima Hill occurrence, but also in Kiruku Hill. Results by the detailed soil-geochemical exploration work are stated below:

Geochemical anomalous zones of niobium, REE and such other elements, as iron, manganese and etc. shown in the following section, have been shown in Kiruku Hill area. Mineralizations of niobium, REE and precious and base metals in Kiruku Hill are geologically inferred to have been formed in association with the forming of silicified rock zones, that could have causedly been formed by hydrothermal activities along faults of NW-SE to WNW-ESE direction. This inference are considered to be supported by the chemical assay results of rocks. General extension and quality of niobium-REE mineralization in Kiruku Hill are evaluated to be smaller than those in Mrima Hill. Those are likely estimated to have genetically been caused by the difference of mode of mineralizations in respective areas that the mineralizations in Kiruku Hill are associated with the occurrence of silicified rocks, meanwhile, those in Mrima Hill are with of carbonatite bodies.

Implementations of further future work in the Area are evaluated to unlikely be deserved to warrant. Implementations of further works with academic interests in the mode of niobium - REE mineral occurrences in more details in Kiruku Hill silicified rocks and in occurrences of secondary enrichment of those are likely estimated to be required. Regional research works on hydrothermal process, that could have caused wall rock silicification in the area, in relations to the extension and to geology and geological structure, for an objective to examine a geological possibility of an occurrence of hydrothermal ore mineralization of varied type, are likely considered to be one of research themes to be studied further in the Area.

Geochemical anomalous zone of significance of niobium and REE has not yet been shown in Nguluku Hill area.

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ATTACHED PLATE

PART I GENERALS

CHAPTER 1. OUTLINE of SURVEY WORK

1-1 Area Covered and Objective of Work

1-1-1 Area covered

The Mombasa Area, as shown in Figure 1 of the current project programme, which covers an area of 9,000 square kilometres, is situated in southeastern district, facing to Indian Ocean, of the Republic of Kenya.

1-1-2 Objective of work

The major objectives of the Mombasa Project Works are to specify ore mineral occurrences of precious and base metals and niobium/rare earths elements through an establishment of the elucidations of geology in the Project Area and to facilitate a geoscientific technical transfer to the counterpart organizations.

1-2 Measures and Quantities of Work

The Mombasa Project Works were implemented in accordance with such level-wisely operated manners, as Outlined, Semi-detailed and Detailed works. The site locations of respective work areas are shown in Figure 2, area figures of those are in Table 1 and quantities of those are in Table 2.

A sequential flow chart of the Project Work progresses and that of the processes to select mineral-promising areas are shown at the end of the volume.

1-3 Period of Works and Survey Teams Organization

Table 2 shows the contents and volumes of field and laboratory works in respective yearly programmes.

Table 3 shows the members of Programming/Negotiation/Coordination Teams of the current Project in respective years 1990-1992, meanwhile, Table 4 shows the members of Field Work Teams of that.

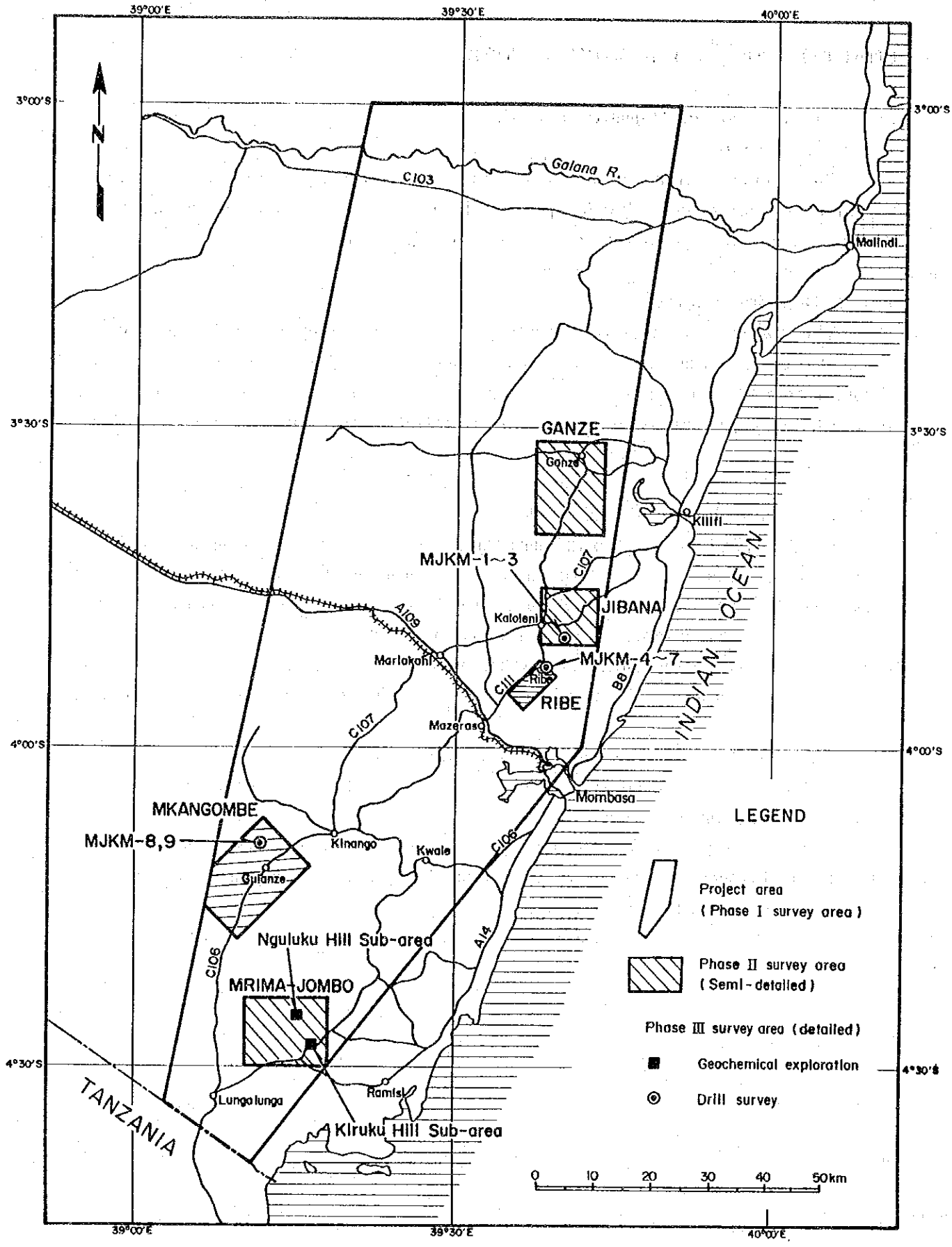

Figure 2 Location Map of Phase I to Phase III Survey Area

Table 1. Project areas

Year, operated	Project area, surveyed		Area, in sq.km
1990 - 1st year	Outlined work, semi-detailed work, partly	Entire Mombasa Project Area	9,000
1991 - 2nd year	Semi-detailed work	Ganze Area	192
		Jibana Area	100
		Ribe Area	32
		Mkangombe Area	196
		Mrima-Jombo Area	100
		(Total)	(620)
1992 - 3rd year	Detailed work	Jibana Area	DD
		Ribe Area	DD
		Mkangombe Area	DD
		Mrima-Jombo Area	6
		(Total)	(6)

DD: Diamond drill operation

Table 2. Contents and Quantity of Field Work and Outline of Laboratory Test

Year	1st year (1990)	2nd year (1991)	3rd year (1992)
Work period	Jul. 1990 - Feb. 1991	Jul. 1991 - Feb. 1992	Jul. 1992 - Feb. 1993
Geological reconnaissance			
Outline	9,000 sq.km 1:100,000 scale Studies of existing informations	–	–
Semi-detail		620 sq.km in 5 Areas, 1:10,000 scale	–
Geochemistry			
Outline	9,000 sq.km, Pan-concentrates 100 by 14 elements, (Au,Ag,Cu,Pb,Zn,Ba, Mn,Fe,S,U,Th,Pt,P,Hg)	–	–
Semi-detail	in 15 ore showings, Soils 769 by 9 elements (Au,Ag,Cu,Pb,Zn, Ba,Mn,Fe,S)	in 5 Areas, Soils 1245 by 11 elements (Au,Ag,Cu,Pb,Zn, Ba,Mn,Fe,As,Hg,S) ---------- Soils 262 by 21 elements (Au,Ba,Sr,Nb,Y,U,Th, La,Ce,Nd,Sm,Eu,Tb,Yb, Lu,Cu,Pb,Zn,Fe,Mn,P)	–
Detailed			Kiruku Hill area, 4 sq.km, by 100m x 100m grid, Soils 400 by 18 elements (Au,Ba,Sr,Nb,Y,U, Th,La,Ce,Nd,Sm,Eu, Tb,Yb,Lu,Fe,Mn,P) Rocks 7 by 18 elements (as above) Nguluku Hill area, 2 sq.km by 100m x 100m grid, Soils 200 by 18 elements (as above) Rocks 3 by 18 elements (as above)
Diamond drill operation			Jibana Area 3 holes, 450.00m, Ore 2 by 6 elements (Au,Ag,Cu,Pb,Zn,Ba) Ribe Area 4 holes, 600.00m, Ore 90 by 6 elements (as above) Mkangombe Area 2 holes, 200.00m, Ore 8 by 6 elements (as above)
Laboratory test			
Thin section	60	30	20
Polished section	50	10	10
Polished thin section	22	–	–
Whole rock analysis	40(12 elements)	–	–
Ore assay	106(14 elements) 30(9 elements)	31(8 elements)	100(6 elements)
X-ray powder diffractometry	35	30	30
EPMA	22	–	–
Pb-Pb Dating	11	–	–

Table 3. Member List of Programming/Negotiation/Coordination Teams

Year	Japanese delegation	Kenyan counterpart
1990	Masaru HENMI, MITI Kazuhiko TODA, MOFA Zenji KITA, MMAJ Hiroshi SHIMOTORI, MMAJ Kenzo MASUDA, MMAJ Takahisa YAMAMOTO, MMAJ Masayoshi JURO, JICA	S.A. WASIKE, MENR P.D. GENGA, MENR O.O. OKOITI, MENR E.M.B.H. OMBOGO-NDONGA, MENR K.M.S. KIGEN, MENR A.I. IGOBWA, MENR M.G. MWATHI, MENR C.Y.O. OWAYO, MGD J.K. WACHIRA, MGD W.M.N. SIAMBI, MGD F.K. MURUGA, MGD
1991	Yoichi YAMAGUCHI, MMAJ Kyoichi KOYAMA, MMAJ Haruhisa MOROZUMI, MMAJ Takahisa YAMAMOTO, MMAJ Nobuyuki OKAMOTO, JICA Katsuichiro SAKAI, JICA	E.M. MASALE, MENR C.Y.O. OWAYO, MGD J.K. WACHIRA, MGD F.K. MURUGA, MGD
1992	Takahisa YAMAMOTO, MMAJ Nobuyuki MASUDA, MMAJ Koji MAKINO, JICA	C.Y.O. OWAYO, MGD J.K. WACHIRA, MGD F.K. MURUGA, MGD

MITI : Ministry of International Trade and Industry
MOFA : Ministry of Foreign Affairs
JICA : Japan International Cooperation Agnecy
MMAJ : Metal Mining Agency of Japan
MENR : Ministry of Environment and Natural Resources
MGD : Mines and Geological Department

Table 4. Member List of Field Survey Teams

Year	Japanese personnel	Kenyan counterpart
1990	Masakazu KAWAI, Leader, SC Akio ONISHI, SC Toru HIROKAWA, SC	F.K. MURUGA, MGD I.K. GITHINJI, Co-leader, MGD S.S. HUSSEIN, MGD M.N. MWANGI, MGD T.N. NDOLA, MGD
1991	Akira TAKIGAWA, Leader, SC Toru HIROKAWA, SC Takao SASAKI, SC	I.K. GITHINJI, Ex-Co-leader, MGD S.S. HUSSEIN, Co-leader, MGD M.N. MWANGI, MGD T.N. NDOLA, MGD M. MASIBO, MGD M. GIKUHI, MGD
1992	Akira TAKIGAWA, Leader, SC Kenjiro KAWADA, SC Masashi HAYAKAWA, SC Takashi UENO, SC Sachio FUKUSHIMA, SC Masaru MARUYAMA, SC	S.S. HUSSEIN, Co-leader, MGD M.N. MWANGI, MGD T.N. NDOLA, MGD M. MASIBO, MGD E. IRURA, MGD J.A. LICHINA, MGD P. OYWA OKELO, MGD J.O. KITINYA, MGD B. OWADE, MGD M.C. NYANG' ARA, MGD J.K. NZINGA, MGD M.M. MUHEA, MGD J.E. SIMWA, MGD L. ANYIKA, MGD A.K. AURA, MGD

SC : Sumiko Consultants Company, Ltd.
MGD : Mines and Geological Department

CHAPTER 2. PREVIOUS WORKS

The summarized generals on geology and mineral resources industry in the Republic of Kenya are collectively reported in the publications by Pulfrey, W. (1969) and Dubois, C.G.B. (1970).

Geological informations in earlier time on coastal district of Kenya are available in the publications by Baron von Decken (1879), Thomson, J. (1879), Gibson, W. (1893), von Reichenbach, S. (1896), Gregory, J.W. (1896), Walker, E.E. (1903), Muff, H.B. (1908), Gregory, J.W. (1921) and etc..

Geological sheets, which include the current Project Area are enumerated as Hadu-Fundi Isa Area (Williams, 1962), Malindi Area (Thompson, 1956), Kilifi-Mazeras Area (Caswell, 1956), Mid-Galana Area (Sanders, 1959), Mariakani-Mackinon Road Area (Miller, 1952) and Mombasa-Kwale Area (Caswell, 1953). Those sheets with explanatory notes, scale of which is 1 to 125,000, were published by Ex-Geological Survey of Kenya. The 26 geological sheets in coastal district of Kenya, accomplished in 1985 by the technical cooperative works of Kenya-UK Geological Mapping Project, published by the Kenyan Government, are available.

Air-borne magnetic and radioactive mapping sheets, Macaria and Limion, 1978, 1 to 25,000, 1 to 50,000 and 1 to 125,000 scales, to cover Mombasa area, were published in 1977 by the Kenyan Government.

The major publications on regional mineral resources exploration results in the vicinity of the current Mombasa Area are enumerated as the geochemical exploration results of stream sediments and soils by the Geological Survey of Kenya in 1977-1981, under the technical cooperations by UK, and Kenya-Austria Mineral Exploration Project in 1978 by Mines and Geological Department of Kenya and Austromineral G.m.b.H..

A number of geoscientific research works for various mineral occurrences and showings in the Area have been implemented by the governmental organization and private sectors. Those chiefly cover the areas of lead-zinc-barite ore vein mineralizations, represented by the Kinagoni mine, and niobium/rare earths elements mineralizations in Mrima Hill. The major reports on the former mineralization are represented in those by Bugg, S.F. (1980, 1982) in coastal district and by Clarke, M.C.G. (1970) in the Kinagoni mine district. The major reports on the latter mineralization are represented in feasibility studies by Anglo American Corp. of South Africa (1955-1957) and by Pechiney-Saint Gobain Ltd. (1968-1971). Anglo American Corp. of South Africa (1957) and Coetzee & Edwards (1959) have provided major reports on Mrima Hill ore mineralizations.

CHAPTER 3. GENERAL GEOLOGY in MOMBASA AREA

General geology in the entire Mombasa Area consists of the formations of Precambrian to Quaternary ages and is chiefly composed of sediments, igneous rocks, metamorphic rocks and unconsolidated sediments. The major geological units in the area are specified to be of Mozambique System in north-western part of Mombasa Area, of Palaeozoic-Mesozoic Groups in major part of the Area and of Tertiary System, associated with later sediments, in coastal province in the Area.

Mozambique System is mainly comprized of metamorphic rocks, i.e., gneiss and schist. Permian System is observed in western part of the Area. Permian and overlying Triassic Systems in the Area are composed of a series of the alternations of grit, sandstone and shale beds. Jurassic System in the Area (Kambe and Mtomkuu Formations) consists of marine limestone and shale beds. Permian-Triassic Systems in the Area (Druma Group, i.e. Taru, Maji-ya-Chumvi and Mariakani Formations and lower part of Mazeras Formation) are correlated to Karroo System in South Africa, however characteristicaly show finer facies than that in other area. Karroo System is typically characterized by being associated with coarse-grained sediments, caused by the repeated sedimentations of materials in connection with geotectonism nearby sedimentary basin structure, however, Karroo System in Mombasa Area, the above, is of a lack of coarse-grained facies. Non-volcanic Tertiary System and Pleistocene sediments are observed along the coastal province in the area. Uplifted coral reefs along the coast are of Pleistocene age.

Limited occurrences of dykes are observed in Palaeozoic and Mesozoic sediments in Mombasa Area. Alkaline rock intrusives are observed in Jombo Hill and nearby, while, carbonatite intrusives are in Mrima Hill.

Faults, extending NNE-SSW to NE-SW directionally and nearly parallel to the direction of sea shore line in Mombasa Area, are well-developed. The major faults among those, which are observed long extendedly along the coast in the area, make the demarcation of Mazeras sandstone and Kambe limestone beds. Another type of faults, which traverse major faults in the Area, the above, and are considered to have been formed later than those, are also observed in association with well-developed fissures.

The Mombasa Area has long been known as one of the major producers of niobium, rare earths elements, lead, zinc, copper, gold, iron, manganese, barite and etc.. Niobium and rare earths elements mineralizations, associated with carbonatite bodies in Mrima Hill have ever been known world-wide, then the mineral exploration works in Mrima Hill area have consecutively been operated since 1950s. Abundant occurrences of lead-zinc-barite ore veining

mineralizations are observed along the faults parallel to Karroo-Jurassic Fault, NNE-SSW to NE-SW directional. Mkangombe North Ore Showing, observed in a fault zone of NNE-SSW direction, chiefly consists of copper-lead-zinc-quartz ore veining mineralizations. Concretions of iron oxide ore in weathered soils of limestone beds in Jaribuni Area are currently in mining operation by man-power.

CHAPTER 4. GENERAL BACKGROUND of PROJECT AREA

4-1 Communication

Mombasa, the second-biggest city in the Republic of Kenya, situated in eastern coastal province of the country, occupies a traffic key station in eastern Africa with International and National air ports. Mombasa and Nairobi, the capital of the country, are actively connected by domestic air services, railroad services and road networks on Route A 109 to maintain vigorous mobilizations of inhabitants and materials.

Road networks in the Project Area are widely well-developed, to be represented by such all-weather road structures, as A 109 of Nairobi-Mombasa, B 8 of Mombasa-Malindi, A 14 of Mombasa-Lunga Lunga, C 106 of Mombasa-Kwale, C 111 of Mazeras-Kaloleni and etc.. Unsealed road networks intercommunicating the villages by motor vehicles in the Project Area are also well-developed, thus, general car accessibilities from Mombasa to the respective Semi-detailed work areas were made capable to be within about 1.5 hours.

4-2 Community and General Geography

Mombasa is one of hubs in coastal province of the Republic of Kenya, where governmental organizations, telephone-telecommunication bureau, dispensaries and hospitals, banks, hotels, air carriers offices, car rentals, shops and etc. are sufficiently well-organized, thus, Mombasa plays a significant role as a centre of liaisons, communication and mobilization/demobilization of works and material procurements and etc..

Three residential provincial geologist are currently in duties in Mombasa in the chapter office of the Mines and Geological Department of Kenya.

The coastal zone nearby Mombasa forms a great recreation resort area, chiefly for European visitors. Abundant facilities of recreation hotels and lodges are well-developed, where supplies of power, waterworks, telephone services and etc. are well-equipped. Inland area close to the coast, where annual raim fall is relatively high, is generally developed for an agricultural industry, meanwhile, that slightly far from the coast, where it is semi-arid, is generally for agricultural and stock farming industries. Man-powers for labour task in the Area are readily available due to a limited opportunity for local people to having net incomes in cash.

General topography in the Project Area is devided into such four units, as coastal plain, lower table land, coastal mountains and Nyika. Coastal plain is elevated in the range less than 30 m high above sea level, and is more than 3 to 5 km wide in some occasions to be developed along the sea shore line. Lower table land, 70 m to 140 m high above sea level, is developed in the back of

coastal plain with a steep increase in altitude. Coastal mountains, 150 m to 400 m high above sea level, form a mountaineous land lay. General land elevation is sharply reduced from the western end of coastal mountains toward Nyika, which is generally elevated in the east about 180 m high above sea level to be more elevated to be some 300 m high in western part of the Project Area and is further extended toward western inland area. General difficulties for reconnaissance works by topographical situation and plant exuberance are considered to be generally few, however, bush knives are prerequisitely required to be carried with work members. Exuberant vegetations and swamps along rivers and streams frequently force work members to move with difficulties.

General climate in coastal province is with high air temperature due to situating at an low altitude to be at 26.4℃ of annual average value. Heavy rain season generally visits in April - May, meanwhile, small rain season in October - November.

CHAPTER 5. CONCLUSIONS and RECOMMENDATIONS

5-1 Outlined Survey Area

5-1-1 Conclusions

In the entire Mombasa Project Area, that covers an area of 9,000 sq.km, the major ore mineralizations are to be of 1. lead-zinc-barite ore veins mineralizations, represented by the Kinagoni mine, 2. copper-lead-zinc-quartz ore veins mineralizations, represented by Mkangombe North Ore Showing and 3. niobium/rare earths elements mineralizations, represented by Mrima Hill.

The type 1, the above, is of low-temperature-formed hydrothermal ore veins mineralization, which is widely observed from north toward south in the Area in such ore showings, as Vitengeni, Kinagoni, Changombe, Mwachi River, Lunga Lunga and etc.. Lead-barite ore bodies in Kinagoni and Vitengeni are currently in mining operations.

The type 2, the above, is of NNE-SSW-extended base metals-quartz ore veins mineralizations, which are estimated to have been formed under a structural control by the faults with nearly identical strike value. Three mineralization occurrences, such as Mkangombe North, Mkangombe South and Mkundi, have ever been known. The mineralized zone with quartz veinings, more than 10 km long, in which Mkangombe North Ore Showing occurs, is likely evaluated to be deserved to warrant further mineral exploration works, by which a thorough accomplishment by detailed work coverage for an entire extension of the zone should be made.

Mineralizations of the type 3, the above, are observed by the current works not only in carbonatite plugs in Mrima Hill, but also in silicified rocks in Kiruku Hill. Mrima Hill mineralization, for which a number of exploration works and feasibility studies have ever been carried out, has not yet been in commercial operation due to the technical difficulties related to mineral processing technology.

Niobium/rare earths element mineralization in Kiruku Hill is reported in the following section 5-2.

5-1-2 Recommendations

Recommendations in the Outlined Survey Area in this section are confined to those for the area, which have not been selected for Semi-detailed and Detailed Work areas.

Consecutive implementations of geological and geochemical research works are recommended in the geochemical anomalous zones, which have been shown by the current first-year programme in Vitengeni environs, where polymetallic geochemical anomalies have been shown, and in the south of Vitengeni, where geochemical gold anomalies have been shown.

Further future works in the areas, which have not been selected for the current Semi-detailed and Detailed Works, are unlikely evaluated to be deserved to warrant.

5-2 Semi-detailed and Detailed Survey Areas

5-2-1 Ganze Area (Semi-detailed survey)

(1) Conclusions

Occurrences of lead-zinc-barite ore veining mineraliztion in Mazeras Formation under a wide development of Karroo-Jurassic Fault have been expected to be promising in the Area. However, an occurrence of barite ore floats was observed in a single spot by the current geological reconnaissance. Geochemical anomalies, which are overlappedly shown by anomalous values of barium and sulphur, are scatteredly shown to be barely related to the behaviour of such heavy metal element, as lead and zinc. Thus, Ganze Area is unlikely evaluated to be potential of the occurrence of ore mineralization of significance.

(2) Recommendations

Implementations of future exploration works in Ganze Area are unlikely evaluated to be deserved to warrant as the exploration results by geological and geochemical research works have shown a limited possibility of potential occurrence of lead-zinc-barite ore veins mineralization.

5-2-2 Jibana (Semi-detailed and Detailed surveys)

(1) Conclusions

Jibana Area is situated at the north of the Kinagoni mine, which is currently in mining operation. An occurrence of lead-zinc-barite ore veining mineralizations has been estimated to could be potentially extended into Jibana Area. The occurrence of Jibana Mineralized Zone, about 100 m wide and about 2 km long, consists of a discontinuous extension of gossanous materials and weakly altered sandstone, has been revealed in the west of Jibana Village by the current geological reconnaissance work. Chemical assay results on four specimens of the gossanous material have shown a limited contents of precious and base metals. Three diamond drill holes, 450 m deep in total, were operated by the current programme because that the Jibana Mineralized Zone is situated nearby Karroo-Jurassic Fault, which is inferred to be genetically related to the areal mineralization and also geochemical lead anomalies of 84 to 142 ppm, which are inferred to be an influenced showing by the areal mineralization, have been revealed in a part of the zone.

The results of diamond drill operation show that the underground extensions of gossanous materials and geochemical lead anomalies on ground surface, which

have been targeted by diamond drill works, are likely estimated to be geologically represented by the occurrences of pyrite disseminations in fault fracture zones and in sandstone and siltstone beds of Mazeras Formation. Gossanous materials and geochemical lead anomalies are inferred to have been formed in the processes of residues and precipitations of iron or heavy metallic elements decomposedly formed by weatherings of such fracture zone clay and rocks, associated with pyrite disseminations, as the above, then, those are likely evaluated to could produce irresponsibilities of showing of the underground occurrence of lead-zinc-barite ore veining mineralizations.

The results of soil-geochemistry have represented lead and zinc anomalies, inferred to have been shown by an accumulation of those, associated with ferruginous concretions in overburden soils of limestone beds of Kambe Formation, copper anomalies, which could be influencedly revealed by the occurrence of shale beds with relatively high content of copper in Mtomkuu Formation, and overlappedly shown barium-sulphur anomalies, north-southerly extended, in sandstone beds of Middle Member of Mazeras Formation. The former two anomalies are inferred to unlikely be influencedly shown directly by the mineralization occurrence, meanwhile, a relation between geochemical anomaly showing and mineralization occurrence is still obscure.

(2) Recommendations

Implementations of consecutive exploration works in Jibana Area are unlikely evaluated to be deserved to warrant.

Occurrences of pyrite-disseminated rocks in Jibana Area are unlikely estimated to be directly resposible to providing a showing of the occurrences of lead-zinc-barite ore veining mineralizations. Since, however, pyrite-disseminations, the above, are possibly inferred to have been formed by hydrothermal activities, which could have taken place nearby Karroo-Jurassic Fault, that could have a relation to ore mineralization, then, the Area is evaluated to could still pose a considerable geological potential of mineral occurrences. Implementations of steady further examinations to specify new ore showing in the Area are considered to be required in future.

It is to be noted that geological identifiable distinction of weathered products between pyrite-disseminated materials and ore-mineralized materials would be significantly required in future works in the Area. Occurrences of silicification, mineralized fine veins, type of geochemical anomalies should be, therefore, carefully studied in the future course of detailed geological and geochemical research works prior to an establishment of diamond drill programming.

5-2-3 Ribe Area (Semi-detailed and Detailed Surveys)

(1) Conclusions

Ribe Area is situated at directly southwestern proximity of the Kinagoni lead mine, currently in mining operation, and includes Changombe Ore Showing, ever known, and Ribe Mineralized Zone, newly discovered by the current work. Ribe Area is likely evaluated to be reasonably potential of the occurrence of ore veining mineralization on the bases of following geological features.

i) NE-SW directional faults, which are estimated to have geological relations of significance to the forming of lead-zinc-barite ore veining mineralization, are well-developed in the Area.

ii) NW-SE directional faults, which intersect to NE-SW directional faults, are also well-developed. Those frequent fault intersections are widely observed in the Area to likly provide a favourable field of the activities of mobilizations of hydrothermal mineralizing materials.

iii) Common strike/dip values of the sediment bedding in the entire Project Area usually show NE/gentle dip toward SE. However, 64 percent of the strike/dip values in the total show to be deviated from the commonness to provide a geological assumption that a geological disturbance in the Area could be considerably intense.

iv) Regionally, Ribe Area and further toward the Kinagoni mining district is situated at a geologically unique field, where the geological structure of NS trend, dominantly observed in northern Project Area, and that of NE-SW trend, dominantly observed in southern Project Area, show a geological encounter.

Chemical assay results of altered rock specimens in Ribe Mineralized Zone generally show limited values of the accumulation of metallic elements of geological significance.

Soil-geochemistry results show silver anomalies of 0.2 to 3.3 ppm, lead anomalies of 88 to 718 ppm and zinc anomalies of 766 ppm in Changombe North and Changombe South Ore Showings.

One diamond drill hole, 150 m deep, was operated in Chiume Hill Mineralized Zone, meanwhile, three holes, 450 m deep in total, were in Ribe Mineralized Zone.

Chiume Hill Mineralized Zone is likely evaluated by the results of the current drill works that the Zone could not provide a downward underground extension of geological significance as shown on ground surface in a form of discontinuous outcrops and floats of mineralized materials of small scale.

Pyrite-disseminated silicified rock beds, which are estimated to represent downward extensions of silicified rock outcrops on ground surface, and abundant fault fracture zones with intense pyrite disseminations have been encountered by

the drill holes of the current programme in Ribe Mineralized Zone. Occurrences of barite fine veins, less than 5 mm wide, are observed by unaided eye in open cracks in silicified rocks. Fault fracturing occurrences, such wall rock alterations concerning to ore mineralization as silicification and pyrite disseminations, and barite fine veins occurrences, are likely evaluated that the Ribe Mineralized Zone could pose a geological possibility to provide a field of lead - zinc - barite ore veining mineralizations, however, the current situations are with a lack of economical significance of ore forming to be associated with sphalerite, galena and etc..

(2) Recommendations

Implementations of consecutive exploration works in Chiume Hill Mineralized Zone and nearby are unlikely evaluated to be deserved to warrant since that the extensions of mineral occurrence of geological significance on ground surface and deep underground in the Zone have been revealed by the current works to be limited and little extended.

Implementations of consecutive exploration works in Ribe Mineralized Zone, where three diamond drill holes have been operated by the current works, are unlikely evaluated to be deserved to warrant. However, the Ribe Mineralized Zone environs are still evaluated to be one of the potentially promising targets of future mineral exploration to be required, since silicified zones, where scrutinized examinations of mineral potentials have ever insufficiently made, are scatteredly known. In accordance with the experiences of the current works, the occurrences of ore minerals of economical significance are to be carefully studied in the progresses of detailed geological and geochemical future works, which are to be implemented prior to an establishment of future drill programmes, for an objective to necessarily exclude unpromising barren silicified zones from the future drill exploration targets.

5-2-4 Mkangombe Area (Semi-detailed and Detailed Surveys)

(1) Conclusions

Mkangombe North OreShowing, which is inferred to have been formed under a structural control by faultings, is comprised of copper - lead - zinc - quartz ore veining mineralizations. The Showing shows a strike/dip value of N25° - 30° E/55° - 70° SE, more than 300 m long and 0.2 m to 1.5 m wide. An occurrence of precious metals in the showing is limitedly observed.

Abundant occurrences of outcrops and floats of quartz veining ore, extended N45° E directionally to connect Mkangombe North and Mkangombe South Ore Showings, are widely observed to form a quartz veining ore mineralized zone, more than 10 km long.

Soil-geochemical anomalies in the Area are scatteredly shown to provide an inference of the showing of limited connection with mineralization occurrence. Those are inferred to have been caused partly by a localization of wall rock alteration in the Showings and partly by inevitable allocations of sampling site of soil-geochemistry with considerably long spacing.

Two diamond drill holes, 200 m deep in total, were operated in Mkangombe North Ore Showing.

It has been shown by the results of diamond drill exploration works that the mineral occurrences in deep underground have been revealed with more encouragements of mineral potential than those on ground surface to foster future prospects of mineral occurrences of significance. The occurrence of a massive sphalerite ore vein, 24 cm wide, encountered by Hole MJKM-8, is likely evaluated to be an emboldening showing that furthers future mineral potential prospects of economical significance in the vicinity.

A new occurrence of outcrops and floats of quartz ore veins in the vicinity of Mkangombe South Ore Showing, associated with copper minerals, has been revealed by a geological reconnaissance work, carried out in accordance with the progress of drill works. The new occurrence is likely evaluated to offer a mineral potential, associated with quartz veins in the zone.

(2) Recommendations

Two drill holes, implemented by the current programme have been allocated about 30 metres apart, while, barely enough to establish an ore intersection to the depth about 60 metres below ground surface. It is to be reminded that the current diamond drill works have established a limited mineral exploration coverage in Mkangombe North Ore Showing area, then, additional future diamond drill works with reasonable scale and quantity are recommended to be consecutively implemented.

Implementations of consecutive detailed geological reconnaissance works in quartz veining mineralized zone are recommended to fulfill a coverage by those mapping in the areas, where detailed work have limitedly been carried out. Those works are to be targeted to eventually decide further prospects of trench pitting or diamond drill and potentially lead to a new discovery of mineral occurrence of significance.

The current programme works in Mkangombe Area are to be recognized to have initially provided a springboard of the exploration activity of base metal minerals in the inland area in the district of Mombasa, otherwise such past activities have been prone to be emphasizedly implemented targeted on lead-barite ore mineralizations in coastal areas. Implementations of consecutive future works for such objectives are likely considered to be deserved to

warrant.

5-2-5 Mrima-Jombo Area (Semi-detailed and Detailed Surveys)

(1) Conclusions

Three types of mineralization, as shown below, are observed in Mrima-Jombo Area.

i) Niobium and rare earths elements (REE) mineral showing, associated with carbonatite plugs.

ii) Mineral showing of precious and base metals.

iii) Mineral showing of iron and manganese.

The current works have been carried out for the objectives of the eluciation of mineral occurrence extensions of the type 1, the above, and of the scouting up of the mineralization of type 2, the above.

It has been shown by the results of soil-geochemistry that geochemical anomalous zones of significance of niobium and REE were shown nearby the carbonatite plugs in Mrima Hill, where niobium-REE mineralizations have ever been known, meanwhile, those of small scale were also shown in Kiruku Hill.

Geochemical anomalous zones in Kiruku Hill area are shown in two locations, namely, in Kiruku Hill crest and in north-eastern part of the crest. Silicified rock beds are observed in the geochemical anomalous coverages. The geochemical anomalous zones are likely extended in superimposed accordance with distributions of silicified rocks. Mineralizations of niobium and REE in Kiruku Hill area are possibly inferred to have been formed in association with rock silicifications as likely supported by the chemical assay results of rocks. Extensions of geochemical anomalous zones and silicified rock zones show a coincidence with those of faults in the area to lead to a geological inference that the mineralizations in the area have likely been formed under a structural control by faultings. Thus, the mineralizations in Kiruku Hill area of niobium and REE, associated with precious and base metallic elements, are likely estimated to have been formed in accordance with progresses of the formings of silicified rocks by hydrothermal activities, which could have taken place along the faults of NW-SE to WNW-ESE directions. The mineralizations have ever been possibly assumed initially by the second-year works to have been formed in connection with agglomerate activity, however, a direct connection to the above is likely reassumed currently to be poor or unfounded.

The general extent and quality of niobium-REE mineralizations in Kiruku Hill is likely evaluated to be smaller than those in Mrima Hill. This could possibly be caused by a difference of geological genesis of the forming of mineralizations between the above two occurrences that the former is associated with silicified rocks, while, the latter is with carbonatite bodies.

Geochemical anomalous zones of significance of niobium and REE have never been shown in Nguluku Hill area. The occurrence of electrum and galena has been reported by Caswell, 1953, however, those have never been selected for an encouraging target of mineral exploration in the vicinity.

(2) Recommendations

Implementations of consecutive exploration works in Mrima-Jombo Area are likely evaluated to be limitedly required in future, since general extension and quality of niobium and rare earths elements mineralizations in Kiruku Hill, which are estimated to have possibly been formed by a different mode of genesis from that in Mrima Hill, are evaluated to be smaller than those in Mrima Hill, which are possibly estimated to have been formed by weathering of carbonatite bodies.

Implementations of research works for academic interests in the mode of occurrences of niobium and rare earths elements minerals and in secondary enrichment in silicified rocks are possibly required, since the mineralizations in Kiruku Hill, possibly associated with silicification, could pose a particular geological interests concerning to an unique field of mineralization. Regional research works of the extensions and relations to geology and geological structure of hydrothermal activity in the Area, that could have caused silicification to rocks, are considered to be one of research themes, which could lead to a possibility to specify hydrothermal ore mineral occurrences of varied types.

PART II DETAILS OF SURVEY WORK

CHAPTER 1. OUTLINED SURVEY WORK AREA

1-1 General Geology

General geology in the entire current Project Area and representative geological profile sections in the Area are shown in Figures 1-1 and 1-2, respectively. The attached coloured geological map, 1 to 200,000 scale, summarily shows the geological research results in the Project Area by the current works in basic reference to the existing 22 geological map sheets of 1 to 50,000 scale, implemented by the Kenya-UK Mapping Project.

General geology in the Area is briefly characterized by being chiefly occupied in most part of the Area by the sediments of Permian-Triassic to Quaternary ages, while, alkaline igneous rocks are minorly associated with those in southern part of the Area.

The sediments in the Area generally show a flat or gently-dipped structure and are geologically divided in such three groups as Duruma Group, Jurassic-Cretaceous sediments and Cenozoic sediments in ascending order.

Duruma Group, which is estimated to be correlated to the Karroo System in South Africa, chiefly consists of terrestrial-lacustrine sandstone and shale beds of Permian to Triassic ages, which are uncommonly intercalated by marine sediments. Duruma Group is characterized by being composed of the clastic materials of metamorphic rocks of the Mozambique System, which covers an enormous sedimentary basin inside of the Gondwana land.

It is considered that rift movements in the Area might have been initiated in early Jurassic age, subsequently been followed by a marine transgression, to form marine sediments after the middle Jurassic age. The marine sediments, chiefly composed of limestone, shale and sandstone beds, are estimated to have been formed during the epoch from middle Jurassic to early Cretaceous ages with some sedimentary intermissions.

Cenozoic sediments in the Area are chiefly composed of Miocene, Pliocene-Pleistocene and Holocene series. Miocene series chiefly consists of sandstone beds, intercalated by limestone and shale beds. Pliocene-Plistocene series is chiefly composed of fluviatile sediments, aeolian sediments, such as sand dunes, and/or coral reefs and derived clastic materials, to be observed along river streams and coastal shores. Holocene series is comprised of colluvial and alluvial beds.

Major fault activities-rift movements in the Area are estimated to have taken place at an epoch prior to the sedimentation of Jurassic System piles. Those activities-movements are considered to have furthermore been reactivatedly reiterated in Cretaceous and Pliocene ages. The Jurassic sediments were formed to unconformably cover a subsided block of the lift movement, namely, the sea-

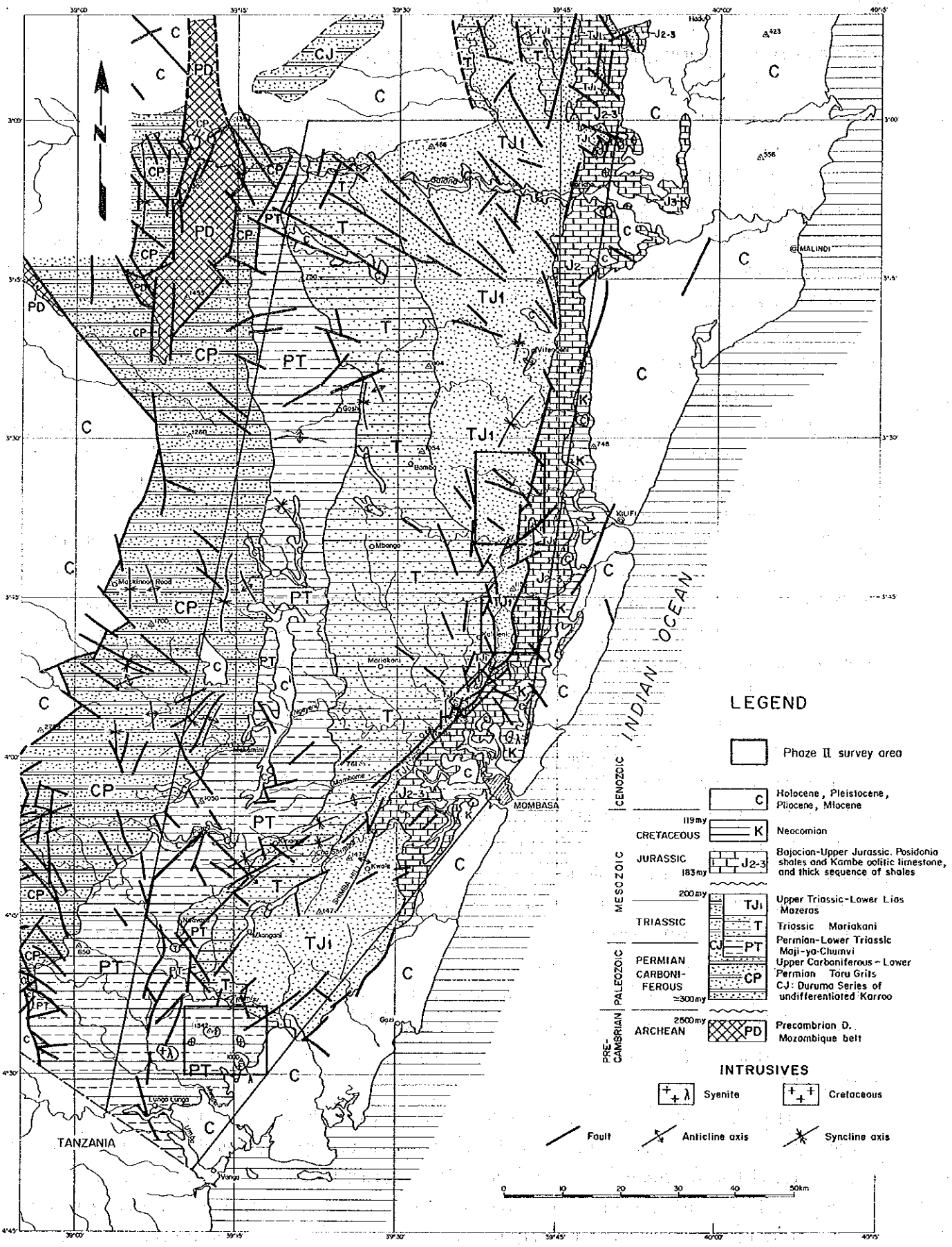

Figure 1-1 Generalized Geological Map of the Mombasa Area

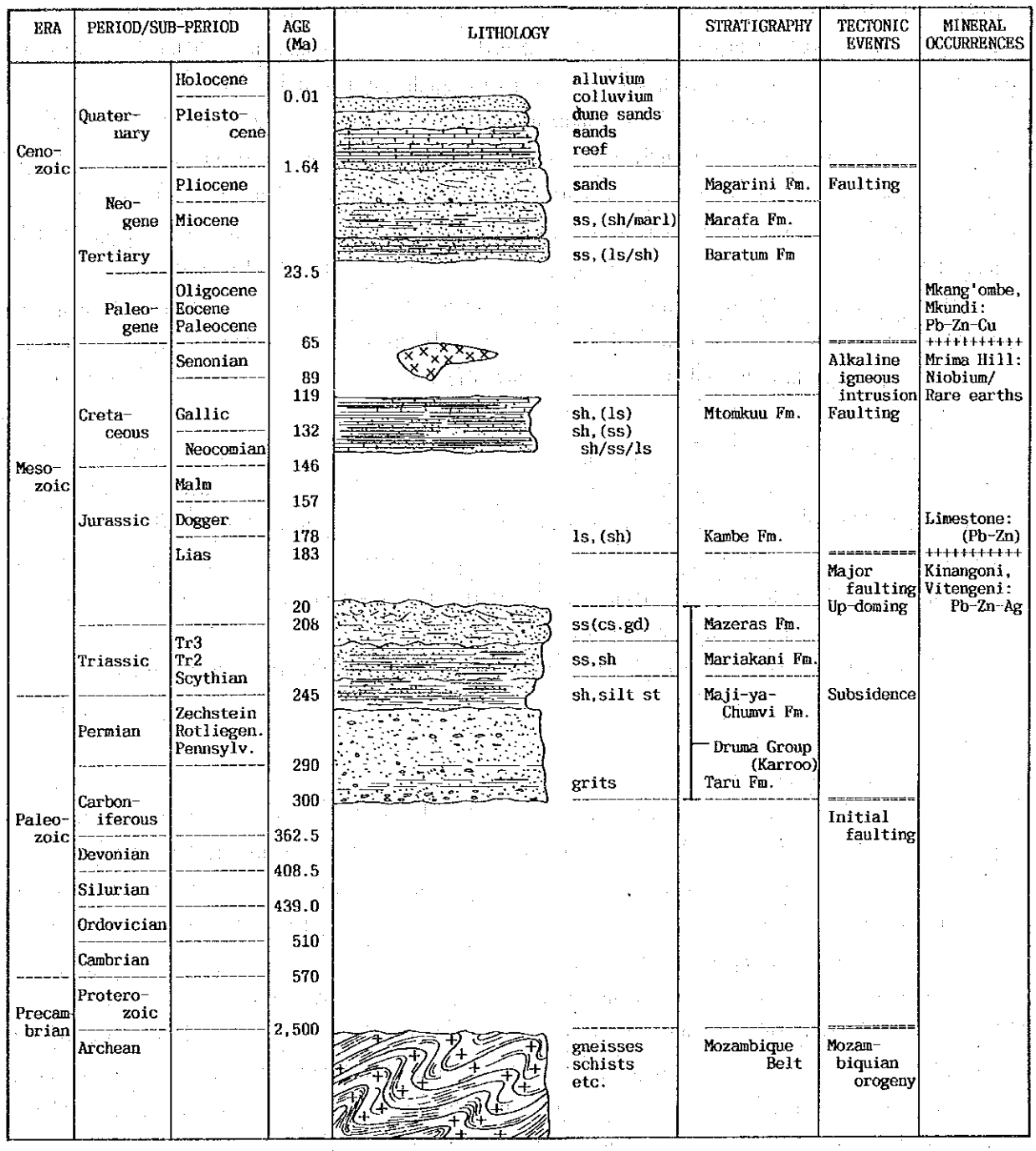

Figure 1-2 Geological sequence of the Mombasa area

shore-sided block currently in the Area.

Alkaline igneous rock activities in the Area are considered to have taken place concurrently with the fault activities in late Mesozoic age to show modes of such intrusive occurrences of varied types, as plutonic plugs, volcanic vents, dikes and etc., which are associated with carbonatite bodies.

Mineral occurrences of significance in the Project Area, such as niobium-rare earths elements ore mineralizations, associated with carbonatite bodies, represented by the Mrima Hill occurrence and lead-zinc-barite ore veins, considered to have been formed in connection with Karroo-Jurassic Fault activity of pre-Middle Jurassic age, and ore showings are known. Lead-zinc-barite ore veining mineralizations and showings, represented by the Kinagoni mine in current mining operations, are widely observed in the Project Area in connection with Karroo-Jurassic Fault occurrences.

1-2 Respective Geological Units

Duruma Group is divided in Taru Formation, Maji-ya-Chumvi Formation, Mariakani Formation and Mazeras Formation in ascending order, while, Jurassic-Cretaceous System is in Kambe Formation and Mtomkuu Formation in ascending order, while, Tertiary System is in Baratum Formation, Marafa Formation and Magarini Formation in ascending order.

Followings are the brief descriptions of the respective geological units.

1-2-1 Duruma Group

(1) Taru Formation

Taru Formation chiefly consists of thick-bedded debris flow sediments, gray, coarse-grained and poor-sorted. The Formation is characterized to of a representataive type of glaciogene sediments, which possibly mark an initiation of the sedimentations of Karroo System, widespread in central and southern Africa, in Permo-Carboniferous times.

The basal part of Taru Formation is significantly composed of tilloid beds-pebbly mudstone beds-, which are inferred to be derivedly related to glaciations in Carboniferous epoch in Gondwana land. The basal part is successively overlain by the piles of conglomerate, pebbly sandstone and arkose beds, which are intercalated by thin shale beds, uncommonly by limestone beds, to show an upward grading to be finer.

Taru Formation is furthermore devided in such three members as Upper, Middle and Lower Members. The Upper Member is chiefly observed in western hem of the Outlined Survey Work Area.

(2) Maji-ya-Chumvi Formation

Maji-ya-Chumvi Formation overlies Taru Formation conformably and/or weak-unconformably (Caswell, 1953). Maji-ya-Chumvi Formation is divided in such three members as Upper, Middle and Lower Members. General manner of the grading of the Formation is different from that of Taru Formation to show an upward grading to be more coarse. Namely, Lower and Middle Members are generally dominated by shale and siltstone beds, while, Upper Member is by sandstone beds. Shale bed of marine sedimentation with abundant quantity of nodules with piscine fossils, where the demarcation of Permian and Triassic periods is to be established, is observed at the lowest part of Middle Member. A high content value of salt has ever been reported in shale beds of Lower Member to pose a sedimentary possibility under arid environmental condition. "Maji-ya-Chumvi", as the name of the Formation, means "saline water" in Swahili language.

Sandstone beds in Upper Member are massive or are comprised of silty sandstone beds with flaggy texture, well-developed joints, cross-laminations, ripple marks, slumpings and etc., to specifiedly show a particular sedimentary condition. Upper Member also poses a sedimentary condition under fresh water, namely, nearby deltas or lacustrine.

(3) Mariakani Formation

Mariakani Formation conformably overlies Maji-ya-Chumvi Formation and is divided in such three members as Upper, Middle and Lower Members. The Formation is chiefly comprised of sandstone beds, massive with well-developed cross-beddings, and is intercalated by silty fine-grained sandstone beds with cross-beddings and well-bedded micaceous shale beds. An occurrence of upward grading to be more coarse with several cycles has ever been reported by Cannon, 1978.

Sandstone beds of the Formation are remarkably characterized by carrying distinct white mottles, 2 to 5 mm diameter, to readily distinguish these from those in different Formations. The Formation is considered to have chiefly been formed under a sedimentary environment of alike deltas, to show an easterly increase in total thickness of the beds, 2000 metres thick in maximum.

(4) Mazeras Formation

Mazeras Formation occupies the uppermost horizon of Duruma Group and unconformably covers underlying Mariakani Formation. The Formation is chiefly comprised of arkose and grit beds, massive and with cross-beddings. The Formation is divided in such three members as Upper, Middle and Lower Members.

Lower Member is chiefly composed of white arkose beds, fissile and medium- to coarse-grained, which are overlain by fine-grained sandstone beds. Cross-bedding structure is distinctly observed in arkose beds, while, overlying

sandstone beds are intercalated by thin shale and mudstone beds.

Middle Member is chiefly comprised of sandstone and arkose beds, intercalated by shale and mudstone beds. The lowermost of the Member is demarcated by an occurrence of petrified woods. Upper Member, widely extended in Shimba Hill district, is chiefly composed of coarse-grained arkose beds, massive and with cross-bedding structure, and is intercalated by poor-bedded grit and lenticular mudstone beds. Grit beds commonly carry sub-rounded quartz grains, granule- to pebble-sized, reaching to be some 5 cm long.

Sandstone beds of Mazeras Formation are commonly observed in hilly regions, which are extended in parallel with the coast line of the Project Area, meanwhile, the eastern extensions of the beds are mostly terminated by fault (Karroo-Jurassic Fault), where the beds form a geological contact to the overlying limestone beds of Kambe Formation of Jurassic age. A transitional rock facies, such as calcareous sandstone, sandy limestone and occasionally microlitic limestone beds, are observed at the contact of Mazeras and Kambe Formations, where fault activities were inactive.

1-2-2 Jurassic- and Cretaceous-aged sediments

(1) Kambe Formation

Kambe Formation chiefly consists of limestone beds. The formation has been reported to overlie the Mazeras Formation conformably in parts, meanwhile, unconformably in other parts. However, the above two Formations are so far observed to be in contact relations with faults on ground surface by the current works. Fault scarps by rift movements are inferred to have been formed after the sedimentations of Kambe Formation to demarcate the western hems of the Formation.

Boulders of sandstone, 1 m long, and granules of the rocks, presumably derived from Mazeras Formation, are observed in the lowermost part of Kambe Formation. The pebbly limestone beds are massive and oolitic, and are associated with abundant quantity of muddy materials. Limestone beds, which overlie the above basal pebbly limestone bed, are divided in three types of rock facies as follows:

a) Facies of calcareous gray mudstone or limestone beds with accidental materials. With a lack of fossil yields generally. Well-bedded generally and intercalated by thin shale beds. Occasionally massive.

b) Facies of gray muddy limestone beds and rich in fossil yields.

c) Facies of oolitic pale gray limestone beds, associated with pisolites and argillaceous pellets.

Varied types of fossils, such as ammonites, corals, crinoids, brachiopods, gastropods, polyzoa and etc. are carried in Kambe Formation. These fossils have been reported to designate the Formation to be of the Bajocian to Bathonian of middle-Jurassic age (McKinnon-Wood, 1930, 1938). An environmental condition of sedimentation of the Formation is inferred to be neritic under tropical warm climate.

(2) Mtomkuu Formation

Mtomkuu Formation is estimated to have been formed in more expanded oceanic emplacement during the epoch from late Jurassic to Cretaceous ages. The Formation chiefly consists of the alternations of sandstone and mudstone beds, which are minorly intercalated by sandstone and limestone beds. Pebbles and boulders of sandstone and limestone, which are inferred to be derivative from the precedingly formed sandstone and limestone in Mtomkuu Formation, are observed in shale beds.

The Formation is divided in such three members as Upper, Middle and Lower Members, meanwhile, such memberings are not established yet in Galana River basin region in northern part of the Project Area. Thin sandstone beds in Lower Member show well-developed cross-bedding structure to likely provide a genetical implication to have been formed nearby deltas or estuaries.

1-2-3 Cenozoic-aged sediments

Neogene-Tertiary System in the Project Area is observed in southwest of Kaloneni, Mombasa environs and east/south of Mrima Hill and is comprised of Baratumu Formation and Marafa Formation of Miocene-Tertiary and upper member of Magarini Formation of Pliocene-Tertiary in ascending order.

Baratumu Formation chiefly consists of sandstone beds and is associated with limestone and shale beds. Marafa Formation is chiefly comprised of sandstone beds and is associated with shale and marl beds. Magarini Formation, extended along the coast line in the Project Area, chiefly consists of unconsolidated sand beds, which are considered to be erodedly formed from Mazares Formation. The Formation is chiefly composed of sands, rich in iron content, and kaolin clay. Outliers of Magarini Formation of limited scale to cover Mtomkuu Formation are observed.

Pleistocene series of Quaternary System is observed nearaby Mombasa and is comprised of coral reefs and detrital sediments and sand beds. Holocene series consists of colluvial and alluvial sediments.

1-2-4 Igneous rocks

The type of igneous rocks in the Project Area is of alkaline igneous rocks.

Abundant number of small intrusive bodies into Duruma Formation are observed in Mrima Hill - Jombo Hill area in southern part of the Area, meanwhile, a couple of bodies, intruded into Mtomkuu Formation of Cretaceous age, is also known in Galana River basin region, north - eastern corner of the Project Area.

Carbonatite bodies are observed in Mrima Hill area, while, alkaline rock complex of nepheline syenite, foyaite and melteigite bodies is in Jombo Hill area. Agglomerate bodies are distributed in Kiruku Hill and Nguluku Hill areas. Intrusive lamprophyric rock bodies, chiefly composed of sannite, camptonite, monchiquite and etc., less than serveral metres wide generally, are widely observed in Mrima Hill - Jombo Hill area. Parts of rocks of Duruma Formation have been subjected to fenitization by alkali metasomatism in connection with the above alkaline rock intrusions.

Igneous activities in Mrima Hill - Jombo Hill areas have been reported by Walsh (1969) to be geochronogically difined as of Cretaceous age to lead to a possible concept that those igneous activities could have taken place in connection with the development or reactivation of the rift movements in Gondwana land.

The details of igneous rock facies are shown in the following section, 2 - 5 Mrima - Jombo Area, CHAPTER 2, PART Ⅱ .

1 - 3 Geological Structure

The geological structure of the most significance in the Project Area is noted to be of the occurreces of normal faults, which are developed in parallel with a configuration of the coast line in the Area. The normal faults are developed in Duruma Formation - covered area to dislocate that eastern block subsidingly. General dip angle of the faults shows nearly vertical mostly or steep eastward. General strike of the faults is somewhat curvedly extented, gently jutting eastward at Mbuyuni, Jibana area, where the semi - detailed survey work by the current programme has been implemented, to show NS to NNE - SSW directional in the district further north from Mbuyuni and NE - SW to NNE - SSW directional in the district further south from Mbuyuni.

The normal faults are characteristically observed along the geological boundary of Mazeras and Kambe Formations to be designated by Bugg, S.F. (1982) as "Major Fault Zone" or as "Karroo - Jurassic Fault Zone".

The fault movements are inferred to have been activated significantly before middle - Jurassic age, since the marine sedimentation of Kambe Formation on subsidingly dislocated blocks might have then been initiated in middle - Jurassic age. The major faults development is considered to could pose a geochronological significance of the initial rift movement that could have enhanced the separation of the Gondwana land, and thus a sedimentary