Natural Environment Research Council
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UK/GOK TECHNICAL COOPERATION
EXPLORATION FOR
GEOTHERMAL ENERGY PROJECT

report
COMPILATION & INTERPRETATION OF ROCK GEOCHEMICAL DATA FOR THE LONGONOT & GREATER OLKARIA VOLCANIC CENTRES

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AUG.1987. REPT.NO.BGS GENKEN/4

PROJECT:
Exploration for Geothermal Energy
(In Cooperation With MERD & UNDP)

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ABSTRACT

187 analyses of lavas and pyroclastics are listed and displayed as bivariant TAS and trace element plots. Compositions at Longonot are slightly oversaturated peralkaline trachytes, while Nb/Zr ratios show a single trend indicating a single source fractionating trachytic magma chamber. Subordinate lavas from the Northern Plain and crater plot as trachytes and benmoreites respectively but other work has shown these to be mixtures of the typical Longonot trachyte with basalt.

Absolute values of incompatable trace elements (ICE) - Nb,Zr,Rb,Th & U - vary widely, being highest in pyroclastics associated with caldera collapse, surge horizons and early plinian beds. ICE contents fall, both during indevidual plinian eruptions, and from early to late in the plinian sequence, indicating magma chamber zonation.

Olkaria compositions are usually alkali rhyolites (comendites) with a tendency for older events to be trachytic. Mixed lavas, having intermediate compositions, and basalts are present north of Olkaria (Ndabibi area). On the plains to the south of Olkaria basaltic looking rocks include mugearites.

ICE content varies widely in comendites, increasing from domes through lavas to pumice paralleling the presumed volatile content. Highest values are found in pumice from surge beds. Nb/Zr & Th/Zr ratios are distinct for different phases of Olkaria activity with the ring fracture related volcanism (O3) having highest Nb,U & Th/Zr ratios and highest absolute contents of these elements (<4000ppm Zr, 1000ppm Nb, 250ppm Th & 43ppm U).

The different ratios exhibited by different phases of volcanism indicate accessing of separate magma batches which may result from different episodes of partial melting.

U & Th contents at Olkaria are higher than at Longonot & Suswa indicating a greater radioactive heating potential.

MCG Clarke
Project Team Leader

COMPILATION AND INTERPRETATION OF ROCK GEOCHEMICAL DATA FOR THE LONGONOT AND OLKARIA COMPLEXES

INTRODUCTION

As part of the UK (BGS) input to the understanding of the geothermal potential of the Central Rift Valley in Kenya a study is being made of the rock geochemistry of several of the young volcanic centres. The data available (183 WR analyses and 43 partial analyses) are listed and the main features and trends illustrated by selected bivariant plots.

DATABASE

The analytical data are compiled as 5 tables in the appendix to this report. Each table commences with a listing giving sample nos.,map-references and where necessary,brief notes on the sample. Analyses have all been reclassified according to the stratigraphic scheme adopted by BGS for this area, (see accompanying draft geological report). Each unit is generally listed in order of increasing Zr content. Locations of all listed samples are plotted on the accompanying map. Background information on the 5 tables is given below:-

Table 1. LONGONOT PYROCLASTICS - comprises 31 wholerock analyses of pumices collected in 1986 from the Longonot pyroclastic sucession by Dr.S.C.Scott of Plymouth Polytechnic, UK, in co-operation with this project. His objective is to establish a detailed history of the development of the Longonot magma chamber BGS is more interested in the broader aspects of the chemistry.

TABLE 2. LONGONOT LAVAS - comprises 52 WR analyses of lavas from Longonot, 49 of which are extracted from Scott's PhD thesis on Longonot (Scott 1977). Also included are 3 analyses of samples collected by BGS for correlative purposes.

TABLE 3. MACDONALD & BLISS DATA- Comprises 43 WR analyses of comendite lavas and pumices from the northern and central part of Olkaria and the Ndabibi area (between Olkaria and Eburru). Most of this data appeared originally in an unpublished thesis on the area (Bliss, 1979) but is now the subject of a publication in preparation, (Macdonald et al). It is emphasised that the grouping of these data is based on the new BGS stratigraphy and not that used by Bliss.

TABLE 4. NEW BGS DATA- comprises 60 WR analyses of lavas and pumice from both the Longonot and Olkaria volcanic sequences. The Olkaria data are mainly from the eastern and southern parts of this complex. Three samples of Limuru Trachytes and one each from Narok and Mara River were also analysed for comparative purposes.

TABLE 5. PUMICE SAMPLES (TRACES ONLY)- 44 pumice samples were collected for correlative purposes to assist tephrochronological interpretation of the western Olkaria area but also form a useful addition to the general data base, especially concerning the highly evolved Olkaria compositions.

DATA ANALYSIS

LONGONOT

Major and trace elements of lavas

Lavas (Table 2 and Fig 1) of the Longonot lava pile (Lt2) and recent flank flows (Lt3) all fall in a resticted portion of the Trachyte field of the Total Alkali-Silica (TAS) diagram proposed by LeBas et al (1986). Silica percentages are between 61-63% and the greater variation in total alkali may result, in part, from soda loss during deuteric or even meteoric processes. There is sufficient excess of alkali over alumina to make the Peralkalinity index greater than unity and therefore these are Peralkaline Trachytes.

Lavas of the northern plain (Lmx1/2) plot in a similar position (Fig. 2) but with slightly lower silica. Previous work has shown that these are in fact 'mixed' lavas, having a subordinate basic component as microscopic tongues and blebs,(Scott, 1984?). The crater-floor lavas, together with samples of the co-eval bombs and cinders on the crater rim (Lmx3) also show a restricted composition, plotting in the Benmoreite field of the TAS dia. This group are of mixed basic-trachyte composition also.

Despite the very restricted major element variation between units Lmx1/2,Lt2 & Lt3 the trace element data, eg Nb/Zr content, varies considerably (Table 1 & Fig. 3). This is so both between units and within Lt2. The recent flank flows (Lt3) appear compositionally equivalent to the more evolved portions of the lava-pile, while Lmx1/2 has a much lower incompatable element (ICE) content than the more 'basic' Lmx3 suite.

Trace elements in pyroclastics

Compositional variation in the Longonot pyroclastic sequence is illustrated in Table 1 and, using Nb/Zr ratios, in Fig. 4. The data indicates that:-

a)There is a generally wider intraunit variation in the pyroclastics than in the lavas.

b)The pyroclastic eruptions were generally tapping more evolved magma, ie magma with greater ICE content than in lavas.

c)The decrease in ICE from bottom to top of the lowest bed of Lp5 (Sp. L318,308 & 309 from a 5m+ thick plinian pumice) is an indication of magma chamber zonation revealed during a large explosive eruption, cf Fisher & Schmincke, 1985, table 2-2.

d)The overlying bed contains pumice of more evolved nature than the upper (ie last) part of the previous eruption. This indicates that the magma chamber had refractionated and therefore a time lapse occurred between these two plinian events. The presence of an intervening palaeosol supports this deduction.

e)There is a general decrease of ICE content from early to late Lp5 events, superimposed on the intrabed variation noted in (c) above. This correlates with a general decrease in bed thickness and clast size.

f)The later beds of Lp5 have similar contents of Zr to those of the most evolved Lt2 & 3 lavas (ie ~1000ppm).

Broad correlation of ICE content with volcanic events is illustrated in Fig. 5. It can be seen that higher ICE contents characterise i), units in which ignimbrites are prominent, ie Lp1 & Lp3, ii),the earlier part of the Lp5 plinian sequence and iii), (highest of all) the Lp4 base-surge.

Volcano-tectono inferences can also be drawn from the cyclical nature of the Zr levels versus time and eruptive style. The three troughs may represent tapping of relatively unfractionated (less evolved) magma, following caldera collapse or crater formation. The relatively high Zr levels present in the most recent flows perhapse signal that pyroclastic activity is to be expected in the (volcanological) near future.

OLKARIA

Background to investigation

Field mapping in the area between the western Longonot Caldera scarp and the Hell's Gate Gorge (the Domes area) showed that Olkaria type comendite volcanism is present in the form of domes mantled by a varied sequence of pyroclastics and localising considerable surface geothermal activity. The pyroclastics consist of interbeds of both Longonot and Olkaria tephra and initially samples were selected for analysis to provide confirmation of the model developed from the fieldwork. Initial interpretation of the data showed that not only could tephra from the two centres be distinguished even when partially altered as a result of proximity to surface geothermal activity but that distinct geochemical trends characterise different phases of Olkaria volcanism.

It was therefore decided to extend the mapping program across the Olkaria Complex to increase project understanding of the volcanological setting of the known resource and to compare and contrast this area with what is now concluded to be a significant eastwards extention of that resource.

As a result of the 1987 investigations a unified stratigraphy has been established for the whole Olkaria Complex by a combination of classic field mapping tecniques and extention of the geochemical model introduced at the Feb 1987 TRM. The following data displays and discussion apply to all of the area characterised by comendite volcanism both east and west of the Hells Gate Gorge - an area for which the name - The Greater Olkaria Volcanic Complex (GOVC) -is proposed.

Major element chemistry

Tables 3,4 & 5 contain the available analytical data. Figs. 6,7,8 & 9 display the various comendite groups in terms of the TAS dia. In general the samples of dome and lava analysed plot in a restricted field with SiO_2 72-77% and total alkalies between 8.5 and 10.5%, ie as rhyolite. Once again, however, the alkali/alumina ratio gives peralkaline indices in excess of unity and so the terms peralkaline rhyolite or comendite are appropriate.

The trend towards higher ICE content (see following section) is accompanied by increase in total alkalies and total iron, both typical of evolution towards increasing peralkalinity. This trend is however accompanied by a decrease in SiO2 and Al and slight decreases in TiO2 and CaO. The increasing iron and alkalies, together with the decrease in alumina, is reflected by the appearence of phases such as aegerine-augite and arfvedsonite, often prominently displayed in late stage small vugs as acicular (vapour-phase ?) aggregates.

The TAS plots show that samples from the Ndabibi area exhibit relatively small variation and have the highest percentage silica. The O2,O3,O4 & O5 units are generally more evolved with O3 exhibiting the widest range, covering the whole spectrum of comendite compositions sampled at Olkaria. The more restricted fields of O4 & O5 overlap indicating the close association more clearly shown by trace element data.

An important observation is that the two groups of data, from Olkaria and Longonot, plot as quite separate fields on the TAS dia. perhaps indicating no direct petrogenetic relationship.

Trachytes, Intermediate rocks and Basalts.

There are trachytes associated with the Olkaria complex, particularly on the southern flanks of the main ring feature (BG1366 & 1406) where they map as part of the O2 phase of volcanism. Trachytes (sl) also occur further south on the plains between Olkaria and the Narok road (BG1045 & 1437/1). The latter are of probably earlier age and may represent pre-late Quaternary 'Flood Trachytes' of the region. Plotted on the TAS dia. (Fig. 10) both pairs are distinct from the Longonot lavas, having higher silica contents. The samples most closely linked with Olkaria exhibit mild peralkalinity while those from the southern plains have P.I.<1. A sample of scoria from one of the Ndabibi tuff cones also plots in the trachyte field but is considered to be one of the 'mixed' compositions discussed below.

Basic and intermediate compositioned volcanics (Table 4 and Fig.10) are also present particularly in the Ndabibi area and south of Olkaria. To a lesser extent they also occur within the main complex, eg,. in S.Hellsgate and at Central Tower, in both cases intimately associated, (texturally mixed), with O4 comendites.

Compositions range from subalkali (Hyn) basalts building cinder cones at Ndabibi, benmoreites, at both Ndabibi and south of Olkaria, through to a composition near the Trachyte/rhyolite boundary on the TAS dia. The latter sample (with P.I.<1) represents dark inclusions and schlieren within comendite forming the Central Tower O4 plug. The field relations and bimodal outcrop appearence of some of these rocks indicate a mixed origin which the WR compositions do not reflect.

Analyses of two lithic blocks from Olkaria pyroclastics in the domes area are also plotted on Fig. 10. One is a ne normative Alkali Basalt, the other an undersaturated, high soda, basic rock plotting as a Tephri-phonolite on the TAS dia. It is not known whether these rocks represent magmas associated with earlier Olkaria events or are simply samples of the earlier volcanic basement

Two further rocks, collected from west of the rift as type examples, are plotted on Fig. 10. These are an Olivine melilitite

(BG1467) and a Phonolite (BG1563), both with Na>K and 18 & 20% Ne in the norm respectively.

East Rift Wall rhyolites compared with comendites.

Seveal outcrops from the upper part of the Limuru Trachyte Fmn., which forms the eastern wall of the Rift at the latitude of Suswa and Longonot, were recognised in the field as being highly silicic. They have been analysed for comparison with Olkaria comendites and plot in similar position on the TAS dia.(Fig. 11). Their Peralkaline Indices ,~1, indicate that they are however more akin to true rhyolites. They do contain high ICE contents and have Nb/Zr ratios similar to the Longonot and Olkaria O3/O4 compositions. Their Th/Zr ratios however fall on the O2 trend far from that of Longonot (Fig. 15). These inconsistences show that they are geochemically distinct from both the younger centres. The presence however of such highly evolved and silicic compositions in the Limuru Trachyte Fmn. could be related to large scale explosive volcanism.

Trace element data from Olkaria and Ndabibi

The Nb/Zr plot (Fig. 12) is again used to illustrate the spread of ICE content and relative evolvement of volcanic products. Three features are immediately visible:-

1. There is much greater variation, compared to the equivalent Longonot display, within which separate Olkaria events can be distinguished. These are O2, O4 & O3, having sucessively higher Nb/Zr ratios and plotting as distinct trends.

2. The upper range is greatly extended, especially in the case of O3 where values of almost 4000ppm Zr and over 1000ppm Nb and Rb are recorded (BG3057/2 & 3115, table 5).

3. The Nb/Zr plot does not allow a clearcut distinction of Olkaria from Longonot data to be made.

Most of the O4 data fall in a very restricted field which is shared by the O5 data. The two Ndabibi samples plot amongst the least evolved compositions, near the common origin. Olkaria trachytes are relatively only weakly enriched in ICE and are most closely aligned with the O2 trend. Two of these samples (BG1366 & 1406), from the south part of the main ring feature, are mapped as O2 equivalents.

Fig.13 displays Nb/Zr data, listed in the appendix as Table 3, reported by Macdonald and Bliss and derived from samples collected in the Ndabibi and north and central Olkaria areas. These samples have been reclassified using the BGS stratigraphy. Also shown on Fig. 13 are the O2,O4 & O3 trends derived by interpretation of Fig 12. Most of the samples plotted from Table 3 fall on one or other of the established trends except for several O4 samples. The O5 data again plots close to that of the bulk of O4 but shows a small relative depletion of Nb. Sp BL333, classified as O4 from its field relations plots at the less evolved end of the O2 trend and does not fit the simple geochemical/stratigraphic model considered here.

Table 3 includes 9 comendites from the Ndabibi area, all except one of which plot in a very restricted field at the least ICE enriched portion of the plot, and very close to the N samples on Fig. 12. It appears that the Ndabibi volcanism was of different character geochemically and, judging by the low ICE contents, was not particularly explosive. (See later discussion of Fig. 17).

Although Nb/Zr ratios clearly differentiate between phases of Olkaria activity there is complete overlap of Olkaria and Longonot data. A number of other ratios were therefore scanned and it was found that a plot of Th v Zr also separates the various Olkaria volcanic phases but in addition allows distinction of Longonot compositions.

These relationships are displayed in Fig. 14 & 15 for the same data set plotted on Fig. 12. Almost identical Ndabibi and Olkaria groupings and trends result but Longonot samples show a consistent much lower Th/Zr ratio compared to all the Olkaria trends.

Also plotted on Fig. 15 is the field enclosing all Th/Zr data listed in the recent UNDP report on Suswa (Tofarson, 1987). The Suswa sample suite is clearly more enriched in Th (and Nb - see Figs. 5.6 & 5.7 in BGS Rept. GENKEN/2) relative to Zr than is Longonot. Three samples of Rhyolite from the Limuru Trachyte Fmn. (Tl) also fall on the Suswa trend displayed on Fig. 15.

Another similarity between the plots of Nb & Th v. Zr is that both data sets defining the O3 trend show a marked inflection between ~500 & 800ppm Zr. In this interval the Th/Zr ratio decreases from ^1:4 to ~1:16 (equivalent figs for Nb/Zr are 1:1 falling to 1:4). ie in that interval Nb & Th are apparently being fixed in the comendites at 4x the normal rate relative to Zr. This marked apparent variation is not exhibited by data defining any other of the trends shown on Fig. 15.

The extremely high absolute levels of ICE present in some O3 samples, particularly pyroclastics, is again demonstrated by Fig. 14. Table 5 includes values >240ppm Th and <43ppm U. In more general terms the available data indicates that the Olkaria complex rocks have a much higher absolute content of radioactive elements (RAE) than is the case at either Suswa or Longonot.

FURTHER CONSIDERATION OF THE Th & U DATA.

Aspects of Th & U variation in the Longonot and Olkaria complexes are illustrated in Fig. 16 where 3 groups of pumice data, extracted from Table 5, are plotted. A colinear relationship exists irrespective of overall composition or phase of volcanism. Relative depletion of RAE at Longonot is clear. The extremely enriched nature of many O3 compositions and relative restricted compositional variation within O4 are well displayed.

Compositional variation related to style of vulcanism is illustrated in Fig. 17, again using Th/U ratios as indicative of ICE content and therefore degree of evolvement. The sample suite plotted comprises all available BGS O3 data. The least evolved compositions are all from domes while the most evolved are all pumice. Intermediate compositions are either of pumice or lavaflows. It is concluded that there is a close relationship between ICE content (degree of magma evolution), and increasing volatility of eruption, ie ICE contents increase from highly viscous dome formation through lava emission to increasingly explosive eruptions including base surges. It is speculated that the most highly evolved compositions represent material from the upper most fractionated part of a large magma chamber.

U & Th CONTENT AND HEAT PRODUCTION

Radioactive elements are the ultimate source of earth heat. High cocentrations of U & Th such as present at Olkaria may be indications that this is an area of particularly thermally anomalous crust. Alternatively these high contents may indicate the presence a large highly fractionated magma chamber. In either case such areas would seem appropriate for geothermal resource investigation. It is not clear yet whether there is a positive relationship between geothermal potential and radioactive element content of host rocks as there is useing the Hot Dry (granite) Rock concept. Factors such as aquifer occurrence and permeability are probably of greater importance. Nevertheless applying such a criterion alone would suggest that Olkaria, including the Domes area, has a greater potential than Longonot or Suswa.

CONCLUSIONS

A)Longonot, and the Greater Olkaria Volcanic Complex each have distinctive geochemical characteristics. Longonot compositions are slightly oversaturated peralkaline trachytes, while those at Olkaria are comendites i.e, alkali rhyolites, but with some trachyte in the older phases of activity exposed at the surface. Another striking difference is the much higher concentration of incompatible elements (ICE) in the pyroclastics of the latter compared with Longonot.

B)At both Longonot and Olkaria there are subordinate volumes of basic and intermediate rocks exposed. At Ndabibi and Olkaria these range in composition from basalt through benmoreite to trachyte. At Longonot there is strong evidence that the intermediate rocks result from mixing and this is also suspected at Olkaria, except for the trachytes.

C)The bimodal nature of the magmatism at both volcanoes can be explained by invoking melting of large volumes of felsic crust due to the intrusion of a large basic body into that crust triggered by extensive tectonism consequent on the rifting process.

D)Data from Longonot is interpreted as indicating tapping of a large single magma chamber as the ICE ratios from all phases of volcanism are very similar.

E)At both Longonot and Olkaria the eruption style (effusive or pyroclastic) is closely linked to the ICE content - higher levels of ICE accompanying more explosive eruptions. At Longonot the highest ICE levels accompany the most powerful events, explosive eruptions which are believed to have preceded caldera or crater collapse.

F)The relatively highly evolved nature of the most recent volcanicity at Longonot (Lt3) indicates that a fractionateing magma chamber still exists and that quite soon (100s yrs) a moderate sized pyroclastic eruption is to be expected.

G)The Olkaria data spread indicates that several distinctly differing magma batchs (chambers ?) were generated and accompany volcanicity of differing character. The occurrence of differing geochemistry could be explained by partial melting of the felsic fraction of the crust at separate times. The case for such is strengthened by recent determinations of high initial 87Sr/86Sr ratios in some Olkaria rocks (R. Macdonald, pers. com.).

G)There is a co-incidence of ring dome formation (O3), present day geothermal activity and high ICE, including radioactive element content, in the area E of the gorge - the Domes area.

H)The generally higher level of radioactive element concentration at Olkaria may be an important factor governing the localisation of a major heat anomaly at high levels in the crust and therefore the occurrence of geothermal activity.

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FIGURES -- 1-17 see following pages.

APPENDIX -- LISTINGS OF ROCK GEOCHEMICAL DATA FROM LONGONOT VOLCANO & THE GREATER OLKARIA VOLCANIC COMPLEX.

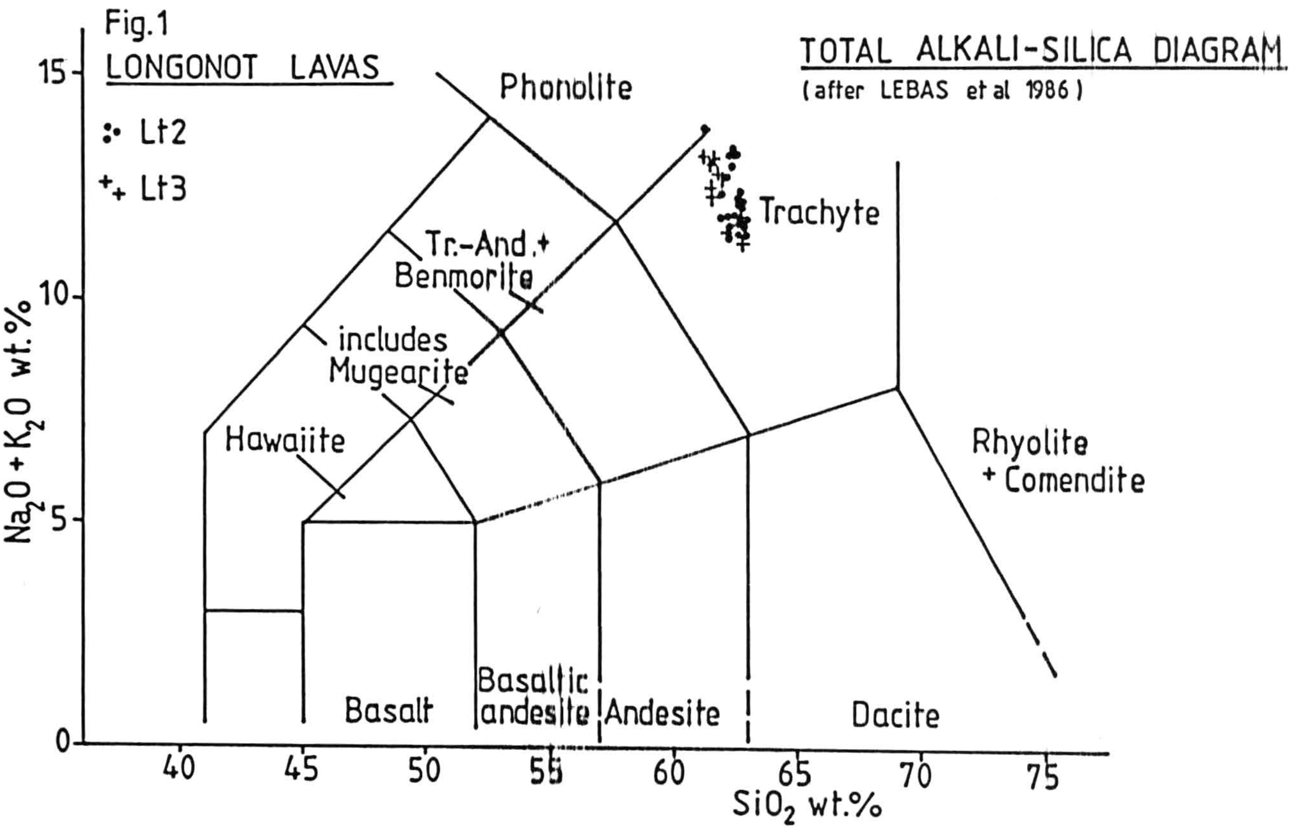


Fig.1
LONGONOT LAVAS
Lt2
Lt3
TOTAL ALKALI-SILICA DIAGRAM
(after LEBAS et al 1986)
Phonolite
Trachyte
Tr.-And.+
Benmorite
includes
Mugearite
Hawaiite
Rhyolite
+ Comendite
Basalt
Basaltic
andesite
Andesite
Dacite
Na2O + K2O wt.%
SiO2 wt.%
0
5
10
15
40
45
50
55
60
65
70
75

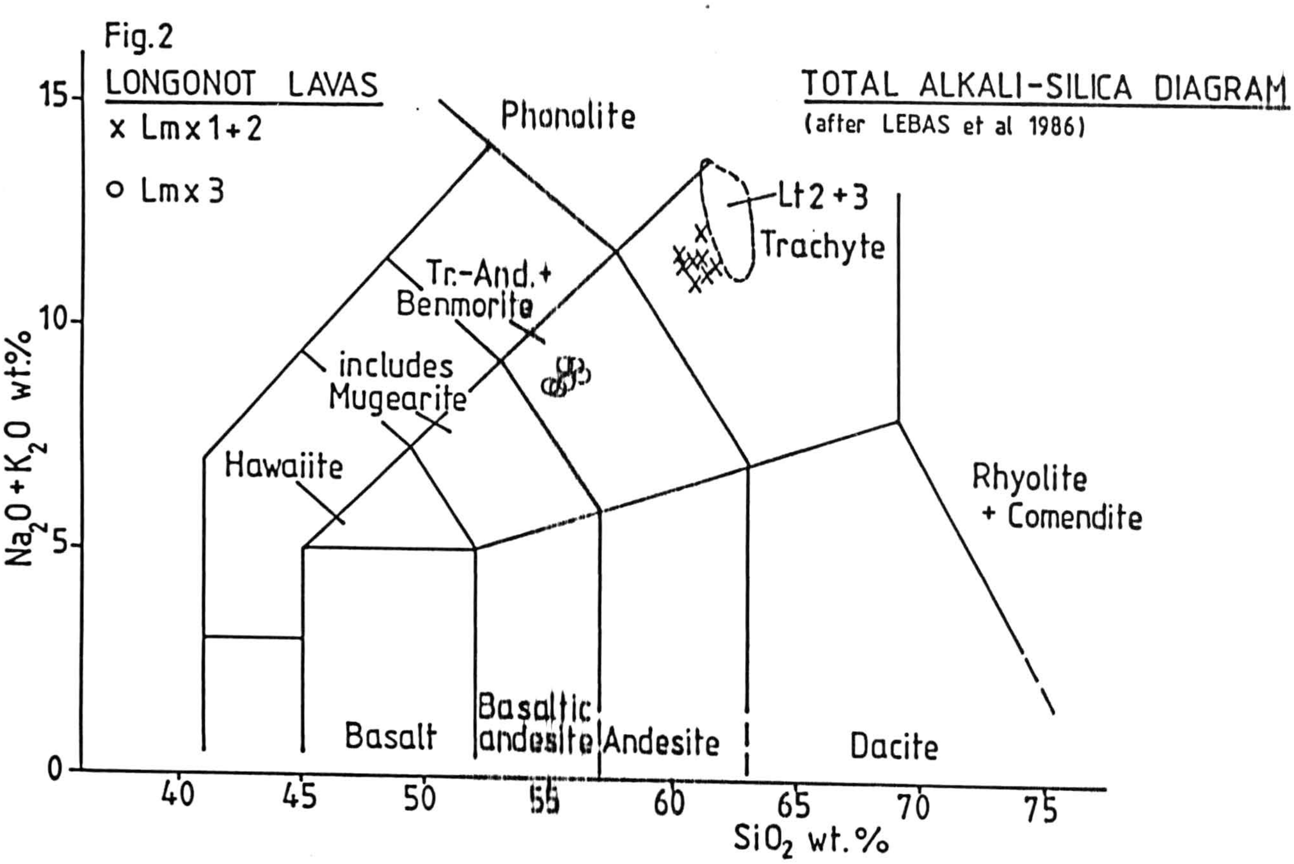


Fig.2
LONGONOT LAVAS
x Lmx 1+2
o Lmx 3
TOTAL ALKALI-SILICA DIAGRAM
(after LEBAS et al 1986)
Phonolite
Lt2 + 3
Trachyte
Tr.-And.+
Benmorite
includes
Mugearite
Hawaiite
Rhyolite
+ Comendite
Basalt
Basaltic
andesite
Andesite
Dacite
Na2O + K2O wt.%
SiO2 wt.%
0
5
10
15
40
45
50
55
60
65
70
75

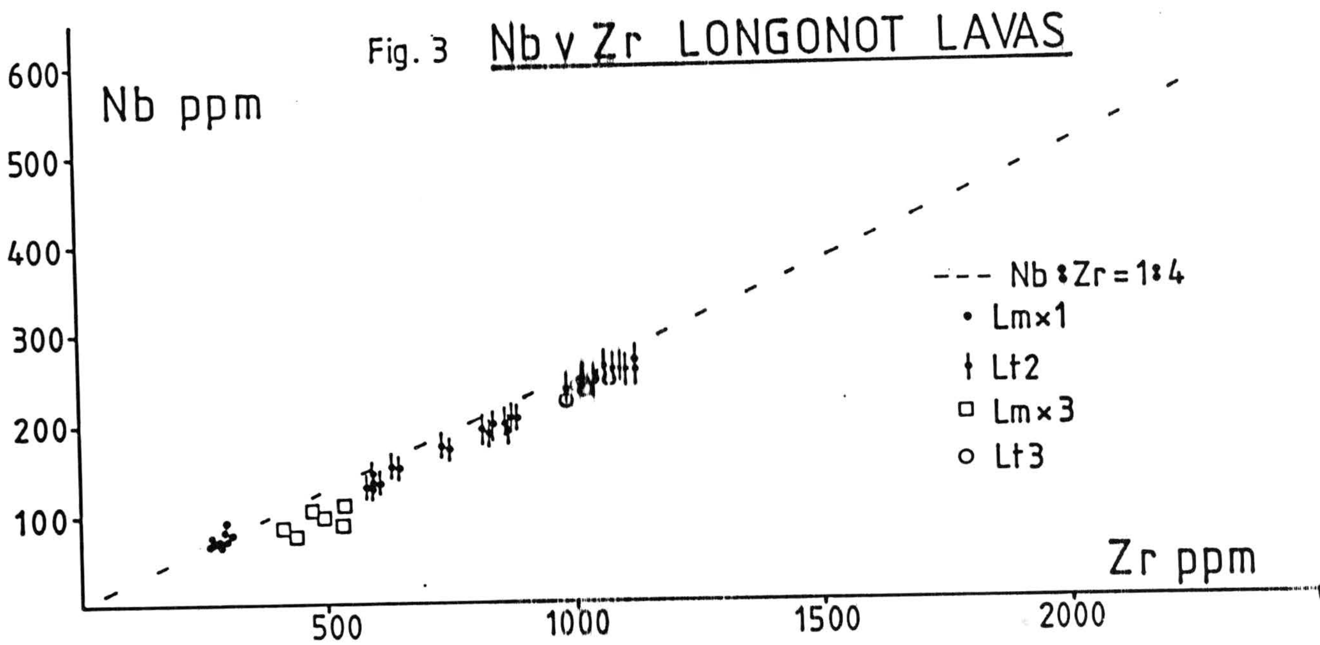


Fig. 3
Nb v Zr LONGONOT LAVAS
Nb ppm
600
500
400
300
200
100
Zr ppm
500
1000
1500
2000
--- Nb : Zr = 1 : 4
• Lmx1
Lt2
□ Lmx3
○ Lt3

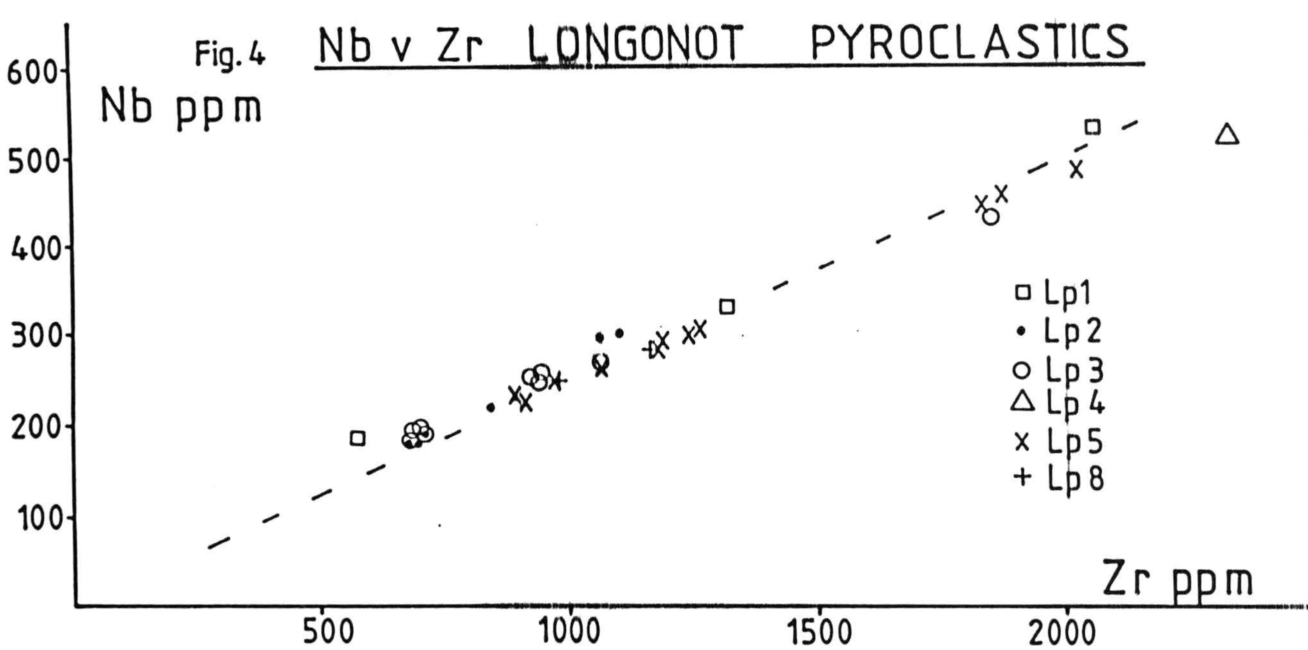
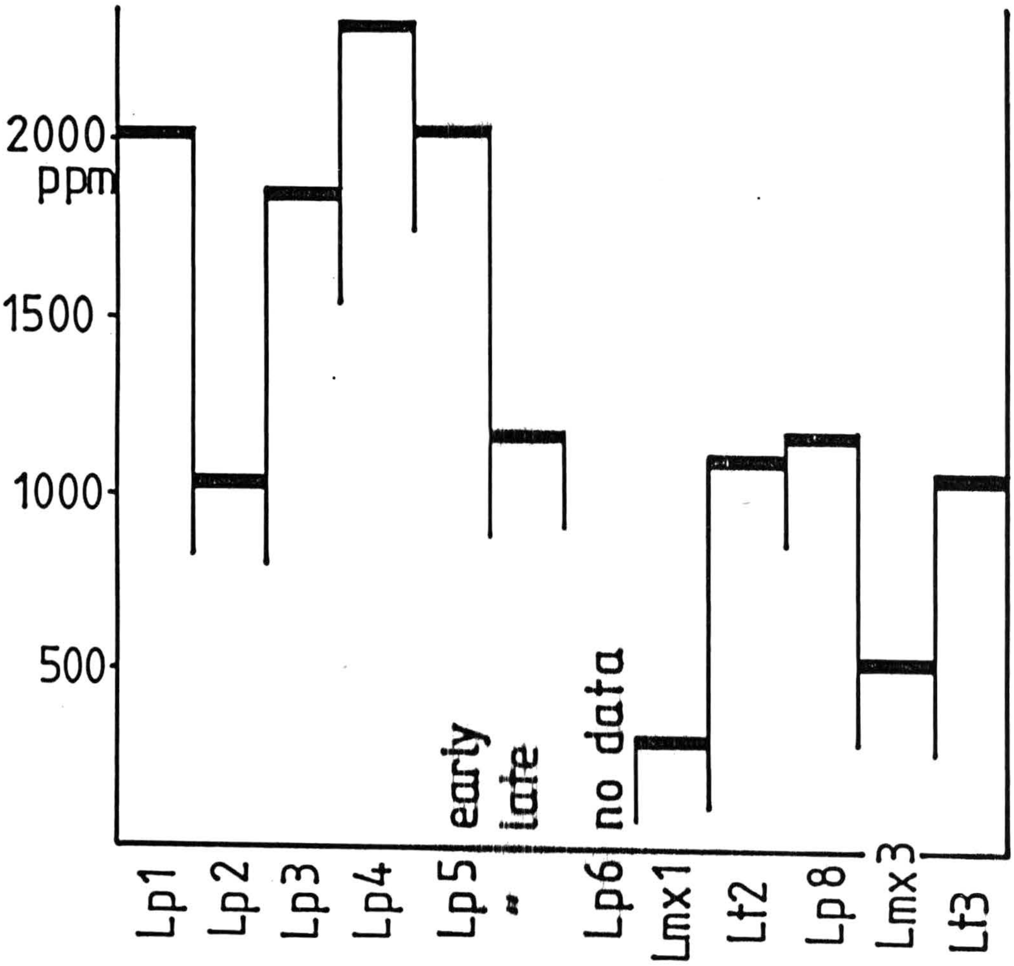


Fig. 4
Nb v Zr LONGONOT PYROCLASTICS
Nb ppm
600
500
400
300
200
100
Zr ppm
500
1000
1500
2000
□ Lp1
• Lp2
○ Lp3
△ Lp4
x Lp5
+ Lp8

Fig. 5

Longonot sequence maximum values of Zr.



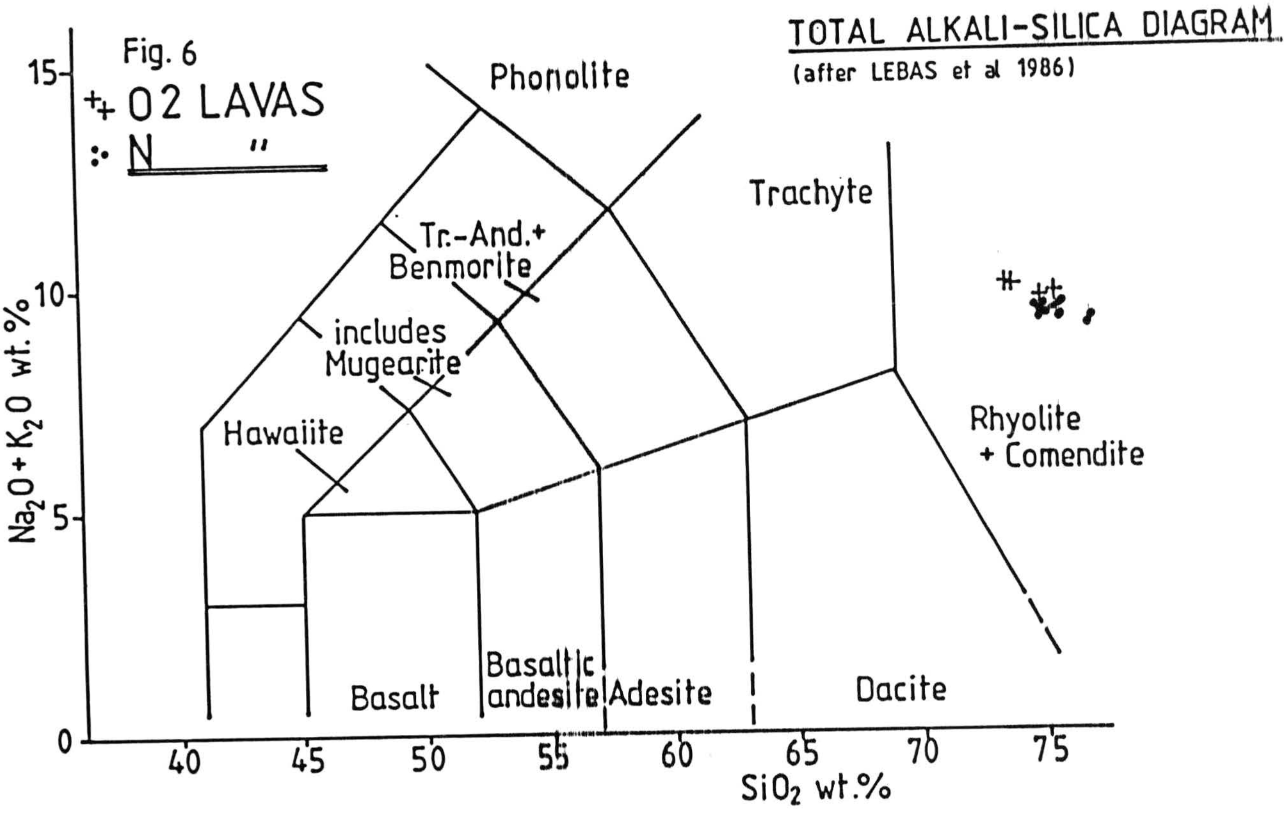


Fig. 6
+ O2 LAVAS
: N "
TOTAL ALKALI-SILICA DIAGRAM
(after LEBAS et al 1986)
Phonolite
Trachyte
Tr.-And.+
Benmorite
includes
Mugearite
Hawaiite
Rhyolite
+ Comendite
Basalt
Basaltic
andesite
Adesite
Dacite
$Na_2O + K_2O$ wt.%
SiO_2 wt.%
0
5
10
15
40
45
50
55
60
65
70
75

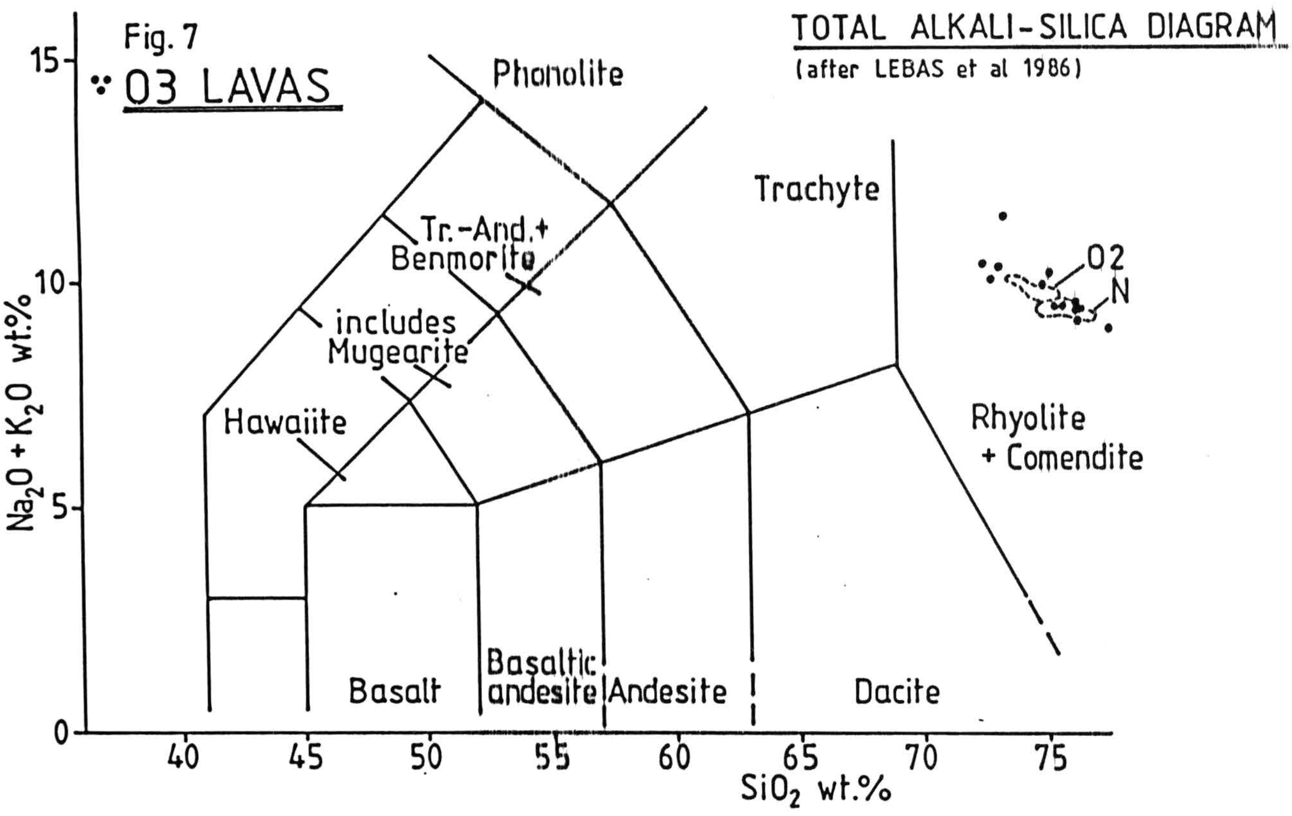


Fig. 7
: O3 LAVAS
TOTAL ALKALI-SILICA DIAGRAM
(after LEBAS et al 1986)
Phonolite
Trachyte
Tr.-And.+
Benmorite
includes
Mugearite
Hawaiite
Rhyolite
+ Comendite
O2
N
Basalt
Basaltic
andesite
Andesite
Dacite
$Na_2O + K_2O$ wt.%
SiO_2 wt.%
0
5
10
15
40
45
50
55
60
65
70
75

Fig. 8

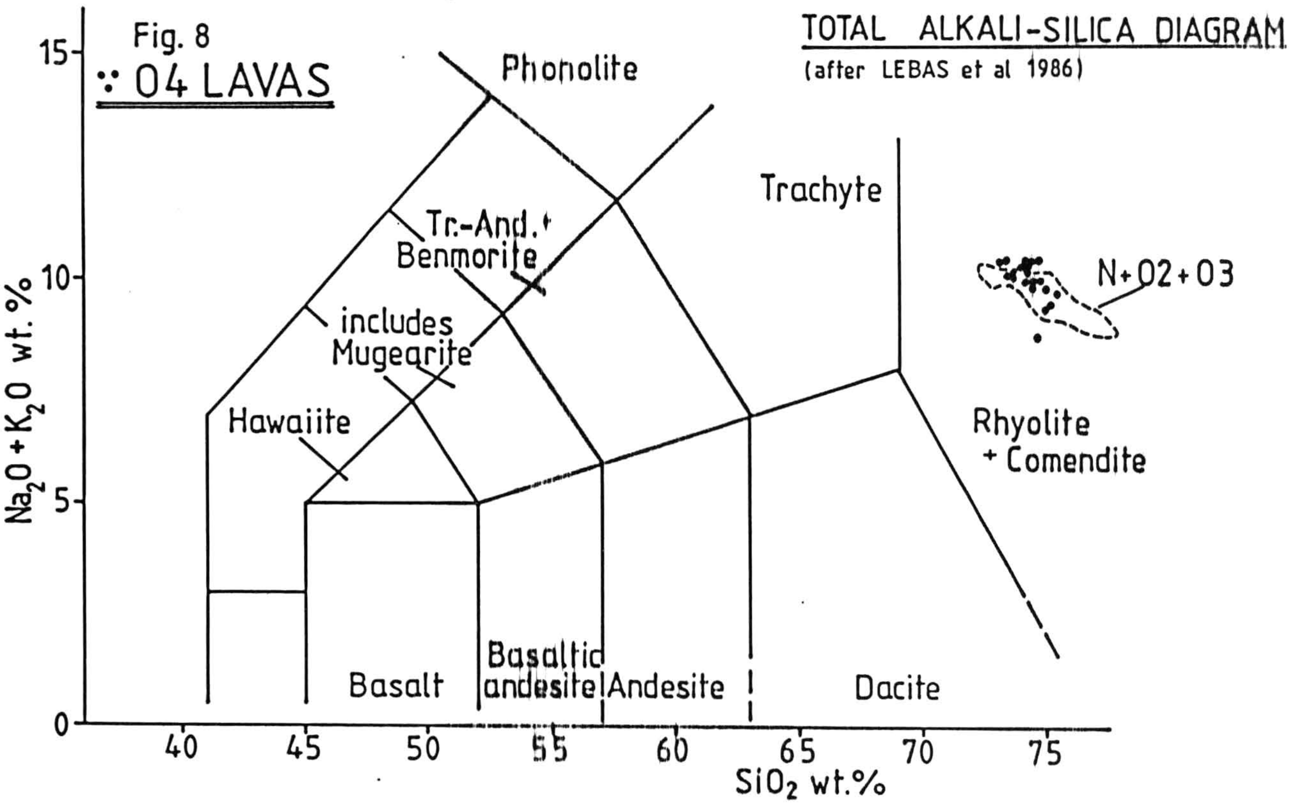
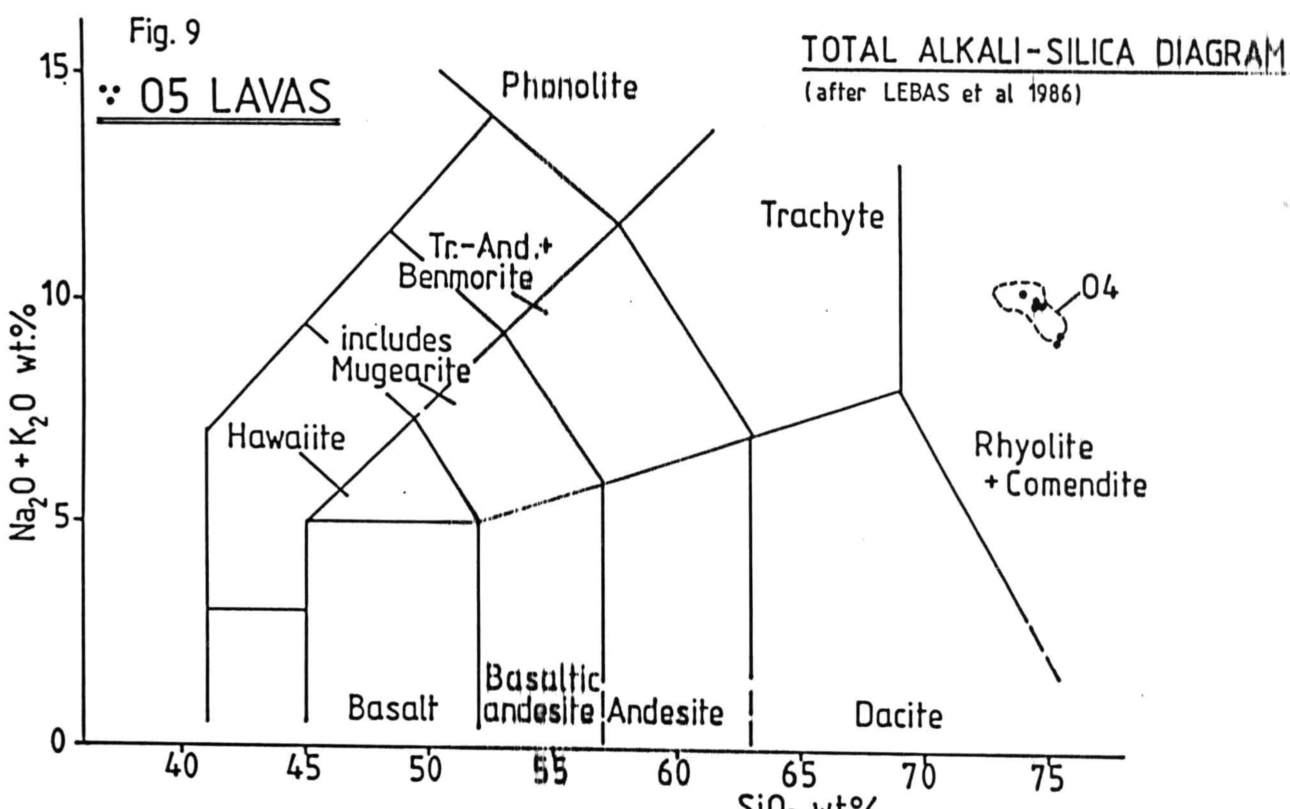

∵ 04 LAVAS
TOTAL ALKALI-SILICA DIAGRAM
(after LEBAS et al 1986)
Phonolite
Trachyte
Tr.-And.+
Benmorite
includes
Mugearite
Hawaiite
N+02+03
Rhyolite
+ Comendite
Basalt
Basaltic
andesite
Andesite
Dacite
$Na_2O + K_2O$ wt.%
SiO_2 wt.%
0
5
10
15
40
45
50
55
60
65
70
75

Fig. 9


∵ 05 LAVAS
TOTAL ALKALI-SILICA DIAGRAM
(after LEBAS et al 1986)
Phonolite
Trachyte
Tr.-And.+
Benmorite
includes
Mugearite
Hawaiite
04
Rhyolite
+ Comendite
Basalt
Basaltic
andesite
Andesite
Dacite
$Na_2O + K_2O$ wt.%
SiO_2 wt.%
0
5
10
15
40
45
50
55
60
65
70
75

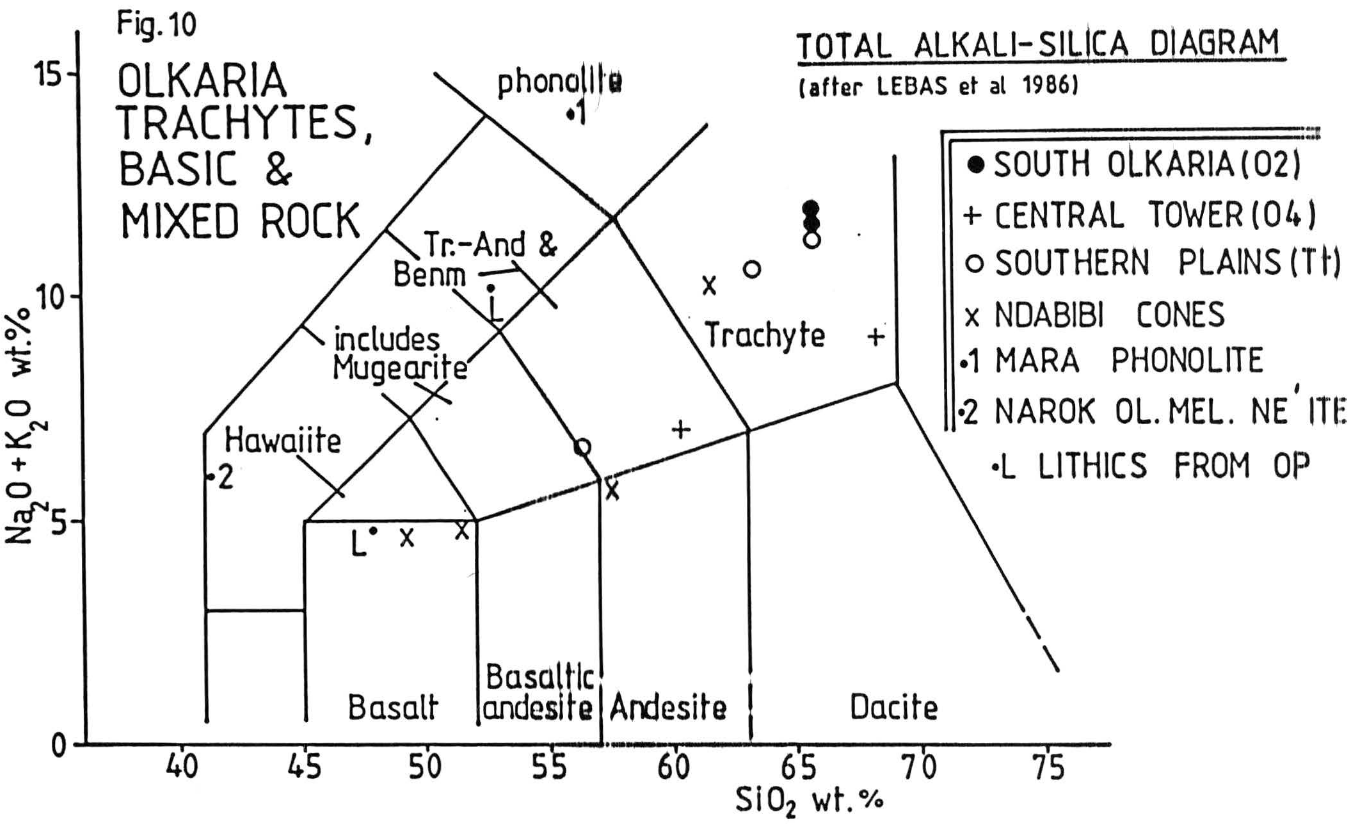


Fig. 10
OLKARIA TRACHYTES, BASIC & MIXED ROCK
TOTAL ALKALI-SILICA DIAGRAM
(after LEBAS et al 1986)
● SOUTH OLKARIA (02)
+ CENTRAL TOWER (04)
○ SOUTHERN PLAINS (Tt)
x NDABIBI CONES
•1 MARA PHONOLITE
•2 NAROK OL. MEL. NE'ITE
•L LITHICS FROM OP
phonolite
Tr.-And & Benm
includes Mugearite
Hawaiite
Trachyte
Basalt
Basaltic andesite
Andesite
Dacite
Na2O + K2O wt.%
SiO2 wt.%
0
5
10
15
40
45
50
55
60
65
70
75

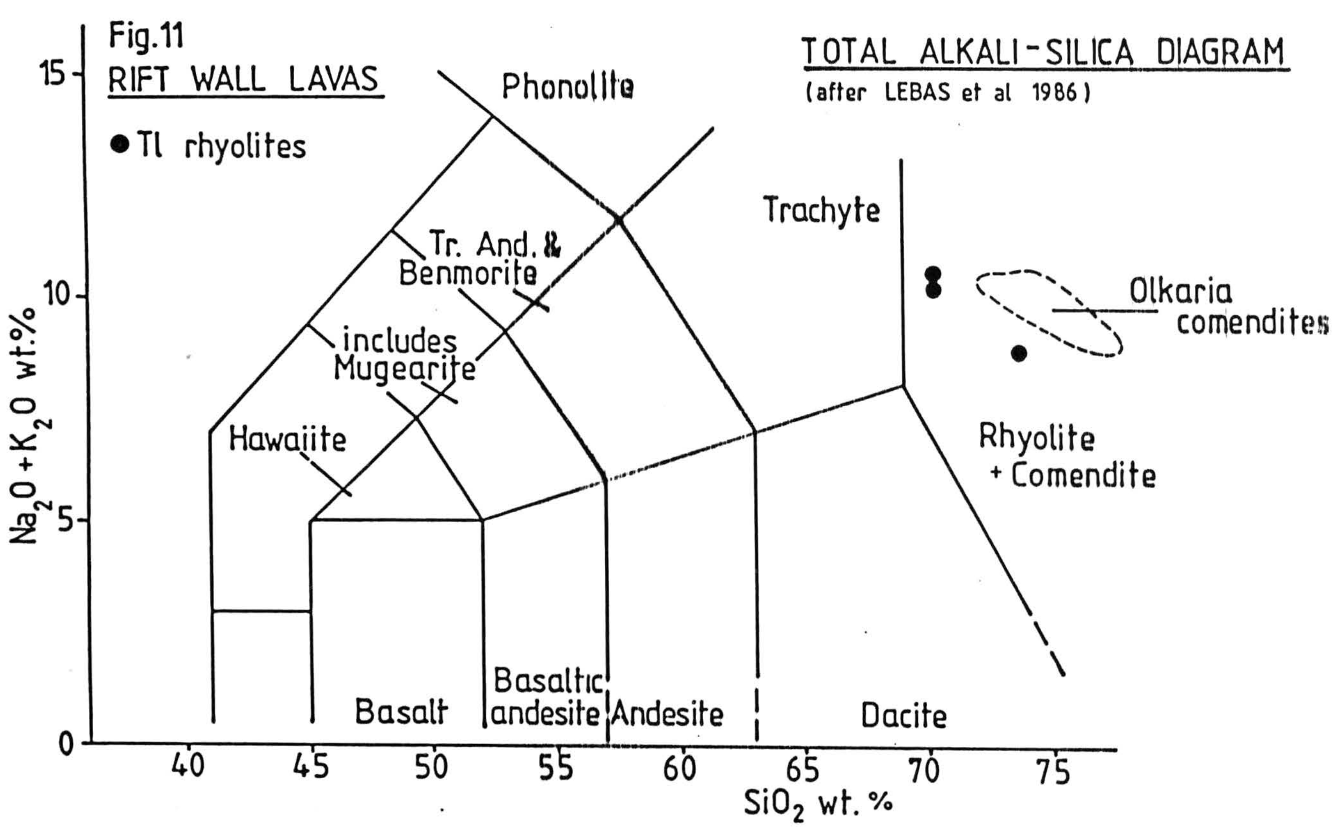


Fig. 11
RIFT WALL LAVAS
● Tl rhyolites
TOTAL ALKALI-SILICA DIAGRAM
(after LEBAS et al 1986)
Phonolite
Tr. And. & Benmorite
includes Mugearite
Hawaiite
Trachyte
Olkaria comendites
Rhyolite + Comendite
Basalt
Basaltic andesite
Andesite
Dacite
Na2O + K2O wt.%
SiO2 wt.%
0
5
10
15
40
45
50
55
60
65
70
75

Fig. 12

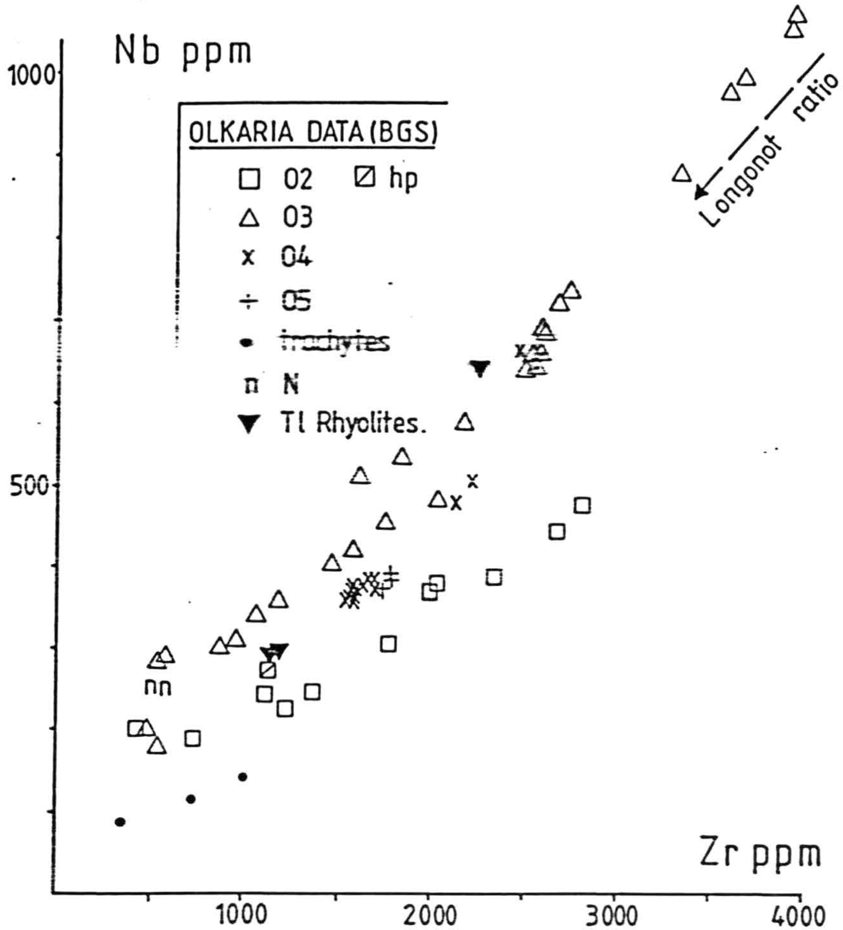
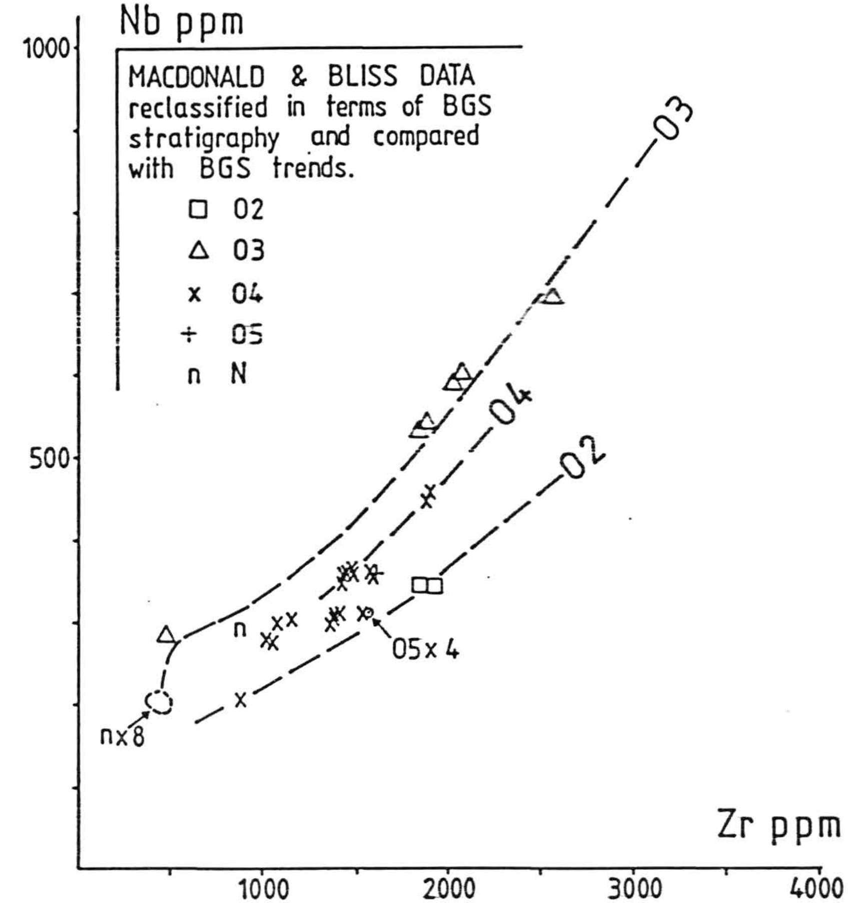

Nb ppm
1000
500
OLKARIA DATA (BGS)
02
hp
03
x 04
÷ 05
trachytes
n N
Tl Rhyolites.
Longonot ratio
Zr ppm
1000
2000
3000
4000

Fig. 13


Nb ppm
1000
500
MACDONALD & BLISS DATA reclassified in terms of BGS stratigraphy and compared with BGS trends.
02
03
x 04
+ 05
n N
03
04
02
05 x 4
n x 8
Zr ppm
1000
2000
3000
4000

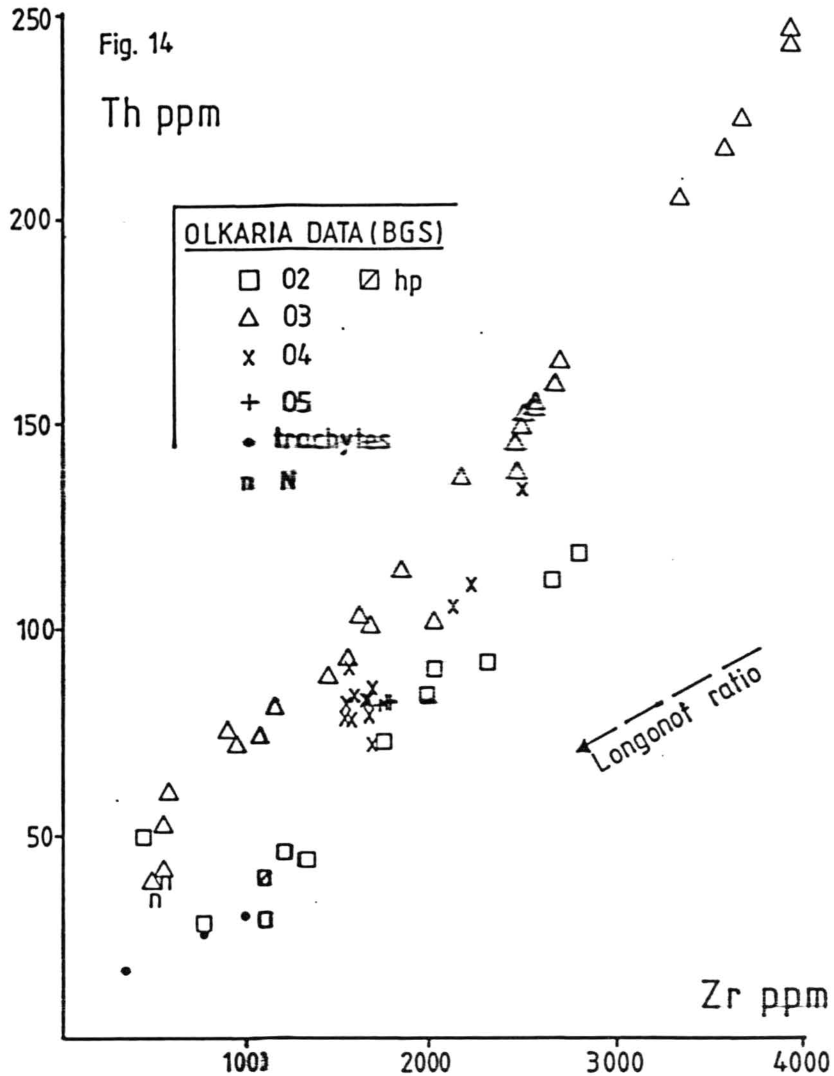


Fig. 14
Th ppm
OLKARIA DATA (BGS)
02
hp
03
04
05
trachytes
N
Longonot ratio
Zr ppm
250
200
150
100
50
1003
2000
3000
4000

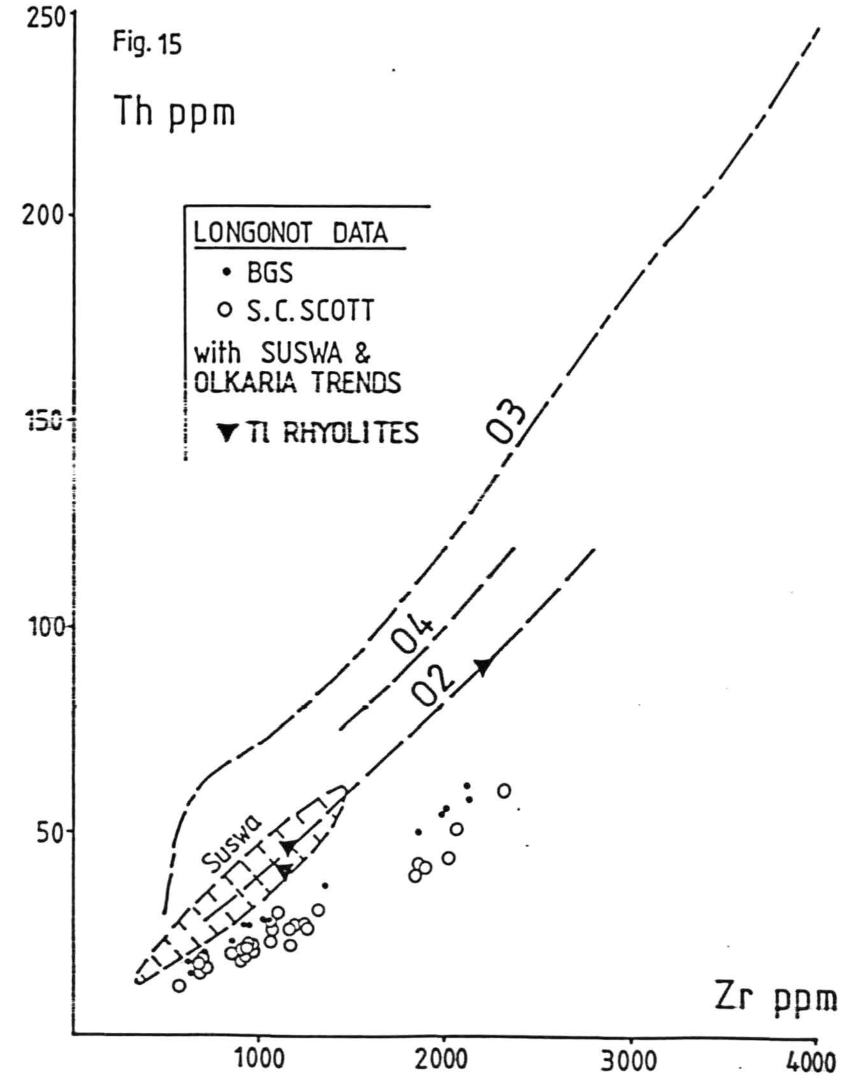
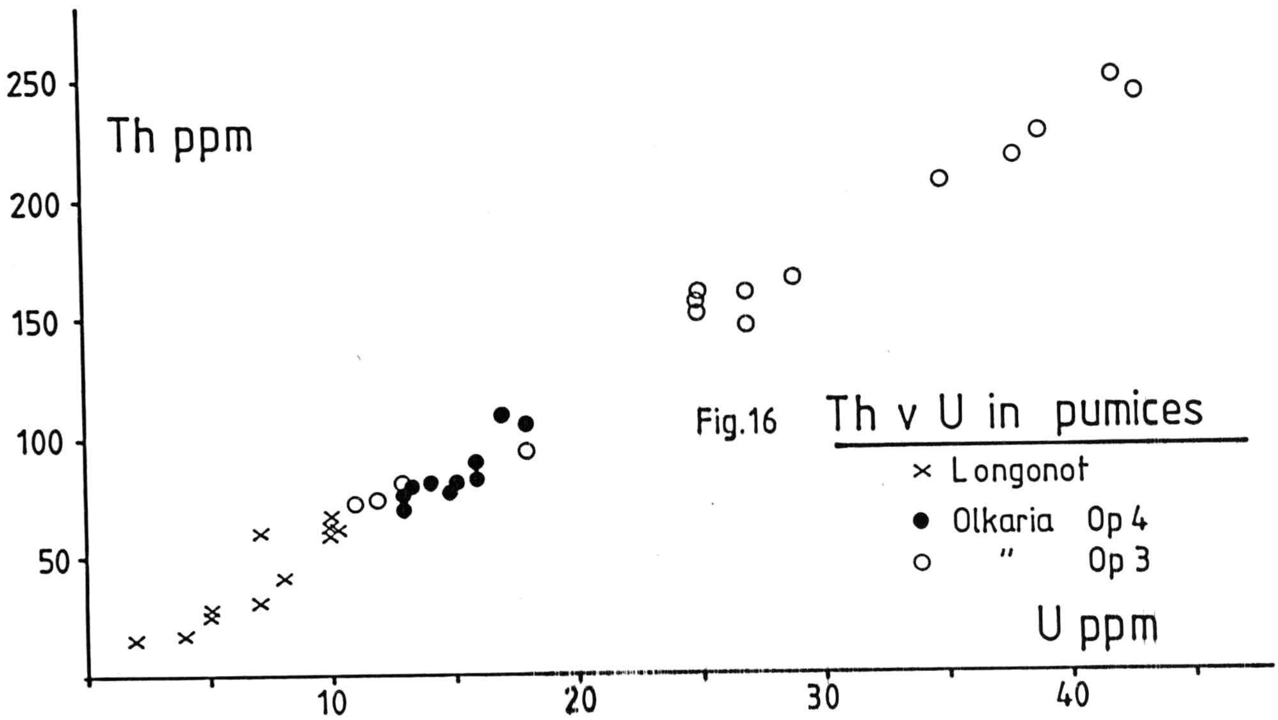


Fig. 15
Th ppm
LONGONOT DATA
BGS
S.C.SCOTT
with SUSWA &
OLKARIA TRENDS
TI RHYOLITES
03
04
02
Suswa
Zr ppm
250
200
150
100
50
1000
2000
3000
4000


250
200
150
100
50
Th ppm
10
20
30
40
U ppm
Fig.16
Th v U in pumices
× Longonot
● Olkaria Op 4
○ " Op 3

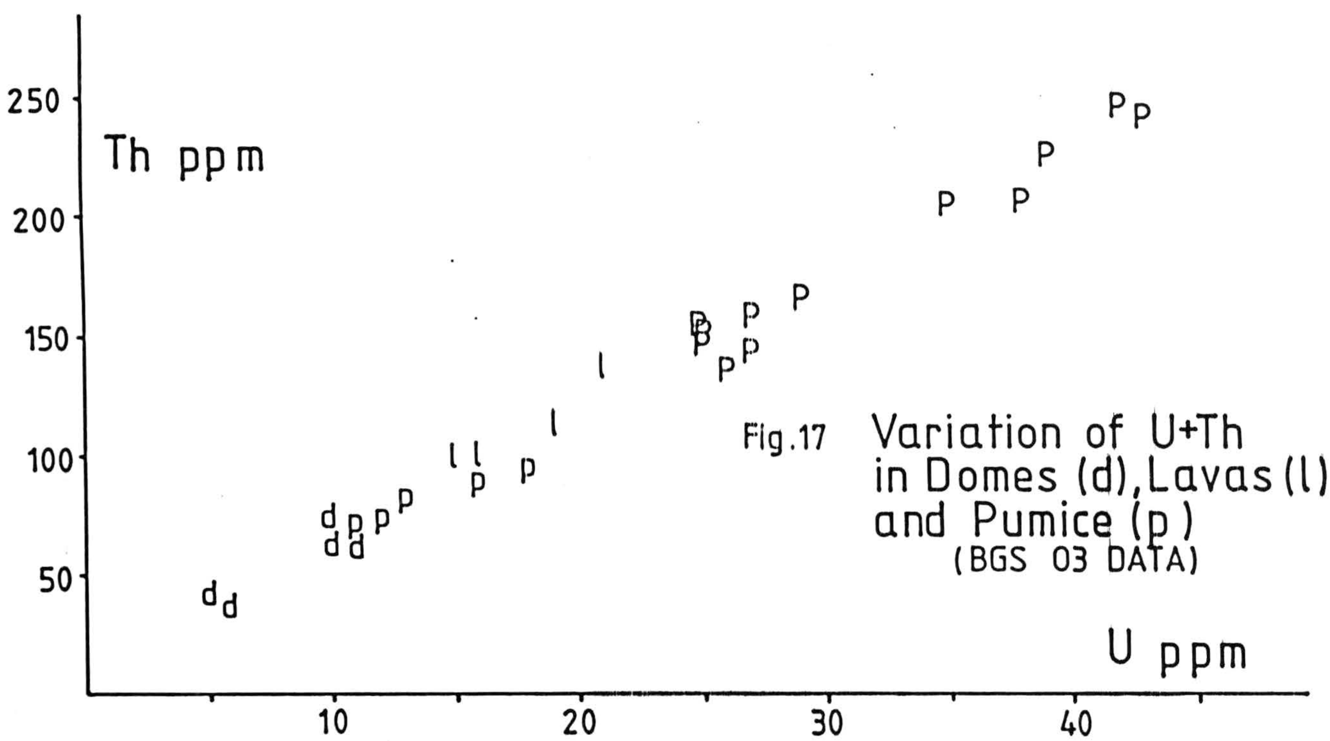

250
200
150
100
50
Th ppm
10
20
30
40
U ppm
Fig.17
Variation of U+Th in Domes (d), Lavas (l) and Pumice (p)
(BGS 03 DATA)

TABLE 1A

LONGONOT PYROCLASTICS - SAMPLE LISTING & MAPREFS

Sample	Map Ref	Sample type
Lp1		
L383	BJ 266982	EARLY Lp1 IGNIMBRITE, MT.MARGARET.
L387	BK 222060	PUMICE LAPILLI FROM LAG DEPOSIT.
L390	BK 222060	DARK IGNIMBRITE.
Lp2		
L380	BJ 195924	PUMICE LAPILLI, AIRFALL UNIT BELOW L378 (Lp3).
L372	BJ 105971	" " " " Lp2
L371	BJ 105971	" " " " Lp2
L343	BJ 261885	" " UPPER PART Lp2 IGNIMBRITE
L342	BJ 261885	" " LOWER PART Lp2 IGNIMBRITE
Lp3		
L355	BJ 108943	PUMICE BLOCKS, UPPER Lp3 IGNIMBRITE 1.
L378	BJ 195924	PUMICE BLOCKS, UPPER Lp3 IGNIMBRITE 1.
L302	BJ 156945	PUMICE LAPILLI, LOWER Lp3, S. CALDERA.
L306	BJ 156945	" BLOCKS, UPPER " , " .
L345	BJ 274862	PUMICE " TOP OF Lp3 IGNIMBRITE.
L329	BK 042034	PUMICE LAPILLI, LOWER PART Lp3 IGNIMBRITE
L324	BJ 260893	PUMICE LAPILLI, UPPER PART Lp3 IGNIMBRITE
L358	BJ 108943	WELDED, EUTAXITIC Lp3 IGNIMBRITE
L386	BK 222060	PUMICE LAPILLI, Lp3 IGNIMBRITE.
Lp4		
L334	BJ 105968	PUMICE FROM Lp4 UNIT JUST BELOW SURGE.
Lp5		
L359	BJ 119945	PUMICE LAPILLI, MIDDLE OF 4th BED.
L361	"	PUMICE LAPILLI, BASE OF 5th BED.
L364	"	PUMICE LAPILLI, TOP OF 5th BED.
L365	"	PUMICE LAPILLI, BASE OF 6th BED.
L316	BJ 114944	PUMICE LAPILLI, BASE OF 4th BED.
L367	BJ 115965	PUMICE LAPILLI, BASE OF 7th BED.
L309	BJ 114944	PUMICE LAPILLI, TOP OF 1st BED.
L313	"	PUMICE BLOCKS, BASE OF 3rd BED.
L308	"	PUMICE LAPILLI, MIDDLE OF 1st BED.
L312	"	PUMICE LAPILLI, UPPERPART OF 2nd BED.
L318	BJ111943	PUMICE LAPILLI, BASE OF 1st BED.
Lp8		
L331	BK 042034	PUMICE FROM Lp8 OVERLYING IGNIMBRITE
L337	CRATER	PUMICE BLOCKS FROM LOWER Lp8 IN CRATER WALL

file d:analist

TABLE 1B

S.C.SCOTT 1987 Data LONGONOT PYROCLASTICS (BGS Fmns. Lp1 & 2).

	Lp1			Lp2				
Sp. No	L383	L387	L390	L380	L372	L371	L343	L342
SiO2	61.73	59.75	61.95	61.65	61.92	61.95	60.29	60.72
TiO2	0.92	0.44	0.63	0.62	0.62	0.62	0.56	0.57
Al2O3	15.86	15.23	15.27	15.66	15.75	15.22	13.57	13.58
FeO				4.7	4.47		3.64	
Fe2O3					1.76		5.68	
" (T)	7.95	8.23	7.76	6.85	6.74	7.15	9.73	9.89
MnO	0.41	0.35	0.32	0.33	0.33	0.32	0.44	0.45
MgO	0.58	0.27	0.42	0.42	0.33	0.33	0.18	0.19
CaO	1.21	0.93	1.26	1.12	1.13	0.97	1	1.03
Na2O	6.7	8.89	7.12	7.58	9.19	8.02	6.83	8.14
K2O	4.86	4.61	5.06	5.13	5.16	4.96	4.79	4.58
P2O5	0.17	0.05	0.06	0.08	0.08	0.08	0.06	0.06
TOTAL								
TRACE ELEMENTS ppm								
Rb	108	211	281	122	122	141	171	171
Sr	70		10					
Ba	171			20	21			
Zn	249	310	312	225	230	262	351	370
Y	109	155	230	95	96	112	140	143
Ce	207	301	429	177	199	221	267	261
Nb	183	333	533	178	183	216	295	296
Zr	576	1327	2072	700	703	846	1065	1102
V	44	21	22	29	30	26	20	24
Pb	19	33	40	20	18	22	26	30
Th	12	31	51	16	16	20	25	28

file a:/t-ao40

TABLE 1B contd.

S.C.SCOTT 1987 Data LONGONOT PYROCLASTICS (BGS Fmn. Lp3).

Sp. No	Lp3 L355	L378	L302	L306	L345	L329	L324	L358	L386
SiO2	61.23	61.88	61.08	61.93	60.58	60.75	60.01	62.76	59.09
TiO2	0.62	0.62	0.62	0.63	0.57	0.56	0.57	0.58	0.51
Al2O3	15.48	15.68	15.5	15.69	15.42	15.65	15.31	15.26	16.54
FeO	2.97								
Fe2O3									
" (T)	6.79	6.89	6.85	6.91	8.1	8.13	8.08	7.38	7.95
MnO	0.35	0.3	0.32	0.3	0.38	0.37	0.35	0.36	0.36
MgO	0.38	0.33	0.36	0.38	0.31	0.31	0.32	0.24	0.27
CaO	1.11	1.09	1.18	1.08	0.99	0.99	1.2	0.9	0.85
Na2O	7.93	7.75	8.04	7.01	9.23	9.4	8.97	8.31	6.98
K2O	5.17	5.26	5.68	5.35	4.87	4.96	5.11	4.97	4.33
P2O5	0.09	0.09	0.09	0.11	0.08	0.08	0.08	0.06	0.04
Total									
TRACE ELEMENTS ppm									
Rb	122	126	134	126	168	170	160	171	236
Sr									23
Ba	15		12						
Zn	223	229	232	230	328	323	312	324	359
Y	95	96	96	114	122	122	120	135	207
Ce	191	215	201	218	243	252	261	280	403
Nb	176	183	187	186	255	258	251	268	434
Zr	684	698	704	708	928	948	945	1064	1855
V	25	28	31	25	24	24	24	24	23
Pb	22	24	14	14	26	27	23	27	39
Th	17	15	17	18	21	23	19	28	42

TABLE 1B contd>

S.C.SCOTT 1987 Data LONGONOT PYROCLASTICS (BGS Fmns. Lp4 & 5).

	Lp4	Lp5						
	L334	L359	L361	L364	L365	L316	L367	L309
SiO2	59.55	61.39	61.96	62.24	61.99	62.22	62.08	60.91
TiO2	0.37	0.5	0.5	0.49	0.49	0.47	0.49	0.52
Al2O3	15.81	14.25	14.09	14.18	13.9	13.7	13.58	16.1
FeO		4.55		3.72	4.33			
Fe2O3		2.72		3.93	3.37			
" (T)	7.42	7.78	7.87	8.07	8.19	8.35	8.57	6.75
MnO	0.35	0.35	0.35	0.36	0.38	0.33	0.35	0.27
MgO	0.13	0.12	0.16	0.13	0.15	0.12	0.17	0.21
CaO	0.8	0.94	0.9	0.94	0.85	0.81	0.85	1.03
Na2O	9.35	7.68	7.65	7.78	7.91	7.45	8.29	7.51
K2O	4.7	4.81	4.79	4.75	4.73	4.68	4.69	4.93
P2O5	0.02	0.05	0.04	0.04	0.04	0.03	0.05	0.06
Total								
TRACE ELEMENTS ppm								
Rb	295	158	159	168	180	189	197	183
Sr								
Ba								
Zn	438	274	271	305	305	357	350	312
Y	252	127	128	150	144	166	156	146
Ce	484	240	239	237	248	296	307	300
Nb	517	229	223	246	261	280	288	298
Zr	2337	900	914	987	1073	1183	1187	1248
V	12	25	23	22	20	15	21	20
Pb	46	26	23	29	27	29	26	30
Th	60	21	18	21	23	26	27	27

TABLE 1B contd

S.C.SCOTT 1987 Data LONGONOT PYROCLASTICS (BGS Fmns. Lp5contd. & Lp8).

	Lp5 contd.				Lp8	
	L313	L308	L312	L318	L331	L337
SiO2	62.35	59.48	60.8	60.01	62.02	62.39
TiO2	0.47	0.43	0.42	0.43	0.61	0.59
Al2O3	14.2	15.15	14.8	14.97	13.86	12.99
FeO						
Fe2O3						
" (T)	8.39	7.34	8.09	7.66	8.44	9.32
MnO	0.36	0.32	0.34	0.36	0.35	0.38
MgO	0.06	0.12	0.08	0.11	0.16	0.14
CaO	0.93	1.26	0.82	0.78	1.08	1.01
Na2O	7.82	7.84	8.07	8.17	8.03	8.21
K2O	4.68	4.69	4.61	4.7	4.7	4.53
P2O5	0.03	0.03	0.04	0.03	0.05	0.06
TRACE ELEMENTS ppm						
Rb	197	245	253	274	151	178
Sr						
Ba						
Zn	369	373	415	404	297	353
Y	165	212	221	225	140	156
Ce	294	413	411	429	255	293
Nb	304	455	444	487	247	282
Zr	1271	1888	1843	2037	986	1183
V	19	14	15	14	27	24
Pb	33	36	36	44	26	27
Th	26	41	39	44	22	22

TABLE 2A

LONGONOT LAVAS - SAMPLE LISTING AND MAPREFS

LONGONOT LAVA PILE (Lt2)

L175	BJ 229914
L70	BJ 213940
L99	BJ 202940
L67	BJ 217953
L65c	BJ 224956
L57	BJ 214990
L148	BJ 120956
L17	BJ 185028
L73	BJ 200957
L124	BJ 174948
L45	BK 208005
L87b	BJ 199942
L172	BJ 224886
L170	BJ 208901
L155	BJ 195925
L154	BJ 196914
L54	BJ 202988
L71	BJ 203965
L149a	BJ 146978
L149b	"
L125	BJ 156955
L20	BK 168015
L14a	BK 171019
KL2	BK 124009
KL15	BK 124039
KL11	BK 188008
L26b	BK 174015

LONGONOT NORTHERN PLAIN LAVAS (LMx2)

L107a	BK 134096
L107b	"
L111a	BK 101088
KL13a	BK 097085
L164	BK 104060
L105a	BK 146059
L104	BK 147053
KL18	BK 148050
KL19	BK 140050

LONGONOT FLANK FLOWS(Lt3)

L33	BK 157018
KL4	BK 151029
L31a	BK 159020
L31b	"
L145	BJ 150969
L130	BJ 159974
KL1a	BJ 141958
KL1b	"
L146	BJ 156974
BG 1427	BK 151032

LONGONOT PIT-CRATER LAVAS (Lmx3)

KL7	BK 174003
L183b	BJ 167998
L220	"
L221	"
BG1619	BJ 158991
BG1620	BJ 162983

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TABLE 2B

S.C.SCOTT Thesis data LONGONOT LAVA PILE (BGS Formation Lt2)

Sp No.	L175	L70	L99	L67	L65c	L57	L148	L17	L73
SiO2	62.17	62.62	62.26	62.48	61.98	62	62.71	62.72	62.6
TiO2	0.69	0.69	0.69	0.69	0.7	0.67	0.64	0.63	0.65
Al2O3	15.48	15.49	15.55	15.57	15.71	15.54	15.62	14.89	14.49
FeO									3.69
Fe2O3									3.97
FeO(T)	6.83	6.86	6.94	6.76	6.84	6.93	6.63	7.09	7.29
MnO	0.25	0.25	0.25	0.27	0.25	0.25	0.26	0.27	0.21
MgO	0.67	0.48	0.44	0.45	0.52	0.42	0.33	0.34	0.32
CaO	1.44	1.37	1.36	1.37	1.41	1.38	1.23	1.36	1.46
Na2O	6.32	6.33	6.64	6.87	6.69	6.61	6.97	6.91	7.31
K2O	4.95	4.97	5.01	4.89	5.03	5.06	5.09	4.77	4.96
P2O5	0.15	0.14	0.15	0.1	0.15	0.12	0.1	0.09	0.07
Loss**	0.41	0.23	0.09	-0.02	0.1	0.34	0.83	0.47	
H2O+									0.72
F									0.24
Cl									0.18
TOTAL	99.36	99.43	99.38	99.43	99.38	99.32	100.41	99.44	100.87
O=F+Cl									-0.14
TOTAL	99.36	99.43	99.38	99.43	99.38	99.32	100.41	99.44	100.73
TRACE ELEMENTS ppm									
Rb	104	111	98	98	105	109	129	122	124
Sr	10	8	7	9	8	7			
Ba	248	254	233	251	248	173		<50	
Zn	167	174	176	166	169	179	192	209	211
Yt	76	80	80	85	82	86	83	98	97
La	86	94	96	89	88	95	111	116	115
Ce	179	171	176	184	176	187		211	224
Zr	590	610	589	590	575	632	646	749	740
Nb	142	131	130	140	138	152	151	169	175
Ni									

** on making fused disc

file d:/s-b140

TABLE 2B contd

S.C.SCOTT Thesis data (BGS Formation Lt2 contd.)

Sp No.	L124	L45	L87b	L172	L170	L155	L154	L54	L71	L149a
SiO2	62.65	62.82	61.27	62.03	62.58	62.12	62.82	62.86	62.74	62.42
TiO2	0.62	0.62	0.61	0.62	0.62	0.6	0.61	0.59	0.59	0.58
Al2O3	14.72	14.77	13.87	14.32	14.43	14.33	14.49	13.91	13.69	13.1
FeO										6.62
Fe2O3										2.05
FeO(T)	7.41	7.41	7.43	7.61	7.63	7.42	7.55	8.31	8.21	8.46
MnO	0.28	0.28	0.28	0.29	0.28	0.28	0.28	0.32	0.32	0.33
MgO	0.21	0.24	0.17	0.16	0.18	0.17	0.18	0.17	0.14	0.13
CaO	1.11	1.29	1.07	1.15	1.17	1.08	1.2	1.12	1.05	1.01
Na2O	7.17	6.55	8.93	7.6	7.03	7	6.99	7.05	7.52	8.32
K2O	4.96	4.88	4.74	4.73	4.79	5.68	4.88	4.67	4.76	4.6
P2O5	0.05	0.06	0.15	0.09	0.08	0.09	0.09	0.05	0.04	0.07
Loss**	0.21	0.46	0.56	0.58	0.5	0.56	0.3	0.13	0.14	
H2O+										0.22
F										0.33
Cl										0.26
TOTAL	99.39	99.4	99.18	99.27	99.29	99.33	99.39	99.18	99.2	100.04
O=F+Cl										-0.2
TOTAL	99.39	99.4	99.18	99.27	99.29	99.33	99.39	99.18	99.2	99.84
TRACE ELEMENTS ppm										
Rb	144	146	132	132	138	141	149	172	168	156
Sr										
Ba	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Zn	227	226	230	222	218	231	226	277	275	277
Yt	107	109	108	102	108	113	109	129	133	136
La	128	125	133	128	130	133	133	161	154	159
Ce	233	239	233	239	242	240	246	294	288	302
Zr	815	831	835	871	882	857	878	993	1015	1041
Nb	191	191	192	192	206	200	205	232	235	233
Ni										

TABLE 2B contd

S.C.SCOTT Thesis data (BGS Formation Lt2 contd.)

Sp No.	L149b	L125	L20	L14a	KL2	KL15	KL11	L26b
SiO2	63.01	62.63	62.8	62.96	62.26	62.26	62.46	62.8
TiO2	0.58	0.65	0.6	0.6	0.61	0.6	0.6	0.61
Al2O3	13.74	13.5	13.91	13.82	12.72	12.78	12.67	12.96
FeO					6.92	7.06	6.75	4.57
Fe2O3					2.01	1.87	2.28	4.96
FeO(T)	8.31	8.7	8.86	8.76	8.72	8.71	8.79	8.99
MnO	0.32	0.34	0.35	0.35	0.31	0.31	0.31	0.35
MgO	0.16	0.18	0.13	0.14	0.12	0.12	0.12	0.13
CaO	1.08	1.2	1.12	1.13	0.98	0.95	0.98	1.03
Na2O	7.17	7.1	6.77	7.05	8.54	8.61	8.53	7.33
K2O	4.55	4.63	4.72	4.38	4.63	4.6	4.6	4.7
P2O5	0.04	0.06	0.05	0.06	0.07	0.07	0.07	0.05
Loss**	0.25	0.09	0.5	-0.11				
H2O+					0.15	0.14	0.1	0.46
F					0.36	0.35	0.36	
Cl					0.27	0.27	0.27	
TOTAL	99.2	99.08	99.09	99.36	99.93	100.02	100.1	99.95
O=F+Cl					-0.21	-0.21	-0.21	
TOTAL	99.2	99.08	99.09	99.36	99.72	99.81	99.89	99.95
TRACE ELEMENTS ppm								
Rb	168	180	168	156	174	170	172	154
Sr	5	11						
Ba	<50	<50	<50	<50	<50	<50	<50	<50
Zn	274	285	299	302	281	281	283	297
Yt	128	133	148	142	120	140	143	144
La	158	164	164	175	172	173	174	173
Ce	296	304	320	316	314	316	322	321
Zr	1016	1052	1124	1125	1066	1080	1096	1108
Nb	239	249	254	263	258	258	258	257
Ni								

TABLE 2B contd

S.C.SCOTT Thesis data LONGONOT FLANK FLOWS (BGS Formation Lt3) plus BG 1427

Sp No.	L33	KL4	L31a	L31b	L145	L130	KL1a	KL1b	L146	BG1427
SiO2	61.97	61.43	61.57	61.53	61.86	61.82	61.21	61.48	62.19	62.63
TiO2	0.67	0.28	0.67	0.68	0.69	0.67	0.68	0.67	0.66	0.69
Al2O3	12.92	12.99	12.98	13.22	13.05	12.97	12.96	13.03	13.16	12.7
FeO	7.14	7.2					7.28	5.51		5.13
Fe2O3	1.68	2.09					2.01	3.96		5.28
FeO(T)	8.99	9.08	8.89	8.99	8.89	8.94	9.08	9.06	8.89	
MnO	0.36	0.33	0.35	0.35	0.35	0.36	0.33	0.34	0.35	0.4
MgO	0.23	0.22	0.24	0.24	0.34	0.24	0.22	0.22	0.29	0.43
CaO	1.3	1.17	1.22	1.25	1.71	1.26	1.19	1.19	1.46	1.32
Na2O	7.98	8.16	8.43	7.48	6.74	8.08	8.33	7.5	6.79	6.31
K2O	4.64	4.76	4.64	4.75	4.67	4.62	4.77	4.84	4.69	5.03
P2O5	0.13	0.09	0.13	0.11	0.12	0.12	0.09	0.09	0.11	0.07
Loss**	-0.25		-0.21	0.29	0.53	-0.14			0.4	
H2O+		0.1					0.1	0.16		
F		0.32					0.33	0.3		
Cl		0.25					0.25	0.15		
TOTAL	99.27	99.38	99.33	98.89	98.95	98.94	99.75	99.44	98.99	99.99
O=F+Cl		-0.19					-0.19	-0.16		
TOTAL	99.27	99.19	99.33	98.89	98.95	98.94	99.56	99.28	98.99	
TRACE ELEMENTS ppm										
Rb	182	155	171	161	156	171	165	162	159	159
Sr	5	T	9	8	8	12	T	T	T	3
Ba	<50	<50	<50	<50	<50	<50	<50	<50	<50	58
Zn	261	260	268	267	264	266	265	261	260	
Yt	130	136	136	139	136	137	126	131	132	121
La	156	161	159	162	161	156	159	157	156	
Ce	291	294	305	301	303	297	288	297	287	
Zr	1070	1023	1069	1069	1070	1051	1017	1031	1041	989
Nb	242	245	249	245	250	245	241	236	239	223
Ni										

Th=26

TABLE 2B contd

S.C.SCOTT Thesis data LONGONOT PIT CRATER LAVAS (BGS Formation Lmx3)
PLUS two new BGS analyses

Sp No.	KL7	L183b	L220	L221	BG1619	BG1620
SiO_2	55.78	55.99	56.25	55.28	54.94	55.65
TiO_2	1.44	1.66	1.67	1.75	2.01	1.61
Al_2O_3	14.76	14.72	14.69	14.67	14.25	14.46
FeO					8.16	7.51
Fe_2O_3					2.58	2.54
FeO(T)	9.4	10.59	9.44	9.6		
MnO	0.22	0.23	0.24	0.22	0.26	0.23
MgO	3.84	2.64	2.43	2.94	3.23	3.68
CaO	4.48	4.87	4.88	5.27	5.41	4.77
Na_2O	5.42	5.81	5.47	5.31	5.6	5.78
K_2O	3.35	3.36	3.41	3.26	3.09	3.38
P_2O_5	0.35	0.42	0.42	0.46	0.48	0.39
Loss**		0.17	-0.26	-0.16		
H_2O+	0.1					
F	0.12					
Cl	0.04					
TOTAL	99.63	100.46	98.64	98.55	100.01	100.01
O=F+Cl	-0.06					
TOTAL	99.57	100.46	98.64	98.55		
TRACE ELEMENTS ppm						
Rb	52	80	80	75	74	74
Sr	261	291	310	329	354	317
Ba	574	554	435	486	525	589
Zn	167	171	165	154		
Yt	66	78	72	68	55	57
La	75	79	71	69		
Ce	145	159	150	157		
Zr	472	539	532	496	416	435
Nb	101	108	87	97	83	88
	49	45	45	52		

TABLE 2B contd

S.C.SCOTT Thesis data LONGONOT N. PLAIN LAVAS (BGS Formation Lmx2).

Sp No.	L107a	L107b	L111a	KL13a	L164	L105a	L104	KL18	KL19
SiO2	61.2	61.6	60.6	60.7	60.27	61.39	60.59	60.93	61.13
TiO2	0.95	0.89	0.99	1.04	1.03	0.91	0.99	1.02	0.66
Al2O3	16.47	16.6	16.68	15.69	16.92	16.41	16.49	15.93	15.9
FeO				5.59				4.68	5.44
Fe2O3				1.21				2.22	1.17
FeO(T)	6.17	6.18	6.23	6.68	6.36	6.19	6.26	6.67	6.49
MnO	0.23	0.23	0.22	0.22	0.2	0.22	0.23	0.23	0.23
MgO	0.59	0.59	0.8	0.89	0.94	0.6	0.79	0.89	0.54
CaO	1.71	1.68	2.21	2.32	2.65	1.82	2.15	2.34	1.64
Na2O	6.46	6.15	6.21	6.41	5.82	5.92	6.48	5.95	6.83
K2O	5.08	5.15	4.97	5.02	4.78	5.15	4.94	5.01	5.27
P2O5	0.33	0.23	0.35	0.29	0.32	0.34	0.37	0.21	0.19
Loss**	0.22	0.14	0.06		-0.02	0.5	0.05		
H2O+				0.37				0.3	0.1
F				0.11			0.1	0.08	0.1
Cl				0.06			0.07	0.02	0.06
TOTAL	99.41	99.44	99.32	99.91	99.27	99.45	99.51	99.8	99.26
O=F+Cl				0.06			0.06	0.04	0.05
TOTAL	99.41	99.44	99.32	99.85	99.27	99.45	99.45	99.76	99.21
TRACE ELEMENTS ppm									
Rb	66	58	54	48	44		60	42	69
Sr	16	T	41	48	78	15	41	48	5
Ba	432	454	500		516	377	507	535	397
Zn	128	126	112	119	134	130	112	132	123
Yt	45	51	47	42	49	47	45	55	46
La	43	64	48	58	53	52	50	60	62
Ce	109	113	105	98	110	115	105	107	111
Zr	295	298	276	260	267	300	280	280	303
Nb	76	72	62	67	63	92	64	68	75
Ni	34	40	42	34		36	41		

TABLE 3A

MACDONALD & BLISS DATA - LISTING & MAPREFS

Sp.No.	MAP REF		ROCK TYPE
N (NDABIBI COMENDITES)			
KN13	AK	942100	OBSIDIAN BLOCKS IN AIRFALL
BL002	AK	942100	OBSIDIAN FLOW
143b	AK	958107	" "
179a	AK	928116	PUMICEOUS OBSIDIAN FLOW
117	AK	943165	" " DOME
210b	AK	946120	OBSIDIAN FLOW
231a	AK	921118	PUMICEOUS OBSIDIAN DOME
184a	AK	924104	COMENDITE DOME
148a	AK	932085	" " (MULLA)
02			
410b	AK	998085	OBSIDIAN FLOW
583b	BK	035080	" "
03			
372	AK	959026	COMENDITE IN EXPLOSION CRATER
570	BK	035061	OBSIDIAN FLOW
504	BK	036039	" "
565	BK	030053	" "
377	AK	958054	AIRFALL PUMICE
361a	AK	980070	" "
04			
333	AK	946072	OBSIDIAN FLOW
524	BK	069039	AIRFALL PUMICE
511d	BK	062054	OBSIDIAN FLOW
KN19	BK	076043	" "
551	BK	062035	" "
534d	BK	059054	AIRFALL PUMICE
KN21	BK	079017	OBSIDIAN FLOW
KN20	BK	081025	" "
KN2	BK	049018	" "
KN4	BK	053018	" "
512	BK	064051	" CHILLED MARGIN OF PLUG
601	BK	056057	COMENDITE
605	BK	064049	OBSIDIAN FLOW
515	BK	042029	" "
530	BK	077027	" "
517	BK	018017	AIRFALL PUMICE
399b	AK	971042	OBSIDIAN FLOW
396b	AK	981047	" "
346	AK	990033	" "
376	AK	955046	" "
05			
KN9	AK	980039	" "
312b	AK	982022	AIRFALL PUMICE
KN6	AK	977025	OBSIDIAN BLOCK IN AIRFALL
KN18	BK	006007	OBSIDIAN FLOW
339c	AK	969001	AIRFALL PUMICE
301a	BK	007006	OBSIDIAN FLOW

file d:listmac-h55

TABLE 3B

MACDONALD & BLISS DATA - NDABIBI AREA

BGS Fm	N	N	N	N	N	N	N	N	N
MAC Fm	Ptb2	Plcl	Plcl	Plcl	Plcl	Plcl	Plcl	Plcl	Plcl
Sp.No	KN13	002	143b	179a	117	210b	231a	184a	148a
SiO2	75.9	75.2	74.7	75.4	75.2	74.9	74.9	75	75.7
TiO2	0.14	0.17	0.15	0.18	0.2	0.15	0.26	0.23	0.26
Al2O3	12.13	12.11	12.11	12.09	12.17	12.11	12.09	12.33	11.09
Fe2O3	0.79	0.83	0.94	0.87	0.88	0.92	0.93	2.25	2.65
FeO	1.11	1.06	1.05	0.97	1.04	1.02	0.98	0.03	0.04
MnO	0.04	0.04	0.04	0.03	0.03	0.03	0.04	0.04	0.04
MgO	0.05	0.07	0.08	0.04	0.07	0.05	0.04	0.04	0.02
CaO	0.39	0.44	0.65	0.46	0.53	0.48	0.43	0.17	0.26
Na2O	4.78	4.59	4.69	4.66	4.71	4.62	4.56	4.54	4.67
K2O	4.69	4.73	4.75	4.73	4.71	4.75	4.74	5	4.52
P2O5	0	nd	0.01	nd	nd	nd	nd	nd	nd
H2O+	<0.10	0.06	0.05	0.1	0.12	0.1	0.17	0.13	0.04
H2O-	-	0.12	0.22	0.21	0.12	0.2	0.06	0.09	0.1
F	0.32	0.37	0.23	0.44	0.13	0.48	0.27	nil	0.19
Cl	0.15	0.22	0.16	0.13	0.08	0.16	0.18	0.03	0.12
O=F,Cl	0.17	0.21	0.13	0.22	0.08	0.24	0.15	0.01	0.1
TOTAL	100.32	99.8	99.7	100.01	99.91	99.73	99.5	99.87	99.6
TRACE ELEMENTS (SELECTED)									
Rb	268	290	285	288	279	287	293	254	368
Sr	-	6.15	7.852	-	-	-	-	6.025	1.665
Ba	9	13	13	8	15	15	10	23	4
Zn	118	129	135	113	115	116	113	65	171
Y	115	108	105	109	112	109	111	77	149
Ce	-	142	143	141	143	143	143	205	158
Nb	202	200	211	204	211	207	210	190	289
Zr	393	439	444	447	450	450	462	502	891
Pb	33	28	27	31	28	29	29	19	36
Th	-	38.8	39.5	38.1	38.7	38.8	39.3	37.2	52.1
U	-	7.1	6.9	7.1	6.8	7.5	7.8	5.8	9.9

file a:blissdata-az41

. TABLE 3B

MACDONALD & BLISS DATA - OLKARIA COMPLEX

BGS Fm	02	02	03	03	03	03	Op3	Op3
MAC Fm	Plc2	Plc2	Ptb2	Plc2	(Gorge	Fm)	Ptp2-	G.Farm
Sp.No	410b	583b	372	570	504	565	377	361a
SiO2	73.7	73.8	76.4	73.1	72.9	72.5	72	69.9
TiO2	0.23	0.22	0.16	0.33	0.23	0.24	0.18	0.24
Al2O3	10.64	10.64	11.41	10.52	10.44	10.32	10.54	11.15
Fe2O3	1.93	1.72	1.89	1.93	1.9	1.93	-	-
FeO	1.62	1.81	0.08	2.15	2.21	2.25	4.10*	4.57*
MnO	0.04	0.05	0.02	0.04	0.06	0.06	0.09	0.12
MgO	0.01	0.01	0.01	0.02	0.02	0.02	0.15	0.06
CaO	0.21	0.22	0.36	0.13	0.15	0.15	0.14	0.88
Na2O	5.46	5.5	4.34	5.74	5.54	5.86	3.86	4.05
K2O	4.44	4.41	4.6	4.45	4.36	4.39	4.39	4.55
P2O5	nd	nd	0.02	nd	nd	nd	0.23	0.03
H2O+	0.19	0.09	0.02	0.13	0.27	0.23	3.38	3.73
H2O-	0.07	0.11	0.08	0.09	0.07	0.03	-	-
F	0.57	0.71	0.44	0.91	0.9	0.95	0.72	1.11
Cl	0.38	0.31	0.1	0.44	0.47	0.47	-	-
O=F,Cl	0.33	0.37	0.21	0.48	0.49	0.51	0.3	0.46
TOTAL	99.16	99.23	99.72	99.5	99.03	98.89	99.48	99.93
TRACE ELEMENTS (SELECTED)								
Rb	439	429	387	593	602	637	606	653
Sr	0.875	1.079	-	1.586	-	1.253	-	15.451
Ba	<1	<1	3	1	2	3	<1	1
Zn	376	396	107	349	394	448	446	481
Y	240	246	149	275	276	296	336	394
Ce	120	121	139	288	300	310	-	-
Nb	346	346	281	531	541	590	599	696
Zr	1859	1905	489	1832	1882	2018	2170	2573
Pb	52	54	27	62	62	68	88	95
Th	69.5	77.7	55.1	108	111	124	-	-
U	11.9	16.2	10.1	22.9	22.5	25.1	-	-

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TABLE 3B

MACDONALD & BLISS DATA - OLKARIA COMPLEX

BGS Fm	04	Op4	04	04	04	Op4	04	04	04	04
MAC Fm	Plc2-3	Ptp2	Plc2-3	Plc2	Plc2	Ptp2	Ptp2	Plc2	Plc2	Plc2
Sp.No	333	524	511d	KN19	551	534d	KN21	KN20	KN2	KN4
SiO2	74.9	74.8	74.5	74.6	74.1	74.6	74.8	74.2	74.5	74.3
TiO2	0.35	0.19	0.3	0.18	0.21	0.19	0.18	0.18	0.18	0.16
Al2O3	10.81	10.94	10.75	10.67	10.67	10.66	10.46	10.62	10.42	10.36
Fe2O3	1.36	-	1.41	1.38	1.87	-	1.51	1.61	1.55	1.61
FeO	1.82	3.26*	1.77	1.89	1.87	3.58*	2.04	2	2.05	2.02
MnO	0.05	0.07	0.04	0.06	0.05	0.09	0.06	0.06	0.06	0.06
MgO	0.03	0.17	0.02	0.01	0.01	0.17	0.01	0.01	0.01	0.01
CaO	0.36	0.2	0.26	0.18	0.25	0.19	0.14	0.15	0.14	0.14
Na2O	5.11	3.8	5.2	5.25	5.31	4.06	5.53	5.7	5.49	5.83
K2O	4.6	4.36	4.55	3.51	4.47	4.23	4.42	4.37	4.44	4.43
P2O5	0.04	0.03	0.01	0	nd	0.02	0	0	0	0
H2O+	0.09	1.82	0.03	0	0.15	2.21	0	0	0	0
H2O-	0.24	-	0.17	-	0.06	-	-	-	-	-
F	0.3	0.4	0.49	0.55	0.59	0.49	0.62	0.65	0.64	0.61
Cl	0.23	-	0.26	0.28	0.22	-	0.15	0.38	0.33	0.35
O=F,Cl	0.18	0.17	0.27	0.3	0.3	0.2	0.3	0.36	0.34	0.34
TOTAL	100.11	99.87	99.49	99.26	99.53	100.29	99.62	99.57	99.47	99.54
TRACE ELEMENTS (SELECTED)										
Rb	233	314	328	322	357	374	383	382	396	394
Sr	3.399	-	2.594	-	2.334	-	-	-	-	-
Ba	19	3	2	1	3	<1	1	1	3	3
Zn	184	252	253	253	274	307	307	307	312	314
Y	130	171	158	176	177	217	219	218	224	223
Ce	258	-	242	-	101	-	-	-	-	-
Nb	203	278	273	297	305	296	310	301	315	312
Zr	889	1026	1065	1083	1169	1356	1384	1389	1398	1413
Pb	29	43	38	42	39	48	51	50	49	50
Th	36.4	-	50.8	-	59	-	-	-	-	-
U	6.6	-	12.7	-	13.8	-	-	-	-	-

file a:blissdata

TABLE 3B contd

MACDONALD & BLISS DATA - OLKARIA COMPLEX

BGS Fm	04	04	04	04	04	Op4	04	04	04	04
MAC Fm	Plc2	Plc3	Plc2	Plc3	Plc2	Ptp2	Rlc4	Plc2	Rlc4	Rlc4
Sp.No	512	601	605	515	530	517	399b	396b	346	376
SiO2	73.5	74.9	74.5	74.1	73.9	74.2	73.3	73.5	73	73.5
TiO2	0.34	0.3	0.22	0.3	0.27	0.18	0.22	0.23	0.29	0.22
Al2O3	10.59	10.62	10.57	10.64	10.55	10.59	10.45	10.46	10.32	10.23
Fe2O3	1.67	3.09	1.64	1.67	1.71	-	1.61	1.66	1.89	1.87
FeO	1.93	0.71	1.98	2	1.98	3.55*	2.01	1.99	2.3	2.27
MnO	0.04	0.06	0.06	0.06	0.05	0.09	0.04	0.05	0.06	0.05
MgO	0.03	0.02	0.01	0.01	0.01	0.08	0.01	0.02	0.01	0.02
CaO	0.55	0.21	0.21	0.22	0.17	0.17	0.19	0.59	0.21	0.18
Na2O	5.57	4.83	5.53	5.39	5.68	4.21	5.56	5.52	5.9	5.95
K2O	4.46	4.49	4.36	4.41	4.48	4.14	4.45	4.44	4.41	4.41
P2O5	0	nd	nd	nd	0.01	0.02	0.01	0.01	0.02	nd
H2O+	0.26	0.08	0.17	0.18	0.09	2.2	0.6	0.52	0.03	0.03
H2O-	0.15	0.02	0.04	0.03	0.14	-	0.13	0.18	0.19	0.2
F	0.8	0.39	0.66	0.76	0.59	0.47	0.62	0.55	0.82	0.67
Cl	0.35	0.07	0.41	0.42	0.35	-	0.32	0.38	0.37	0.38
O=F,Cl	0.45	0.18	0.37	0.41	0.33	0.2	0.33	0.32	0.43	0.37
TOTAL	99.79	99.61	99.99	99.78	99.65	99.7	99.19	99.78	99.39	99.61
TRACE ELEMENTS (SELECTED)										
Rb	408	433	416	400	398	381	403	398	471	486
Sr	-	-	-	1.919	-	-	1.513	-	-	2.029
Ba	1	1	1	2	1	0.5	1	1	3	3
Zn	321	326	332	289	302	335	333	323	408	421
Y	207	196	209	221	219	235	222	224	258	259
Ce	110	268	111	279	113	-	259	271	345	348
Nb	358	347	361	363	362	311	357	356	446	457
Zr	1419	1426	1459	1469	1488	1529	1577	1590	1892	1909
Pb	48	43	50	50	50	54	52	51	60	62
Th	70.9	72.7	70.1	72.3	72.7	-	66.9	69.7	88.6	90.6
U	15.2	17.5	17	15.2	15.2	-	13.6	14.1	16.1	17.1

file a:blissdata

TABLE 3B contd

MACDONALD & BLISS DATA - OLKARIA COMPLEX

BGS Fm	O5	Op5	O5	O5	Op5	O5
MAC Fm	Rlc5	Rt5	Rt5	Rlc5	Rt5	Rlc5
Sp.No	KN9	312b	KN6	KN18	339c	301a
SiO2	74.7	75.5	74.5	74.6	75.4	74
TiO2	0.18	0.18	0.18	0.18	0.19	0.2
Al2O3	10.47	10.94	10.38	10.53	10.95	10.44
Fe2O3	1.58		1.58	1.55		1.61
FeO	2.05	3.47*	2.05	2.05	3.68*	2.03
MnO	0.06	0.08	0.06	0.06		0.05
MgO	0.01	0.13	0.01	0.01	0.1	0.02
CaO	0.14	0.17	0.14	0.15	0.21	0.18
Na2O	5.48	4.71	5.45	5.68	4.59	5.62
K2O	4.44	4.49	4.45	4.39	4.47	4.54
P2O5	0	0.03	0	0.01	0.03	0.02
H2O+	0	0.85	0.12	0	1.52	0.11
H2O-	-	-	-	-	-	0.21
F	0.64	0.47	0.62	0.64	0.48	0.6
Cl	0.31	-	0.33	0.37	-	0.36
O=F,Cl	0.34	0.2	0.34	0.35	0.2	0.34
TOTAL	99.72	100.82	99.53	99.87	101.42	99.65
TRACE ELEMENTS (SELECTED)						
Rb	389	384	387	393	391	407
Sr	-	-	-	-	-	1.59
Ba	1	2	2	1	1	<1
Zn	327	326	323	342	336	312
Y	237	234	236	239	238	225
Ce	-	-	-	-	-	263
Nb	315	315	134	313	315	360
Zr	1535	1540	1549	1571	1576	1604
Pb	54	50	51	55	55	49
Th	-	-	-	-	-	67.5
U	-	-	-	-	-	11.9

file a:blissdata

TABLE 4A

LISTING OF NEW BGS ANALYTICAL DATA

Sp.No.	Sh No	Map. Ref.		ROCK TYPE
LONGONOT AFFINITY PYROCLASTICS (BGS Fmn Lp5)				
BG1544/4	133/3	AK	963026	GREY PUMICE LAPILLI
1606	133/4	BK	030038	PORPHYRITIC,CINDERY GREY PUMICE LAPILLI
1217	"	BJ	175947	BLOCKEY TRACHYTE LAVA OR ASH FLOW
1544/3	"	AK	963026	GREY PUMICE LAPILLI
1394/1	"	BJ	016979	GREY-GREEN PUMICE CLASTS
1608	"	BJ	119947	" " "
1034/2	"	BJ	119945	GREY PUMICE LAPILLI
1034/1	"	BJ	119945	" " "
1445	"	AJ	946925	GREY-GREEN PUMICE LAPILLI
1371	"	AJ	971949	ALTERED GREYISH PUMICE LAPILLI
1547/2	"	AK	959024	GREY-GREEN PUMICE LAPILLI
Lt2				
1427	"	BK	151032	RECENT LONGONOT FLANK FLOW
OLKARIA AREA TRACHYTES				
1366	"	AJ	975960	PORPHYRITIC TRACHYTE LAVA
1406	"	BJ	008969	FLOWBANDED PALE PUMICEOUS LAVA AT DOME TOP
1437/1	147/2	BJ	002859	PORPHYRITIC TRACHYTE
1045	"	BJ	025863	SCORIACEOUS LAVA RESIDUAL
OLKARIA COMENDITES (BGS Fmns O2 & O3)				
1144	133/4	BJ	039958	GLASSY BANDED LAVA
1422	"	AJ	975979	PORPHYRITIC COMENDITE AT DOME TOP
1584	"	AK	947158	COMENDITE AT SHALLOW CRATERED DOME
1160/1	"	BK	058009	PALE-GREY PORPHYRITIC COMENDITE
1544/2	"	AK	962026	PORPHYRITIC COMENDITE
1317	"	AJ	943936	" " AT DOME TOP
1547/1	"	AK	959024	" "
1331	"	BJ	025937	" " AT DOME TOP
1140	"	BJ	063999	" " LAVA
1325	"	BJ	064984	" BANDED COMENDITE
1208	"	BJ	061976	" COMENDITE LAVA
1206	"	BJ	065970	PUMICEOUS COMENDITIC LAVA
1344	"	BJ	007910	GREY MICROPORPHYRITIC COMENDITE LAVA
1503/2	"	BK	004127	GLASSY, FLOWBANDED DARK GREEN HIPPO POINT LAV
1358	"	BJ	979952	ALTERED PALE PUMICE LAPILLI
1381	"	BJ	016974	FLOWBANDED (EUTAXITE?) DARK GREEN COMENDITE
1616/1	"	BK	007005	CREAM PUMICE CLASTS
1196	"	BJ	059938	" " FROM SURGE HORIZON
1330/6	"	BJ	064984	" " " " "
1582	"	BK	024011	" " " " "
OLKARIA COMENDITES (BGS Fmns O4 & Op4)				
1121/2	"	BK	064048	FLOW BANDED COMENDITE LAVA
1124/2	"	BK	063052	PALE CREAM COMENDITE LAVA
1352/1	"	BJ	006910	PUMICEOUS COMENDITIC OBSIDIAN
1152	"	BJ	068989	CREAM OLKARIA AIRFALL PUMICE
1162	"	BK	054008	CREAM OLKARIA AIRFALL PUMICE
1338	"	BJ	022966	CREAM OLKARIA AIRFALL PUMICE
1514	"	BK	056023	WHITE PUMICE BLOCKS
1599	"	BK	018040	"WELDED FALL" COMENDITE

TABLE 4A contd

BASIC & "MIXED" COMPOSITIONS (BGS Fmns				
1136/2	"	BJ	063999	BASIC LITHIC FROM Op4
1148/7	"	BJ	039968	FRESH BLOCK OF BASIC LAVA FROM Op4
1449/1	"	AJ	960913	BASIC LAVA FROM ERODED CRATER WALL
1531/5	"	BK	019012	BASIC CINDERS FROM INTRUSIVE BRECCIA
1310	"	BK	019013	GREY "MIXED" DYKE ROCK
1587/1	"	AK	955165	BASIC CINDERS FROM SCORIA CONE
1587/2	"	AK	955165	BASALT BLOCK FROM SCORIA CONE
1577	133/3	AK	925132	APHYRIC BASIC LAVA
1580/2	"	AK	937164	BASIC CINDERS FROM SCORIA CONE
LONGONOT BASICS (BGS Fmns Lmx3)				
1619	133/4	BJ	158991	BASIC CINDERS FROM LONGONOT CRATER RIM
1620	"	BJ	162983	BASIC BOMB " " " "
RHYOLITES FROM LIMURU TRACHYTES				
1433/2	148/1	BJ	268636	GREY APHYRIC ACID LAVA
1433/3	"	BJ	268636	OBSIDIAN
1466	148/1	BJ	311038	PORPHYRITIC LIMURU "TRACHYTE"
TWO EXAMPLES OF UNDERSATURATED TERTIARY LAVAS WEST OF THE RIFT VALLEY				
1467	146/2	ZP	190844	MELILITE NEPHELINITE 7km N. OF NAROK
1563	145/1	YP	262655	PHONOLITE FROM MARA RIVER

file d:mesalist-j85

TABLE 4B

NEW BGS Data

LONGONOT AFFINITY PYOCLASTICS (BGS Fmn.Lp5).

Sp. No	1544/4	1606	1217	1544/3	1394/1	1608	1034/2	1034/1	1445	1371
SiO2	63.58	61.54	63.06	64.6	64.97	63.4	61.34	61	60.61	60.06
TiO2	0.66	0.6	0.5	0.59	0.53	0.48	0.51	0.43	0.39	0.38
Al2O3	15.74	16.66	13.74	15.4	13.34	13.29	15.47	14.58	15.53	15.46
FeO	4.68	4.14	2.76	4	3.91	4.56	3.36	3.85	3.78	3.69
Fe2O3	2.56	1.43	5.64	4.06	5.65	3.97	4.37	4.27	4.14	4.04
" (T)										
MnO	0.28	0.22	0.31	0.32	0.34	0.3	0.3	0.31	0.29	0.29
MgO	0.38	0.48	0.16	0.4	0.19	0.04	0.3	0.12	0.2	0.41
CaO	1.2	1.27	0.99	1.12	0.97	0.85	1.24	1.15	0.99	0.85
Na2O	5.2	8.01	7.77	4.06	4.86	7.93	7.94	9.23	7.84	8.62
K2O	5.63	5.55	5.03	5.39	5.2	5.14	5.12	5.01	6.18	6.16
P2O5	0.09	0.1	0.04	0.05	0.03	0.04	0.06	0.04	0.05	0.05

TOTAL RECALCULATED ON LOI FREE BASIS TO 100%.

TRACE ELEMENTS ppm										
Rb	122	133	151	169	169	178	209	246	294	301
Sr	4	37	2	7	3	2	12	4	8	3
Ba	59	305	33	36	42	36	59	19	23	17
Y	75	75	106	107	128	125	140	186	190	193
Nb	145	172	197	220	223	231	318	418	447	448
Zr	611	701	849	915	1020	1050	1370	1860	1994	1999
Th	18	20	23	27	28	28	37	50	55	56
U	5	3	3	4	6	5	6	8	11	9
LOI	5.8	1.87	0.38	7.05	6.22	3.28	1.63	3.59	4.14	4.09
Per.I.	0.93	1.15	1.33	0.81	1.02	1.4	1.2	1.41	1.26	1.35

file d:newbgs-as40

TABLE 4B contd

NEW BGS Data

	Lp5	Lt2	OLKARIA AREA TRACHYTES			
Sp. No	1547/2	1427	1366	1406	1437/1	1045
SiO2	62.53	62.63	65.74	65.64	63.41	65.7
TiO2	0.4	0.69	0.44	0.51	0.68	0.48
Al2O3	15.79	12.7	15.76	14.48	15.75	15.78
FeO	3.29	5.13	1.32	2.2	4.22	2.66
Fe2O3	5.16	5.28	3.27	4.45	2.31	2.25
" (T)						
MnO	0.33	0.4	0.09	0.12	0.19	0.13
MgO	0.37	0.43	0.35	0.53	0.43	0.27
CaO	0.97	1.32	1.11	0.48	2.35	1.47
Na2O	4.82	6.31	5.72	5.56	4.49	5.36
K2O	6.31	5.03	6.15	5.99	0.04	5.85
P2O5	0.03	0.07	0.04	0.05	0.13	0.05

TOTAL RECALCULATED ON LOI FREE BASIS TO 100%.

TRACE ELEMENTS ppm						
Rb	286	159	135	499	106	122
Sr	10	3	28	21	72	23
Ba	21	58	418	490	1741	207
Y	192	121	48	228	51	72
Nb	459	223	113	478	87	138
Zr	2043	989	786	2045	355	1002
Th	55	26	26	102	17	30
U	8	4	4	15	3	3
LOI	6.79	0.24	0.18	0.79	0.39	0.95
Per.I.	0.93	1.25	1.02	1.08	0.96	0.88

TABLE 4B contd

NEW BGS Data OLKARIA COMENDITES (BGS Fmns.02 + 03)

Sp. No	1144	1422	1584	1160/1	1544/2	1317	1547/1	1331	1140	1325
SiO2	75.57	77.71	76.96	76.47	76.4	76.86	76.29	75.78	75.54	75.33
TiO2	0.12	0.11	0.1	0.15	0.09	0.1	0.09	0.12	0.15	0.15
Al2O3	12.05	11.21	11.56	11.38	11.53	11.67	11.77	11.9	10.72	10.67
FeO	1.26	0.67	0.37	1.47	1.39	0.4	0.83	0.26	0.24	1.71
Fe2O3	0.72	1.37	1.68	1.04	0.65	1.86	1.23	2.49	3.92	1.9
" (T)										
MnO	0.04	0.04	0.04	0.06	0.04	0.04	0.03	0.05	0.05	0.06
MgO	0.1	0.12	0.04	0.1	0.12	0.01	0.19	0.01	0.03	0.01
CaO	0.36	0.09	0.07	0.05	0.24	0.05	0.28	0.04	0.02	0.1
Na2O	4.59	4.09	4.56	4.52	3.87	4.43	4.7	4.21	4.56	5.61
K2O	5.18	4.59	4.62	4.75	5.65	4.59	4.58	5.13	4.78	4.45
P2O5	0	0	0	0	0	0	0	0.01	0	0

TOTAL RECALCULATED ON LOI FREE BASIS TO 100%.

TRACE ELEMENTS ppm										
Rb	290	274	327	259	386	342	382	422	601	546
Sr	2	0	1	2	0	2	2	0	0	0
Ba	22	12	25	47	0	17	18	19	0	12
Y	110	34	31	79	136	28	106	105	139	202
Nb	203	198	249	176	283	253	287	303	514	455
Zr	447	487	502	548	554	555	567	890	1613	1665
Th	49	38	34	41	62	38	60	75	102	100
U	7	6	8	5	10	8	11	10	16	15
LOI	3.07	0.24	0.11	0.05	3.48	0.24	1.34	0.37	0.08	0.24
Per.I.	1.09	1.04	1.08	1.11	1.08	1.05	1.08	1.05	1.18	1.32

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TABLE 4B contd

NEW BGS Data OLKARIA COMENDITES (BGS Fmns O3, Op2 & Op3)

Sp. No	1208/1	1206	1344	1503/2	1358	1381	1616/1	1196	1330/6	1532
SiO2	75.02	73.5	75.91	71.98	75.36	75.03	74.23	74.15	73.87	75.89
TiO2	0.15	0.15	0.18	0.39	0.19	0.17	0.18	0.17	0.17	0.18
Al2O3	10.73	10.37	10.77	10.98	11.11	10.27	10.55	10.5	10.97	10.7
FeO	1.13	0.01	2.1	1.31	2.14	2.31	2.5	2.44	2.59	2.47
Fe2O3	3.08	4.39	2.82	4.87	2.85	2.35	1.74	1.99	1.96	2.21
" (T)										
MnO	0.06	0.09	0.11	0.15	0.08	0.07	0.07	0.07	0.06	0.1
MgO	0.01	0.03	0.02	0.19	0.06	0.02	0	0.04	0	0.18
CaO	0.11	0.11	0.11	0.28	0.25	0.1	0.28	0.25	0.2	0.12
Na2O	5.04	6.54	1.83	4.92	2.15	5.1	5.72	5.96	5.53	3.91
K2O	4.67	4.8	6.16	4.94	5.81	4.57	4.73	4.42	4.65	4.25
P2O5	0.01	0.01	0	0	0	0.01	0	0	0	0

TOTAL RECALCULATED ON LOI FREE BASIS TO 100%.

TRACE ELEMENTS ppm										
Rb	615	693	678	182	484	600	696	753	732	676
Sr	0	0	2	4	0	0	2	0	0	0
Ba	12	14	18	28	9	14	0	19	12	10
Y	220	359	371	39	311	310	345	370	360	379
Nb	532	576	660	273	445	476	640	692	688	719
Zr	1829	2179	2504	1124	2674	2802	2489	2577	2577	2658
Th	114	137	152	39	111	118	137	153	154	159
U	19	21	27	3	16	18	26	25	25	27
LOI	0.42	1.33	5.1	0.55	3.36	0.16	3.78	3.47	3.41	5.47
Per.I.	1.24	1.54	0.9	1.22	0.88	1.3	1.38	1.39	1.29	1.03

TABLE 4B contd

NEW BGS Data OLKARIA COMENDITES (BGS Fmns O4 & Op4)

Sp.No	1121/2	1124/2	1352/1	1152	1162	1338	1514	1599
SiO2	74.7	75.4	75.15	74.63	74.82	75.08	74.7	74.18
TiO2	0.18	0.17	0.19	0.18	0.18	0.18	0.17	0.17
AlO3	10.57	10.47	10.79	10.66	10.66	10.78	10.55	10.46
FeO	2.49	0.73	1.38	2.56	2.65	1.19	1.35	0.13
Fe2O3	1.37	3.44	2.75	1.28	1.25	2.88	2.63	4.37
" (T)								
MnO	0.08	0.06	0.06	0.06	0.06	0.07	0.05	0.06
MgO	0.05	0.05	0.11	0.06	0.05	0.01	0.14	0.04
CaO	0.2	0.05	0.11	0.27	0.23	0.18	0.31	0.13
Na2O3	5.87	5.08	4.87	5.41	5.21	4.95	5.03	5.9
K2O	4.49	4.54	4.59	4.86	4.87	4.66	5.07	4.55
P2O5	0	0.02	0.01	0.01	0.01	0.02	0	0
TOTAL RECALCULATED ON LOI FREE BASIS TO 100%								
TRACE ELEMENTS ppm								
Rb	446	448	403	429	418	434	425	743
Sr	2	0		6	2	3	0	2
Ba	19	21	19	30	14	13	12	9
Y	228	72	51	222	223	69	217	356
Nb	386	368	379	368	367	382	368	661
Zr	1644	1688	1679	1590	1588	1676	1582	2488
Th	82	71	84	83	81	78	77	133
U	16	13	8	14	15	9	15	
LOI	1.09	0.21	0.26	5.93	4.15	0.42	2.72	0.82
Per.I.	1.37	1.27	1.2	1.33	1.3	1.22	1.3	0.4

file d:bgs2-ar40

TABLE 4B contd

NEW BGS Data BASIC & "MIXED" COMPOSITIONS (BGS Fmns

Sp.No	1136/2	1148/7	1449/1	1531/5	1310	1587/1	1587/2	1577	1580/2
SiO2	48.02	52.64	56.3	60.49	68.17	49.55	51.54	57.77	61.7
TiO2	2.9	2.16	1.78	1.9	0.96	0.98	1.87	1.25	0.91
AlO3	14.64	17.33	14.78	12.69	1.52	15.02	14.97	13.8	13.79
FeO	10.91	4.25	6.32	6.76	4.34	6.89	9.2	6.96	8.62
Fe2O3	2.35	4.2	3.43	3.27	0.3	4.65	1.52	1.85	0.87
" (T)									
MnO	0.2	0.19	0.16	0.21	0.12	0.21	0.2	0.15	0.38
MgO	5.47	2.69	3.36	2.24	1.08	6.37	5.99	4.77	0.62
CaO	10.16	5.76	6.69	4.79	2.19	10.06	9.25	7.63	2.57
Na2O3	3.28	6.66	3.88	3.97	5.11	3.46	3.47	3.37	5.21
K2O	1.48	3.62	2.78	3.05	3.93	1.19	1.42	2.22	5.12
P2O3	0.58	0.51	0.51	0.62	0.28	0.61	0.56	0.23	0.2

TOTAL RECALCULATED ON LOI FREE BASIS TO 100%

TRACE ELEMENTS ppm	1136/2	1148/7	1449/1	1531/5	1310	1587/1	1587/2	1577	1580/2
Rb	30	88	86	201	340	22	39	112	42
Sr	605	1064	295	238	21	506	478	262	2
Ba	621	1616	572	1386	713	917	859	293	162
Y	30	32	51	119	167	32	34	54	47
Nb	34	128	80	168	303	31	41	91	53
Zr	167	377	336	698	1286	131	144	237	224
Th	9	17	14	35	61	1	2	22	8
U	0	5	2	7	10	0	0	3	0
LOI	0.27	0.99	0.03	3.28	0.05	0.05	0	0	0.08
Per.I.	0.48	0.86	0.64	0.77	1.1	0.46	0.48	0.58	1.02

TABLE 4B contd

NEW BGS Data Lgn't BASICS,LIMURU TRACHYTES,NAROK MELILTITE,MARA PHONOLITE

Sp.No	1619	1620	1433/2	1433/3	1466	1467	1563
SiO2	54.94	55.65	70.28	70.28	73.73	40.97	56.61
TiO2	2	1.61	0.55	0.55	0.46	3.14	0.95
AlO3	14.25	14.46	14.11	13.61	12.19	8.79	19.8
FeO	8.16	7.51	0.6	2.77	1.05	7.35	3.03
Fe2O3	2.58	2.54	3.15	0.93	3.01	5.23	1.96
" (T)							
MnO	0.26	0.23	0.07	0.16	0.17	0.24	0.29
MgO	3.23	3.68	0.42	0.46	0.34	14.76	1.25
CaO	5.41	4.77	0.26	1.01	0.26	12.71	1.87
Na2O	5.6	5.78	5.16	4.72	3.67	4.09	8.15
K2O	3.09	3.38	5.38	5.44	5.1	2.09	5.85
P2O5	0.48	0.39	0.02	0.06	0.01	0.64	0.23
TOTAL RECALCULATED ON LOI FREE BASIS TO 100%							
TRACE ELEMENTS ppm							
Rb	74	74	220	221	367	55	144
Sr	354	317	53	54	27	847	175
Ba	525	589	275	273	65	547	669
Y	55	57	66	97	90	28	54
Nb	83	88	297	293	636	2	211
Zr	416	435	1163	1140	2233	285	602
Th	14	9	46	40	90	7	22
U	2	2	5	7		4	5
LOI	0	0	0.56	0.45	0.43	0.11	3.92
Per.I.	0.88	0.91	1.01	1	0.95	1.02	1

TABLE 5A

LISTING OF PUMICE SAMPLES FOR TRACE ANALYSIS ONLY (JUNE 1987)

Sp. No.	Lab. No.	Sheet no		G.R.	Notes
BG1492	KG1	133/3	AK	925093	LIGHT GREY AIRFALL PUMICE
1673	2	"	AK	894033	GREY-GREEN SURGE PUMICE
3015/1	3	133/4	BJ	010947	PUMICE CLASTS BELOW 04 LAVA
3021/1	4	"	BJ	012949	CREAM AIRFALL PUMICE
3021/2	5	"	BJ	012949	WEATHERED CREAM AIRFALL PUMICE
3029	6	"	BK	033039	PUMICE CLASTS FROM SURGE
3030	7	"	BK	031044	CREAM AIRFALL PUMICE
3031	8	"	BK	025048	CREAM PUMICE CLASTS FROM SURGE
3033	9	"	BK	021047	AIRFALL PUMICE BLOCKS
3034	10	"	BK	022045	" " "
3037	11	"	BK	018021	CREAM PUMICE FROM SURGE
3040	12	"	AK	996034	TRIPARTITE AIRFALL OLK PUMICE
3043	13	"	AK	015063	PROXIMAL BLOCKEY OLK PUMICE
3047/1	14	"	AJ	958995	" " " "
3049/1	15	"	AK	966005	" " " "
3049/2	16	"	AK	966005	" " " "
3052	17	"	AK	982043	PROXIMAL BLOCKEY OLK PUMICE
3056/1	18	133/3	AK	934076	GREY AIRFALL PUMICE
3056/2	19	"	AK	934076	" " "
3057/1	20	133/4	AK	998090	LONGONOT AIRFALL PUMICE
3057/2	21	"	AK	998090	WHITE OLK PUMICE
3057/3	22	"	AK	998090	PUMICEOUS OBSIDIAN LAVA
3067/2	23	"	BK	018013	PALE PUMICE CLASTS
3071	24	"	BK	016013	" " "
3075	25	133/3	AJ	877987	DARK GREY PUMICE (MAU ASH?)
3076	26	"	AJ	883993	THIN, LATE OLK PUMICE
3078/1	27	"	AK	879072	BASIC CINDERS - BIMODAL AIRFALL
3078/2	28	"	AK	879072	FELSIC PUMICE - " "
3079/1	29	"	AK	883095	'MAIELLA TYPE' PUMICE
3079/2	30	"	AK	883095	WHITE OLK PUMICE OVER 29
3084	31	133/4	AJ	964933	PORPHYRITIC Lp5 CINDER
3090/1	32	"	AJ	953943	PROX. OLK PUMICE BLOCKS
3110	33	133/3	AK	919019	PALE-GREY AIRFALL PUMICE
3115	34	133/4	AK	966133	CREAM OLK AIRFALL PUMICE
3121	35	"	BK	016097	GREY-GREEN AIRFALL PUMICE
3122/1	36	"	BK ?		CREAM AIRFALL PUMICE
3122/3	37	"	BK ?		GREY-GREEN AIRFALL PUMICE
3122/4	38	"	BK ?		CREAM-WHITE AIRFALL PUMICE
3125	39	"	BK	015080	" PROX. OLK PUMICE
3126	40	"	BK	014078	" PUMICE BLOCK
333	41	"	BK	220060	BASAL PUMICE OF Lp2
2628	42	133/3	AK	939053	PUMICE BLOCK
2637	43	133/4	AK	972068	" "
2716/2	44	133/3	AJ	919977	" "

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TABLE 5B

BGS NEW DATA - TRACE ELEMENT RESULTS ON 44 PUMICE SAMPLES COLLECTED FOR CORRELATION STUDIES

Sp.No.	Rb	Sr	Ba	Y	Nb	Zr	Th	U	INTERPRETED FORMATION
BG1492	285	1	96	194	451	1998	66	10	Op2 or Maiella
1673	166	2	59	113	229	935	27	5	Lp
3015/1	429	7	70	217	362	1555	81	14	Op4
3021/1	407	6	50	214	356	1531	77	13	Op4
3021/2	349	6	58	135	240	1122	29	7	Op2
3029	510	2	34	234	420	1568	92	18	Op3
3030	443	2	23	246	375	1641	82	13	Op4
3031	432	4	32	220	366	1567	90	15	Op4
3033	727	1	17	360	655	2494	148	25	Op3
3034	699	2	41	356	640	2456	144	27	Op3
3037	804	1	23	392	737	2717	165	29	Op3
3040	511	5	25	292	474	2131	105	18	Op4
3043	914	2	30	480	875	3324	205	35	Op3
3047/1	433	2	28	240	378	1782	82	16	Op5
3049/1	423	3	<8	232	365	1727	81	15	Op5
3049/2	434	1	22	240	379	1785	82	15	Op5
3052	506	4	27	286	501	2236	110	17	Op4
3056/1	255	5	200	151	225	1220	45	5	Op2
3056/2	432	6	40	292	386	2320	91	14	Op2
3057/1	295	6	52	204	475	2111	61	10	Lp
3057/2	1092	7	27	568	1065	3940	241	43	Op3
3057/3	419	8	18	271	376	2021	90	9	02
3067/2	183	4	48	155	307	950	71	11	Op3
3071	125	57	266	92	192	763	28	6	Op2
3075	201	6	92	155	330	1301	40	7	Lp (Mau ash)
3076	313	4	35	221	334	1726	57	10	Op2?
3078/1	58	340	266	45	56	204	10	3	Bimodal fall
3078/2	288	9	28	108	197	465	44	9	Np
3079/1	301	14	33	198	464	2076	59	10	Maiella pum
3079/2	977	17	30	511	968	3581	217	38	Op3
3084	131	27	254	71	157	627	15	2	Lp
3090/1	411	4	15	228	305	1762	72	11	Op2
3110	209	13	25	119	212	974	23	5	Lp
3115	1013	12	57	544	1045	3917	246	42	Op3
3121	120	48	381	69	146	590	17	4	Lp
3122/1	246	8	30	151	349	1490	40	8	Op2 or Op3
3122/3	282	9	28	200	472	2142	58	10	Lp
3122/4	458	6	18	256	356	1171	80	13	Op3
3125	1004	4	11	572	988	3660	224	39	Op3
3126	451	3	12	220	336	1066	73	12	Op3
333	252	4	26	178	247	1366	47	7	Lp
2628	249	2	19	177	246	1352	44	6	Op2
2637	470	1	9	230	370	1995	83	14	Op2
2716/2	478	32	40	213	397	1448	88	16	Op3

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BGS - MERD GEOTHERMAL EXPLORATION PROJECT.
GEOLOGICAL MAP OF LONGONOT VOLCANO, THE GREATER OLKARIA VOLCANIC COMPLEX, & ADJACENT AREAS
SCALE 1:50,000
LOCATION OF ROCKS ANALYSED FOR MAJOR & TRACE ELEMENTS.
PREFIXED BG & BGT - BGS/MERD 1987 ANALYSES
" L > 300 - S.C. SCOTT ANALYSES PARTLY IN CONJUNCTION WITH BGS.
" L < 300 - S.C. SCOTT (1977)
" BL & KN - QUOTED FROM MACDONALD & BLISS (IN PREP.)
LONGONOT
KIJABE HILL
Longonot
Kenton
Njoya
Kinari
Akira
Suswa
Kongoni
OLOIDIEN BAY
Maiella
Estate
Magaia
Escarpment
Mai Mahiu
Mwiciringiri
Nyamasi
Kanari
Giththa
Lari
Kireiga
Gicheege
Ereri