4–2–2 Geology of Buru Hill environs

General geology in the Buru Hill environs is shown in Figure II–4–1 (Phase–1 Report, 1988). General geology of the Buru Hill Area is mostly composed of granitoid gneiss, ores considered to be originated from volcanic agglomerate, sparse occurrences of dikes, overburden and etc..

The Buru Hill is considered to be formed by an intrusion of carbonatite, however, its geological features and structure, other than showings of lateritic overburden, ferruginous veins, siliceous veins and dikes and gneiss on the ground surface, are still unknown in details.

4–3 Results of Geological Survey

4–3–1 Geology

Geological Map and Geological Cross Sections of the Buru Hill Area arw shown in Plate-1 and Figures II–4–2, II–4–4 and II–4–5. General geology in the area is composed of gneiss of basement, fenitized rock, siliceous breccias, carbonititic rock, ore veins, volcanic rock, lateritic rock, surface weathered rock and etc.. Details are shown below in accordance with rock classifications in the geological map.

(1) Amphibole gneiss, amphibole bearing gneiss (P – mg^a)

Amphibole gneiss and amphibole bearing gneiss, associated with other types of gneiss, forming the basement rocks in the area, are observed in north-eastern and north-western portions of the Buru Hill and also in south-eastern portion of the area. They are viridescent to greyish green, and have gneissose texture and/or schistosity, assoiated with green-chloritized or epidotized amphiboles and felsic minerals. They also show a amphibolite-like facies due to a partial abundant concentration of amphiboles. They are considered to be originated from intermediate to basic intrusive rocks.

(2) Granitoid gneiss (P – mg^2)

Granitoid gneiss occupies a major body of the basement, which widely occurres in the Buru Hill area and its environs. It also occupies a western foot of the Buru Hill in the area. It is greyish white and shows an evident gneissose texture, felsitic and with little ferro-magnesian minerals. A small amount of mica minerals, biotite mostly, is partially observed in it in north-western portion of the Buru Hill.

A gradual increase in mineralization effects, resulted in frequent occurrences of fine vesins and/or networks of iron oxide in the rock and also in brownish colouring, are observed from hill

Age	Unit	Geologic column	Rock facies	Event
Quaternary			alluvial deposits gravel, sand, silt	
			colluvial deposits	
?			laterite and earthy rock mineralized, secondary enrichment	lateritization
?				
Tertiary	Buru Hill Carbonatite		siliceous ore dyke, vein and brecciated dyke	carbonatite activity and Nb, Y, REE mineralization
			ferruginous ore vein	
			ferrocarbonatite dyke and vein	
			alvikite cone sheet	
			sövite massive intrusive	
			siliceous breccia plug or dyke	
			phonolite plug or dyke	volcanic activiy
			nephelinite plug or dyke	
?			sheared gneiss	shearing
?				
Precambrian	Mozanbique Metamorphic Rocks		granitoid gneiss	metamorphism
			amphibole gneiss amphibole bearing gneiss	

Fig. II – 4 – 2 Generalized Geological Columnar Section of the Buru Hill Area

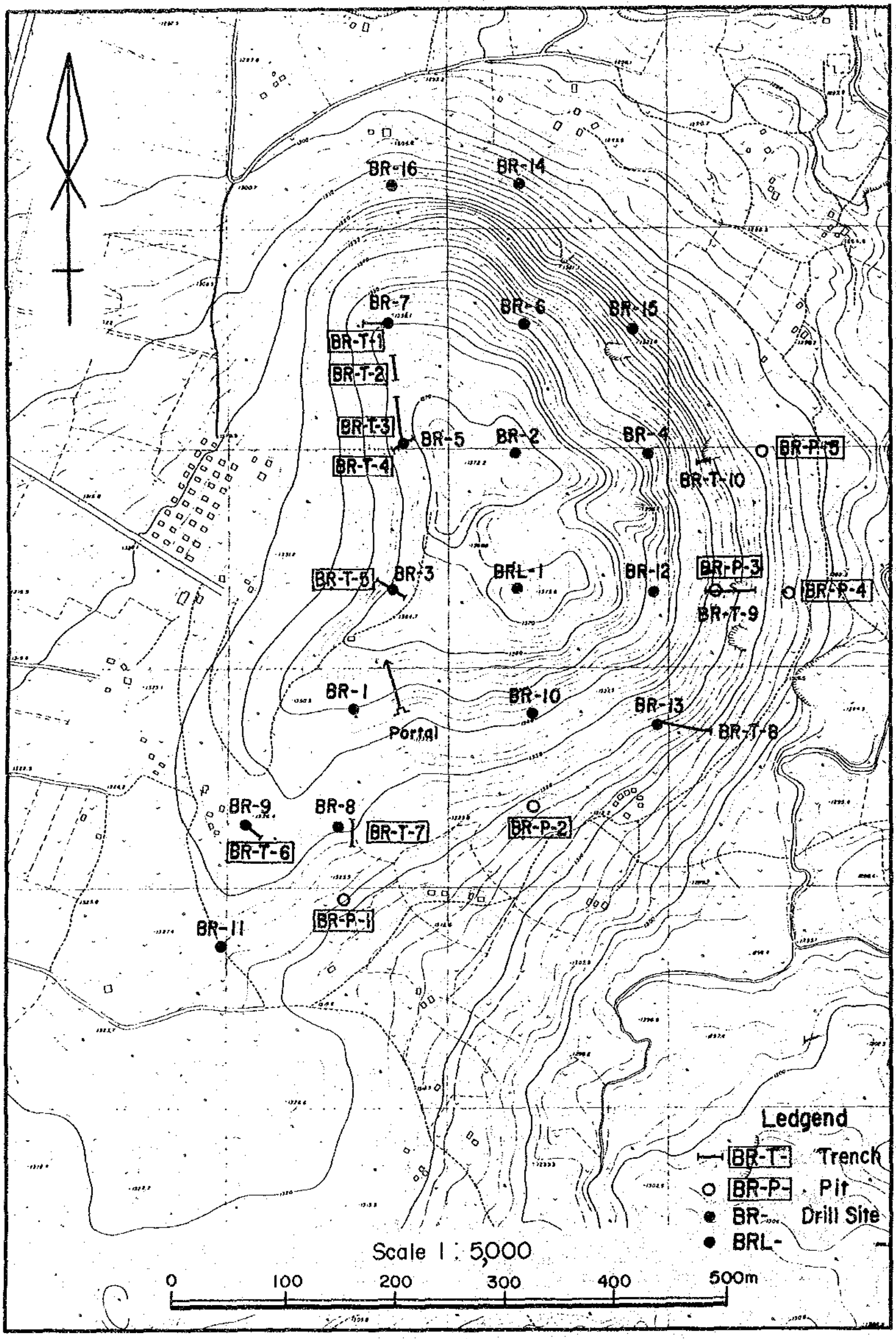


Fig. II – 4 – 3 Location of Trenches, Pits and Diamond Drilling Holes in the Buru Hill Area foot towards hillside. Lateritization of the rock due to weathering, by which an identification of primary rock is less possible, is observed at the crest of the hill.

It is considered to be of granite origin and is regionally correlated to the Mozambique metamophic rocks (Binge, 1962).

(3) Fractured gneiss (P. – mg^3)

Fractured gneiss is observed in the area of east-northeast to west-southwest directional, along the Buru Fault (newly named), which makes a demarcation of the southern end of the Buru Hill. It also occurres in southern portion of the Buru Hill.

It has a facies of fractured felsitic gneiss with fragments of about 5 centimetres in diameter mostly, sparsely less than 1 cnetimetre, and is cemented by fine debris. It is pale brown to pale greyish brown and etc. in a whole and is discoloured to liver brown due to limonite stainings. It should be considered to be formed by a shearing activity concurring with the Buru Faulting.

Fractured gneiss, observed in southern province of the Buru Fault, is mostly composed of the fractured rock with mylonite gneiss breccias, and shows similar facies to that along near to the Buru Fault. Breccias of mylonite gneiss are pale greyish, of well-developed weak schistosity and include fine-graind porphyroblasts of feldspars.

Granitoid gneiss described above are subjected to mylonitization and cataclastization (Binge, 1962). Fractured gneiss is considered to have been undergone under similar conditions. Fractuations might possibly be considered to be caused by the Buru Faulting or shuttering associated with local igneous intrusive activities.

(4) Fractured and silicified gneiss (P. - mg^b)

Fractured and silicified gneiss is observed in south-west of the Buru Hill Area, underlain by fractured gneiss described above in (3). It is characteristic of that it is subjected to intensive silicification, however, shows a similar rock facies to that of fractured gneiss associated with mylonite gneiss breccias described above. It likely shows itself a breccia rock or a tuff breccia in some portion. It is possibly considered that it might be of fractured roof-pendant situated in upper portion of the intrusive rock.

(5) Fenitized rock (P. – mg^b–f^b)

Fenitized rock is observed in small several locations in eastern foot and in western hillside of the Buru Hill. It consists of hard and slightly fractured or granulated gneiss by fractuation, and is widely intruded by green fine veins, possibly aegirine. In general, it presents a limited number of exposures on the ground surface, spotted occurrences of the rock are represented on the geologi-

LEGEND

Qrs_1	Alluvium
Qrs_2	Colluviul deposits
Lt_1	Laterite (hord crust)
Lt_2	Laterite and earthy rock, mineralized
T-vp	Phonolite
T-vn	Nephelinite, Melanephelinite
Os	Siliceous ore (dyke, vein)
Of	Ferruginous ore (vein)
Cf	Ferrocarbonatite
Ca-s	Carbonatite (alvikite, sövite)
Brcs	Siliceous breccia (dyke, plug)
Ᵽ-mg^{f}	Fenitized rock (original rock : gneiss or intrusive rock)
Ᵽ-mg^{b}	Brecciated, silicified gneiss
Ᵽ-mg^{s}	Sheared gneiss
Ᵽ-mg^{g}	Granitoid gneiss
Ᵽ-mg^{a}	Amphibole gneiss, amphibole bearing gneiss
	Mineralized zone (Plane)
	Mineralized basement zone (Section)
	Strike and dip of foliation
	Strike and dip of vein
	Fault : existing, infered (UP) · concealed (low)
	Water level
	Lower limit of strongly weathered zone
BR- BRL-	Location of DDH site (BRL-1, BR-1 to BR-16)
BR-P-	Location of Pit (BR-P-1 to BR-P-5)
BR-T-	Location of Trench (BR-T-1 to BR-T-10)
	Portal (inclined shaft)
A A'	Line of section

LEGEND OF GEOLOGICAL MAP AND SECTIONS
(BURU HILL AREA)

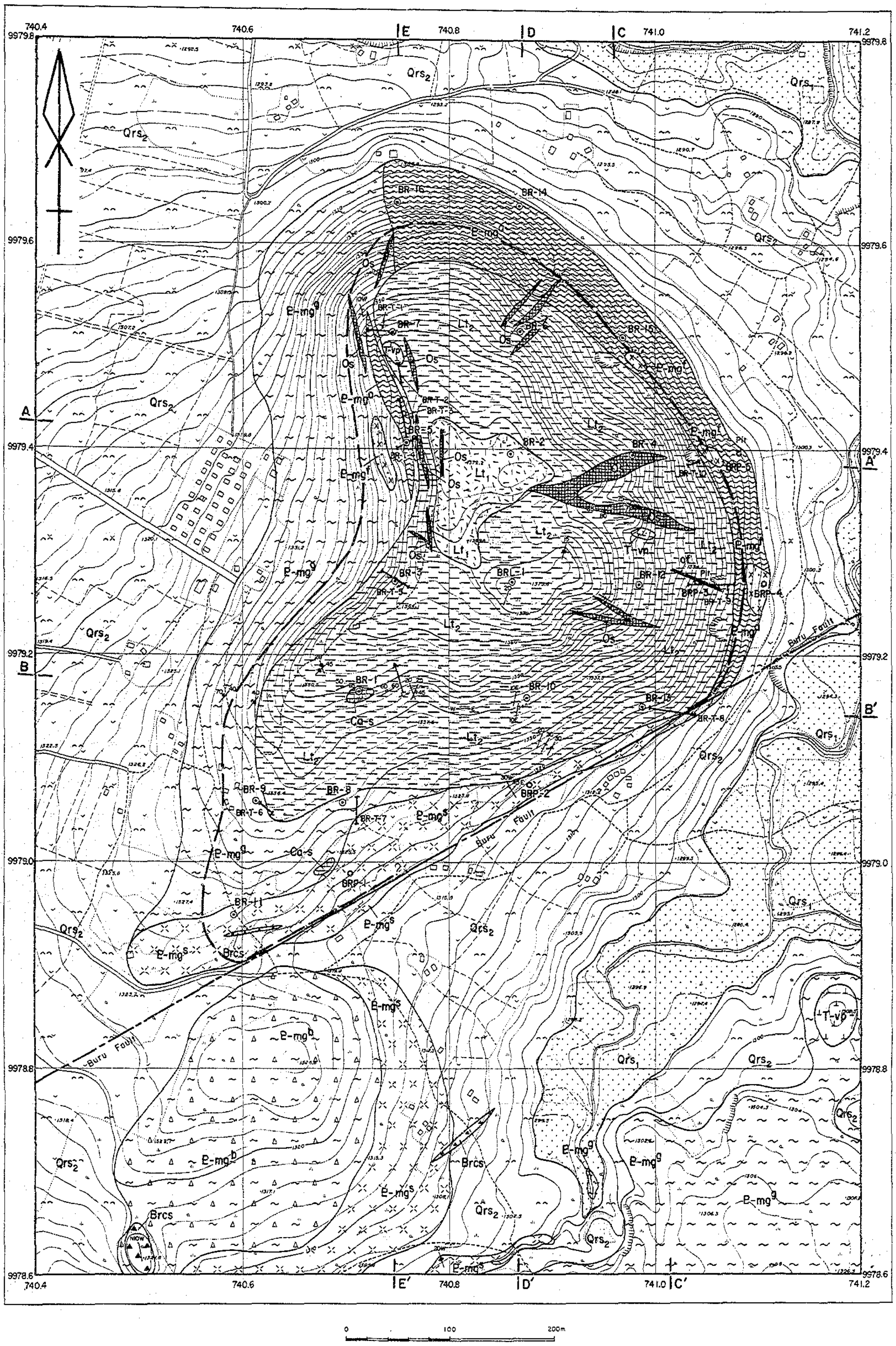


Fig. II – 4 – 4 Geological Map of the Buru Hill Area

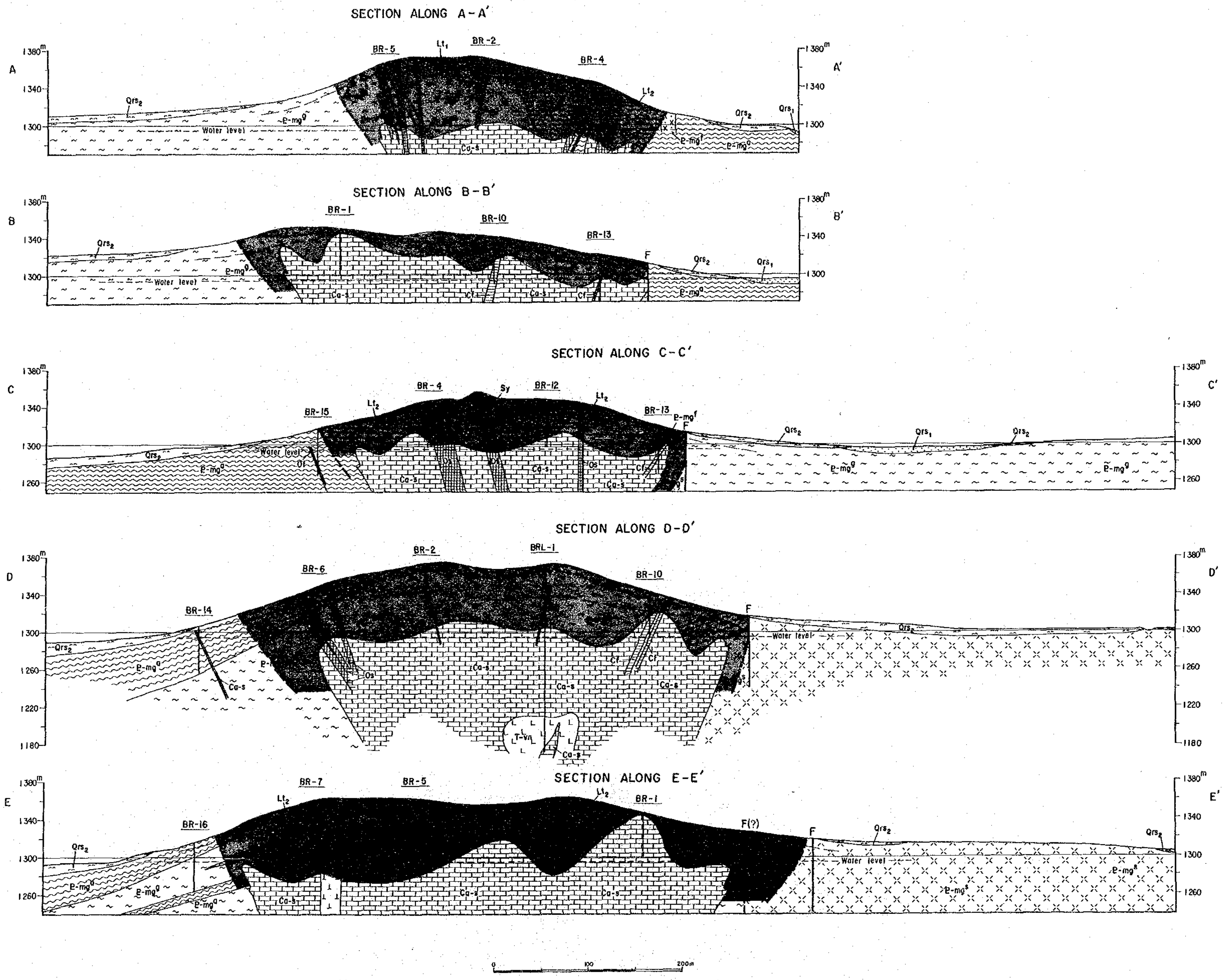


Fig. II – 4 – 5 Geological Sections of the Buru Hill Area

cal map, consequently. However, further wider fenitization of gneiss is possibly presumed in a whole.

(6) Siliceous breccias (Brcs)

Siliceous breccias are observed in the form of volcanic necks of small body in south-western portion of the area and also as dikes in mid-south. They are hard and are composed of abundant mylonite gneiss fine breccias and a brown groundmass of quartz.

(7) Carbonatite (Ca-s)

Carbonatite is observed in a small exposure located in southern foot of the Buru Hill. It is pale greyish, fine and is associated with a small amount of magnetite (corresponds to alvikite).

Carbonatite is frequently discernible in diamond drill cores. Detailes are described below in 4–5–3 and 4–5–4.

(8) Ferrocarbonatite (cf)

Ferrocarbonatite is discernible in diamond drill cores. Details are described below in 4–5–3 and 4–5–4.

(9) Ferruginous veins

Ferruginous veins are observed mostly in lateritic rocks and also in surroundings of gneiss, with random directional behaviours of veins and mostly networks, making mineralized zones and are of less than 10 centimetres wide mostly, less than several ten centimetres in some occasion and 1 metre wide in maximum in Trench BR–T–9 located in mid-eastern portion of the area. The most frequent occurrence of ferruginous veins is observed in the area from daimond drill hole BR–1 toward old inclined-shaft working, where several veins, having a 10 centimetres width each, are observed at an every 1 square metre segment.

They are brown, reddish brown, black, orange-coloured and others and make effects of stainings by limonite in veins environs. Iron ions in minerals are mostly oxidized to be of trivalent by weathering, however, iron minerals show a magnetism in some place due to a remnant of primary magnetite. Extreme weatherings of iron minerals are observed on ground surface, where gossans are mostly discernible. Mineralogical examinations of iron minerals obtained from diamond drill cores were implemented. Details are shown below in 4–5.

(10) Siliceous ore (Os)

Abundant occurrences of siliceous ore as dikes are observed in a northern half of the Buru

Hill area, dominantly in the vicinity from diamond drill holes BR–4 to BR–12, BR–6 environs and from BR–7 to BR–3.

It is very hard and shows an occurrence of a small rise in general, while, jutting two small ridges near to BR–4 are conspicuous.

It is pale-greyish, brown or dark grey, extremely hard and mostly consists of abundant quartz and oxide minerals. Quartz are of chalcedony mostly, oxide minerals comprise themselves goethite, hematite, lepidochrosite, and magnetite. Details of petrological and mineralogical examinations are described below in 4–4.

(11) Nephelinite, melanephelinite (T-vn)

Nephelinite is observed in a form of small stock in northern part of the diamond drill hole BR–12. It is dark greyish, fine porphyritic associated with cloudy fine phenocrysts, feldspathoid presumably and a small amount of mafic minerals with microcrystalline groundmass.

Melanephelinite is observed in the diamond drill cores obtained from the lower portion of diamond drill hole BRL–1. It is green, fine grained and volcanic with an extreme alteration subjection. Details of petrological and mineralogical examinations are described below in 4–4.

(12) Phonolite (T-vp)

Phonolite is observed in two locations in the Buru Hill area, i.e., in south-western portion of the area and in the vicinity of diamond drill hole BR–7 near the Buru Hill.
The former shows dark greenish grey, porphyritic with vitreous groundmass associated with nepheline and feldspar of phenocrysts.
The latter shows viridescent grey with vitreous grondmass, and consists of a small amount of phenocrysts that are clean nepheline and slightly cloudy feldspar and none of mafic minerals by unaided eye.

(13) Laterite and earthy rock (Lt_2)

Laterite and earthy rock are widely observed in the area from mid-hillside toward the crest of the Buru Hill. They are brown, pale brown, weathered and are associated with abundant iron oxides. An identification of the primary rock is hardly possible. Networks of fine iron oxide veins, by which a gentle jutting topography is represented, are well developed in the area. Pisolitic layer, overlain by thin humic soil layer, is rich in iron content, dark brown, ten to several ten centimetres thick and is underlain by extremely weathered earthy rock, several to more than ten metres thick, partially argillaceous, which is intersected by diamond drill holes.

(14) Hard laterite crust (Lt_1)

Hard laterite crust is observed in a flat portion close to the crest of the Buru Hill. It is pale brown or orange-coloured, somewhat vesicular, hard and lateritic. It is breakable into block–wise to be used for construction materials.

(15) Colluvial deposits (Qrs_2)

Colluvial deposits are observed on a gentle slope of the Buru Hill environs. They consist of soil materials and boulders of mineralized materials and gneiss.

(16) Alluvial deposits (Qrs_1)

Alluvial deposits are observed in flat lands along the Raragwit River in north-eastern and south-eastern portions of the area. They are composed of boulders, pebbles, sands and silts.

4–3–2 Geological structure

The Buru Hill is a small hill formed by a carbonatite intrusion essentially. It is elucidated by diamond drill exploration that the carbonatite is a rock mass which has no showing on a ground surface and has a roof of basement rock that is extremely fractured and also mineralized. The Buru Hill, composed of carbonatite and roof, is situated in northern portion of the Buru Fault.

A geological existence of the Buru Fault has been inferred, - locally confirmed -, by the current survey. It is presumed to be of a major fault from the stand point of the mode of fractuation associated with it. The Buru Fault has a strike of N60°E trend and is possibly considered to be extending southwestward to the Kendu Fault (Geological sheet: Kericho; Binge, 1962) or to its branch. The Kendu Fault is considered to be possibly extended toward the Kaniamwia Fault (Report, Phase 1, 1988), which defines the southern demarcation of the Kavirondo Rift.

All of the carbonatite-alkaline rock complex in the Homa Bay Area is distributed within the Kavirondo Rift. The Buru Hill Area is also reasonably considered to be under the structural control of the Kavirondo Rift.

Geological structure of the major rocks observed in the Buru Hill Area is descibed below:

Gneiss of Basement: It shows a north-south trend in general, steeply dipping toward west or east ununiformly. General trend of the rock shows a structural disturbance by a carbonatite intrusion. It frequently shows a northeast-southwest trend in south-western portion of the area, north by northwest to south by southeast trend in the north. Fractured facies, primarily of mylonite gneiss, is observed in south-western portion of the area, where the geological structure is hardly elucidated. Occurrences of fractured gneiss and silicified fractured gneiss inside of that may possibly indicate an existence of an intrusive carbonatite underneath separated from that in the Buru Hill Area.

Carbonatite: Geological structure of carbonatite in a whole is hardly elucidated resulted from insufficient intersections to carbonatite by diamond drill exploration. Each drill hole, other than the hole BRL–1, has made unsuccessful intersections and/or narrow intersections against upper portion of carbonatite. It is envisaged at present that carbonatite in the Buru Hill area has an irregular surface configuration and shows a cone-shaped massive body being narrow downward. Frequent inclusions of basement rock renmants are observed in carbonatite body. It is possibly considered that an upper portion of carbonatite is mostly formed by swarms of sheets and a massive portion of it may be more or less deeply located.

4–4 Results of Petrological and Mineralogical Examinations

4–4–1 Whole rock analyses

Results of the whole rock analyses on forty (40) samples of diamond drill cores are shown in Table II–4. Average values on minerals and rocks are also shown individually. Remarkable features are attained stated below.

Carbonatite : Fe_2O_3 content shows 17.7 %, fairly high. It corresponds itself to ferrocarbonatite (LeBas, 1977). It shows a facies of alvikite or sövite under a microscope and an unaided eye, and is to be classified as the carbonatite of high iron content. Iron content is mostly due to magnetite and siderite. Calcite, occasionally contains a considerable amount of iron, is also identified by semi-quantitative analysis of Electron Probe Microanalyser. P_2O_5 content shows the highest value among the all of rock facies, 3.84 % in average, indicating a feature to be of shallow-type carbonatite, however, it is more or less lower than another type of carbonatite in the world, where phosphorous is operated for major- or by-products.

Ferrocarbonatire : It is characteristic that Fe_2O_3 content shows about 33 %, considerably high and CaO about 20 %, considerably low. Most of the content of iron is to be due to goethite from magnetite and/or hematite.

Calcareous iron ore : It is characteristic that it shows a higher content of Fe_2O_3 and a lower content of CaO in comparison with ferrocarbonatite and also shows a low content of P_2O_5 and an extremely high fluorine. Calcareous iron ore is considered to be of hydrothermal product based on characteristic occurrences of fluorite, crandallite mineral in the form of fine veins.

Manganiferrous iron ore : It is characteristic that it shows a very high content of Fe_2O_3, a very low contents of CaO, P_2O_5 and fluorine. Manganiferrous iron ore frequently poses a difficulty of being distinguished from calcarous iron ore other than that in an occasion having a black luster. However, chemical values show a distinct difference between them.

Siliceous ore : It is mostly composed of silicate and iron oxide minerals. A SiO_2 content shows about 30 %, distinctly different from another rock facies. A Fe_2O_3 content is similar to that of ferrocarbonatite however, a CaO content is about 10 %, considerably low compared with other types of carbonatite.

Alkaline volcanic rock : Detailed rock classification is hardly made under a microscope due to an exteme alteration subjection. Chemical values show a considerably rich content in mafic mineral component. It, consequently, possibly corresponds to nephelinite or melanephelinite.

Figure II–4–6 shows chemical compositional variations of carbonatite and ore samples on SiO_2, Fe_2O_3 and CaO in the Buru Hill Area, as delinerated on a triangular diagram. Rock facies classifications are clearly made by using the diagram. Three carbonatite samples in the field of ferrocarbonatite in the diagram are rich in magnetite. It is considered that Fe_2O_3 content of carbonatite, in which magnetite is discernible by unaided eye, has a chemical character similar to that of ferrocarbonatite.

Figure II–4–7 shows variations of major chemical elements of mineralized rocks and ore samples in the Buru Hill Area.

The figure is delineated after an arrangement of formative succession in chronological order, based on occurrences and mineral components, as stated below.

1. carbonatite (later), 2. ferrocarbonatite, 3. calcareous iron ore

4. manganiferrous iron ore 5. siliceous ore (earlier)

A simply gradual increasing tendency in contents of Fe_2O_3, MnO, Al_2O_3 and SiO_2 from carbonatite toward manganiferrous iron ore, other than siliceous ore, is easily recognizable.

A simply gradual decreasing tendency in contents of CaO and P_2O_5 in the same way above is also similar. A remarkable concentration of fluorine into calcareous iron ore is also recognizable.

4–4–2 Microscopic examinations of ores under polished thin sections

Microscopic observatory examinations under polished thin sections were implemented on twelve (12) samples of calcareous iron ore, manganiferrous ore and siliceous ore. Ores were processed into the form of polish thin sections for the examinations. X-ray power diffractions were supplementarily applied to the minerals that can be hardly identified only by the microscope. Major results are shown in Apendices 3, –7 and –9 below.

Appendix 3 Summary of microscopical observation
– Polished thin sections
– Thin sections

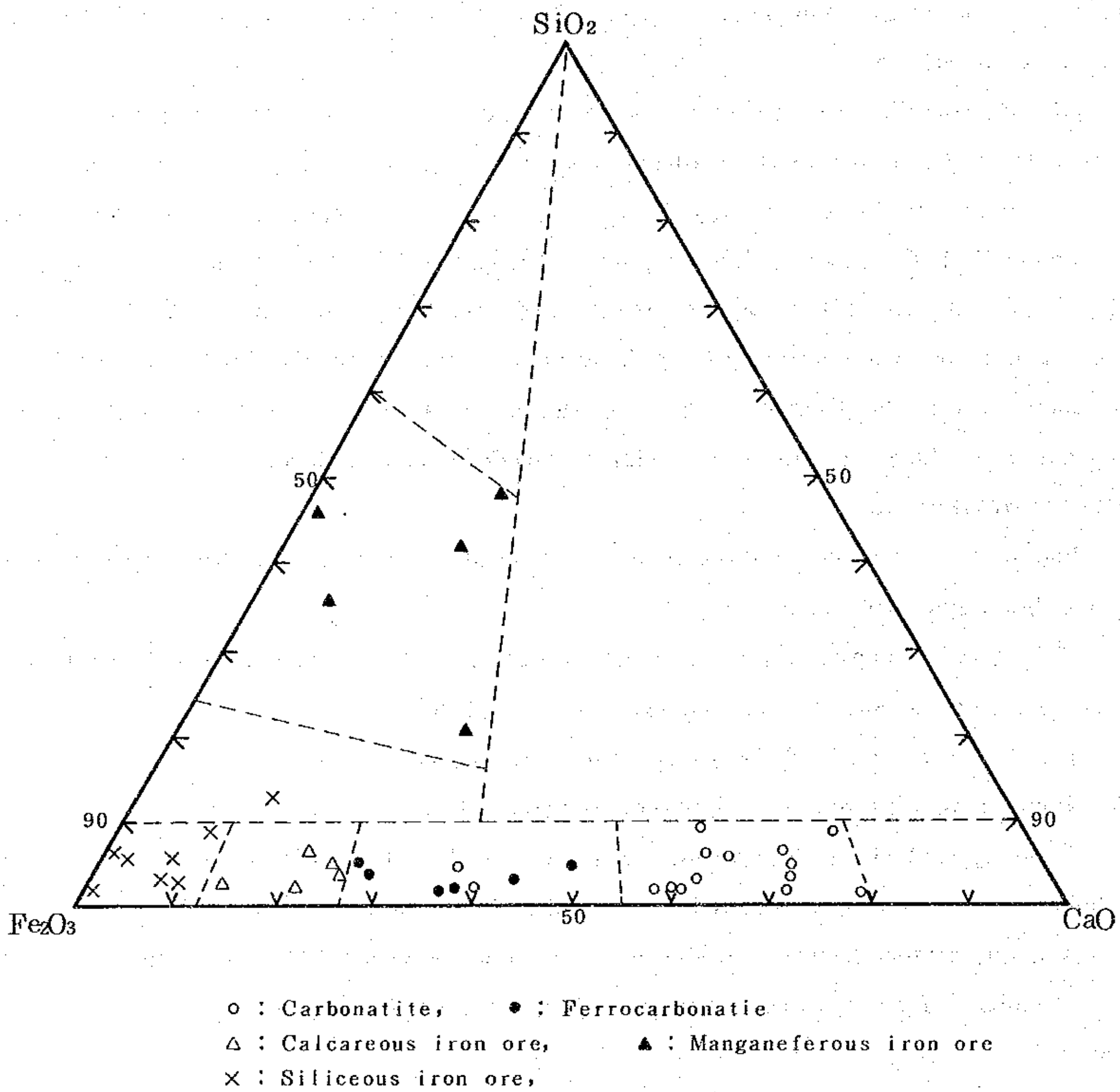


Fig. II–4–6 Variation of the Carbonatites and Ores at Buru Hill on SiO_2 – Fe_2O_3 – CaO Diagram

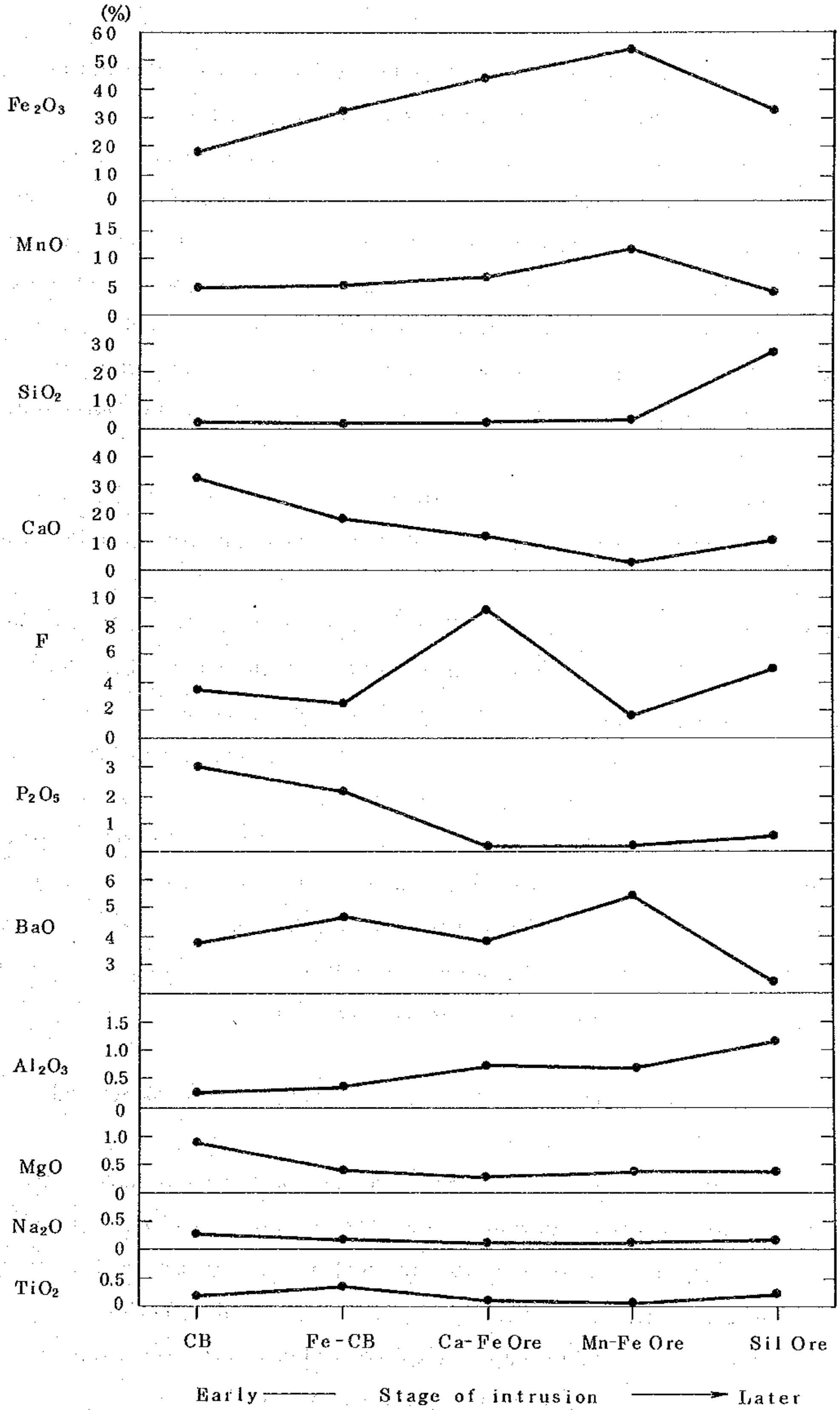


Fig. II—4—7 Chemical Variation of Major Elements of Carbonatites and Ores at Buru Hill

Appendix 9. Microscopic observation of ores under polished thin sections

Appendix 7. Microphotographs under polished thin sections

An abundant amount of goethite, hematite, lepidochrosite and magnetite are discernible in the ores the above, except siliceous ore. They ocuppy major portions of the mineral components. In general, goethite, hematite and lepidochrosite occur as aggregates in the form of pseudomophs of magnetite, or as dendritic forms. Magnetite is discernible in hematite in a form of irregularly granular remnant mineral. It may show an alteration process of magnetite rendered to hematite, taking into consideration with a showing of pseudomorph occurrence. Hematite is replaced by goethite and lepidochrosite, which are produced by lateritization resulted from the weathering.

None of manganese minerals are identified in manganiferrous ore. The major portion of manganese is possibly considered to be contained in manganiferrous goethite associated with goethite.

Siliceous ore is majorly composed of a large amount of quartz associated with iron minerals. Quartz is usually of chalcedonic and normally shows an occurrence of microcrystal aggregates in paragenesis with nontronite, - iron bearing smectite -, and crandallite.

Siliceous ore is possibly considered to be produced on hydrothermal stage of low temperature from the stand point of its paragenesis and occurrence.

Fluorite, bastnaésite, barite and calcite are identified as transparent minerals, associated with quartz, crandallite and nontronite the above. In general it shows an occurrence of intergranular textural components against ore minerals, magnetite mostly, Bastnaésite is discernible in most types of ore and makes itself a major mineral of REE. Crandallite is also generally observed in most types of ore with a possibility of containing REE in it.

4–4–3 Microscopic examination of carbonititic rock, melanephelinite and manganiferrous ore under thin sections

Microscopic observatory examinations under thin sections were implemented on nineteen (19) samples after processing to thin sections. The minerals, which were opaque and/or hardly identified by only microscope, were also operated by an X-ray power diffraction of mineral identifications. Major results are shown in Appendices 4, –8 and –10 below.

Appendix 4. Summary of microscopic observation – thin sections

Appendix 8. Microphotographs under thin sections

Appendix 10. Microscopie observation of rocks under thin sections

Carbonatite : : The most portion of carbonatite shows of fine to medium grained texture and petrologically corresponds to alvikite (LeBas, 1977). Calcite occupies a major portion of carbonate minerals and is associated with iron-bearing calcite and siderite. Barite, apatite and fluorite are major assessory minerals frequently associated with a small amount of pyrochlore, bastnaésite, synchysite and mica minerals. Opaque minerals are composed of goethite, hematite and magnetite. Goethite, an abundant alteration products from magnetite and hematite, is remarkably observed in oxidized zone. In the section of diamond drill hole BRL–1, which is deeper than 74 metres depth from the hole mouth and is to be of reduction zone, magnetite and hematite are observed instead of little association of goethite.

Ferrocarbonatite : Ferrocarbonatite has a similar mineral compositin to that of carbonatite above, however, an abundant amount of goethite, frequently of pseudomorphs of magnetite, is observed as an alteration product by weathering.

Manganiferrous iron ore : Goethite and hematite are observed abundantly. These are overwhelmingly more major than carbonate minerals in quantity. It is also characteristic that none of fluorite and manganese mineral are observed. The major portion of manganese is presumed to be contained in manganiferrous goethite.

Melanephelinite : Malanephelinite is of volcanic rock, viridescent, fine to medium grained and is also observed in the section of diamond drill hole BRL–1 at the depth from 164.90 metres to 196.85 metres. Under the microscope, it shows a porphyritic texture, having phenocyrets of euhedral and tabular rhombic pyroxene (aegirine), amphibole, apatite, sphene, and feldspathoid or feldspar (?). A groundmass is extremely altered and is composed of chalcedony(?), epidote and zeolite (?). It reasonably corresponds itself to melanephelinite by showing a chemical composition of 41.28 % SiO_2 after a whole rock chemical analysis.

4–4–4 Electron probe microanalyser examination

In accordance with the results of microscopic examinations, seven (7) samples of carbonatite, two (2) samples of ferrocarbonatite, one (1) sample of manganiferrous iron ore were selected to implement qualitative and quantitative chemical analyses of component minerals by using an enegy-dispersive X-ray spectrometer. It is also to implement identifications of REE minerals in carbonatite and proper compositional analyses.

Qualitative analysis : Minerals identified by qualitative analysis are shown in Appendix 5. X-ray power diffraction was supplementarily applied to mineral identifications.

Pyrochlore, bastnaésite, synchysite, parisite and huanghoite are identified for possible REE-bearing minerals. An occurrence of fluorine-bearing carbonate mineral as REE-mineral, except pyrochoore, is characteristic. Bastnaésite is widely observed in the samples among them. Rancieith, which is of a manganese mineral and hardly observed under the microscope, is also identified. Monazite, which has been reported by Cluver (1958) and Binge (1962) and is considered to be resistive chemically against weathering, is not discernible by the current examination studies during Phases 1 and 2. It is envisaged that the carbonatitic rocks in the Buru Hill Area may carry less amount of monazite than any other type of carbonatite in Africa.

Quantitative analysis : Nine (9) verieties of minerals, totally fifteen (15) mineral samples, stated below, were chemical-composionally analysed. The measurements were carried out for three points on individual mineral crystal surfaces.

. four (4) varieties of REE minerals i.e. bastnaésite, parisite, synchysite and huanghoite-synchysite

. pyrochlore

. rancieite, sparsely occurs in the area

. barium rich-rancieite

. strontianite

. barite, widely occurs in various variety of ore in the area

Major results are shown in Appendices 6 and −11.

Parisite, $(Ce, La)_2\ Ca\ (CO_3)_3\ F_2$: It shows aggregates of acicular microcrystals. Relatively rich in lanthanum, poor in neodymium. A small amound of strontium is detected.

Synchysite, $(Ce, La)\ Ca\ (CO_3)_2\ F$: It shows aggregates of acicular microcrystals or radially developed microcrystals. Poor in lanthanum and rich in neodymium in comparison with parisite, Considered to be of synchysite -(Ce) - synchysite-(Nd) series.

Huanghoite-Synchysite, $BaCe\ (CO_3)_2\ F$–$(Ce, La)\ Ca\ (CO_3)_2\ F$: It shows aggregates of acicular microcrystals similar to two varieties of minerals mentioned above. Rich in lanthanum and barium and poor in neodymium in comparison with above-mentioned synchysite. Considered to be of Synchysite-(Ce)-Huanghoite series.

Bastnaésite, $(Ce, La)\ (CO_3)\ F$: It shows aggregates of acicular microcrystal or radially developed microcrystals. Detected both of varieties relatively rich and poor in neodymium contents. Yttrium was detected in one (1) crystal of bastnaésite, however, shows a low content, presumably of bastnaésite-(La). Bastnaésite associated with carbonatite in the Buru Hill Area is considered to be of a major mineral, contains yttrium, as the bastnaésite above-mentioned carries yttrium trioxide (Y_2O_3) approximately as much as one hundredth (0.01) of cerium trioxide (Ce_2O_3) in weight.

Pyrochlore, $(Na, Ca, Ce)_2\ (Nd, Ta)_2O_6\ (OH, F)$: It shows euhedral crystals of relatively coarse-grained, sexangular or granular. It carries tantalum and titanium. The weight ratio of neodymium : tantalum : titanium is of 100 : 16 : 8.

Strontianite, $SrCO_3$: It shows euhedral crystals of granular and tabular. The weight ratio of strontium oxide (SrO) : Calcium oxide (CaO) is of 10:1. The strontianite above-mentioned is almostly on the Sr-end member component of the strontianite-aragonite solid solution series.

Barite, $BaSO_4$: It shows aggregates of euhedral and granular crystals and has fairly pure chemical compositions with much less contents of strontium, calcium and iron.

Rancieite, $(Ca, Mn^{+2}) Mn_4^{+4} O_9 \cdot 3H_2O$: It occurs as intergranular materials against barite and bastnaésite. It carries rich contents in barium oxide (BaO), thirteen (13) percent approximately.

Barium rich rancieite : It occurs as intergranular materials against calcite and shows fibrous crystals. It also shows similar chemical compositions to that of rancieite mentioned above, however, relatively rich in ferrous iron oxide (FeO).

4–5 Results of Diamond Drilling Exploration

4–5–1 Outline

Diamond drill operations of seventeen (17) vertical holes, the toal metrage of one thousand metres (50 metres x 16 holes and 200 metres x 1 hole) were implemented during the course of the current survey. Figure II–4–8 shows the area, where diamond drill exploration works were implemented, Figure II–4–9 for drill holes location and Table II–4–1 for each hole locations and hole depths.

Table II–4–1 Location of Diamond Drill Holes

DDH Number	X (km)	Y (km)	Hole elevation above sea level (m)	Hole depth (m)
BRL–1	E740,860	N9,979,271	1,373.0	200.10
BR–1	E740,712	N9,979,164	1,350.0	50.40
BR–2	E740,860	N9,979,395	1,372.5	50.10
BR–3	E740,748	N9,979,271	1,361.0	50.40
BR–4	E740,978	N9,979,395	1,346.0	50.50
BR–5	E740,758	N9,979,406	1,366.0	50.40
BR–6	E740,868	N9,979,515	1,349.0	50.10
BR–7	E740,745	N9,979,514	1,360.0	50.40
BR–8	E740,697	N9,979,057	1,331.5	50.40
BR–9	E740,613	N9,979,058	1,335.5	50.40
BR–10	E740,873	N9,979,159	1,342.0	50.40
BR–11	E740,592	N9,979,949	1,326.5	50.30
BR–12	E740,954	N9,979,268	1,347.5	50.40
BR–13	E740,986	N9,979,150	1,321.0	50.40
BR–14	E740,868	N9,979,637	1,307.0	50.30
BR–15	E740,968	N9,979,510	1,318.0	50.30
BR–16	E740,650	N9,979,639	1,315.7	50.40

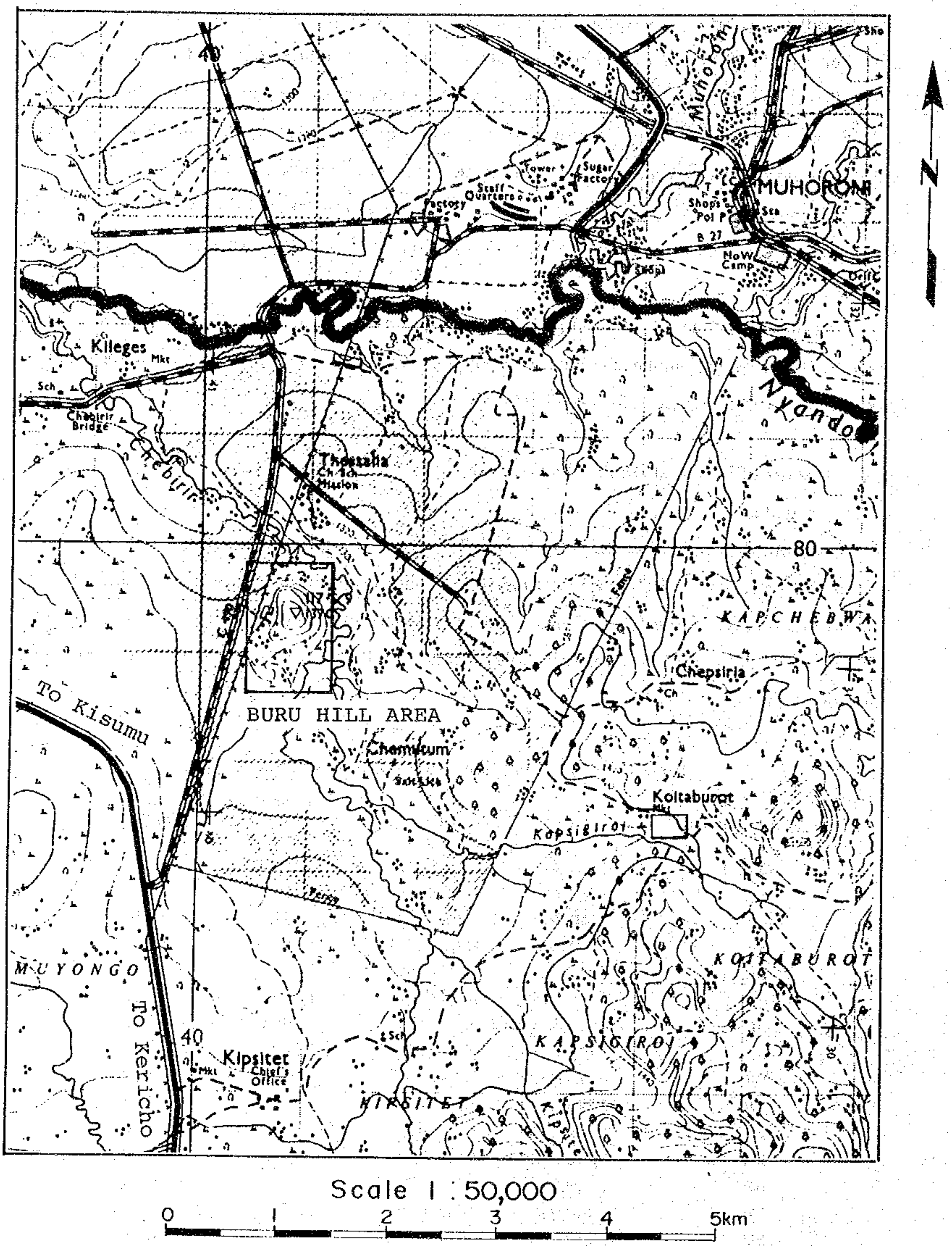


Fig. II – 4 – 8 Location Map of Drilling Area

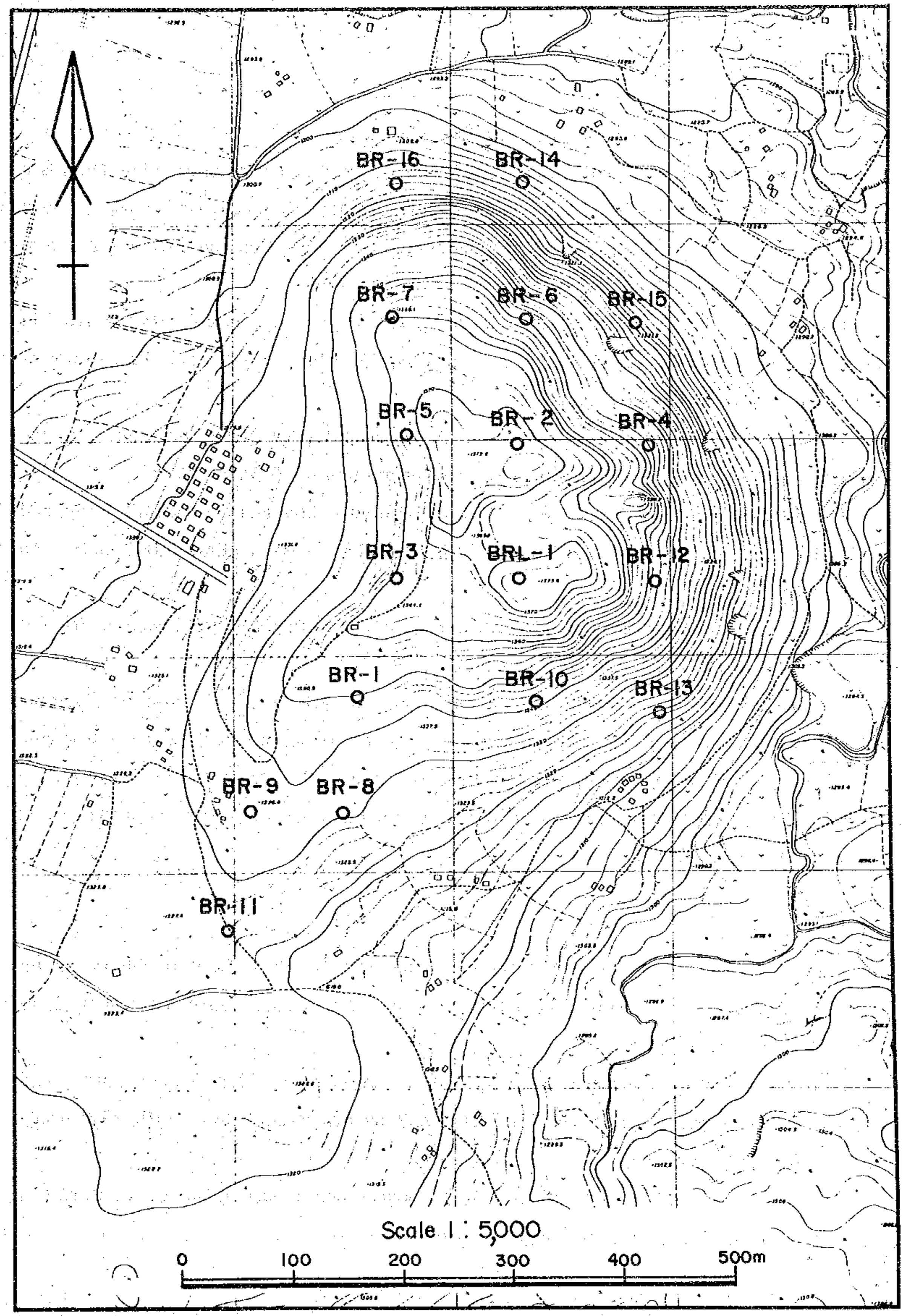


Fig. II – 4 – 9 Location Map of the Drilling Sites in the Buru Hill Area

4–5–2 Diamond drill operations

(1) Mobilization, Demobilization

All of the drill rigs, equipments and materials to be used for the current survey were shipped by sea cargos from Yokohama Port, Japan, on 23rd June 1988 and were unloaded on Mombasa Port, Kenya, on 20th July 1988. After completion of a custom clearance, inland transportations and etc., all of the drill rigs, equipments and materials were transported and arrived in Kericho, Kenya, on 24th August 1988.

The drill operation team crew, three Japanese, left Tokyo on 31st July 1988, arrived in Nairobi, Kenya, on 1st August 1988 and in Kericho on 3rd August 1988, where base camps of the team members were then constructed.

The provisional works of drill operations were started on 5th August 1988 and then the first hole, numbered BRL–1, was commenced into operation on 27th August 1988.

The total drill operation works were successfully implemented and uneventfully completed the total programme of holes and metrages, 17 holes having a total depth of 1,000 metres, on 19th October 1988.

The provisional works of demobilization were commenced directly after the completion of drill works. The works were completed on 27th October 1988.

Japanese crew of the diamond drill team removed from Kericho to Nairobi on 28th October 1988. They made courtesy visits and reporting in Naibori to the governmental organization concerned to the works. They left Nairobi on 2nd November 1988 and arrived in Tokyo on 4th November 1988. The total progresses and itineray of the diamond drill operation of the current survey are shown in Appendix 73.

(2) Local situations

Diamond drill operations were implemented in the Buru Hill Area. The Buru Hill, occupying an area of 800 metres east-west by 500 metres north-west, shows a dome-shaped hill circumscribed by flat sugar cane fields.

Jutting carbonatite occurrences are widely observed in the Buru Hill, which are approximately 70 metres high above the sugar cane field elevation. Cars are accessible to the drill sites through the Buru Hill ridge.

Chebirir River, a tributary of Nyando River, flows down in eastern side of the Buru Hill. Water supply for drill works is available from Chebirir River.

(3) Rigs to be used and drill techniques

Two (2) sets of drill rigs were used for the current survey. An outline is as follows.

Rig	Model	Specification	Quantity
Spindle-type, wire-line revised, high-speed rotated, engine built-in	YBM-BES, Yoshida Tekko Ltd., Japan made	300 metres capable (non-used)	1
do.	THS-5, Tone Boring Ltd., Japan made	400 metres capable (used)	1

Caterpillar carriers were employed for moving-removing operations of drill rigs within drill sites area due to local topography and ground surface conditions.

Polyvinyl chloride pipes were used for water supply services as water head showed a 80 metres difference in maximum and a 800 metres distance. Conventional automatic suction pumps were employed at the initial stage of works, however, these were replaced by plunger-type pumps beyond the mid due to of frequent breaking out of pump troubles caused by a migration of considerable amount of sands and soils into the river water.

Basically, the wire-line technique was employed for drill works. Recoverable core diametre ranged NQ and BQ.

Rock qualities were classified into three (3) categories, hard rock i.e. siliceous rock, semi-hard rock i.e. carbotatite rock and soft rock i.e. weathered earthy rock and overburden.

A satisfactory core recovery was achieved by the wire-line technique in the occasions of hard and semi-hard rocks, while, rock was prone to be broken and flushed away into slime. Consequently, dry drill technique by using NX-single metal crown bit was employed for the soft rock and satisfactory core recovery, say 100 percent, was then achieved.

An average bit life in an occasion of siliceous rock showed two (2) to three (3) metres per new diamond bit and drill works were of extremely heavy-duties.

Appendix 77 shows quantities of drill rig, equipments and etc., Appendix 78 shows quantities of general consumables for diamond drills and diamond bits.

(4) Operation organization of personnel

Three (3) Japanese drill engineers were involved in the diamond drill operation during the course of the current survey.

Three (3) drill parties were initially embodied for an implementation of dill hole BRL–1, 200 metres deep, by forming three (3) shifts per 24 hours.

After completion of the BRL–1 operation, additional sixteen (16) holes, 50 metres deep each, were implemented by two (2) shifts per 16 hours per day by two (2) rigs after personnel organizations were formed as follows, i.e. two (2) drill parties for drill works exclusively and another one (1) party for rig transportation and mounting/dismounting to and at sites exclusively.

	Number of Japanese Drill Engineer	Number of Kenya Counterpart	Number of Labour
1st Drill Party	1	2	2
2nd Drill Party	1	2	2
Transportation Party	1	–	5
Access road construction & site preparation	(Transportation Party concurr.)	–	5
Pump maintenance	–	Daytime 1 Night-time 2	3
Guard at site	–	Daytime 1 Night-time 2 to 3 per site	9
Guard at materials storage	–	Daytime 1 Night-time 2	3

(5) Drill operations

Drill operations were implemental by 3 shifts per 24 hours for the Hole BRL–1 and by 2 shift per 16 hours per day by two (2) rigs for another sixteen holes, BR–1 to BR–16. As mentioned above, the transportation party lead by a Japanese drill engineer was embodied to carry out transportation and mounting/dismounting of the drill rig and supplementary works. It was effective to avoid any breaking-out of work suspension and to ensure from a continuous actual drill work. This type of organization was also reasonable to keep a proper aptitude of a water supply capability by water pumps, which were sometimes to prone to be overtasked by whole-water-running out in drill holes. The major performances of diamond drill operations, general progresses of the whole operation and the individual progress of each hole of the current survey are shown in Appendices 74, 75 and 76.

Hole BRL–1 (200.10 metres deep)

Hole mouth – 4.00 m : Overburden. Drilled by NX-single metal crown bits. Reamed and inserted NX-casing pipes 4.00 metres long.

4.00 m – 123.10 m : Weathered gneiss and carbonatite. Drilled by NQ-wire line.

4.00 m – 65.70 m : Mineralized gneiss.

65.70 m – 123.10 m : Carbonatite with a satisfactory recovery of unbroken cores. Insertered BW-casing pipes 123.10 m long.

123.10 m – 200.10 m : Carbonatite. Drilled by BQ-wire line, achieved a satisfactory performance and recovery of unbroken cores.

An average core recovery in a whole of Hole BRL–1 showed an 89.4 percent.

After commencement of work, river water flow was extremely increased in by a heavy rain, resulted in a sunk of a pump under water and a trouble. A whole day was needed for a repairing. A location of water pump was replaced for a safety since then.

Hole BR–1 (50.40 m deep)

Hole mouth – 4.00 m : Drilled by NX-single metal crown bits in heavily weathered rock. Reamed and insertered NW-casing pipes 4.00 m long.

4.00 m – 33.10 m : Carbonatite, Drilled by NQ-wire line, achieved a satisfactory 100 percent recovery of unbroken cores of limonite stained, fine- to medium-grained carbonatite. Encountered to a whole water-run-out at 11 m-depth, however, continued operations having none of improvements. Detergent powder was used for a lightening of drill resistivity in replacing an usage of cutting oil. Inserted BW-casing pipes 33.10 m long.

33.10 m – 50.40 m : Carbonatite and weathered gneiss. Drilled by BQ-wire line. Abundant iron oxide veins and carbonatite with gneiss-renmants were observed. Encountered to extremely fractured carbonatite, resulted in a whole-water-run-out. Continued an usage of detergent powder.

Hole BR–2 (50.10 m deep)

Hole BR–2 was intially drilled by BQ-wire line, however, was troubled by a very insufficient core recovery of a 48.2 % in average, caused by an occurrence of heavily weathered and argillized gneiss. So then it was re-drilled by a dry drilling technique mostly.

Hole mouth – 4.10 m : Weathered soil. Dry-drilled by NX-single metal crown bits. Reamed and inserted NW-casing pipes 4.10 m long.

4.10 m – 50.10 m : Weathered gneiss with mineralized veins and heavy stainings of iron oxide in a whole. Heavily fractured and argillized. Mostly dry-drilled by NX-single metal crown bits to ensure an improvement of core recovery. Partially drilled by NQ-wire line for hard rocks. An average core recovery of an 82.8 percent was achieved.

Hole BR–3 (50.40 m deep)

Hole mouth – 4.00 m : Weathered soil. Dry-drilled by NX-single metal crown bits. Inserted NW-casing pipes 4.00 m long.

4.00 m – 50.40 m : Intensely weathered gneiss, wholly fractured associated with abundant iron oxide veins and limonite-stainings. Detergent powder was used in water supply for a lightening of drill resistivity, leaving water-run-out without any of improving on. An average core recovery showed an 81.0 percent.

Hole BR–4 (50.50 m deep)

Hole mouth – 9.60 m : Overburden and intensely weathered rock. Dry-drilled by NX-single metal crown bits. Reamed and inserted NW-casing pipes 9.60 m long.

9.60 m – 18.80 m : Siliceous rocks. Very hard in a whole intercalated by weathered earthy rocks. Drill performance rate got down due to an occurrence of hard rock and core-clog. Inserted BW-casing pipes 18.80 m long.

18.80 m – 50.50 m : Siliceous rocks, gneiss and carbonatite. Drilled by NQ-wire line. Obtained a low drill performance rate caused by fractured siliceous rocks resulted in frequent core-clog and a short bit life. A satisfactory core recovery was achieved in limonite-stained gneiss and carbonatite in lower portion of the hole. Showed an average core recovery of an 86.3 percent.

Hole BR–5 (50.40 m deep)

Hole mouth – 5.70 m : Overburden and weathered earthy rocks. Dry-drilled by NX-single metal crown bits. Reamed and inserted BW-casing pipes 4.00 m long.

5.70 m – 27.10 m : Iron oxide stained siliceous rocks intercalated by weathered gneiss. Drilled by NQ-wire line with low performance rate. Inserted BW-casing pipes 27.10 m long.

27.10 m – 50.40 m : Siliceous rocks, gneiss and carbonatite. Drilled by BQ-wire line. Weathered gneiss showed partially earthy and fractured. Satisfactory unbroken core recovery was achieved in portions of siliceous rocks and carbonatite. Showed an average core recovery of a 90.9 percent.

Hole BR–6 (50.10 m deep)

Hole mouth – 4.10 m : Overburden. Dry-drilled by NX-single metal crown bits, reamed and inserted NW-casing pipes 4.10 m long.

4.10 m – 24.10 m : Densely iron-oxide stained weathered rock and weathered gneiss. Dry-drilled by NX-single metal crown bits in earthy rock toward 7.60 m-depth. Continuously drilled by NQ-wire line toward 24.10 m-depth in densely iron-oxide stained weathered rock and intensely weathered gneiss, heavily fractured. Inserted BW-casing pipes 24.10 m long.

24.10 m – 50.10 m : Weathered gneiss with siliceous veins, intensely fractured in a whole. Hardly core-recovered in earthy rock portions. Showed an average core recovery of an 80.0 percent.

Hole BR–7 (50.40 m deep)

Hole mouth – 4.10 m : Intensely weathered earthy rock. Dry-drilled by NX-single metal crown bits. Reamed and inserted NW-casing pipes 4.10 m long.

4.10 m – 24.10 m : Weathered earthy rock and argillized gneiss. Dry-drilled by NX-single metal crown bits in weathered earthy rock toward 6.20 m-depth. Continuously drilled by NQ wireline in gneiss. Inserted BW-casing pipes 24.10 m long.

24.10 m – 50.40 m : Green gneiss, fractured in a whole and associated with iron-oxide fine veins. Showed an average core-recovery of a 100 percent.

Hole BR–8 (50.40 m deep)

Hole mouth – 4.10 m : Overburden. Dry-drilled by NX-single metal crown bits and inserted NW-casing pipes 4.10 m long.

4.10 m – 27.10 m : Weathered earthy rocks, gneiss associated with iron oxide fine vein and siliceous ores. Drilled by NQ-wire line mostly in fractured rocks and partially dry-drilled by NX-single metal crown bits in the section at about 10 m-depth. Inserted BW-casing pipes 27.10 m long.

27.10 m – 50.40 m : Weathered and mineralized gneiss and carbonatite. Drilled by BQ-wire line. Encountered to gneiss with abundant iron oxide veins toward about 34 m depth, followed by carbonatite toward hole bottom.

Showed an average core recovery of an 86.9 percent.

Hole BR–9 (50.40 m)

Hole mouth – 4.10 m : Overburden. Dry–drilled by NX-single metal crown bits. Reamed and inserted NW-casing pipes 4.10 m long.

4.10 – 30.10 m : Weathered gneiss associated with abundant iron oxide veins and intercalated siliceous ores. Drilled mostly by NQ-wire line. Dry-drilled by NX-single metal crown bits in the section of weathered earthy gneiss at about 20 m depth. Inserted NW-casing pipes 30.10 m long.

30.10 m – 50.40 m : Carbonatite and intercalated siliceous ores. Drilled by BQ-wire line. Achieved a satisfactory recovery of unbroken cores and a drill performance. Showed an average core recovery of a 96.6 percent.

Hole BR–10 (50.40 m deep)

Hole mouth – 4.10 m : Overburden. Dry-drilled by NX-single metal crown bits. Reamed and inserted NW-casing pipes 4.10 m long.

4.10 m – 27.10 m : Intensely weathered gneiss. Dry-drilled by NX-single metal crown bits in the section of earthy weathered gneiss and drilled by NQ-wire line in the section of hard rocks. Showed an average core recovery of a 98.5 percent in the section. Inserted BW-casing 27.10 m long.

27.10 m – 50.40 m : Ferrocarbatite. Achieved a satisfactory recovery of unbroken cores resulted from much less rock facies variations and a sufficient drill performance. Showed an average of core recovery of a 94.6 percent.

Hole BR–11 (50.30 m deep)

Hole mouth – 4.10 m : Weathered rock. Dry-drilled by NX-single metal crown bits. Reamed and inserted NW-casing pipes 4.10 m long.

4.10 m – 18.10 m : Intensely weathered argillaceous rock. Dry-drilled by NX-single metal crown bits. Achieved a core recovery of a 100 percent in the section. Inserted BW-casing pipes 18.10 m long.

18.10 m – 50.30 m : Gossanous gneiss and carbonatite. Drilled by BQ-wire line. Gossanous gneiss is observed toward about 30 m depth, followed by carbonatite toward hole bottom.

Achieved a satisfactory recovery of unbroken cores and a sufficient drill performance. Showed an average core recovery of an 84.5 percent.

Hole BR–12 (50.40 m deep)

Hole mouth – 4.10 m : Overburden and weathered rock. Dry-drilled by NX-single metal crown bits. Reamed and inserted NW-casing pipes 4.10 m long.

4.10 m – 36.10 m : Intensely weathered green gneiss. Dry-drilled by NX-single metal crown bits. Inserted BW-casing pipes 36.10 m long.

36.10 m – 50.40 m : Gossanous gneiss and carbonatite. Drilled mostly by BQ-wire line, however, partially dry-drilled in an upper half section toward 43 m depth of vesicular gossanous rock, weathered, fractured and earthy portion, where the cores were might be dardly recovered. The section is followed by an oxidized carbonatite section toward hole bottom with a satisfactory core recovery. Showed an average core recovery of an 89.5 percent.

Hole BR–13 (50.40 m deep)

Hole mouth – 4.10 m : Intensely weathered rock. Dry-drilled by NX-single metal crown bits. Reamed and inserted NW-casing pipes 4.10 m long.

4.10 m – 30.10 m : Weathered gneiss with abundant iron oxide fine veins. Dry-drilled by NX-single metal crown bits toward 5.40 m depth, followed by NQ-wire line. Dry-drilled partially in earthy sections. Inserted BW-casing pipes 30.10 m long.

30.10 m – 50.40 m : Medium–grained carbonatite. Drilled by BQ-wire line. Achieved a satisfactory unbroken core recovery and a sufficient drill performance. Showed an average core recovery of a 98.4 percent.

Hole BR–14 (50.30 m deep)

Hole mouth – 4.10 m : Overburden. Dry-drilled by NX-single metal crown bits. Reamed and inserted NW-casing pipes 4.10 m long.

4.10 m – 21.10 m : Felsitic gneiss and carbonatite. Dry-drilled by NX-single metal crown bits toward 6.50 m depth, followed by NQ-wire line. Inserted BW-casing pipes 21.10 m long.

21.10 m – 50.30 m : Green amphibole-gneiss, intercalated by fractured zones of silicified rock. Drilled by BQ-wire line.

Showed an average core recovery of a 93.8 percent.

Hole BR–15 (50.30 m deep)

Hole mouth – 4.10 m : Overburden. Dry-drilled by NX-single metal crown bits and inserted NW-casing pipes 4.10 m long.

4.10 m – 33.10 m : Felsitic gneiss. Dry-drilled by NX-single metal crown bits toward 8.10 m depth, followed by NQ-wire line. Extremely fractured rocks in a whole and inserted BW-casing pipes 33.10 m long.

33.10 m – 50.30 m : Amphibole gneiss. Drilled by BQ-wire line. Amphibole gneiss is fractured in a whole, underlain by intrusive carbonatite.

Showed an average core recovery of a 92.4 percent.

Hole BR–16 (50.40 m deep)

Hole mouth – 4.10 m : Overburden. Dry-drilled by NX-single metal crown bits. Reamed and inserted NW-casing pipes 4.10 m long.

4.10 m – 21.10 m : Amphibole gneiss. Drilled by NQ-wire line. Amphibole gneiss is fresh in a whole and achieved a satisfactory recovery of unbroken cores and a sufficient drill performance. Inserted BW-casing pipes 21.10 m long.

21.10 m – 50.40 m : Biotite bearing felsitic gneiss. Drilled by BQ-wire line. Abundant segregation quartz veins in biotite bearing felsitic gneiss, fresh. Ahieved a satisfactory recovery of unbroken cores and a sufficient drill performance. Showed an average core recovery of a 100 percent.

4–5–3 Geological descriptions of diamond drill cores

The geological logs of each diamond drill hole implemented during the course of the current survey are shown in Appendices from 79 to 95 with Plates from 2 to 18 and geological cross sections, combined with the drill hole logs, are also shown in Plates 19 and 20. General geology represented by the core loggings are as follows.

(1) Hole BRL–1 (200.10 m deep)

Hole mouth – 1.40 m : Vesicular laterite.

1.40 m – 16.50 m : Intensely weathered gneiss of variegated colours such as pale grey, dark grey, brown, reddish brown, brownish orange-coloured. Goethitized iron oxide veins in networks are widely observed.

16.50 m – 16.80 m : Mineralized rock. Oxidized iron ore veins are widely developed.

16.80 m – 26.75 m : Intensely weathered gneiss. Grey or dark grey, stained by manganiferrous iron oxide minerals. Iron oxide minerals of brownish orange-coloured are widely developed.

26.75 m – 36.00 m : Intensely weathered gneiss stained by brownish-orange coloured iron oxide minerals. Manganiferrous veins of black to orange-coloured are well-developed. In sections 32.30m–32.80m is fractured, 32.80 m–36.60 m earthy.

36.00 m – 38.40 m : Vesicular iron oxide veins, blackish brown to black. Black portions are of possibly manganiferrous.

38.40 m – 52.30 m : Weathered gneiss, greyish brown to brownish orange-coloured with iron-oxide staining and sparse fine veining. Dark grey iron oxide ore and silica minerals veins in sections 41.40 m--44.40 m and 46.10 m--49.20 m depths.

52.30 m – 65.65 m : Vesicular gossanous rock, brown and intensely weathered. Goethite veins randomly developed. This type of gossan likely shows a favourable occurrence directly overlying carbonatite.

65.65 m – 77.60 m : Medium-grained carbonatite, brown in an upper half and pale brown in a lower half, limonite stained. Banded and rich in magnetite stripes. Several number of brown iron oxide veins, one metre wide each, are observed. Staining by iron-oxide mineral get sparse toward lower down, followed by a fresh portion of rock at 77.60 m depth. This may represent a current elevation of water table.

77.60 m – 93.40 m : Medium-grained banded carbonatite with magnetite stripes. Pale grey to white. Fine vein and disseminations of fluorite are observed. Alvikite of later-staged, pale brown and micro-fine grained, is developed in a lower portion, followed by swarms of fine dikes in the section 92.80 m–93.40 m.

93.40 m – 101.20 m : Sövititic medium to coarse grained carbonatite with sparse bands of magnetite, pale grey to white.

101.20 m – 124.50 m : Medium grained massive to banded carbonatite, white to pale grey. Magnetite occurs in bands and disseminations and fluorite in fine veins and disseminations. Fine bands of pyrite and pyrrhotite are observed limitedly. Frequent occurrences of alvikite veins, later-staged, pale brown and microfine-grained, are observed. None of irox-oxide minerals are discernible.

124.50 m – 130.00 m : Randomly banded carbonatite, white to pale grey. Variegated from fine-grained to coarse-grained. Sparsely disseminated by magnetite, pyrite and fluorite.

130.00 m – 142.30 m : Brecciated carbonatite, pale grey, medium to fine grained. Breccias show three (3) centimetres in diameter in maximum and less than one (1) centimetre in average. Breccias associated with abundant green pyroxene minerals are also observed. It shows a lapilli tuff facies in general, possibly generated by a similar process to volcanic breccias.

142.30 m – 164.90 m : Medium-grained, banded carbonatite, pale grey to white. Disseminated by magnetite and fluorite. Green pyroxene mineral veins are well-developed in the section 159.00 m–159.70 m.

164.90 m – 196.85 m : Intensely altered holocrystalline-wise volcanic rock, viridescent grey to greyish green. Strongly altered in a whole, calcite fine veins widely-developed. A 0.5 metre width, at a contact of overlying and underlying carbonatite, is fractured. Alvikite, and quartz-calcite vein of later-staged are observed in the section 182.60 m–183.60 m. This rock is to be of volcanic rock referred to melanephelinite by a whole rock chemical analysis and a microscopic examination.

196.85 m – 197.95 m : Grey, fine-grained carbonatite. Xenoliths of overlying nephelinite are observed.

197.95 m – 200.10 m : Medium-grained, banded to massive carbonatite. Dark grey, rich in magnetite.

(2) Hole BR–1 (50.40 m deep)

Hole mouth – 4.45 m : Vesicular weathered rock, reddish brown. Rich in magnetitie and non-calcareous. Presumed to be of a weathered product of carbonatite.

4.45 m – 14.05 m : Fine-grained carbonatite, pale reddish brown. Banded and disseminated by magnetite. Reddish brown iron-oxide minerals of limonitized variety are sparsely observed, and fine veins concentrations are limitedly formed.

14.05 m – 17.55 m : Fine-grained carbonatite, banded and pale brown. Disseminated by magnetite and limonitized iron oxide veins, reddish brown, are well-develped.

17.55 m – 19.80 m : Fractured gneiss, white, fine veins of iron-oxide are well-developed.

19.80 m – 27.70 m : Fine- to medium-grained carbonatite, iron-oxide minerals stained, brown to reddish brown. Xenoliths of fractured gneiss are discernible. Possibly shows of cone-sheet occurrences.

27.70 m – 32.00 m : Medium-grained carbonatite, dark brown and rich in iron. Abundant iron oxide fine veins, dark brown, are observed.

A limonite vein, reddish brown, in the section of 31.20 m–31.50 m.

32.00 m – 35.60 m : Biotite-bearing granitoid gneiss, heavily weathered, fractured and brown.

35.60 m – 41.90 m : Fine-grained carbonatite brown-stained, associated with fine spotted crystals of apatite.

Massive iron-oxide vein in the section of 40.30 m–40.60 m and dark brown-stained gneiss in the section of 41.10 m–41.90 m.

41.90 m – 44.40 m : Iron-oxide vein, dark brown.

44.40 m – 47.10 m : Fine-grained vesicular gneiss, brown.

47.10 m – 50.40 m : Massive, fine-grained carbonatite, limitedly fractured and pale greyish brown. Gneiss xenoliths are limitedly observed, associated with brown iron-oxide fine veins.

(3) Hole BR–2 (50.10 m deep)

Hole mouth – 6.40 m : Heavily weathered earthy rock, brown associated with fragments of siliceous vein and iron-oxide vein.

6.40 m – 13.40 m : Argillized gneiss, pale grey in an upper half and visicular weathered rock, brownish orange-coloured in a lower half.

13.40 m – 15.05 m : Argillized altered rock, pale grey, possibly of fenitized gneiss.

15.05 m – 18.30 m : Siliceous rock, dark grey, associated with abundant iron-oxide minerals.

18.30 m – 22.50 m : Sandy materials, dark grey. Cavity-filling materials presumably.

22.50 m – 24.90 m : Argillized and granulated gneiss, grey to pale grey.

24.90 m – 26.20 m : Limonitized gossanous rock, greyish brown, presumably originated from ferrocarbonatite.

26.20 m – 30.00 m : Slimy sandy materials, dark grey, presumably of cavity-filling materials as same as those at 18.30 m–22.50 m depth the above.

30.00 m – 35.80 m : Fragmental cores, dark grey, with abundant iron-oxide vein chips in an upper half and fragmental cores, brownish orange-coloured, with abundant limonite chips in a lower half. Considered to be of network-mineralized gneiss both of them.

35.80 m – 41.60 m : Heavily weathered earthy rock, dark grey, presumably of gneiss-originated.

41.60 m – 50.10 m : Vesicular gossanous rock, brownish orange-coloured, associated with a strong iron-oxide vein mineralization.

(4) Hole BR–3 (50.40 m deep)

Hole mouth – 3.90 m : Intensely weathered overburden, brown.

3.90 m – 33.50 m : Heavily limonite-stained granitoid gneiss, showing variegated colours, reddish-brown, brownish orange-coloured, dark grey and etc.. Associated with an abundant iron-oxide mineralization of vein-typed and net-work. Black manganiferrous veins and orange-coloured siliceous veins are also observed.

33.50 m – 50.40 m : Brown-stained gneiss by iron-oxide. A relic texture as a chlorite-bearing gneiss is discernible. Considered to be of amphibole-gneiss originated. An occurrence of limonitized iron-oxide veinings is common.

(5) Hole BR–4 (50.50 m deep)

Hole mouth – 0.70 m : Weathered overburden, brownish orange-coloured.

0.70 m – 15.00 m : Vesicular limonitic rock, weathered gneiss and earthy weathered rock, with three (3) siliceous ore veins, one (1) to two (2) metres wide, dark grey.

15.00 m – 23.50 m : Massive siliceous veins, hard and dense, grey-pale grey-dark grey. Associated with abundant iron-oxide minerals.

23.50 m – 27.00 m : Vesicular gossanous rock with an abundant magnetite association. Dark grey, and to be of ferrocarbonatite originated presumably.

27.00 m – 33.10 m : Limonitized, fine-grained iron-oxide veins, brownish orange-coloured. Presumably of an oxydation product of ferrocarbonatite.

33.10 m – 42.00 m : Oxidized iron-oxide minerals stained gneiss in an upper half and weathered, mineralized gneiss by iron-oxide fine veins, dark grey in a middle to lower half. Medium- to coarse-greined carbonatite dike, pale grey and of ununiformed texture at the depth of 40.50 m–40.70m.

42.00 m – 50.50 m : Medium- to coarse-grained carbonatite pale grey to white, relatively fresh and of ununiformed texture. Limitedly banded and ferruginous.

(6) Hole BR–5 (50.30 m deep)

Hole mouth – 3.80 m : Heavily weathered overburden.

3.80 m – 10.00 m : Weathered amphibole-gneiss, grey to brown. Amphiboles are altered to chlorites. Abundant siliceous veins and iron-oxide veins are well-developed in a whole.

10.00 m – 15.80 m : A limitedly vesicular, ferruginous vein, dark grey. Dense in general. Siliceous fine veins are also developed.

15.80 m – 25.40 m : Chloritized amphibole-gneiss. Two (2) limonitized iron-oxide veins, 1.5 m–2 m wide, are observed.

25.40 m – 35.50 m : A hard and dense quartz vein, brown, shows a brecciated facies at 31.50 m–35.50 m depth, associated with gneiss fragments.

35 30 m – 39.20 m : Weathered gneiss, brown. Limitedly brecciated.

39.20 m – 49.90 m : Fine-grained amphibole-gneiss, heavily weathered and brown. Limonite-stained in a whole with iron-oxide veinings. Silicified at the depth of 46.60 m–49.50 m.

49.90 m – 50.40 m : Siliceous to ferruginous veins, dark brown.

(7) Hole BR–6 (50.10 m deep)

Hole mouth – 5.60 m : Heavily weathered overburden, presumed to be of chloritized gneiss-originated.

5.60 m – 23.90 m : Chloritized gneiss, heavily weathered, presumed to be of amphibole-gneiss originated, reddish brown in an upper half and greyish green in a lower half. Abundant veinings of siliceous and limonitic fine lodes are well-developed. Mauve iron-oxide veins at the depth of 8.60 m–13.20 m, and iron-oxide veins, less than one (1) metre-wide each, in a lower portion.

23.90 m – 50.10 m : Gossanous rock, thin-intercalated by weathered gneiss, brownish orange-coloured to dark grey. Hard and dense quartz-iron oxide veins or dikes, dark grey-dark brown-brown, are also observed. It is a portion with very abundant siliceous veins occurrences. Iron oxide vein, brownish orange-coloured, are also observed at the depth of 40.60 m–43.10 m.

(8) Hole BR–7 (50.40 m deep)

Hole mouth – 2.70 m : Weathered overburden.

2.70 m – 19.80 m : Heavily weathered and earthy rock. Presumed to be of chloritized gneiss-origin, resulted from an examination of fragmental inclusions. Brown gossanous portions are frequent. Presumed to be vein-mineralized in a whole.

19.80 m – 31.60 m : Weathered gneiss of medium scale, pale grey to pale brown. Vein mineralization is hardly observed.

31.60 m –39.10 m : Gneiss associated with intense fine-veinings, brown. Fine veins show five (5) to ten (10) centimetres wide each, both of vesicular and hard-dense types.

39.10 m – 50.40 m : Weathered gneiss on a medium scale, pale grey to brown. Vein mineralizations show lesser in an upper portion and stronger in a lower portion. Two (2) iron oxide veins, one (1) metre wide, are observed.

(9) Hole BR–8 (50.40 m deep)

Hole mouth – 5.00 m : Heavily weathered overburden.

5.00 m – 12.00 m : Argillized rock in an upper half and slimy sandy materials in a lower half, inserted by mineralized gneiss between them.

12.00 m – 13.20 m : Siliceous iron-oxide veins, hard and dense, brownish orange-coloured.

13.20 m – 34.05 m : Gneiss with heavy iron-oxide stainings, brown, brownish orange-coloured, reddish brown. Limonitic iron-oxide veins dominated. Fine-grained carbonatite dikes, grey, at 25.65 m–26.20 m depth.

34.05 m – 50.40 m : Medium-grained carbonatite, pale brown to pale grey. Weathered on medium-scale and slightly stained by iron-oxide minerals. This might be of a possible showing of an upper facies of carbonatite dike and/or cone sheet considering in connection with an occurrence of gneiss at the depth of 37.10 m–39.40 m of the Hole BR–8.

(10) Hole BR–9 (50.40 m deep)

Hole mouth – 4.60 m : Heavily weathered overburden.

4.60 m – 15 25 m : Weathered gneiss, pale grey to grey to dark grey. Hardly observed vein mineralization. Associated with weak stainings of limonite.

15.25 m – 17.60 m : Limonitized iron-oxide veins, brownish orange-coloured.

17.60 m – 27.70 m : Weakly weathered gneiss, grey to dark brown. Iron-oxide veins are common.

27.70 m – 31.40 m : Banded carbonatite, fine-grained and mauve-stained. Iron-oxide veins are abundant.

31.40 m – 32.70 m : Limonitized iron-oxide veins, brownish orange-coloured.

32.70 m – 40.70 m : Gneiss, dark grey or viridescent grey, intruded by ferrocarbonatite, four (4) metres wide and dark brown.

40.70 m – 50.40 m : Medium-grained banded carbonatite, fresh and white. Intruded by micro-grained carbonatite, - alvikite -, of later-staged. Fenitized holocrystalline rock, medium grained and green, is observed at the depth of 43.85 m–46.40 m.

(11) Hole BR–10 (50.40 m deep)

Hole mouth – 1.00 m : Weathered overburden.

1.00 m – 22.50 m : Extremely weathered earthy, argillaceous, fragmental rock, associated with chips of iron-oxide minerals and gneiss, reddish brown to dark brown to black. Presumably of vein-mineralized gneiss originated.

22.50 m – 25.60 m : Gneiss, heavily iron-oxide stained. Iron-oxide mineral fine veins are abundantly developed.

25.60 m – 28.20 m : Massive ferrocarbonatite, dark grey to dark brown. Abundantly spotted by fine-grained minerals, pale yellow.

28.20 m – 36.30 m : Ferrocarbonatite, limitedly banded and massive, brown. Limitedly associated with gneiss fragments.

36.30 m – 37.00 : Fractured gneiss, associated with fine veins of ferrocarbonatite.

37.00 m – 48.20 m : Carbonatite, fine-grained, ununiformed textural, slightly stained by iron oxide, pale brown to brown, associated with fine veins network of ferrocarbonatite.

48.20 m – 50.40 m : Ferrocarbonatite, medium-grained and dark brown.

(12) Hole BR–11 (50.30 m deep)

Hole mouth – 0.50 m : Overburden.

0.50 m – 11.20 m : Argillaceous rock, brown to reddish brown partly.

11.20 m – 17.90 m : Earthy rock, greyish brown. Partly reddish brown by iron-oxide mineral stainings.

17.90 m – 19.80 m : Gneiss, fractured, abundantly associated with limonitic iron-oxide fine veins.

19.80 m – 30.15 m : Vesicular gossanous rock, dark grey. Two (2) dikes of fine-grained carbonatite, a half a metre wide each, pale brown, are observed.

30.15 m – 50.30 m : Fine- to medium-grained banded carbonatite, pale brown to pale grey. Ferrocarbonatite dikes at the depth of 34.80 m–36.00 m. Several iron-oxide veins, several ten (10) centimetres wide each, are observed. Alvikite fine dikes of later staged, mirofine granular, are also distributed beyond the depths deeper than forty-five (45) metres in the hole.

(13) Hole BR–12 (50.40 m deep)

Hole mouth – 2.75 m : Overburden.

2.75 m – 34.90 m : Amphibole-bearing gneiss, heavily weathered, greyish green. Frequently discoloured by iron-oxide minerals stainings to brown, mauve, brownish orange-coloured. Iron–oxide fine veins are well-developed in a whole, while, three (3) veins of magnetite-hematite, less than one (1) metre wide each, are observed at the depth of 13.60 m–18.70 m.

34.90 m – 41.35 m : Vesicular gossanous rock, brownish orange-coloured, which is envisaged to be situated showing a favourable weathered facies at an upper portion of massive carbonatite.

41.35 m – 48.20 m : Carbonatite, medium-grained, discoloured to brown to mauve by weathering. Intruded by iron-oxide fine veins.

48.20 m – 50.40 m : Ferrocarbonatite, medium-grained, limonitized, dark brown, which intersect itself into carbonatire as dikes. Carbonatite, brown, is observed at the lowermost of the hole.

(14) Hole BR–13 (50.40 m deep)

Hole mouth – 0.50 m : Overburden.

0.50 m – 7.00 m : Heavily weathered earthy rock, dark grey to partly greyish mauve. Gneiss fragments are discernible at an upper portion.

7.00 m – 14.75 m : Gneiss, weathered and pale brown, intercalated by amphibole-gneiss. Gossanous facies at the lowermost.

14.75 m – 19.70 m : Fenitized gneiss, greyish green. Green fine veins, mostly composed of aegirine, are well-developed.

19.70 m – 23.20 m : Limonitized gneiss in an upper half, associated with iron-oxide veins. Heavily weathered earthy rock in a lower half.

23.20 m – 50.40 m : Carbonatite, fresh, mostly none of weathered portion. Grey, pale brown in an upper portion. Medium-grained, ununiformed, pale brown to white in a lower portion.

Iron–oxide minerals and ferrocarbonatite dikes are observed at the depth of 26.35 m–34.80 m. These are of intrusives into carbonatite.

(15) Hole BR–14 (50.30 m deep)

Hole mouth – 4.90 m : Earthy rock, brown to pale brown. Limonitized iron-oxide veins are at the lowermost.

4.90 m – 7.80 m : Gneiss, weathered, pale grey, associated with a small amount of amphibole.

7.80 m – 13.40 m : Carbonatite, medium- to coarse-grained, pale grey to pale brown, intersected by vesicular iron-oxide veins, brown.

13.40 m – 38.00 m : Amphibole gneiss, greyish green, very weakly weathered, fairly fresh. Iron-oxide minerals are hardly discernible. Intercalated by white calcareous schist at the depth of 21.10 m–24.30 m.

38.00 m – 40.90 m : Amphibole gneiss, fractured and silicified. Associated with a lesser amount of iron-oxide fine veins.

40.90 m – 41.90 m : Calcareous schist, fine-grained, pale grey.

41.90 m – 46.20 m : Amphibole gneiss stained by iron-oxide minerals, brown.

46.20 m – 50.50 m : Acid intrusive rock, metamorphosed, fine-grained, pale grey to white, associated with amphibole gneiss xenoliths.

(16) Hole BR–15 (50.30 m deep)

Hole mouth – 8.10 m : Earthy rock, heavily weathered, pale brown to grey.

8.10 m – 13.50 m : Gneiss, heavily weathered, grey to brown, associated with a single oxidized ore vein, forty (40) centimetres wide.

13.50 m – 50.30 m : Amphibole-bearing gneiss, pale grey to pale greyish green, intercalated by thin granitoid gneiss. Several limonitized iron-oxide veins, about one (1) metre wide each, are observed, meanwhile, iron-oxide fine veins are sparsely developed in a whole. Carbonatite dikes, less than one (1) metre wide, medium-grained, brown, are distributed at the depths of 25 m and 43 m.

(17) Hole BR–16 (50.40 m deep)

Hole mouth – 2.30 m : Overburden.

2.30 m – 13.20 m : Amphibole gneiss, weathered, fractured and pale greyish green.

13.20 m – 50.40 m : Biotite-bearing gneiss, pale brown in an upper half and pale grey in a lower half. A solitary biotite occurrence ever known in gneiss in Buru Hill Area. Segregation quartz veins are well-developed. Biotites locally show a concentration in limited portions. Iron-oxide fine veins are sparsely observed, however, somewhat faint.

4–5–4 Mineralization

It is elucidated by the current diamond drill exploration that the mineralizations in the Buru Hill Area are divided into two types of category, i.e., the primary mineralizations and the supergene enrichment.

(1) Primary mineralizations

Primary mineralizations are devided into five (5) types of category, i.e., carbonatite, ferrocarbonatite, calcareous iron ore veins, manganiferrous iron ore veins and siliceous iron ore veins.

● Carbonatite : A massive carbonatite body was intersected by the current drill holes on lower elevations mostly in central to southern portions of the Buru Hill Area. Frequent occurrences of carbonatite dykes are also observed by the current drill holes. Meanwhile, a geological extension toward north and/or west of the massive carbonatite body mentioned-above is still unknown on the topographical elevations investigated by the current diamond drill exploration. However, a possible carbonatite extension deeply underlying from the ground surface is inferred in northern portion of the area, where abundant ferruginous and/or siliceous veins, possibly related to the genesis of carbonatite, are observed in Holes BR–2, –3, –5, –6 and –7 and carbonatite dykes themselves are discernible in Holes 14 and –15. Carbonatite, itself, is fine-to medium-grained, pale grey in general and is brown-stained in an oxidized zone. It is mostly of banded and massive texture, of relatively uniform facies, meanwhile, of brecciated facies in the lower portion of the Hole BRL–1.

Carbonatite is majorly composed of carbonate minerals, associated with barite, fluorite, magnetite and a small amount of REE minerals.

• Ferrocarbonatite : Ferrocarbonatite generally shows an occurrence of dykes, several ten (10) centimentres to several metres wide usually, ten (10) metres wide in maximum, in the form of intersections into carbonatite body and overlying ferruginous gneiss mass. Ferrocarbonatite is also generally observed having a geological association with calcareous and/or manganiferrous iron-oxide veins, however, shows less frequent occurrences than those with iron-oxide vein mentioned above. A massive carbonatite mass is observed in a lower portion of the Drill Hole BRL–1 of the current survey works, however, none of the association of ferrocarbonatite with carbonatite itself is observed. It is inferred that ferrocarbonatite may likely show a concentrated occurrence in an upper portion of the massive carbonatite body.

Ferrocarbonatite is generally fine-to medium grained, brown to reddish brown in an oxidized zone, majorly composed of carbonate minerals, rich in iron-mineral contents and is easly distinguished from iron-oxide ore by showing a bubbling after a reaction to diluted hydrochloric acid. Ferrocarbonatite more or less shows a vesicular facies compared with carbonatite.

• Calcareous iron ore vein : Calcareous iron ore veins are observed in all of the drill cores carried out in the course of the current survey works, five (5) metres wide in maximum, generally in the forms of veins, several ten (10) centimetres to several metres wide or of networks less than ten (10) centimetres wide. A less occurrence of the vein is observed by Holes BR–14 and –16 in northern portion of the carbonatite body, where the mineralization is weak. It is considered that calcareous iron ore veins occur in the forms of irregular swarms of veins and/or networks, and intersect into carbonatite and/or overlying rocks through the fissures, which were formed during the course of the carbonatite intrusion. It is usually variegated such as dark brown, reddish brown. brownish orange-coloured, dark grey and etc., and is also visicular, hard and dense mostly. Iron minerals are mostly altered to goethitic limonite by weathering.

• Manganiferrous iron ore vein : Manganiferrous iron ore veins show similar occurrences to those of calcareous iron ore veins. Manganiferrous iron ore is distinguished from calcareous iron ore by showing a peculiar black appearance, however, it is frequently made hard by discolouring of the former. A whole rock chemical analysis properly offers a definitive resolution to produce a clear distinction between them.

• Siliceous iron ore vein : Siliceous iron ore veins are abundantly observed in the diamond drill cores carried out in mid to northern portions of the Buru Hill Area, particularly form Holes BR–4, –5 and –6, where carbonititic dykes of relatively large size are observed on the ground surface in the area. Siliceous ore vein usually shows one (1) to several metres wide, less than ten (10) metres wide in maximum. An occurrence of siliceous ore vein, estimated to be having an apparent width of twenty (20) metres wide, at the hole mouth of the Hole BR–4, is considred to be re-estimated by drill cores examinations as to be having a swarm of veins of one (1) to five (5) metres wide.

Siliceous ore veins show pale grey, brownish orange-coloured, dark grey and are dense and hard by microcrystalline characters, mostly composed of quartz and iron minerals.

(2) Supergene enrichment

Supergene enrichment in the Buru Hill Area might be controled under geological processes by weathering and water-borne category, i.e., a concentration of minerals by weathering and also a downward concentration of metalic elements dissolved in water in an oxidized zone.

The current water table elevation in the Buru Hill Area has been confirmed by the diamond drill Hole BRL–1 to be situated at the depth of seventy five (75) to eighty (80) metres below the present ground surface, i.e., 1294 metres to 1299 m high above sea level.

Based on th examinations of Hole BRL–1 cores, the following facts and estimation are conducted as described below :

- Limonite-stainings in carbonatite rock are not discernible in the core beyond the depth of 77.60 metres, i.e., 1296.40 metres high above sea level.
- None of the trace of oxydation effect are discernible in the BRL–1 drill cores mentioned above.
- The current water table elevation has also been estimated by other couple number of diamond drills of the current survey works at the same elevation, beyond where limonite stainings are vanishing.

It is, consequently, conducted that the current water table elevation in the Buru Hill Area is to be situated on 1295 metres high above sea level approximately and the rock located lower than the current water table may also ever be located under the water table of the past geological time. Relations between the estimated current water table elevation and the modes of water table intersections by individual drill holes of current works are shown as follows :

Table II − 4 − 2 Underground water level in Diamond Drilling Holes

DDHNo.	Drill site Elevation (m)	water level Depth (m)	Elevation from the sea level (m)	Core length drilled under water level
BR1−1	1,373.0	77.6	1,295.4	122.5m
BR−1	1,350.0	−	(<1,300)	−
BR−2	1,372.5	−	(<1,322)	−
BR−3	1,361.0	−	(<1,311)	−
BR−4	1,346.0	50.0±	(≦1,296)	−
BR−5	1,366.0	−	(<1,316)	−
BR−6	1,349.0	−	(<1,299)	−
BR−7	1,360.0	−	(<1,310)	−
BR−8	1,331.0	34.0	1,297	16.4
BR−9	1,335.5	41.4	1,294.4	8.9
BR−10	1,342.0	50.0±	1,292±	−
BR−11	1,326.5	30.0	1,296	20.30
BR−12	1,347.5	−	(<1,297)	−
BR−13	1,321.0	25.0	1,296	25.40
BR−14	1,307.0	18.0±	1,289±	32.30
BR−15	1,318.0	25.0±	1,293±	25.3
BR−16	1,315.5	20.0±	1,295±	30.4

It is also conducted theat the supergene enrichment in the Buru Hill Area may be allocated at on a higher level than the current water table elevation based on the examination results that a characteristic facies change of rock under the current water table is not remarkable. Consequently, the major fields of supergene enrichment in the area should be noted as follows :

- Soils and/or argilliged rocks near the ground surface.
- Oxidized and mineralized rocks such as gneiss, geologically classified as roofs, intruded by carbonititic rocks.

Soil and/or argilliged rock near ground surface : These units, primary rocks of which are hardly identified, are observed in most sections of the drill cores, showing several to six (6) metres thick, twenty (20) metres thick in maximum in southern Buru Hill of flat land.

A possible concentration of pyrochlore or monazite, which are resistive to chemical weathering, should be inferred in the units.

Rocks in oxidized zone, under overburden down toward water table elevation : The basement rocks, overlying massive carbonatite body and roof-shaped, are subjected to fractuation by carbonatite intrusion and mineralization of veins, vein networks and dissemination types. The rocks are further subjected to weathering and oxydation near to ground surface and supergene enriched (Refer to Chemical Analyses Results of Ores, 4–5–5). The primary rock facies of the altered portions by mineralization and supergene enrichment are hardly identified. Remnant minerals are solitary recourses for a geological identification of the primary rocks.

Decrease in volumes of primary rock by weathering and reprecipitations of the elements, water-borne downwards, should be considered to be of farourable modes of supergene enrichment in the Buru Hill Area.

4–5–5 Results of chemical analyses of ores

(1) Sampling and chemical analyses of ores

The 210 ore samples, intersected by the current diamond drill works, were collected to be chemically analysed.

Eight (8) rare earth elements, lanthanum (La), cerium (Ce), neodymium (Nd), samarium (Sm), europium (Eu), telbium (Tb), ytterbium (Yb) and lutecium (Lu) and other related seven (7) elements, gold (Au), barium (Ba), strontium (Sr), niobium (Nb), yttrium (Y), uranium (U) and thorium (Th) were analysed chemcally by Geochemical Trace Level – parts per million – unit. Ore Level – percent – unit was applied to Ba, La, Ce, Nd, which were frequently contained more than the detection limits of Geochemical Trace Level.

The general method and specifications are shown in Table II–4–3.

Table II－4－ 3 Analytical Method, Detection Limit and Upper Limit

DESCRIPTION	METHOD	DETECTION LIMIT	UPPER LIMIT
Au g／tonne : 1／2assayton	FA－AAS	0.07	500.00
Ba ppm : HC104－HNO3－HF digestion	AAS	10	10,000
Ba ppm : HC104－HNO3－HFdigestion	AAS	1	10,000
Nb ppm	XRF	5	10,000
Y ppm	XRF	5	10,000
Ce ppm : Trace level	NAA	2	10,000
Eu ppm : Trace level	NAA	0.5	100.0
La ppm : Trace level	NAA	1	1,000
Lu ppm : Trace level	NAA	0.1	500
Nd ppm : Trace level	NAA	5	1,000
Sm ppm : Tracer level	NAA	0.1	500
Tb ppm : Tracer level	NAA	0.1	1,000
Th ppm : Tracer level	NAA	1	1,000
U ppm : Gamma counting	NAA	1	10,000
Yb ppm : Tracer level	NAA	0.1	1,000
Ba % Ore grade	XRF	0.01%	100.0%
La % Ore grade	XRF	0.01%	100.0%
Ce % Ore grade	XRF	0.01%	100.0%
Nd % Ore grade	XRF	0.01%	50.0%

FA－AAS : Fire assay－Atomic absorption spectrometry

AAS : Atomic absorption spectrometry

XRF : X－ray fluorescent analysis

NAA : Neutron activiation analysis

(2) Statistics of chemical analyses and statistical interpretation

(a) Statistics

The total samples are interpreted to be of a mode of a simple population. Three (3) samples of nephelite and guartz with a vein show a minor population, separated from the single population, toward the low-content side of REE. A relatively distinct minor population on the high-U side is considered to be caused by high uranium samples collected from the drill cores of the Hole BRL–1, from the ground surface toward 45 metres depth.

An average of the chemical analyses values of the elements of 210 drill core samples shows higher in contents than those of 47 samples from the ground surface by the first year programme – Phase 1.

It is deserving of a special mention that most of the elements in the drill cores samples, other than Nb and Y, are ranked on the level as much as 1.5 times higher in content than those of surface samples. It possibly suggests an effect of leaching of the elements on the ground surface.

(b) Interpretations of correlation

The correlation coefficients among fifteen (15) elements are shown in Table II–4–5. The mutual correlations among each element are briefly summerized as follows :

Abbreviations are to be used herein after for simplicity also as follows :

LREE : Light REE, i.e., La, Ce, Nd

MREE : Medium REE, i.e., Sm, Eu, Tb

HREE : Heavy REE, i.e., Yb, Lu

REE : A whole rare earth elements for current chemical analyses

i) Au and Sr are not correlated to other elements

ii) Ba is correlated to Th and LREE moderately, Nb is to Y and HREE weakly, U is to Ba, Y and REE mederately or weakly.

iii) Y, Th and REE are mutually correlated mederately or strongly.

Y is correlated to MREE–HREE (from Eu to Lu) strongly.

Th is correlated to LREE–MREE (from Nd to Tb) strongly.

La, Ce, and Nd are mutually correlated strongly.

Nd is correlated to Sm and Eu strongly.

Sm, Eu and Tb are mutually correlated storongly.

Sm is correlated to Nd strongly, Tb is to Yb and Lu strongly.

Yb and Lu show the second strongest mutual correlation after La-Ce.

(c) Principal component analysis

The general characteristis of the mutual chemical relations among the elements to be analized are hardly elucidated by only dealing with the correlation coefficients, due to of fairly numerous components, fifteen (15) this work. Principal component analysis was implemented for the purpose to summerize up the chemical analysis data. Gold, frequently shows a less content against detection limited value, was omitted from the processing.

A summary of principal component analysis are shown in Table II–4–6.

Seven (7) principal components, which produce major contributions for the analysis, are listed in the Table, however, the cumulative contribution by four (4) principal components, from the 1st to the 4th in descending order, which occupies an eighty-three (83) percent of the total contribution, may represent a general contribution tendency in a whole. Major results by the analysis are as follows :

- The 1st principal component : It represents a fifty-three (53) percent of the total analysis data. It is determined by a factor loading of Y and REE (0.75–0.90) and clearly represents the mineralization of rare earth elements .

  The sample, which holds a high score of the component, should be herein after used for providing chondrite-normalized REE patterns.
- The 2nd principal component : It represents the mineralization of Nb. It is tightly related to the concentration of HREE as mentioned above.
- The 3rd principal component : A factor loading of Sr shows 0.677, very high. Consequently the sample, which holds a high score of the component, may carry high Sr, which is less correlated to other components.
- The 4th principal component : It is to be representing the mineralization of U.

The essential difference, by results of the analysis, between the current Phase–2 work and the previous Phase–1 work, when 47 samples from the ground surface were analysed, are to be that the principal component contributed by La, Ce and Nd properly, was not identified in Phase–2 work. It is possibly considered that the samples, which contain La, Ce and Nd that show a different activity from other REE against weathering on the ground surface, might occupy a minor share in number among the whole in the Phase–2 work.

(3) Interpretation of the results by chemical analyses

(a) Average value of elements by rock/ore

Average values of the elements in five (5) types of rock/ore obtained by whole rock analyses are shown in Table II–4–7. Chondrite-normalized REE patterns based on the Table are also shown in Fig. II–4–10–(3) respectively. The samples used for the calculation were also identically used for the whole rock chemical analyses.

It is elucidated from the Table that ferrocarbonatite has a character rich in LREE and HREE, while, manganiferrous ore is rich in MREE. It is also indicated that carbonatite is relatively rich in LREE and HREE, meanwhile, is poor in MREE. In a whole, the group of carbonatite, ferrocarbonatite and calcareous iron ore, shows a contrary character against the group of manganiferrous iron ore and siliceous iron ore by showing that the latter is poor in LREE. The tendency above is also clearly shown in the chondrite-normalized REE patterns.

(b) Average value of rocks devided by geological logs

Nine (9) types of rock, related to the mineralization of Nb, Y and REE, such as overburden, oxidized and mineralized gneiss, ore – this type includes both of manganiferrous iron ore and calcareous iron ore after hard classification by unaided eye –, siliceous iron ore, gossanous ore – mostly developed overlying the massive carbonatite –, carbonatite – weathered more or less –, fresh carbonatite, and ferrocarbonatite are shown in geological logs. An average chemical value of individual rock/ore type is shown in Table II–4–8, chondrite-normalized REE patterns are in Figures II–4–10–(1) and – (2). Figure II–4–11 shows chondrite-normalized REE patterns on six (6) samples, which hold high scores of the 1st principal component.

Table II–4–8 summerize the characters of individual rock as follows :

i) Ferrocarbonatite is of the richest in REE, followed by gossanous ore, overlying carbonatite.

ii) Iron-ore is of the most poor in REE, particully poor in LREE and in HREE, relatively rich in MREE, especially in Sm. This character is similar to that of manganiferrous ore stated in (a). Iron ore carries a similar content of LREE to that of manganiferrous ore. Consequently, most part or major part of so-called "ore" is to be possibly identified as manganiferrous ore.

iii) Average chemical values, other than Sr, of carbonatite-weathered and fresh carbonatite-non weathered are resemble, particularly of REE. It is possibly considered that REE might be still unmobile under weathering condition. Both of carbonatite and fresh carbonatite carry relatively low REE and Ba. It may be suggested that carbonatite might provide lesser contribution to carrying a high REE content.

iv) Siliceous ore is poor in REE, other than Sm, in general, meanwhile, similar to that of carbonatite.

v) Mineralized gneiss in oxidized zone carries a relatively high content of REE.
As gneiss in oxidized zone is extremely weathered, REE in the rock might be considered to be supergene-enriched to the current level. The current content of REE in gneiss might not be reasonably expected under the primarily mineralized condition – fine veining and network in fractured portions –.

Table II – 4 – 4 Summary of Statistics of Analysis – Drill Core Samples –

Component	Unit	No. of sample	Maximum	Minimum	Mean(m)	Standard deviation	m − 26	m − σ	m + σ	m + 2σ
AU	PPB	210	0.27	0.07	0.071	0.0453	0.057	0.064	0.078	0.087
BA	PPM	210	135000	4800	35783.9	0.268	10399.0	19290.3	66379.8	123136.0
SR	PPM	210	10000	300	1529.9	0.259	464.2	842.7	2777.3	5041.8
NB	PPM	210	4950	46	690.9	0.342	143.3	314.6	1517.3	3332.0
Y	PPM	210	1850	62	588.9	0.204	230.3	368.3	941.7	1505.9
U	PPM	210	429	1	13.5	0.626	0.8	3.2	57.0	240.7
TH	PPM	210	2025	64	753.4	0.227	264.3	446.2	1272.1	2147.8
LA	PPM	210	23100	40	5266.6	0.389	878.6	2151.1	12894.0	31568.2
CE	PPM	210	24400	500	7746.4	0.263	2309.9	4230.1	14185.6	25977.4
ND	PPM	210	7300	100	2310.0	0.231	797.5	1357.3	3931.3	6690.8
SM	PPM	210	633.5	20.8	245.95	0.199	98.53	155.67	388.58	613.93
EU	PPM	210	169.4	5.6	67.07	0.200	26.76	42.37	106.18	168.11
TB	PPM	210	65.6	2.6	22.24	0.206	8.63	13.85	35.72	57.35
YB	PPM	210	72.3	4.5	27.44	0.203	10.79	17.21	43.75	69.76
LU	PPM	210	10.7	0.6	4.25	0.198	1.71	2.69	6.71	10.60

Remarks: Standard deviation is shown in logarithmic scale.

Table II – 4 – 5 Correlation Coefficients – Drill Core Samples –

	Au	Ba	Sr	Nb	Y	U	Th	La	Ce	Nd	Sm	Eu	Tb	Yb	Lu
Au	1														
Ba	.032	1													
Sr	-.148	-.003	1												
Nb	-.037	-.089	.012	1											
Y	-.029	.321	-.012	.311	1										
U	-.120	.334	-.030	.131	.338	1									
Th	-.012	.404	-.228	-.006	.671	.334	1								
La	-.067	.469	.109	.125	.584	.452	.469	1							
Ce	-.069	.547	.087	.051	.584	.470	.568	.950	1						
Nd	-.049	.567	-.133	-.071	.534	.379	.729	.683	.838	1					
Sm	-.028	.336	-.201	.040	.651	.340	.861	.454	.575	.803	1				
Eu	-.041	.336	-.200	.152	.764	.391	.874	.478	.557	.726	.951	1			
Tb	-.037	.256	-.108	.309	.884	.349	.763	.491	.503	.538	.786	.892	1		
Yb	-.029	.234	-.040	.393	.887	.261	.479	.484	.435	.337	.462	.592	.759	1	
Lu	.019	.230	-.013	.364	.863	.376	.505	.558	.511	.384	.479	.584	.735	.940	1

Table II – 4 – 6 Summary of Principal Component Analysis – Drill Core Samples –

Prin. compo-nent	Eigen value	Contri-bution	Cum. contri-bution		BA	SR	NB	Y	U	TH	LA	CE	ND	SM	EU	TB	YB	LU
1	7.364	0.526	0.53	Eigen vector	0.184	-0.038	0.081	0.327	0.187	0.308	0.274	0.292	0.295	0.311	0.330	0.325	0.280	0.289
				Factor loading	0.499	-0.103	0.219	0.888	0.507	0.836	0.745	0.793	0.800	0.845	0.897	0.883	0.759	0.785
				Contribution	0.249	0.011	0.048	0.789	0.257	0.698	0.555	0.628	0.640	0.714	0.804	0.779	0.576	0.616
2	1.859	0.133	0.66	Eigen vector	-0.348	0.032	0.489	0.245	-0.107	-0.128	-0.164	-0.265	-0.357	-0.125	-0.008	0.204	0.391	0.341
				Factor loading	-0.475	0.043	0.667	0.334	-0.145	-0.174	-0.223	-0.361	-0.487	-0.171	-0.011	0.278	0.533	0.465
				Contribution	0.225	0.002	0.445	0.111	0.021	0.030	0.050	0.130	0.237	0.029	0.000	0.077	0.284	0.216
3	1.484	0.106	0.76	Eigen vector	0.202	0.556	0.156	0.030	0.208	-0.295	0.397	0.319	-0.031	-0.316	-0.285	-0.162	0.088	0.142
				Factor loading	0.246	0.677	0.190	0.037	0.254	-0.359	0.484	0.388	-0.038	-0.385	-0.347	-0.198	0.107	0.174
				Contribution	0.060	0.459	0.036	0.001	0.064	0.129	0.234	0.151	0.001	0.148	0.120	0.039	0.011	0.030
4	0.866	0.062	0.83	Eigen vector	0.142	-0.638	0.376	-0.139	0.592	-0.117	0.057	0.020	-0.022	-0.137	-0.091	-0.119	-0.053	0.004
				Factor loading	0.132	-0.593	0.350	-0.130	0.551	-0.109	0.053	0.018	-0.021	-0.127	-0.084	-0.110	-0.049	0.004
				Contribution	0.017	0.352	0.122	0.017	0.304	0.012	0.003	0.000	0.000	0.016	0.007	0.012	0.002	0.000
5	0.692	0.049	0.88	Eigen vector	-0.404	0.444	0.254	-0.127	0.502	0.086	-0.103	-0.049	-0.001	0.248	0.227	0.122	-0.323	-0.232
				Factor loading	-0.336	0.370	0.211	-0.105	0.418	0.072	-0.085	-0.041	-0.001	0.207	0.189	0.101	-0.269	-0.193
				Contribution	0.113	0.137	0.045	0.011	0.175	0.005	0.007	0.002	0.000	0.043	0.036	0.010	0.072	0.037
6	0.617	0.044	0.92	Eigen vector	0.171	0.122	-0.594	0.117	0.529	0.036	-0.266	-0.273	-0.260	-0.090	-0.010	0.052	0.182	0.227
				Factor loading	0.135	0.096	-0.466	0.092	0.416	0.028	-0.209	-0.214	-0.204	-0.071	-0.008	0.041	0.143	0.178
				Contribution	0.018	0.009	0.218	0.008	0.173	0.001	0.044	0.046	0.042	0.005	0.000	0.002	0.020	0.032
7	0.559	0.040	0.96	Eigen vector	0.749	0.225	0.386	-0.002	-0.090	0.077	-0.344	-0.246	-0.029	0.048	0.093	0.072	-0.043	-0.168
				Factor loading	0.560	0.169	0.289	-0.001	-0.067	0.057	-0.257	-0.184	-0.022	0.036	0.069	0.054	-0.032	-0.126
				Contribution	0.313	0.028	0.083	0.000	0.004	0.003	0.066	0.034	0.000	0.001	0.005	0.003	0.001	0.016

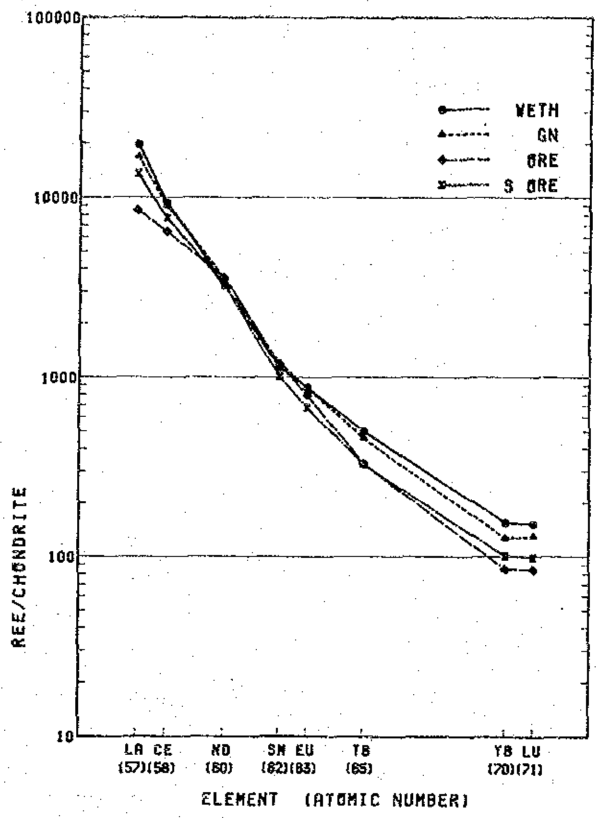
Table II – 4 – 7 Average Value of Elements by Rock (Ore) Type–1

Type (No. of sample)	Carbonatite (15)	Ferro-carbonatite (6)	Calcareous Fe Ore (5)	Manganeferous Fe Ore (7)	Siliceous ore (5)
Ba %	3.18	3.81	4.12	4.65	2.83
Sr ppm	2,790	2,008	2,060	1,064	1,330
Nb ppm	681	854	1,362	601	911
Y ppm	521	647	632	539	572
U ppm	18	18	46	18	3
Th ppm	606	795	638	1,014	695
La %	0.776	0.933	0.598	0.34	0.486
Ce %	0.91	1.07	0.87	0.60	0.68
Nd %	0.22	0.26	0.26	0.29	0.21
Sm ppm	218.1	274.2	230.6	356.9	235.8
Eu ppm	52.2	75.5	62.0	96.6	64.2
Tb ppm	19.5	22.9	24.0	25.7	24.1
Yb ppm	26.7	29.4	27.6	24.4	24.3
Lu ppm	3.9	4.8	4.6	3.4	3.8
La+Ce+Nd %	1.906	2.263	1.728	1.230	1.376
Sm+Eu+Tb ppm	289.8	372.6	316.6	479.2	324.1
Yb+Lu ppm	30.6	34.2	32.2	27.8	28.1

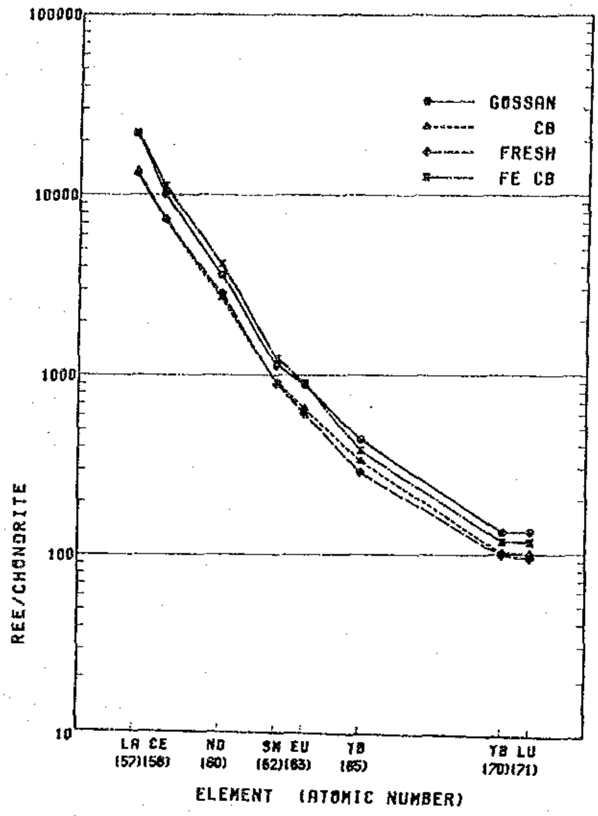
Table II – 4 – 8 Average Value of Elements by Rock (Ore) Type–2

Elements	Unit	1	2	3	4	5	6	7	8
Au	ppm	0.070	0.072	0.070	0.070	0.070	0.071	0.070	0.070
Ba	ppm	40198.8	43968.0	32414.3	38272.8	45292.9	28402.6	26504.8	42338.1
Sr	ppm	1151.8	1295.3	1318.4	1298.2	1885.6	1912.2	2615.7	1645.2
Nb	ppm	1062.0	893.3	459.0	423.3	958.0	702.6	558.9	597.4
Y	ppm	764.4	678.5	496.1	529.6	750.5	540.7	478.6	683.2
U	ppm	26.4	20.8	14.7	12.0	16.4	8.6	4.0	12.8
Th	ppm	795.6	956.2	781.2	710.7	861.1	612.6	558.7	956.2
La	ppm	7449.8	6405.1	3231.4	5159.9	8281.7	5145.9	4980.7	8372.4
Ce	ppm	9122.4	8856.7	6359.1	7542.9	9828.3	7104.2	7183.8	10975.7
Nd	ppm	2328.6	2556.4	2566.8	2337.6	2578.6	1920.2	2028.3	2984.6
Sm	ppm	261.20	276.31	271.47	233.71	260.74	210.17	207.72	285.54
Eu	ppm	76.56	76.80	69.80	59.45	77.53	57.53	53.55	79.18
Tb	ppm	29.73	27.10	19.68	19.43	26.01	19.69	17.04	22.55
Yb	ppm	38.57	31.67	21.31	25.14	33.38	25.53	24.68	29.66
Lu	ppm	5.91	5.06	3.29	3.84	5.22	3.93	3.68	4.56
La+Ce+Nd	ppm	18,900.8	17,818.2	12,157.3	15,040.4	20,688.6	14,170.3	14,192.8	22,332.7

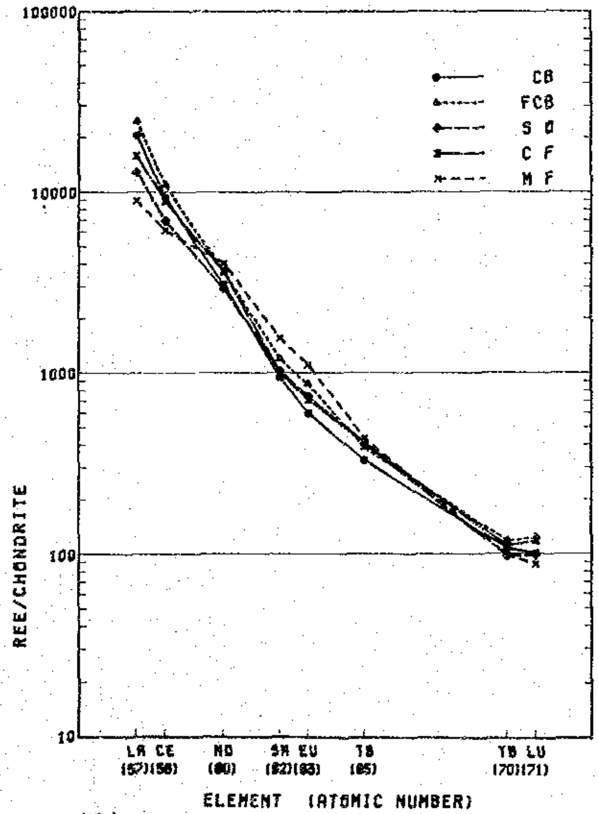
1: Weathered surface material, 2: Oxidized mineralized gneiss, 3: Ferruginous ore, 4: Siliceous ore,
5: Gossan like ore, 6: Carbonatite, 7: Fresh carbonatite, 8: Ferrocarbonatite



(1)



(2)



(3)

(1), (2)

WETH	:	Weathered surface material
GN	:	Oxidized mineralized gneiss
ORE	:	Ferruginous ore
S ORE	:	Siliceous ore
GOSSAN	:	Gossan like ore
CB	:	Carbonatite
FRESH	:	Fresh carbonatite
FE	:	Ferrocarbonatite

(3)

CB :Carbonatite
FCB:Ferrocarbonatite
SO :Siliceous ore
CF :Calcareous Fe ore
MF :Manganeferous ore

Fig. II – 4 – 10 Chondrite-Normalized REE Patterns by Rock or Ore Type (Average Value)

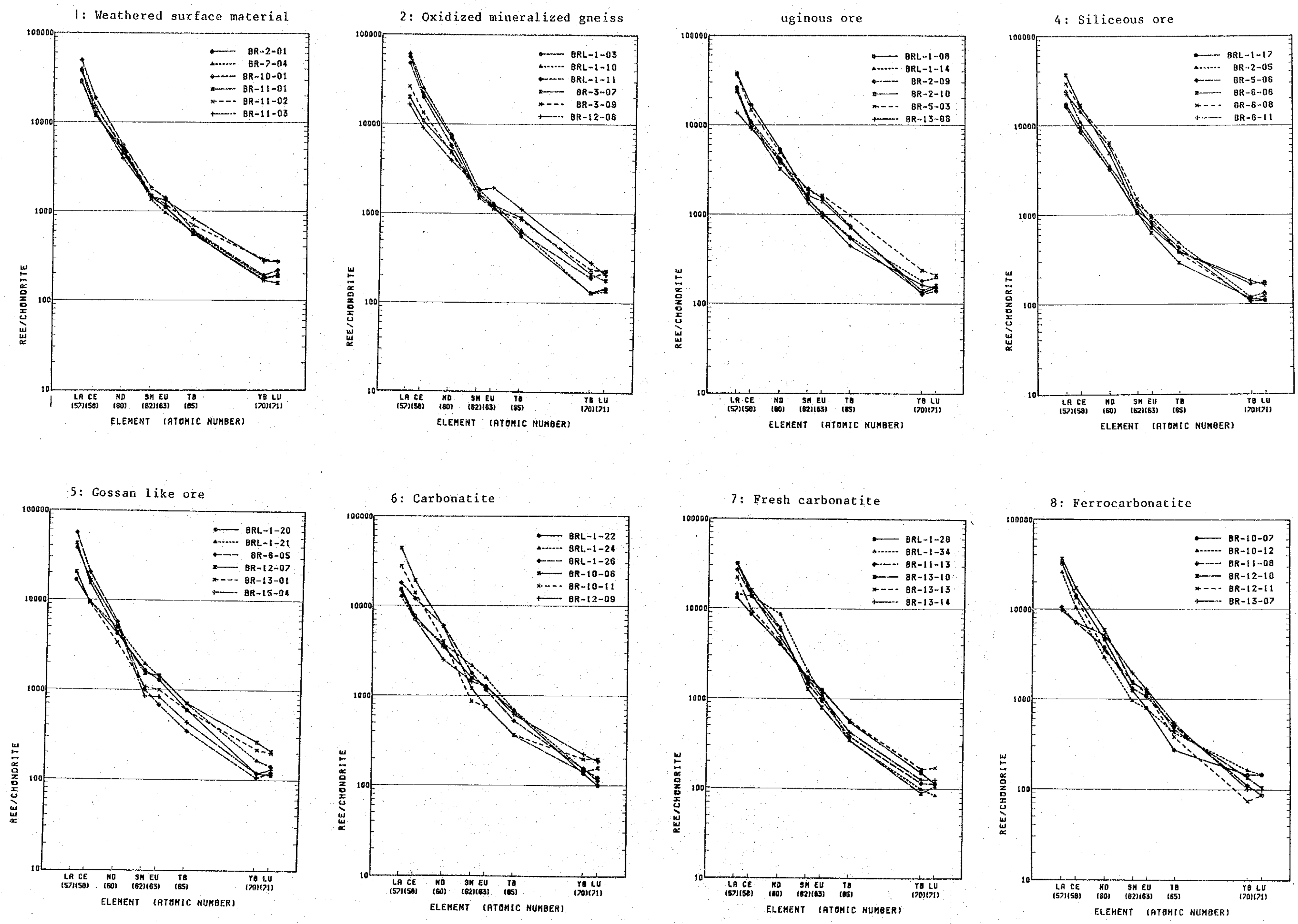


Fig. II – 4 – 11 Chondrite-Normalized REE Patterns by Rock or Ore Type (High Score Samples for Z1 Component)

vi) It is remarkably pointed out that Nb shows a relatively high content in overburden. It should be caused by an occurrence of pyrochlore as the weathered residual.

Chondrite-normalized REE patterns reasonably privide the estimation as follows :

vii) Patterns of individual rock/ore show identical tendencies and levels. These are considered to be caused by products from a serial carbonatite activity.

viii) In general, patterns show of slightly downward-curves on the positions of MREE. Negative anomalies of Sm and positive anomalies of Eu are also observed in a limited number of samples.

4–5–6 Chemical grades of drill cores

(1) Representative chemcial values

Table II–4–9 shows weighted chemical average values of the elements on the 207 samples of drill cores, three (3) unmineralized samples among 210 sample, stated in 4–5–5–(1) are omitted, by representing in the form of "Total sum of (sample width x grade)/Total sum of sample width)".

The total lengths of diamond drill holes by the current survey works are of 1,000 metres. Fractional segments for the processing of the total cores comprise as follows :

- 700 m of cores were processed to be of 210 samples for chemical analyses.
- Remaining 300 m of cores comprise approximately as follows '

  90 m of unmineralized portions in holes BR–14, –15 and –16.

  30 m of nephelinitic rock in hole BRL–1, beyond 165 m depth

  170 m of overburden and weakly mineralized portions in other holes.

Unmineralized portions of the rock and limitedly partial overburden are inevitably included in the 210 samples. Table II–4–9, accordingly, represents a total of weighted chemical average values of the elements of the mineralized rocks, which occupy a volume toward the depths of fifty (50) metres from the ground surface, excluding the northern portion of the Buru Hill Area, where drill holes BR–14, –15 and –16 were allocated.

The weighted average values of the major elements are represented as follows :

Nb ; 954 ppm, Y ; 685.5 ppm, La+Ce+Nd ; 19265 ppm, Sm+Eu+Tb ; 369 ppm and Yb+Lu ; 37 ppm.

(2) Chemical values by individual drill hole

Table II–4–10 shows weighted chemical average values by individual diamond drill hole of the current survey works.

It is likely pointed out that mineralization in the Buru Hill Area has a tendency in a whole

Table II – 4 – 9 Average, Maximum and Minimum Values of All Drill Core Samples

Elements	Unit	No. of samples	Maximum value	Minimum value	Average	Total assayed length
Au	ppm	207	0.27	0.07	0.071	688.80
Ba	ppm	207	135000	4800	41818.8	688.80
Sr	ppm	207	10000	300	1930.6	688.80
Nb	ppm	207	4950	46	954.3	688.80
Y	ppm	207	1850	185	685.5	688.80
U	ppm	207	429	1	34.4	688.80
Th	ppm	207	2025	81	831.2	688.80
La	ppm	207	23100	390	7419.1	688.80
Ce	ppm	207	24400	1900	9270.2	688.80
Nd	ppm	207	7300	500	2576.2	688.80
Sm	ppm	207	633.5	44.9	264.71	688.80
Eu	ppm	207	169.4	18.2	73.52	688.80
Tb	ppm	207	65.6	5.2	25.60	688.80
Yb	ppm	207	72.3	6.8	32.31	688.80
Lu	ppm	207	10.7	1.0	4.95	688.80

Average : La+Ce+Nd = 19,265.5ppm, Sm+Eu+Tb = 363.8ppm, Yb+Lu = 37.3ppm

"Average value" = Σ core length analyzed x contents/Σ core length analyzed as follows :

- strongly mineralized in northern Buru Hill, where Holes BR–5, –6 and –7 are allocated.
- weakly mineralized in the circumscribing hem of the above, where Holes BR–14, –15 and –16 are allocated.
- strongly mineralized in gentle-sloped southern area of the Buru Hill, where Holes BR–8, –10 and –11 are allocated.
- weakly mineralized in Hole BR–9 close to western Buru Hill, which is occupied by unmineralized gneiss.
- the average values are mostly shown by other holes carried out inside of the area from the above.

(3) Vertical variations of the elements by individual holes

Figure II–4–12 and Appendix 72 show vertical variations of Nb, Y, Th, La+Ce+Nd, Sm+Eu+Tb and Yb+Lu by individual diamond drill hole of the current survey works.

The chemical content of the elements are largely dependent on the type of samples and mobilization of the elements under oxidation-reduction conditions. Also, general patterns of the variation diagrams are largely controled by sampling width and sampling frequency. The most appropriate representation of the variations may be available by the cores of drill, which has a sufficient depth to penetrate an oxidized zone and to attain a reach to a reduction zone, from which a sufficient quantity of cores should be continuously collected. Drill cores of the Hole BRL–1 is considered to be fitted for the purpose properly.

General interpretations are tentatively shown as follows in accordance with Figure II–4–12.

i) Defined by the current elevation of the water table, elements content shows a high value in an upper portion of the water table and a low value in a lower portion in general.

Variations in a lower portion should be caused by rock varieties, i.e., at some 150 m depth by brecciated carbonatite and an some 180 to 200 m depth by melanephalinte.

ii) It is generally shown in an upper portion of the water table as follows, disregarding a rock classification for the time being :

- Nb might be concentrated/remained near the ground surface.
- Y shows a little variation.
- Th and LREE are concentrated slightly underneath the ground surface.
- MREE is concentrated at a little upper portion of the water table. This should correspond to a gradual transition zone.
- HREE shows little variation, however, slightly concentrated in an upper portion.

Table II – 4 – 10 Average Value of Elements by Drill Hole

DDH No.	Number of Samples	Total length Analyzed(m)	Au (ppm)	Ba (ppm)	Sr (ppm)	Nb (ppm)	Y (ppm)	U (ppm)	Th (ppm)	La (ppm)	Ce (ppm)	Nd (ppm)	Sm (ppm)	Eu (ppm)	Tb (ppm)	Yb (ppm)	Lu (ppm)	La+Ce+Nd (ppm)	Sm+Eu+Tb (ppm)	Yb+Lu (ppm)
BRL-1	37	158.45	0.070	35,269.8	2,736.6	936.7	573.2	64.4	814.0	6,233.8	8,391.5	2,544.2	262.92	68.68	21.96	28.93	4.48	17,169.5	353.56	33.41
BR-1	12	32.90	0.077	27,853.6	1,874.4	1,009.7	497.5	25.1	544.5	6,859.6	8,555.0	2,245.6	226.68	58.86	18.76	22.02	3.89	17,660.2	304.3	25.91
BR-2	13	48.45	0.070	38,850.0	2,433.1	1,058.2	725.6	70.2	935.6	8,252.9	9,040.9	2,172.7	295.51	91.58	32.57	31.97	5.51	19,466.5	419.66	37.48
BR-3	9	46.60	0.070	66,348.4	1,217.5	1,092.4	859.2	5.8	1,172.4	6,439.2	9,401.2	2,941.6	304.24	85.33	36.37	41.36	6.01	18,782.0	425.94	47.37
BR-4	11	38.40	0.070	32,331.0	1,896.6	735.5	662.1	3.4	701.0	5,854.4	7,970.8	2,318.2	250.06	61.53	21.35	28.85	4.17	16,143.4	332.94	33.02
BR-5	10	48.30	0.070	37,013.9	1,447.4	1,083.0	788.0	9.8	1,105.7	7,601.2	10,056.7	2,824.4	292.17	89.03	34.98	34.15	5.00	20,482.3	416.18	39.15
BR-6	11	32.90	0.070	51,586.0	1,928.3	609.7	680.9	51.3	676.8	9,109.4	12,356.5	3,353.5	255.54	63.16	21.48	29.22	4.44	24,819.4	340.18	33.66
BR-7	10	33.10	0.070	45,542.0	1,312.1	910.9	720.7	26.8	628.8	8.730.5	10,153.8	2,510.3	237.75	65.57	27.21	34.52	4.92	21,394.60	330.53	39.44
BR-8	13	49.70	0.070	52,412.7	1,792.4	766.0	665.9	45.6	791.6	9,817.0	10.887.8	2,646.7	268.22	70.34	24.70	29.92	4.93	23,351.5	363.26	34.85
BR-9	11	21.25	0.079	29,768.2	1,946.5	1,470.8	436.5	10.9	516.0	4,820.6	6,392.2	1,823.3	200.58	48.86	17.72	23.86	4.03	13,036.1	267.16	27.89
BR-10	12	42.00	0.070	34,761.0	1,606.5	852.1	618.8	17.2	716.6	9,517.4	11,072.6	2,664.5	233.94	64.28	18.08	33.43	5.81	23,254.5	316.3	39.24
BR-11	14	48.95	0.070	36,973.7	1,341.8	1,138.9	809.3	12.3	767.4	9,404.8	9,534.4	2,394.5	233.78	71.46	26.39	43.00	6.40	21,333.7	331.63	49.4
BR-12	11	29.50	0.070	49,167.3	1,229.7	1,560.4	1,160.8	33.7	1,085.7	7,454.6	9,176.1	2,632.5	317.23	112.69	39.85	48.72	6.12	19,263.2	469.77	54.84
BR-13	14	35.40	0.070	53,349.0	1,927.7	726.0	794.5	15.8	951.7	6,403.5	8,554.1	2,727.8	334.42	90.33	27.51	35.52	5.32	17,685.4	452.26	40.84
BR-14	8	11.85	0.070	22,576.8	2,605.3	1,169.4	603.3	15.1	792.9	5,466.9	7,183.5	2,152.7	244.18	66.75	23.75	25.24	3.60	14,803.1	334.68	28.84
BR-15	9	11.95	0.070	70,160.7	1,016.7	241.4	398.6	21.5	814.3	4,879.4	8,597.1	3,184.5	188.75	52.44	13.18	14.07	2.23	16,661.0	254.37	16.3
BR-16	3	2.00	0.070	79,815.0	665.0	625.8	481.0	7.4	1,160.8	4,310.0	5,470.0	2,135.0	205.71	66.07	17.00	29.58	3.71	11,915.0	288.78	33.29
Average	207	688.80	0.071	41,818.8	1,930.6	954.3	685.5	34.4	831.2	7,419.1	9,270.2	2,576.2	264.71	73.52	25.60	32.31	4.95	19,265.5	363.83	37.26

Average value = Σ core length analyzed x contents / Σ core length analyzed

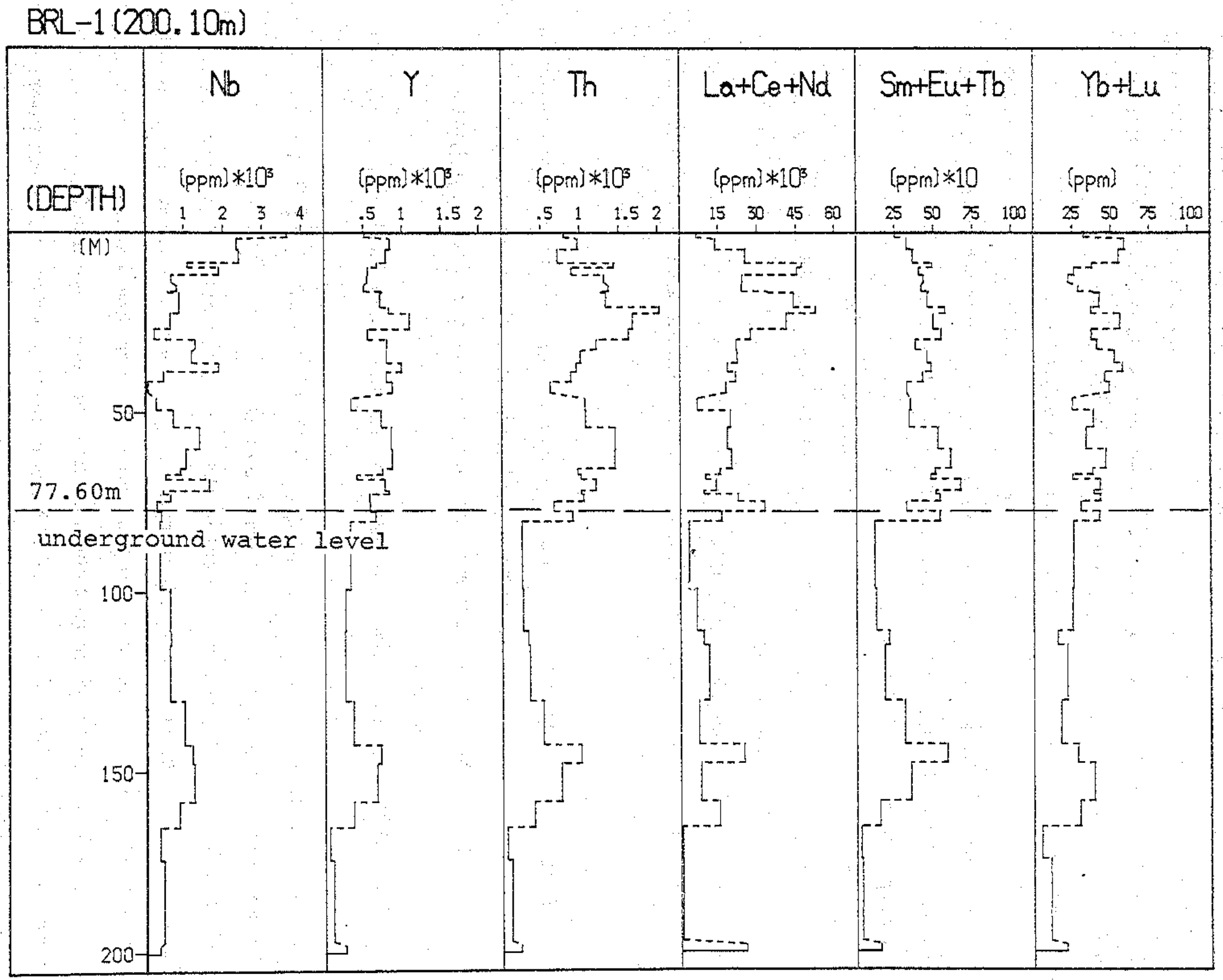


Fig. II – 4 – 12 Vertical Variation of Elements, BRL–1

It is to be noted that the general tendency of the vertical variations of the element in the area should be examined in details in connection with the water table elevation of the past geological time and comparisons between types of rock facies. Further implementations of the deeper drill hole than the above, from which more numerous samples should be collected, are required to achieve an elucidation of the general tendency the above.

(3) Lateral and vertical variations of the elements in mineralized zone

In order to establish a more brief summary of the general tendency on variations of the chemical content of the elements, re-calculations of weighted average values were implemented by making individual diamond drill informations into three (3) zonings vertically.

Zonings were made as follows :

Zoning A

- Zone I : Heavily weathered zone, toward 15 metres depth from the ground surface normally.
- Zone II : Oxidized mineralized zone.
- Zone III : Fresh zone, deeper than the water table elevation, that is 1295 m high above sea level.

Zoning B

- Zone I : Weathered zone close to ground surface, overburden and/or argillized zone, toward 5 metres depth from the ground surface normally.
- Zone II : Mineralized basement rock, including carbonatitic dykes overlying massive carbonatite.
- Zone III : Massive carbonatite, including ferrocarbonatite and veins intersecting carbonatite.

The outlined results of re-calculations are shown in Tables II–4–11 and II–4–12.

Average values are shown in lower columns of the Tables.

Little variation of the chemcial content of the elements are observed in Zones I and II. Elements, other than Sr, show a low content remarkably in Zone III. This tendency likely corresponds to the previous description in (3), that carbonatite carry low contents of the elements.

Lateral variations of the chemcial content of the elements are shown in Figures II–4–13, II–4–14 and II–4–15. Nb, Y and La+Ce+Nd were selected for the representing element/component. Sm+Eu+Tb and Yb+Lu are not shown due to less variation. The type of "Zoning B" is selected for a delineation, as Zone III is limitedly distributed by Zoning A.

4–6 DISCUSSION

The followings are elucidated and pointed out by detailed geological survey and diamond drill operations of the current survey works, Phase 2.

i) The Buru Hill was geologically formed by a carbonatite intrusion. The carbonatite is of a sub-surface occurrence overlain by fractuned basement rock of roof type.
A gentle rise of topography, which provides a geological implication of sub-surface occurrence of an additional carbonatite, is observed in southern portion of the Buru Hill. More detailed additional investigation works are required successively.

ii) The primarily mineralized materials in the Buru Hill Area are composed of carbonatite, ferrocarbonatite, calcareous iron ore, manganiferrous iron ore, siliceous ore in the order of formative succession. Particular attention should be extended to gneiss, which is mineralized by the mineralizing materials in the forms of veins, networks, disseminations and of supergene enrichment by oxydation.

iii) Bastnaésite, synchysite, parisite, huanghoite are discernible as the fluorine-bearing carbonate minerals. Bastnaésite is at the most abundant. Pyrochlore is also discernible as a Nb-bearing mineral.

iv) After chemical analyses of the drill cores of the current workds, an intense mineralization of REE, Y, Nv and etc. was elucidated widely in the Buru Hill Area, excluding the northern portion of the area, where Drill Hole BR–14, –15 and –16 were carried out. Extentions of the mineralized zone toward east, south and west, is still unknown by the current drill works. Further drills are required in the future.

v) Weighted chemical average values show Nb : 0.095%, Y : 0.065%, La+Ce+Nd : 1.93%, Sm+Eu+Tb : 0.036%, Yb+Lu : 0.0037%. The La+Ce+Nd value shows a higher content than that obtained by Phase–1 work–1.31%,– when ground surface samples were properly processed, while, Nb and Y do not show any remarkable difference.

vi) Ferrocarbonatite, gossanous rock, soil and oxidized weathered gneiss show high contents of Light REE (La, Ce, Nd), while, the latest two types of rock are considered to be strongly supergene enriched. Massive carbonatite carries low REE content. However, geological informations have been available by only Hole BRL–1 of current survey work. Additional deep hole drills are required to obtain further informations.

vii) Supergene enrichment of the elements are observed by Hole BRL–1 in an upper portion of the current water table elevation – 1.925 metres high above sea level. Vertical variations of individual elements were examined by processing drill cores of Hole BRL–1. Concentration tendencies of Nb near to the ground surface, of Light REE (La, Ce, Nd) to a shallow portion from ground surface, of Medium REE (Sm, Eu, Tb) to an upper portion of the water table elevation, are clearly observed.

viii) Mineralized zones were classified into two types of ocurrence, i.e., intrusive massive carbonatite itself and the overlying rock. The former clearly carries a low content of REE, while, the latter a high content. Further deep hole drills, which should have sufficient lengths to penetrate massive carbonatite body are required.

ix) Several species of REE mineals have been identified from drill cores, meanwhile, modes of mineral occurrence on the ground surface and in supergene enriched zone have not yet been thoroughly investigated by the current survey works. Metallurgical refractorinesses of REE and Y are also to be carefully noted. Further mineralogical examinations are required.

Table II – 4 – 11 Average Value of Elements by Zone--(1)

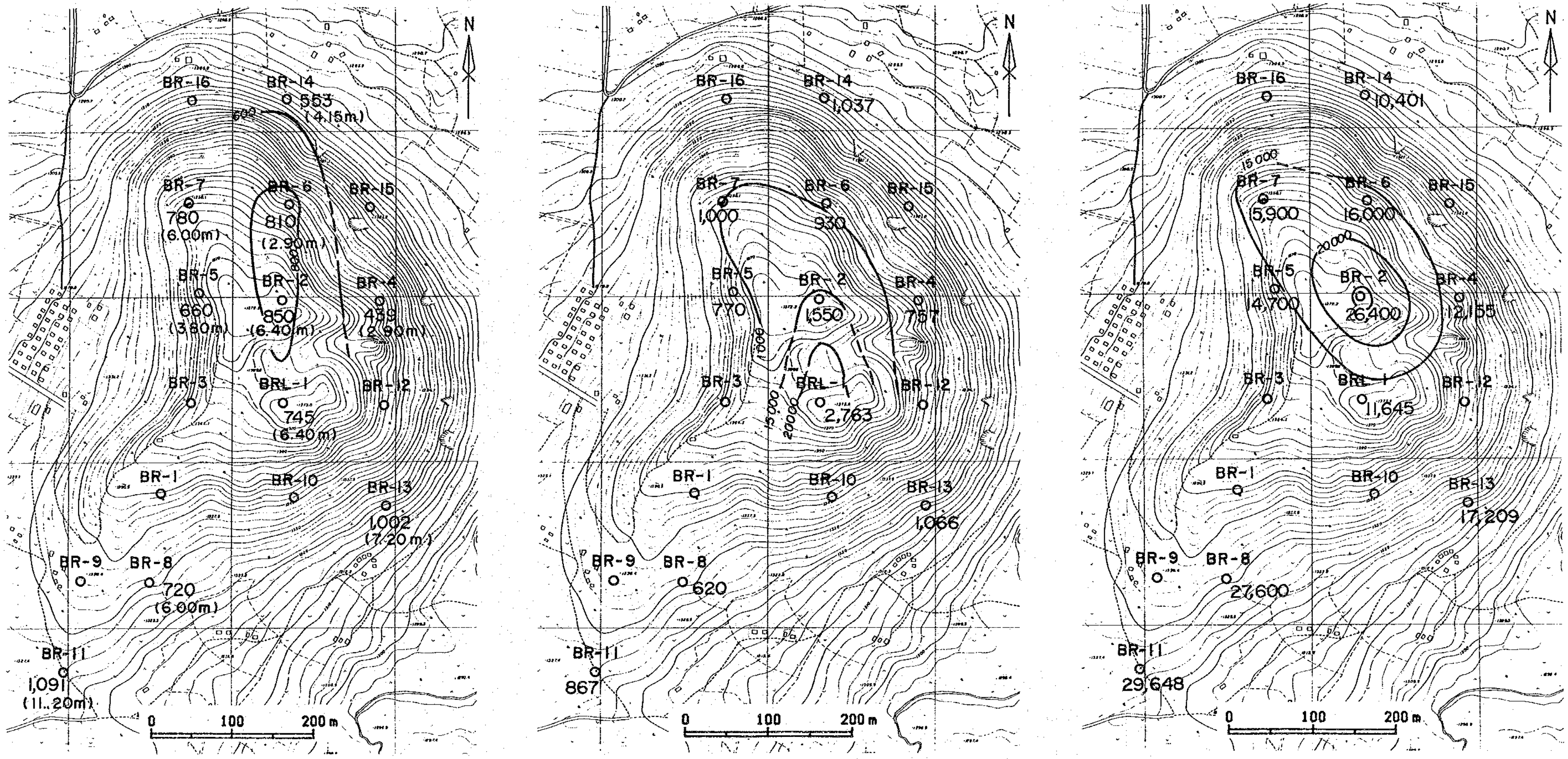
DDH No.	Zone	Number of Samples	Total length Analyzed(m)	Au (ppm)	Ba (ppm)	Sr (ppm)	Nb (ppm)	Y (ppm)	U (ppm)	Th (ppm)	La (ppm)	Ce (ppm)	Nd (ppm)	Sm (ppm)	Eu (ppm)	Tb (ppm)	Yb (ppm)	Lu (ppm)	La+Ce+Nd (ppm)	Sm+Eu+Tb (ppm)	Yb+Lu (ppm)
BRL-1	Str. weth. Z	6	13.70	0.070	46,506.2	1,490.0	2,062.7	694.8	214.5	970.0	10,196.4	12,618.6	3,204.0	275.89	74.68	25.97	36.41	6.48	26,019.0	376.54	42.89
	Oxd. Min. Z	21	60.25	0.070	40,229.4	1,679.4	872.0	769.1	117.8	1,220.3	9,242.6	11,424.8	3,151.9	348.18	95.51	31.49	35.89	5.75	23,819.3	475.18	41.64
	Fresh. Z	10	84.50	0.070	29,911.8	3,692.4	800.2	413.8	2.0	499.0	3,446.0	5,543.3	2,003.9	200.03	48.57	14.52	22.75	3.25	10,993.2	263.12	26.00
BR-1	Str. weth. Z	2	9.60	0.070	11,951.0	2,046.1	1,246.9	522.7	5.8	493.1	1,472.9	3,318.7	1,359.4	201.29	56.83	20.80	23.96	3.63	6,151.0	278.92	27.59
	Oxd. Min. Z	10	23.30	0.081	34,405.8	1,803.6	912.0	487.1	33.1	565.6	9,079.0	10,712.4	2,610.7	237.14	59.70	17.91	21.22	3.99	22,402.1	314.75	25.21
BR-2	Str. weth. Z	4	13.40	0.070	38,347.0	1,738.1	1,284.4	654.5	12.0	794.3	8,077.6	9,279.1	2,398.5	257.28	75.53	25.47	30.62	5.51	19,755.2	358.28	36.13
	Oxd. Min. Z	9	35.05	0.070	39,042.2	2,698.8	971.7	752.7	92.4	989.6	8,320.0	8,949.8	2,086.3	310.12	97.72	35.29	32.48	5.51	19,356.1	443.13	37.99
BR-3	Str. weth. Z	2	10.90	0.070	67,525.7	850.9	985.9	633.0	3.8	1,155.2	3,452.3	7,139.4	3,028.4	270.36	72.41	25.98	31.32	4.41	13,620.1	368.75	35.73
	Oxd. Min. Z	7	35.70	0.070	65,988.9	1,329.4	1,124.9	928.3	6.4	1,177.6	7,351.1	10.091.7	2,915.1	314.59	89.28	39.54	44.43	6.50	20,357.9	443.41	50.93
BR-4	Str. weth. Z	5	12.60	0.070	38,923.0	2,122.6	861.8	663.5	2.1	586.3	4,608.7	6,704.8	2,149.2	235.08	51.10	19.00	30.22	4.17	13,462.7	305.18	34.39
	Oxd. Min. Z	6	25.80	0.070	29,111.6	1,786.2	673.8	661.4	4.0	757.0	6,462.8	8,589.1	2,400.8	257.37	66.63	22.50	28.18	4.17	17,452.7	346.50	32.35
BR-5	Str. weth. Z	3	14.90	0.070	48,282.5	1,974.8	824.6	1,039.2	11.9	1,323.4	9,223.5	11,598.7	3,264.4	349.46	113.31	44.00	44.32	6.05	24,086.6	506.77	50.37
	Oxd. Min. Z	7	33.40	0.070	31,986.8	1,212.1	1,198.3	675.9	8.8	1,008.5	6,877.5	9,368.9	2,628.1	266.61	78.20	30.95	29.61	4.53	18,874.5	375.76	34.14
BR-6	Str. weth. Z	3	10.50	0.070	32,293.3	1,288.1	630.5	681.8	18.5	603.0	5,868.6	8,312.4	2,371.4	224.44	63.77	26.02	24.82	3.59	16,552.4	314.23	28.41
	Oxd. Min. Z	8	22.40	0.070	60,629.5	2,228.3	600.0	680.5	66.5	711.4	10,628.6	14,252.2	3,813.8	270.12	62.88	19.35	31.28	4.84	28,694.6	352.35	36.12
BR-7	Str. weth. Z	3	13.00	0.070	38,453.8	1,407.7	940.5	748.2	18.9	452.3	6,236.2	7,976.9	2,030.0	210.33	62.04	28.53	34.82	4.78	16,243.1	300.90	39.60
	Oxd. Min. Z	7	20.10	0.070	50,126.4	1,250.2	891.7	702.9	32.0	742.9	10,343.8	11,561.7	2,820.9	255.49	67.86	26.36	34.33	5.00	24,726.4	349.71	39.33
BR-8	Str. weth. Z	9	36.40	0.070	61,472.7	1,784.1	656.0	705.5	57.6	806.0	11,172.0	12,151.0	2,925.7	279.01	74.17	25.48	30.32	4.94	26,248.7	378.66	35.26
	Fresh Z	4	13.30	0.070	27,616.9	1,815.0	1,066.9	557.7	13.0	752.2	6,108.6	7,430.8	1,883.1	238.69	59.85	22.57	28.80	4.90	15,422.5	321.11	33.70
BR-9	Str. weth. Z	2	1,75	0.184	36,157.1	321.4	309.3	585.7	3.6	783.0	4,571.4	7,071.4	2,328.6	257.09	58.66	18.29	30.49	5.73	13,971.4	334.04	36.22
	Oxd. Min. Z	7	13.90	0.070	37,198.6	2,020.1	1,393.5	504.1	14.9	598.0	5,786.9	7,569.8	2,120.1	231.51	55.42	20.89	26.53	4.49	15,476.8	307.82	31.02
	Fresh Z	2	5.60	0.070	9,328.6	2,271.4	2,025.7	222.1	3.4	229.0	2,500.0	3,257.1	928.6	106.16	29.53	9.67	15.17	2.36	6,685.7	145.36	17.53
BR-10	Str. weth. Z	2	8.60	0.070	33,409.3	1,573.3	978.8	770.0	9.9	973.7	12,202.3	13,083.7	3,081.4	318.97	91.47	26.85	38.49	7.02	28,367.4	475.78	45.51
	Oxd. Min. Z	9	31.20	0.070	33,812.2	1,566.8	831.4	553.1	16.8	632.7	8,348.4	10,100.3	2,476.6	211.11	55.28	15.07	31.09	5.31	20,925.3	281.46	36.40
	Fresh Z	1	2.20	0.070	53,500.0	2,300.0	650.0	960.0	51.0	903.0	15,600.0	17,000.0	3,700.0	225.40	85.60	26.60	46.90	8.10	36,300.0	337.60	55.00
BR-11	Str. weth. Z	3	17.90	0.070	40,550.8	481.0	1,010.3	1,206.7	18.6	1,160.4	13,320.1	12,922.3	3,312.8	338.36	105.83	41.62	63.36	9.51	29,555.2	485.81	72.87
	Oxd. Min. Z	7	20.20	0.070	37,591.1	1,820.5	1,683.2	592.9	9.2	497.6	6,845.3	7,081.9	1,714.1	147.68	46.56	16.83	32.47	4.91	15,641.3	211.07	37.38
	Fresh Z	4	10.85	0.070	29,922.6	1,870.5	337.7	556.7	7.4	621.1	7,710.5	8,511.1	2,146.1	221.55	61.09	19.04	20.01	4.03	18,367.7	301.68	33.04
BR-12	Str. weth. Z	2	4.90	0.070	86,587.8	580.6	2,255.1	411.2	21.6	318.5	3,806.5	6,881.6	2,940.8	195.67	62.13	17.50	26.00	4.23	13,628.9	275.3	30.23
	Oxd. Min. Z	9	24.60	0.070	41,713.6	1,359.0	1,362.3	1,310.1	36.1	1,238.5	8,181.3	9,633.1	2,571.1	341.45	122.76	44.31	53.25	6.50	20,385.5	508.52	59.75
BR-13	Str. weth. Z	2	7.20	0.070	40,763.9	2,320.1	1,066.4	1,002.2	18.6	971.8	7,143.1	8,443.1	1,623.6	243.12	81.13	31.48	57.03	8.00	17,209.8	355.73	65.03
	Oxd. Min. Z	2	5.05	0.070	45,905.0	1,188.6	767.6	832.6	17.6	900.6	1,616.8	3,477.2	1,139.6	386.29	110.29	30.00	35.72	4.55	6,233.6	526.58	40.27
	Fresh Z	10	23.15	0.070	58,887.0	1,966.8	611.0	721.6	14.5	956.6	7,217.7	9,696.1	3,417.7	351.50	88.84	25.73	28.79	4.65	20,331.5	466.07	33.44
BR-14	Str. weth. Z	6	7.80	0.070	28,151.3	2,204.8	735.8	433.8	17.8	705.5	5,601.0	7,296.8	2,232.7	217.34	52.00	16.72	20.76	3.06	15,130.5	286.06	23.82
	Fresh Z	2	4.05	0.070	11,840.7	3,376.5	2,004.3	929.6	9.9	961.3	5,208.6	6,965.4	1,998.8	295.88	95.16	37.29	33.85	4.62	14,172.8	428.33	38.47
BR-15	Str. weth. Z	2	1.60	0.070	71,012.5	742.2	426.6	220.8	7.0	723.3	2,071.9	4,759.4	2,446.9	224.69	45.99	8.72	8.89	1.27	9,278.2	279.4	10.16
	Oxd. Min. Z	1	0.40	0.070	38,300.0	650.0	175.0	185.0	7.0	895.0	610.0	3,000.0	2,800.0	330.50	70.80	9.60	9.60	1.70	6,410.0	410.9	11.30
	Fresh Z	6	9.95	0.070	71,304.5	1,075.6	214.3	435.8	24.4	825.7	5,502.5	9,439.2	3,318.6	177.27	52.74	14.04	15.08	2.40	18,260.3	244.05	17.48
BR-16	Str. weth. Z	3	2.00	0.070	79,815.0	665.0	625.8	481.0	7.4	1,160.8	4,310.0	5,470.0	2,135.0	205.71	66.07	17.00	29.58	3.71	11,915.0	288.78	33.29
Average	Str. weth. Z	59	186.75	0.071	45,918.3	1,539.6	1,011.9	748.6	36.2	845.9	8,147.9	9,765.2	2,662.2	267.46	75.83	27.55	35.51	5.46	20,575.3	370.84	40.97
	Oxd. Min. Z	110	348.85	0.071	42,077.3	1,701.1	986.2	737.8	45.0	917.0	8,158.9	10,042.9	2,654.5	280.68	79.46	28.14	34.10	5.25	20,856.3	388.28	39.35
	Fresh Z	39	153.60	0.070	35.873.2	2,891.5	798.4	498.6	7.6	627.8	4,865.6	6,912.9	2,286.7	225.72	57.83	17.79	24.49	3.68	14,065.2	301.34	28.17

Average value = Σ length analyzed x contents / Σ length analyzed
Str. weth. Z ; Strongly weathered zone (usually 15m from surface)
Oxd. Min. Z ; Oxidized mineralized zone
Fresh Z ; Fresh zone (below 1,295m from the sea level)

Table II – 4 – 12 Average Value of Elements by Zone–(2)

DDH No.	Rock Type	Number of Samples	Total length Analyzed(m)	Au (ppm)	Ba (ppm)	Sr (ppm)	Nb (ppm)	Y (ppm)	U (ppm)	Th (ppm)	La (ppm)	Ce (ppm)	Nd (ppm)	Sm (ppm)	Eu (ppm)	Tb (ppm)	Yb (ppm)	Lu (ppm)	La+Ce+Nd (ppm)	Sm+Eu+Tb (ppm)	Yb+Lu (ppm)
BRL-1	Surf. Mat	2	4.40	0.070	21,881.8	847.7	2,763.6	745.0	67.9	925.7	3,468.2	6,195.5	1,981.8	216.24	63.29	26.33	43.75	6.99	11,645.5	305.86	50.74
	Min. Basm	17	46.10	0.070	45,123.0	1,743.4	958.0	750.3	207.7	1,172.5	11,211.1	13,365.6	3,292.8	315.13	84.99	28.38	36.12	6.51	27,869.5	428.50	42.63
	Msv. Carb	18	107.95	0.070	31,607.7	3,237.7	853.2	490.6	3.0	656.3	4,221.0	6,356.7	2,247.4	242.53	61.93	19.04	25.25	3.51	12,825.1	323.50	28.76
BR-1	Msv. Carb	12	32.90	0.077	27,853.6	1,874.4	1,009.7	497.5	25.1	544.5	6,859.6	8,555.0	2,245.6	226.68	58.86	18.76	22.02	3.89	17,660.2	304.30	25.91
BR-2	Surf. Mat	1	6.40	0.070	53,500.0	1,900.0	1,550.0	850.0	4.0	981.0	11,100.0	12,100.0	3,200.0	327.70	96.80	33.20	43.00	7.60	26,400.0	457.70	50.6
	Min. Basm	12	42.05	0.070	36,620.2	2,514.2	983.4	706.6	80.2	928.7	7,819.6	8,575.3	2,016.3	290.61	90.79	32.48	30.29	5.19	18,411.2	413.88	35.48
BR-3	Min. Basm	9	46.60	0.070	66,348.4	1,217.5	1,092.4	859.2	5.8	1,172.4	6,439.2	9,401,2	2,941.6	304.24	85.33	36.37	41.36	6.01	18,782.0	425.94	47.37
BR-4	Surf. Mat	2	2.90	0.070	83,517.2	1,520.7	757.8	439.5	2.6	355.3	4,469.0	6,003.4	1,682.8	141.68	32.91	12.61	20.04	2.67	12,155.2	187.20	22.71
	Min. Basm	7	27.80	0.070	27,029.9	1,582.9	812.8	715.1	3.9	785.6	5,072.3	7,729.9	2,481.7	281.84	66.64	22.51	30.38	4.33	15,283.9	370.99	34.71
	Msv. Carb	2	7.70	0.070	32,192.2	3,170.8	448.2	544.7	2.0	525.9	9,200.0	9,581.8	1,967.5	176.15	53.89	20.46	26.65	4.18	20,749.3	250.50	30.83
BR-5	Min. Basm	9	44.50	0.070	34,733.5	1,434.4	1,109.7	798.9	10.4	1,123.1	7,900.2	10,258.0	2,818.0	292.68	89.55	35.30	34.80	5.14	20,976.2	417.53	39.94
	Surf. Mat	1	3.80	0.070	32,100.0	1,600.0	770.0	660.0	2.0	902.0	4,100.0	7,700.0	2,900.0	286.10	83.00	31.20	26.50	3.30	14,700.0	400.30	29.80
BR-6	Surf. Mat	1	2.90	0.070	39,000.0	1,450.0	930.0	810.0	7.0	551.0	7,000.0	7,200.0	1,800.0	232.60	79.20	36.20	39.80	4.90	16,000.0	348.00	44.70
	Min. Basm	10	30.00	0.070	52,802.7	1,974.5	578.7	668.5	55.5	689.0	9,313.3	12,855.0	3,503.7	257.76	61.61	20.06	28.20	4.40	25,672.0	339.43	32.60
BR-7	Surf. Mat	1	6.00	0.070	28,100.0	1,800.0	1,000.0	780.0	24.0	428.0	6,100.0	7,700.0	2,100.0	219.80	64.00	30.20	40.80	5.30	15,900.0	314.00	46.10
	Min. Basm	9	27.10	0.070	49,403.7	1,204.1	891.1	707.5	27.5	673.3	9,312.9	10,697.0	2,601.1	241.73	65.92	26.55	33.13	4.83	23,611.0	334.20	37.96
BR-8	Surf. Mat	1	6.00	0.070	68,000.0	1,450.0	620.0	720.0	132.0	935.0	11,900.0	12,800.2	2,900.0	307.80	79.20	28.00	28.70	5.80	27,600.0	415.00	34.50
	Min. Basm	7	27.35	0.070	62,981.7	1,889.0	669.1	742.5	45.3	825.6	10,563.1	11,690.9	2,945.3	280.28	76.47	26.24	32.00	5.00	25,199.3	382.99	37.00
	Msv. Carb	5	16.35	0.070	29,012.8	1,756.3	981.7	518.0	14.5	682.0	7,804.6	8,842.8	2,054.1	233.53	56.82	20.92	26.88	4.51	18,701.5	311.27	31.39
BR-9	Min. Basm	3	4.25	0.117	29,182.4	1,750.0	2,362.6	617.6	14.4	580.1	3,647.1	6,147.1	2,194.1	268.39	66.98	24.18	31.73	5.54	11,988.3	359.55	37.27
	Msv. Carb	8	17.00	0.070	29,914.7	1,995.6	1,247.8	391.2	10.1	500.0	5,114.0	6,453.5	1,730.6	183.63	44.33	16.10	21.90	3,66	13,298.1	244.06	25.56
BR-10	Min. Basm	5	17.90	0.070	40,983.2	1,419.8	881.9	646.3	15.8	877.5	10,449,7	11,761.5	2,993.9	282.08	77.67	21.20	33.31	6.10	25,205.1	380.95	39.41
	Msv. Carb	7	24.10	0.070	30,139.4	1,745.2	830.0	598.4	18.2	597.2	8,824.9	10,561.0	2,419.9	198.20	54.32	15.77	33.52	5.59	21,805.8	268.29	39.11
BR-11	Surf. Mat	2	11.20	0.070	42,316.1	409.8	867.0	1,091.1	24.4	929.2	12,913.4	13,115.2	3,619.6	341.33	100.59	37.51	60.05	8.85	29,648.2	479.43	68.90
	Min. Basm	2	11.30	0.070	29,824.8	579.6	2,064.2	1,070.3	9.0	1,163.5	8,911.5	8,529.2	2,026.5	251.09	85.09	36.12	56.44	8.52	19,467.2	372.30	64.96
	Msv. Carb	10	26.45	0.070	37.765.6	2,062.0	858.8	578.6	8.5	529.6	8,129.8	8,447.6	2,032.9	180.85	53.30	17.52	30.04	4.45	18,610.3	251.67	34.49
BR-12	Min. Basm	6	14.60	0.070	52.232.2	970.2	1,972.4	1,129.0	37.9	865.0	3,987.1	7,005.5	2,669.9	315.81	115.60	44.10	42.87	5.41	13,662.5	475.51	48.28
	Msv. Carb	5	14.90	0.070	46,164.1	1,484.1	1,156.7	1,191.9	29.5	1,301.9	10,852.3	11,303.0	2,596.0	318,63	109.84	35.69	54.46	6.82	24,751.3	464.16	61.28
BR-13	Surf. Mat	2	7.20	0.070	40,763.9	2,320.1	1,066.4	1,002.2	18.6	971.8	7,143.1	8,443.1	1,623.6	243.12	81.13	31.48	57.03	8.00	17,209.8	355.73	65.03
	Min. Basm	1	2.00	0.070	54,300.0	1,400.0	520.0	1,050.0	23.0	1,051.0	2,100.0	3,900.0	1,200.0	479.00	153.90	44.80	48.10	5.40	7,200.0	677.70	53.50
	Msv. Carb	11	26.20	0.070	56,734.9	1,860.1	648.1	717.9	14.5	938.6	6,528.8	8,939.9	3,147.9	348.47	88.01	25.10	28.65	4.58	18,616.6	461.58	33.23
BR-14	Surf. Mat	2	4.15	0.070	23,348.2	1,034.3	1,037.5	553.3	9.7	634.6	3,928.9	4,934.9	1,537.3	183.23	49.05	18.35	31.86	4.53	10,401.1	250.63	36.39
	Msv. Carb	5	4.80	0.070	31,381.2	5,084.4	358.6	346.4	22.3	813.2	7,501.6	9,842.7	2,897.9	258.87	58.88	16.12	10.40	1.64	20,242.2	333.87	12.04
BR-15	Min. Basm	9	11.95	0.070	70,160.7	1,016.7	241.4	398.6	21.5	814.3	4,879.4	8,597.1	3,184.5	188.75	52.44	13.18	14.07	2.23	16,661.0	254.37	16.30
BR-16	Min. Basm	3	2.00	0.070	79,815.0	665.0	625.8	481.0	7.4	1,160.8	4,310.0	5,470.0	2,135.0	205.71	66.07	17.00	29.58	3.71	11,915.0	288.78	33.29
Average	Surf. Mat	15	54.95	0.070	42,891.6	1,377.1	1,115.8	829.5	31.7	812.1	8,289.4	9,525.2	2,528.3	267.89	78.47	30.22	43.21	6.48	20,342.9	376.58	49.68
	Min. Basm	109	355.50	0.071	47,365.6	1,586.6	988.3	759.2	52.8	954.0	8,133.8	10,234.3	2,795.3	284.10	80.64	29.31	34.31	5.34	21,163.4	394.05	39.65
	Msv. Carb	83	278.35	0.071	34,552.8	2,479.2	879.1	562.8	11.4	678.1	6,334.5	7,988.4	2,305.7	239.32	63.46	19.96	27.60	4.16	16,628.6	322.74	31.76

Average value = Σ length analyzed x contents /Σ length analyzed
Surf. Mat ; Surface material (soil or clay zones)
Min. Basm ; Mineralized Basements
Msv. Carb ; Massive Carbonatite



(A) Y ppm

(16.35 m) : Total core length of each zone analyzed

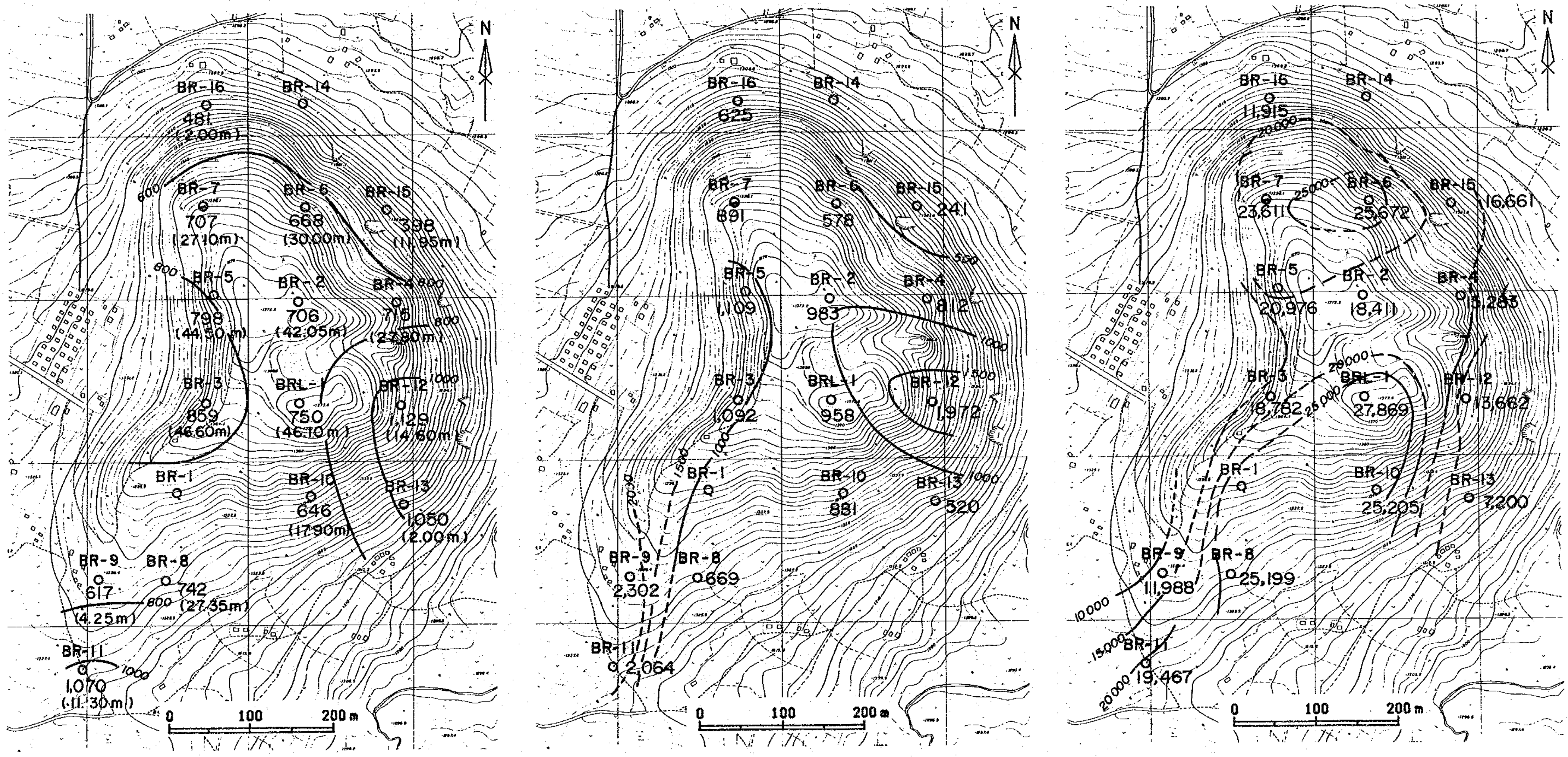
(B) Nb ppm

Total core length of each zone analyzed is shown on (A).

(C) La + Ca + Nd ppm

Total core length of each zone analyzed is shown on (A).

Fig. II – 4 – 13 Distribution of Y, Nb and La+Ce+Nd Contents in the Weathered Surface Zone



(A) Y ppm

(16.35m) : Total core length of each zone analyzed

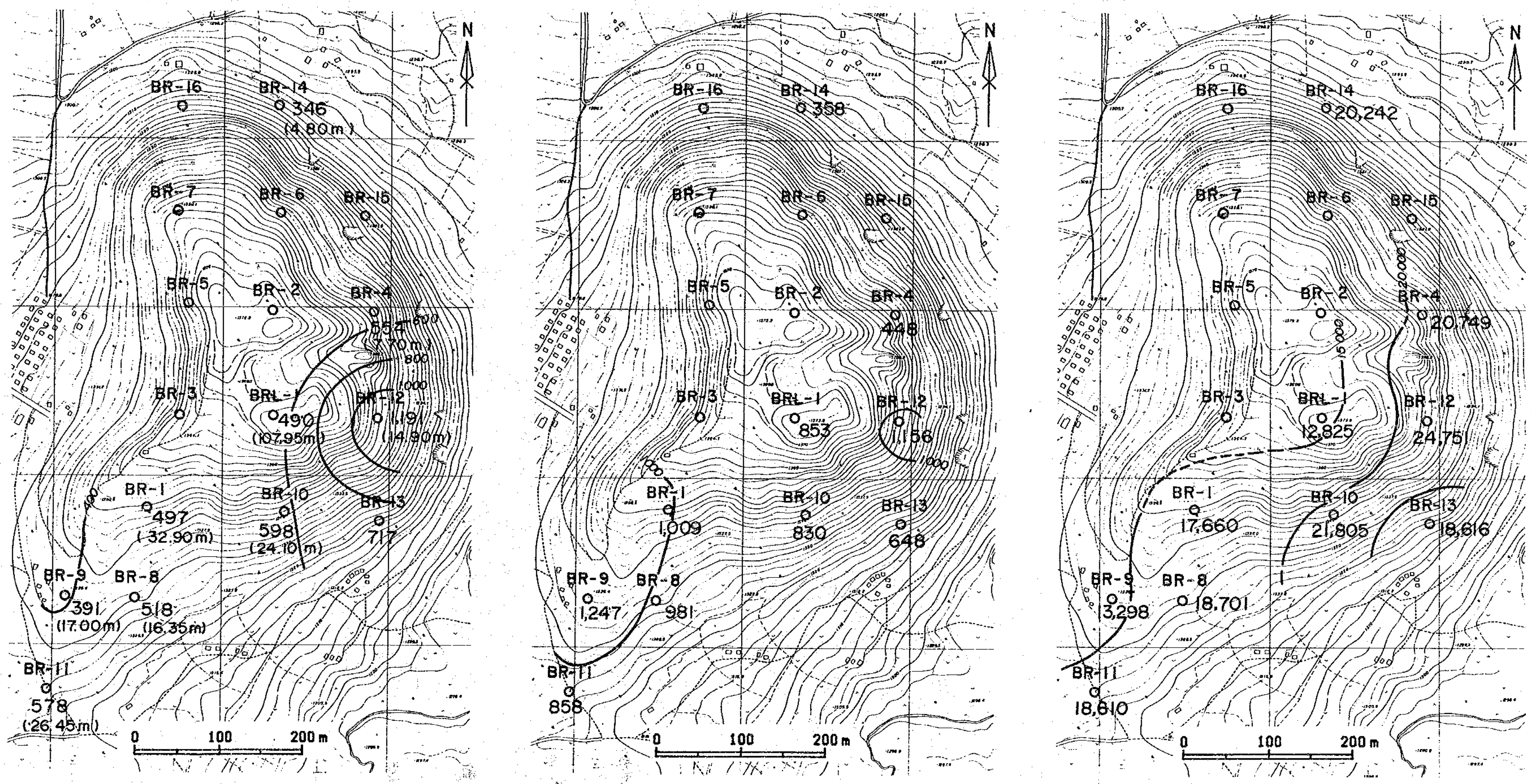
(B) Nb ppm

Total core length of each zone analyzed is shown on (A).

(C) La + Ca + Nd ppm

Total core length of each zone analyzed is shown on (A).

Fig. II – 4 – 14 Distribution of Y, Nb and La+Ce+Nd Contents in the Weathered Mineralized Basement Zone



(A) Y ppm

(16.35m) : Total core length of each zone analyzed

(B) Nb ppm

Total core length of each zone analyzed is shown on (A).

(C) La + Ca + Nd ppm

Total core length of each zone analyzed is shown on (A).

Fig. II – 4 – 15 Distribution of Y, Nb and La+Ce+Nd Contents in the Massive Carbonatite Zone