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Textural and Mineralogical Significances of Charnockites from Localised Area of Ado-Ekiti, Ekiti-State

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ABSTRACT

Samples of Charnockite from five (5) localised area of Ado-Ekiti, Ekiti-State Southwestern Nigeria (Idemo Area, Balota Community, Ado/Ikere Road, Igirigiri Road and Ado/Ijan Road) have been subjected to petrographical analysis in order to determine their textural and mineralogical significances. The samples were sectioned with diamond-coated cutting wheel and the sections were set in epoxy resin and polished to a 1µm diamond paste finish. After necessary preparations, the sections were studied with petrological microscope under both crossed and plane polarised light at X80 magnification, and the estimated modal counts of the minerals and compositions of the minerals present in each slide were determined. The results revealed that all the studied Charnockite rocks contain Quartz, Biotite, Hornblende and Feldspar. The higher average percentage of quartz of 40-60% showed that the rock could have been of intermediate acidic composition. All the slides have quartz as constituent mineral at an average percentage occurrence of 37%. Biotite is also present at an average percentage occurrence of 25%. Except in the sample of Charnockite from Balota where the Biotite is altered with mottled appearance. All the slides have hornblende with maximum occurrence in Balota at 29.4% and minimum occurrence of 5.3% within the Charnockite from Ado/Ijan road. Most of the studied rocks are porphyritic in texture except the ones at Ado-Ijan road and Igirigiri that are Granulitic and Equigranular respectively. Because of differences in melting temperatures and growth rates, the surrounding material may not have appreciably crystallized and this is an indication that the studied rocks are likely to be magmatic origin. Idemo and Ado/Ikere Charnockite have porphyritic texture. Ado/Ijan charnockite is granulitic. Igirigiri sample of charnockite is equigranular while Balota is granular porphyritic. The altered or mottled biotite in Balota must have exhibited the difference between biotite and hornblende by mottled appearance of the interference colours in the large biotite crystal which is near to its extinction position.

INTRODUCTION

Charnockite is a series of foliated metamorphosed igneous rock of wide distribution. The charnockite series include rock of many different types some being acid and rich in quartz and microcline other, basic and full of pyroxene and Olivine, while there are also intermediate varieties corresponding, mineralogically to norites, quartz norites and diorites. A special feature, re – occurring in many member of the group is the presence of strongly pleochroic reddish or green hypersthene.

According to Nwodim, *et al*, (1998). The mineral composition of the Ado – Ekiti charnockites are quartz, alkali feldspar, and the ferromagnesian minerals like hornblende, olivine pyroxene and biotite: other minerals include Zircon and Apatite.

Charnockitic rocks are broadly defined as granitoids in terms of Quartz-Alkali feldspar Plagioclase (QAP) ternary space but contain orthopyroxene (or fayalite + quartz) and, typically, perthite, mesoperthite or antiperthite (Le Maitre, 2002). Although not included in the formal definition, charnockitic rocks are typically characterized by meso- to melanocrati colour indices, being commonly described as having a —dark green, greasy lustre and in contrast to the leuco appearance normally expected of granitoids.

Charnockitic rocks generally have diverse origins, spanning a range of metamorphic and igneous derivations (Kilpatrick and Ellis, 1992), which implies that igneous or metamorphic

fabric can be exhibited. In Nigeria, charnockitic rocks constitute one of the major petrologic units of the Precambrian basement complex (Olarewaju, 2006). The rock suite has been of interest to the earth scientists partly because of aesthetic value particularly when polished and partly because of the controversy surrounding the origin. Oyawoye (1962, 1964), presented a model of metasomatic origin, Olarewaju (1988), presented the fractional crystallization model while Rahaman *et al*. (1988) presented the tectonic model and Dada *et al*. (1989) presented an igneous origin model.

Charnockite is applied to any orthopyroxene bearing granite composed mainly of quartz, perthite, or anti-perthite and orthopyroxene (usually hypersthene as an end member of the charnockite (Deer *et al* 1997). The charnockite suite or series is a group of igneous rocks variably metamorphosed and of wide distribution and great importance especially when categorizing them on the basis of their origin.The charnockitic series include rocks of many different types, some being acidic, rich in quartz and microcline, others being basic full of pyroxene and olivine (fayalite and forsterite) while there are also intermediate varieties corresponding mineralogically to norites.

The term charnockite is consequently not the name of a rock, but of the assemblages of rock types (Rahaman 2001).The charnockitic rocks in all the basement complex areas of Nigeria have been recorded from the northern, eastern, western and southern parts of the country (Cooray 1999). These rocks occur generally as low lying outcrops with smooth rounded boulders and few hills all forming oval to sub-circular and elongated bodies (Streckeisen 1994).

The charnockitic rocks are important and cover about 70% of the total area of Ado-Ekiti (Mc Curry 1999). According to Boluwade *et al* (2013), Ado Ekiti terrain is one of the important basement complex in Nigeria that is characterized by crystalline rocks among which charnockites are the dominant.Charnockites are generally dark greenish feldspar, plagioclase, antiperthite, biotite, hypersthene (Rahaman 2001) and the different rocks units indicates that the coarse grained variety is youngest. The coarse grained charnockite cover the central portion of Ado-Ekiti.

Charnockites generally have diverse origins spanning a range of metamorphic and igneous derivation (Kilpatrick and Ellis, 1992) which implies that igneous or metamorphic fabric can be exhibited. In Nigeria, charnokitic rocks constitute one of the major petrologic units of Precambrian basement complex (Olarewaju, 2006). There is the need to study the rocks textural and mineralogical constituents, being the commonest in Ado Ekiti. Such Investigation including their formations and origin imparticular would help in their exploitation thereby boosting the Ekiti State economy.

The study is aimed at petrologically assessing the minerals and textures of the Ado Ekiti Charnockites to know their industrial significance. The Charnockites were studied in thin section under a petrological microscope in order to assess their textural and mineralogical properties.

Charnockite occurs in many parts of South Western Nigeria. Jones and Hockey (2000) and Hubbard (1998) highlighted other areas of its occurrence. Notable areas are Oke – Patara, Ara, Osuntedo and Wasimi. Others are Ikole – Ekiti, Ado – Ekiti, Otun, Egosi, OsiIdanre and Akure. Charnockites occur along the margins of older granite charnockites are rock with mineralogical characteristics indicating that they have crystallized under high temperature and medium to high pressure conditions. Cooray (1999) studied the contact of the charnockite around Otun, Egosi and Osi and observed that there was a rapid transition from granitic gneiss to charnockitic rocks.

A review of the basement geology of South Western Nigeria was made by Rahaman (2001), who described the charnockites of Akure and Ado – Ekiti areas. Rahaman and Molomo (1990) believed that the charnockitic rocks East of Efon psammatic formation runs N – S for almost 200km South of Idanre through Akure – Ado and that, charnockites in these areas are extensively developed. The multiplicity of metamorphic and deformational events occurred during the Pan – African Orogeny, and theoretically, early and pre – orogenic granite show evidence of at least two phases of folding

whilst syn – late Orogenic granites should show evidence of the N – S folding deformational event and Non – Orogenic granite (Rahaman and McCurry 2006). According to Rahaman (2001), these rocks belong to the six major lithological unit recognized amongst which are:

- Magmatite – gneiss – quartzite complex.
- Charnockitic rocks and other minor rock such as pegmatite, microgranite and quartz reins.
- Older granite.

Dawould (2001) attempted to rationalize the nomenclature of these rocks without specifying whether they were igneous or metamorphic in origin, he distinguished between rocks containing hypersthene or fayalite plus quartz, indicating crystallization at low water pressure and rocks containing hornblende or biotic indicating crystallization at high water pressure.

Vans Beeman, *et al* (1999) however suggested that the charnockitic rock may be classified based on their structures and petrographic charnockitics. According to Olarewaju (1998), charnockitic rocks are formed to intrude into the migmatite gneiss found in Odo – Ado and Oke – Ila area.

For the classification of Nigeria Older Granites and charnockites the proposed method of classification by Olarewaju (1998).The charnockites appear to have been derived from porphyroblastic granite or the regional gneiss by a passive permeation of various basic magmas Oyawoye (2001). He further said that many of the charnockite and fayalite – bearing rocks were formed from the surrounding rock by hybridization with a ferrous – iron rich magma.

METHODS AND METHODOLOGY

Sample Collection

Five samples of Charnockitic rocks were collected from five locations, as shown in (fig. 1). The locations are tabulated (tab 1):

- Idemo area
- Balota Community
- Ado/Ikere Road
- Igirigiri Road
- Ado/Ijan Road

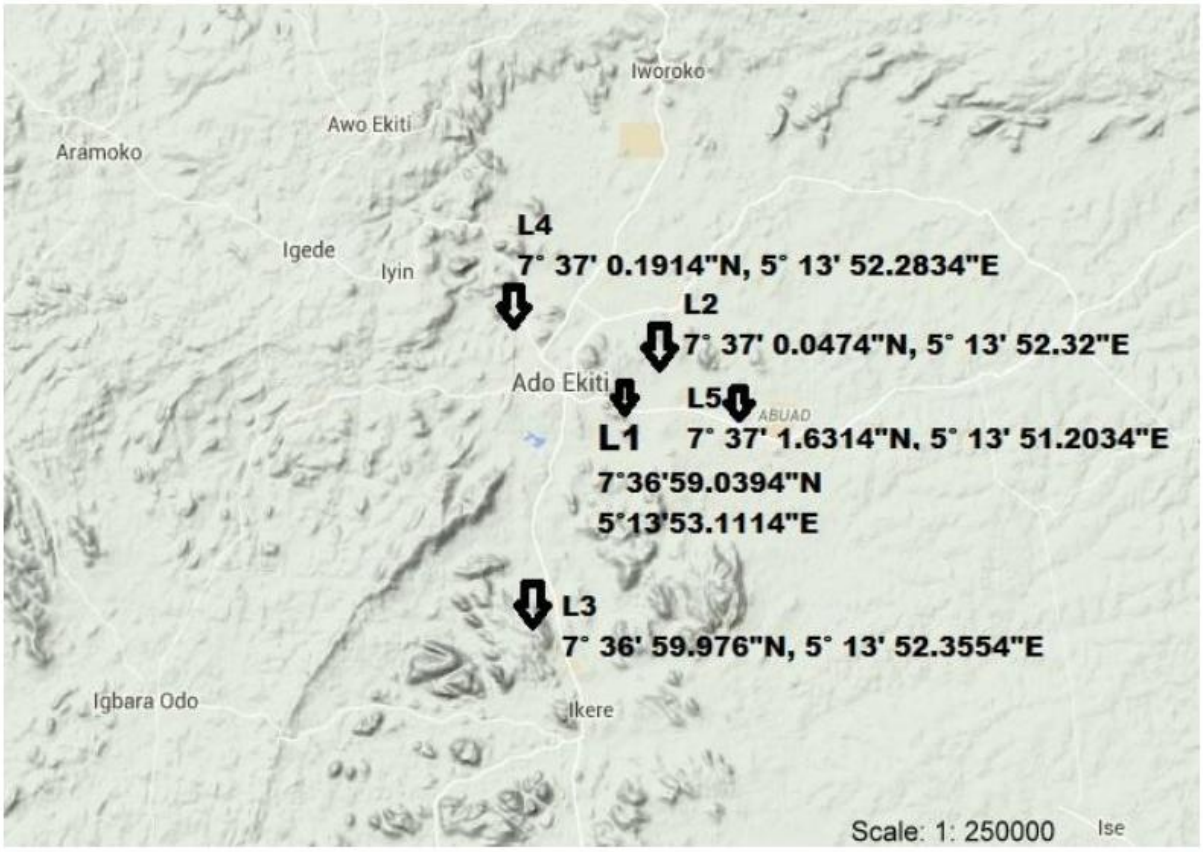


Fig1. *Map of the Study Area showing location of samples.*

Table1.*Table of sample location*

LOCALITY	LOCATION	COORDINATES		ELEVATION	DIRECTION
L1	IDEMO AREA	7°36'59.04"N	5°13'53.11"E	448 M	243^0SW
L2	BALOTA COMM	7°37'0.05"N	5°13'52.32"E	465 M	110^0E
L3	ADO/IKERE RD	7°36'59.98"N	5°13'52.36"E	460 M	120^0SE
L4	IGIRIGIRI RD	7°37'0.19"N	5°13'52.28"E	463 M	344^0SW
L5	ADO/IJAN RD	7°37'1.63"N	5°13'51.20"E	460 M	356^0N

MATERIALS

- Topographical map of Ado – Ekiti which describes the elevational variations of the study area .
- Global Positioning System (G.P.S):- This is used to take the heights and coordinates of each location of study.
- Geological Hammer:-This is used to break fresh rock samples from the outcropson the field.
- Sample Bags:- These are used to pack the rock samples.
- Paper tape:- This is used to label the rock samples that were separated from the outcrops

PETROGRAPHICAL ANALYSIS

The sampled rocks were sectioned with diamond-coated cutting wheel and the sections were set in epoxy resin and polished to a 1µm diamond paste finish. A fragment of the rock not more than 8-10mm in thickness is obtained from hard specimens by making use of a small hammer.

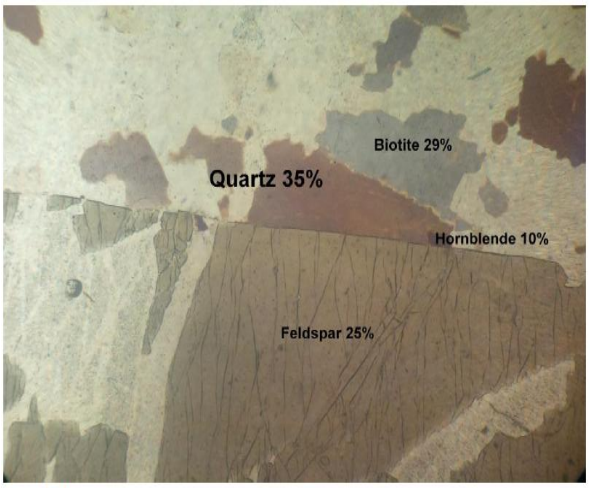
One surface of the chip was grounded smooth by making use of 120, 220, and 3F grade carborundum abrasive. This surface was glued to a microscope slide that measure 30cm by 30cm and up to 1cm thickness by lakeside 70c cement which was supplied in short rods and must be melted on a hot plate at temperature between 85^0C and 100^0C.

The other side of the rock fragment is now cut from its original thickness of 5-10cm to about 1mm with a diamond saw. This latest size was later reduced to 200um by using 100 micron size carborundum, a 60 micron size from 0.2mm to 0.1mm, a stage where quartz and feldspar shows bright second order interface colours under cross polars. The final grade of grinding was from o.1mm to 0.03mm. This was accomplied by using 12 micron size carborundum. It was carefully done to the 30micron while maintaining a uniform thickness over its whole area. At such standard thickness, a Canada Balsam diluted in xylene was used in mounting slide.

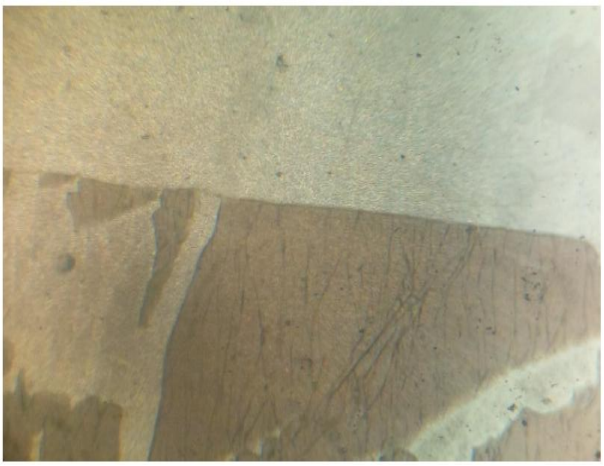
Ensure that no air or gas bubbles are trapped between the cover glass and the rock.

This thin section for each rock is studied under the stage of a petrological microscope under both crossed and plane polarized light at X80 magnification (Plate 1-5). The estimated modal counts of the minerals and compositions of the minerals present in each slide were determined.

RESULTS OF THE PETROGRAPHICAL ANALYSIS



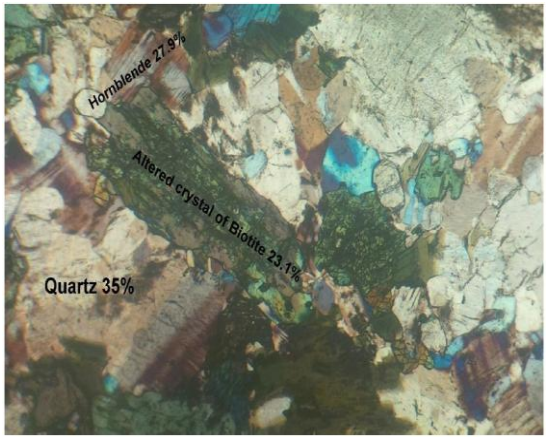
Cross Polar



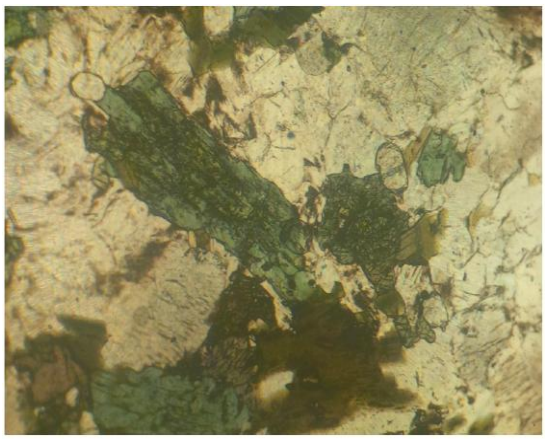
Plane Polar

***Mineral content**: Quartz (35%), Biotite (29%), Feldspar (25%), Hornblende(10%)*
***Texture**: Porphyritic*
***Magnification**: X80*

Plate1. *Petrograpy Of Idemo Road Charnockite Rock (Sample 1)*



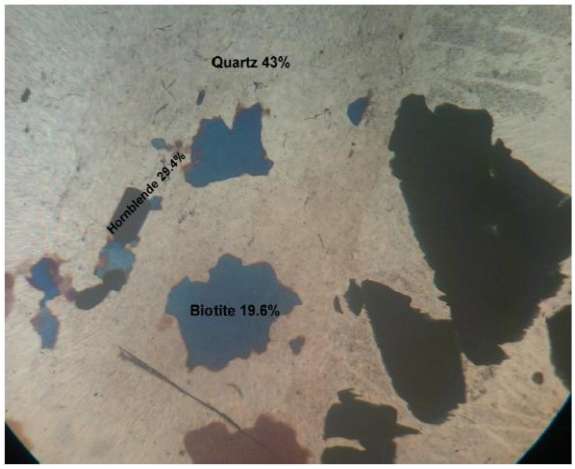
Cross Polar



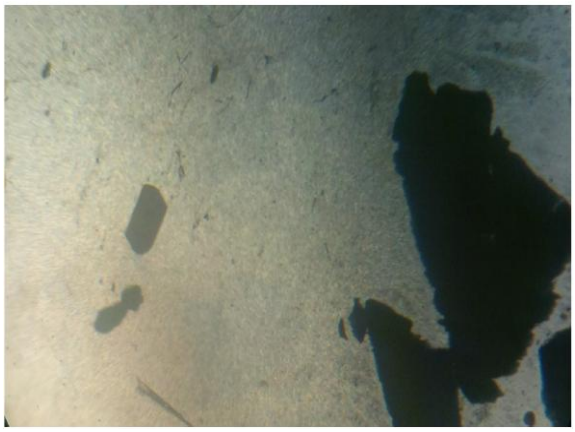
Plane Polar

***Mineral content**: Quartz (35%), Altered crystal of Biotite (23.1%), Hornblende(27.9%)*
***Texture**: Granular porphyritic*
***Magnification**: X80*

Plate 2. *petrograpy of balota community charnockite rock (sample 2)*



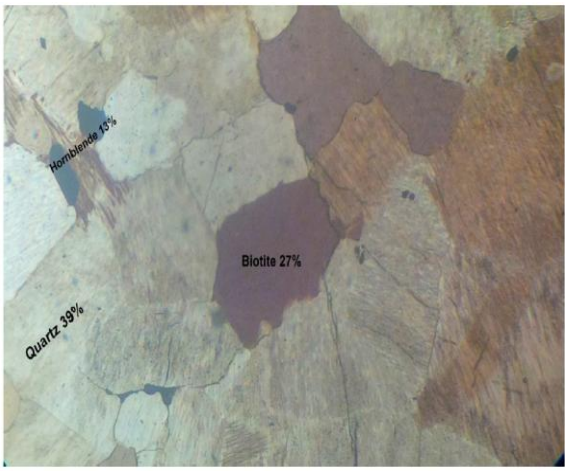
Cross Polar



Plane Polar

***Mineral content**: Quartz (43%), Biotite (19.6%), Hornblende (29.4%)*
***Texture**: Porphyritic*
***Magnification**: X80*

Plate 3: *petrograpy of ado/ikere road charnockite rock (sample 3)*

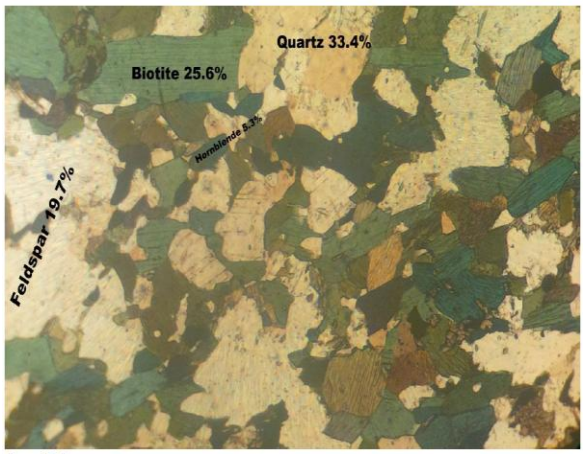


Cross Polar

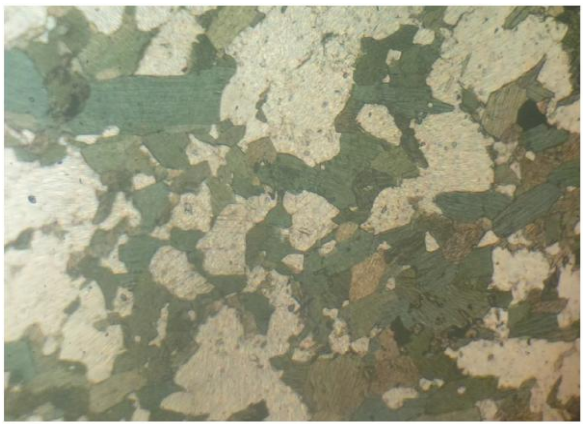
Plane Polar

***Mineral content**: Quartz (39%), Biotite (27%), Hornblende (13%)*
***Texture**: Equigranular*
***Magnification**: X80*

Plate 4: *Petrograpy of Igirigiri Road Charnockite Rock (Sample 4)*



Cross Polar



Plane Polar

Mineral content*: Quartz (33.4%), Biotite (25.6%), Hornblende (5.3%), Feldspar (19.7%)*
Texture*: Granulitic*
Magnification*: X80*

Plate5. *Petrograpy Of Ado/Ijan Road Charnockite Rock (Sample 5)*

All the studied Charnockitic rocks contained Quartz, Biotite, Hornblende, and Feldspar. The higher average percentage of quartz of (40%-60%) shows that the rock could have been of intermediate acidic composition. All the slides have quartz as constituent mineral at an average percentage occurrence of 37%. Biotite is also present at an average percentage occurrence of

25%. Except in the sample of Charnockite from Balota where the Biotite is altered with mottled appearance. All the slides have hornblende with maximum occurrence in Balota at 29.4% and minimum occurrence of 5.3% within the Charnockite from Ado/Ijan road.

Most of the studied rocks are porphyritic in texture except the ones at Ado-Ijan road and Igirigiri that are Granulitic and Equigranular respectively. According to Ademeso(2009), the scenario for the production of porphyritic textured rocks involves the formation of certain types of mineral crystals over a long period deep in the earth. Because of differences in melting temperatures and growth rates, the surrounding material may not have appreciably crystallized and this is an indication that the studied rocks are likely to be magmatic origin.

Idemo and Ado/Ikere Charnockite have porphyritic texture. Ado/Ijan charnockite is granulitic. Igirigiri sample of charnockite is equigranular while Balota is granular porphyritic. The altered or mottled biotite in Balota must have exhibited the difference between biotite and hornblende by mottled appearance of the interference colours in the large biotite crystal which is near to its extinction position.

CONCLUSION

LOCATION	MINERAL COMPOSITIONS (%)			
	Quartz	Biotite	Feldspar	Hornblende
IDEMO AREA	35.0	29.0	25.0	10.0
BALOTA COMM	35.0	23.1		27.9
ADO/IKERE RD	43.0	19.6		29.4
IGIRIGIRI RD	39.0	27.0		13.0
ADO/IJAN RD	33.4	25.6	19.7	5.3

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