FLOWS AND CONES SURROUNDING THE MASSIF.

KABFUMU FLOW.

The Kabfumu flow consists of block lava and is cut by the Goma-Rutshuru road near to km point 234. The extension and origin of the flow is unknown. The flow is partly covered by ash and disappears under younger flows. From topographic features and from the presence of ejected blocks on the Kabfumu hill, it is suggested that the small crater of that hill, situated E of km point 234,4 of the said road, might represent the source of the flow. This correlation is, however, only tentative.

Specimen FEAE No. 83 was taken as a batch of more than 100 kg at km point 234,7 on the road. This specimen is considered the type specimen of the Kabfumu flow.

Petrographic characteristics and bulk chemical composition of the rock have already been reported on a previous occasion [32]. However, the name Kabfumu flow was not applied to this lava in that paper. Since 1953, some of the constituents of the Kabfumu flow lava have been subjected to more detailed investigation. The chemical analysis of the rock previously published is reproduced in Table I, No. 13. According to its mineralogical composition, the rock may be called olivine-melilite-nephelinite, kalsilite-bearing. The amount of modal olivine is considerably smaller than indicated by the norm, yet it is characteristic of the rock and can not be regarded only as an unessential accessory.

The rock is typically glomeroporphyritic with large aggregates of complex nepheline-kalsilite and melilite phenocrysts in a medium-grained groundmass. Melilite was chemically analyzed and the result of the analysis with additional optical and physical data are presented in Table V, No. 1. The mineralogy of the complex nepheline-kalsilite phenocrysts and their history of crystallization has been recently described by SMITH and SAHAMA [42], SAHAMA and SMITH [40] and SAHAMA [35]. The phenocrysts consist of a core of perthitic nepheline-kalsilite of average composition 72 $\pm$ 3 mol. % Ks, surrounded by a nepheline margin of 40 mol. % Ks in parallel orientation. The perthitic core consists of the following phases in parallel growth : nepheline I (59 mol. % Ks), nepheline II (35 mol. % Ks), d-kalsilite with $a_0 \backsim$ 5,15 Å (ordinary disordered form of kalsilite), o-kalsilite with $a_0 \backsim$ 8,9 Å (ordered form of kalsilite), trikalsilite with $a_0 \backsim$ 15,3 Å. On heating, the core inverts at 860° $\pm$ 10° C into homogeneous tetrakalsilite with $a_0 \backsim$ 20,5 Å. The inversion is very rapid and reversible. At a temperature of ca. 1.000° C, tetrakalsilite inverts into extremely potassian nepheline. Trikalsilite is considered entirely metastable. Transitional forms between d-kalsilite and o-kalsilite occur. It is concluded that the phase transitions in the complex nepheline-kalsilite phenocrysts have not reached equilibrium.

TEMBO FLOW.

The Tembo (= elephant) flow has been so named because of the frequent appearance of these animals in this area where geographical denominations are sadly lacking. The flow is a thin sheet of pahoehoe and aa with badly marked borders. It originates somewhere W of km points 233-234 of the Goma-Rutshuru road, probably near to the Gisi hill. This hill must not be confused with the Gisi or Kisi near to Nyundo which is supposed to be the type locality of kivite. Towards NE, the flow dies out in small tongues in the hilly terrain N of Kibumba.

Specimen S. 6 was taken at km point 234,2 and specimen S. 3 comes from the layer on top of the Kabfumu flow at km point 234,7 of the road.

Specimen S. 6.

Melilite-nephelinite. (m, S). A dark grey lava with a few small clinopyroxene phenocrysts. The rock was chemically analyzed as the type specimen of the flow and the result is presented in Table I, No. 14. The main leucocratic constituent is euhedral nepheline (23,3 mol. % Ks). No kalsilite lines were found in the powder pattern of the isolated nepheline fraction of which the determination was made. The optically negative melilite occurs as stout prisms with positive sign of elongation. $\varepsilon = 1{,}634$, $\omega = 1{,}638$. The clinopyroxene shows color and hour-glass texture typical of the titanian variety. The composition of the euhedral olivine that occurs in small amounts is 61,2 mol. % Fo. Leucite is very scarce. Magnetite abundant. Small amounts of apatite and calcite present. Interstitially, a greenish glass is common.

Specimen S. 3.

Melilite-nephelinite similar to specimen S. 6, except that a few small phenocrysts were found that consist of a kalsilite core surrounded by a nepheline margin.

LEUCITE FLOWS.

This important rock unit has been named for the presence of conspicuous leucite aggregates that make the lava easily recognizable in the field. All the flows encountered were of the pahoehoe type, often with beautiful structures of ropy lava.

The origin of the Leucite flows lies on the E slope of Nyiragongo somewhere in the dense forest that covers the lower central part of the massif. No representative of this lava type has been found in the upper part of the main cone of the mountain. As the Leucite flows cover advanced

tongues of the Nepheline Aggregate flows, they can not be correlated with the leucite-nephelinites occurring in the main crater of Nyiragongo but represent a leucite-dominated phase of the Nyiragongo lavas that is posterior to the nepheline phase. The absence of important eruptive structures in the area of the supposed origin of the Leucite flows is not astonishing, since the demonstration of the emission of about 4×10^8 m^3 of lava during the 1938-1940 eruption of Nyamuragira from a vent that would just hold a good-sized bungalow [49].

With the exception of some cracks and groups of hornitos, the Leucite flows are the youngest volcanic feature in the region E of Nyiragongo. They surround or bury partly or nearly completely the smaller cones and cover adjacent flows. They have invaded and filled the depression of nearly 50 km^2 between Kibati and Kibumba, overflowing towards S and creating lava scarps in the constricted passages.

The main types are represented by the following specimens :

Specimen S. 45. SW of Tshawato.

Specimen FEAE No. 85. Near to km point 232 of the Goma-Rutshuru road.

Specimen S. 42. W foot of Tshawato.

Specimen S. 106. 1 km W of the Goma-Rutshuru road along the path leading to Nyamushwa.

The vesicular Leucite flow lava is glomeroporphyritic with aggregates or single crystals of leucite and titanian clinopyroxene as phenocrysts. The aggregates may reach 1 cm in diameter. The number of the large leucite aggregates varies. In most parts of the flow they are very abundant, in others less numerous and sometimes they are almost entirely lacking. The size of the clinopyroxene crystals occurring as phenocrysts does not usually exceed a few tenths of a millimeter. In the hand specimen, the clinopyroxene phenocrysts or phenocryst aggregates are by far less pronounced than the leucite aggregates. The groundmass is fine- to medium-grained and shows a dark grey color. In some spots the groundmass of a thin layer of the lava surface is glassy.

According to chemical and mineralogical composition, the Leucite flow lava represents olivine-leucitite, more or less nepheline-bearing. Microscopic examination of specimens collected on a number of spots throughout the flow reveals certain variations. Accordingly, the lava material may be divided into a few types each of which has its own characteristics. These types differ in the groundmass, not in the phenocrysts.

The main type.

The specimen S. 45 was selected as the type specimen for the main type of the lava of the Leucite flows. A microscopic description of this specimen is given below.

Leucite occurs as phenocrysts that are beautifully twinned and as small euhedral crystals in the groundmass. n = 1,509.

The clinopyroxene occurring as phenocrysts shows a pale brownish color, very slightly violet, without noteworthy pleochroism. The crystals are often strongly zoned with the margin slightly darker than the core. The zoning causes relatively large variations in optical properties :

$$\alpha = 1{,}711\text{-}1{,}722,$$
$$\beta = 1{,}722\text{-}1{,}729,$$
$$\gamma = 1{,}732\text{-}1{,}744,$$
$$2V_{\gamma} = 49°\text{-}63°,$$
$$c\Lambda\gamma = 46°\text{-}64°.$$

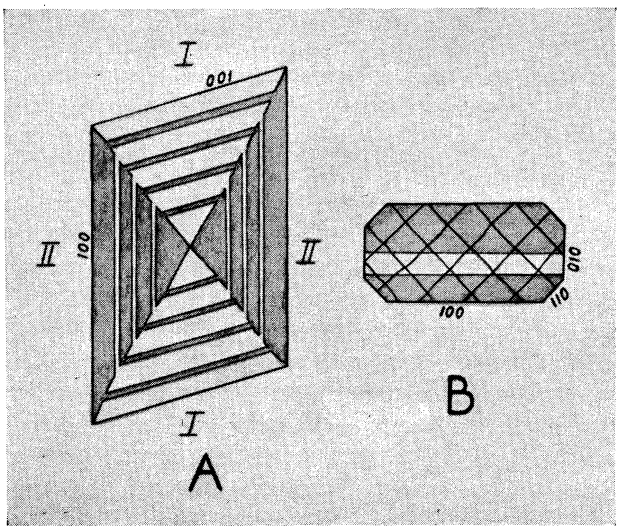

FIG. 4. — Schematical presentation of hour-glass texture (A) and twinning (B) in the clinopyroxene of specimen S. 45. Leucite flows.

These optical properties are virtually identical with those of the titanian clinopyroxene from specimen FEAE No. 85 of which a chemical analysis will be given below. Accordingly, also the clinopyroxene of specimen S. 45 must represent a titanian variety. In addition to the zoning, almost every clinopyroxene crystal occurring as a phenocryst or in the groundmass shows a well-developed hour-glass texture. Because the hour-glass texture in a similar development is extremely common in the titanian clinopyroxene of the Nyiragongo area lavas, it may be briefly described taking the clinopyroxene of this specimen as a type mineral.

The hour-glass texture is schematically shown in figure 4-A that represents a section parallel to (010). The crystal consists of two pairs of sectors

that are marked I and II in figure 4-A. The boundaries between the sectors are sharp but irregular. The position of extinction is slightly differing for the two pairs of sectors. A preliminary universal stage study revealed the fact that the crystallographic c-axes of the both pairs of sectors are closely, but not exactly, parallel with each others. In both pairs of sectors a number of relatively thin and very sharp lamellae are seen that lie parallel with the outer faces of the clinopyroxene crystal. These lamellae seem not to represent alternate zones of differing chemical compositions. Between crossed nicols the lamellae found in sector I extinguish simultaneously with sector II and the lamellae occurring in sector II show an extinction position parallel with that of sector I. Accordingly, the lamellae occurring in sector I have the same orientation as sector II and vice versa. An X-ray

FIG. 5. — Leaf-like skeletons of basaltic hornblende in the main type of lava of the Leucite flows. Specimen S. 45.

study of the hour-glass texture will be undertaken later. In addition to the hour-glass texture, the clinopyroxene crystals are often twinned on (100), sometimes in lamellar development. The twinning, schematically illustrated in figure 4-B, is mostly seen in sections closely perpendicular to the crystallographic c-axis. The color of clinopyroxene of the groundmass varies from brownish violet to greenish and to almost colorless.

In addition to clinopyroxene, the groundmass contains a relatively large amount of basaltic hornblende. It occurs only as leaf-like skeletons schematically illustrated in figure 5. The angle between the two prism faces corresponds to that of an amphibole. The optic axial plane is parallel to (010). The extinction angle $c\Lambda\gamma$ is small. Because of the small grain size (0,01 mm or less), its accurate value is difficult to determine. Pleochroism very strong : γ and β dark brown, α yellowish green.

According to planimetric analysis, the amount of olivine present in the rock is ca. 1 %. It occurs as small euhedral phenocrysts with notable signs of resorption. Its composition corresponds to 68,8 mol. % Fo.

Magnetite occurs in two generations, as euhedral crystals and in skeletal development in the groundmass. The groundmass contains small amounts of nepheline detectable only with very high power. The extremely small grain size made its identification difficult. For the same reason, it can not be enriched with heavy liquids for X-ray determination of composition. Small apatite prisms are present.

The small grain size of the groundmass does not allow a planimetric analysis with the integration stage. The bulk chemical composition of the rock is presented in Table I, No. 15. The chemical compositions of basaltic hornblende and of nepheline not being known, the modal mineralogical composition of the rock can not be calculated from the bulk analysis.

The more coarsely crystalline type.

The specimen FEAE No. 85 was selected as the type specimen for this type of lava of the Leucite flows. In the field, the more coarsely crystalline type can not be distinguished from the main type described above. Microscopically the more coarsely crystalline type differs from the main type by the somewhat larger grain size of the groundmass that averages 0,05 mm. Basaltic hornblende is absent and, therefore, no skeletal leaf-like texture occurs in the groundmass. Like the main type, also the more coarsely crystalline type contains leucite and clinopyroxene as most abundant constituents, both occurring as phenocrysts and in the groundmass. The leucite crystals are always twinned. The mineral was separated and chemically analyzed. Table VI gives the result of the analysis indicating 6,8 mol. % sodium component. The clinopyroxene phenocrysts were also separated and chemically analyzed. The result of the analysis and the optical properties are reproduced in Table IV, No. 1. The mineral represents a typical titanian variety of clinopyroxene. According to the analysis, the atomic ratio Ca : Mg : $(Fe^{3+} + Fe^{2+})$ is 51,9 : 32,6 : 15,5. The mineral thus represents a titanian salite. Zoning, hour-glass texture and twinning are similar to those found in specimen S. 45. The color of the clinopyroxene varies in the groundmass more than in the phenocrysts. The margins in the crystals of the groundmass do not often show the brownish violet color typical for titanian clinopyroxene but are pale greenish to colorless. Accordingly, the chemical composition of clinopyroxene in the groundmass varies more than in the phenocrysts and is probably partially poor in titanium. Because of the small grain size of the groundmass, the optical orientation of its clinopyroxene was not accurately determined. The euhedral olivine crystals sometimes reach a grain size above that of the groundmass. The crystals show no sign of resorption. A determination of the composition of olivine yielded 71,0 mol. % Fo. In contrast to the

main type, the more coarsely crystalline type contains relatively abundant nepheline in well detectable grains in the groundmass. Its composition is 11 mol. % Ks and is, accordingly, unusually poor in potassium. The low potassium content of nepheline is probably a result of the high leucite content of the rock. Magnetite occurs in two generations, as euhedral crystals that may reach a grain size somewhat larger than that of the average groundmass and, on the other hand, in a skeletal development in the groundmass together with the interstitial leucite and nepheline. In addition, the groundmass contains small apatite prisms and brownish to greenish isotropic glass with n = 1,50-1,51. Some few amygdules of quartz have been found that contain small amounts of a cristobalite-looking mineral. The powder pattern of that material gives the two strongest lines of cristobalite.

The bulk chemical composition of specimen FEAE No. 85 is given in Table I, No. 16. A comparison of the analyses of Table I, Nos. 15 and 16 with each others reveals a similarity between these two rocks of the Leucite flows. The slightly higher figure for silica for specimen FEAE No. 85 may be partly caused by the quartz amygdules not found in specimen S. 45. In alkali ratio, however, the two specimens differ from each others, the figure for potash being clearly higher for specimen FEAE No. 85. The groundmass of specimen FEAE No. 85 is too fine-grained for a complete planimetric analysis. Only the amounts of olivine and leucite could be approximately measured with the integration stage. On the basis of the chemical analysis supported by the integration stage measurements, the following very rough modal composition may be given :

Modal composition of specimen FEAE No. 85.

Leucite	36 %
Nepheline	17 %
Clinopyroxene	38 %
Olivine	1 %
Magnetite	5 %
Apatite	3 %
Total	100 %

Highly nepheline-rich type.

In addition to the rock types described above in which leucite definitely predominates over nepheline, the lava of the Leucite flows may sometimes show an amount of nepheline that exceeds that of leucite. The leucite phenocrysts are relatively scarce. The clinopyroxene phenocrysts are similar to those of the main type and of the more coarsely crystalline type. The clinopyroxene of the groundmass, on the other hand, is mostly greenish or colorless and only to a lesser extent brownish violet.

The specimens S. 42 and S. 106 represent glassy surface of the lava of Leucite flows. In these specimens euhedral phenocrysts of clinopyroxene, leucite, olivine and apatite are in a glassy groundmass. The glass of specimen S. 42 has n = 1,599.

TSHAWATO.

The small cone Tshawato is the easternmost outpost of the cluster of satellite cones SE of Shaheru. The volcano is relatively old and is completely surrounded by the Leucite flows. Cored bombs containing basement rocks and isolated fragments of mica-schists and pegmatitic material are abundant. The location of Tshawato near to the strike of the Uashungwe ridge, the N end of which is situated 2 km S of Tshawato, leads to the suggestion that this ridge of basement rocks has a northern extension now buried under lava flows.

Specimens collected : S. 44 and S. 43 are pieces of bombs from the N rim of the crater.

Specimen S. 44.

Very dark olivine-leucitite. (vf, M). Phenocrysts of pale-colored titanian clinopyroxene and olivine (84,5 mol. % Fo) in an almost cryptocrystalline groundmass that consists of clinopyroxene, magnetite, small amounts of olivine and traces of leucite.

Specimen S. 43.

Nepheline-leucitite. (f, L). Chemical composition summarized in Table I, No. 17. Phenocrysts of leucite, often collected in aggregates, titanian clinopyroxene, magnetite and apatite. Holocrystalline, fine-grained groundmass containing clinopyroxene, leucite, nepheline (28,0 mol. % Ks), magnetite and traces of accessory olivine.

WAR CEMETERY FLOW.

The War Cemetery flow has been named after the double Cemetery of World War I, situated at Kibati between the main flow and its W tongue. The region covered by this study is cut by the border between the Belgian Congo and Ruanda, formerly part of German East Africa, and was the scene of fierce fighting in 1914-1915.

The material of the flow is block lava in the N part and grades into aa towards S. The flow originates in the group of small cones N of Kibati called Kabfumu and Kanenemohange but these names have not been applied to the flow because of their confusing or cumbersome character. To E, the flow disappears under the Leucite flows while to W it is first covered by the Nyakabanda flow and then skirts the Buhama and Bushwaga hills.

Towards S, one tonge crosses the Goma-Rutshuru road between km points 211,1 and 211,6 and stops close to the Goma aerodrome while the main mass forms rocky knolls SE of Bushwaga.

Localities of specimens collected :

Specimen S. 40. E of Badgiru hill.
Specimen S. 46. W of Mukondo hill.
Specimen S. 67. S of Bukanda hill.
Specimen S. 22. Km point 211,5 of the Goma-Rutshuru road.

In the field, the War Cemetery lava shows only a few phenocrysts of pyroxene and leucite. Specimen S. 40 was selected as a type specimen and was chemically analyzed. The result is presented in Table I, No. 18. According to its chemical and mineralogical composition, the rock may be called leucite-nephelinite.

Under the microscope, the clinopyroxene phenocrysts show the brownish violet colors typical of the titanian variety. Hour-glass texture and twinning is common. The following optical properties were measured on material from specimen S. 40 :

$$\alpha = 1{,}713\text{-}1{,}726,$$
$$\beta = 1{,}719\text{-}1{,}731,$$
$$\gamma = 1{,}735\text{-}1{,}748,$$
$$2V_{\chi} = 56°\text{-}60°,$$
$$c\Lambda\gamma = 44°\text{-}50°.$$

The large variations in the optical properties are caused by heavy zoning. The leucite phenocrysts form sometimes small aggregates that, unlike those in the lava of the Leucite flows, are never numerous. The constituents of the almost cryptocrystalline groundmass are clinopyroxene, magnetite, nepheline, leucite and, in minute quantities, greenish glass. The clinopyroxene of the groundmass is pale greenish to colorless. The magnetite crystals are usually euhedral, mostly very small and only very rarely reach a grain size slightly above that of the average groundmass. Nepheline is very abundant and is usually sprinkled with small magnetite and clinopyroxene crystals. The composition of nepheline was determined of the following specimens :

Specimen.	Composition of nepheline.
S. 40	29,7 mol. % Ks.
S. 46	28,0
S. 67	27,2
S. 22	25,4

Leucite occurs as twinned rounded crystals. The apatite prisms often reach a size considerably larger than that of the average groundmass. Olivine is very scarce. Only a few small crystals were detected.

Mudjoga flow.

The small Mudjoga flow originates in the saddle between the Buyinga and Mudjoga cones and seems to be related to the latter. The official map uses the spelling Djoga but the authors retained the native denomination. The flow is block lava, only 2 km long, and partly surrounds the Lemera hill. The flow is older than the Buyinga and Nyakabanda flows. In the field, only a few minute phenocrysts of pyroxene and very rarely small aggregates of leucite may be detected in the dark grey groundmass.

Specimen S. 107 was collected immediately N of Lemera and represents the lava. This specimen was chemically analyzed and the result of the analysis is presented in Table I, No. 19. The composition of this rock is not very different from those of the Nyakabanda and Buyinga flow lavas. The Mudjoga flow lava is, however, slightly less melanocratic. According to its mineralogical composition, the Mudjoga flow lava represents leucite-nephelinite. Microscopically, the pyroxene of specimen S. 107 occurring as phenocrysts proved to be a titanian clinopyroxene. Small leucite aggregates or separate crystals, apatite needles and magnetite grains reach a size well above that of the average groundmass. Nepheline phenocrysts are small and rare. A small amount of nepheline was isolated with Clerici's solution. Its composition was determined to 27,6 mol. % Ks. Olivine, as small euhedral phenocrysts, is very scarce. The groundmass is almost cryptocrystalline. It is very rich in nepheline, pale greenish clinopyroxene and magnetite. A small amount of green glass is detectable.

Buyinga flow.

The Buyinga flow represents one of the main rock units being second in extension only to the Leucite flows. The lava is of the pahoehoe type and flowed at least 10 km towards SSW. Excavations made during the construction of the new aerodrome at Goma show that the S part of the Buyinga flow is a thin sheet of lava covering another flow of similar characters that flows into Lake Kivu. It is not clear wheather this lower flow also belongs to the Buyinga lava. The flow originates in the composite cone called Luyaka, the two main craters of which are separated by the Buyinga spur. This flow is the youngest in the area and would probably be historical if records were kept during times as long as in Europe.

Specimen S. 12, collected 2 km SW of Lemera hill, is the type specimen.

Specimen S. 12.

Dark leucite-nephelinite with nepheline predominating over leucite. (f, S). The result of the chemical analysis made of the specimen is summarized in Table I, No. 21. The small rounded crystals of leucite,

sometimes collected to small aggregates, are by far less abundant than in the lava of the Leucite flows. The clinopyroxene that is the dominant constituent of the rock shows the typical brownish violet color of a titanian variety. $2V_\gamma = 54°\text{-}64°$; $c\Lambda\gamma = 52°\text{-}58°$. The mineral is heavily zoned. Because of the small grain size, the hour-glass texture and the twinning are less pronounced than in the lava of the Leucite flows. Nepheline is abundant and occurs as thin lamellae in a graphic intergrowth with clinopyroxene and greenish glass. The composition of nepheline is 29,5 mol. % Ks. Olivine plays only the role of an accessory constituent. It's scarcity makes it difficult to collect in sufficient amounts for X-ray determination of composition. The pleochroic basaltic hornblende occurs in the same manner as in the main type of the lava of the Leucite flows although in much smaller amounts. Magnetite shows the two generations described from the Leucite flows. The green glass occurring as graphic intergrowth with nepheline and clinopyroxene is very abundant. Some apatite crystals and small amounts of calcite were also found.

A specimen of the glassy surface of the flow collected NE of the Kinyunzo crater, S. 30, shows phenocrysts of leucite, clinopyroxene, apatite, magnetite and olivine in a completely isotropic glassy matrix. The refractive index of the glass is n = 1,607.

NYAKABANDA FLOW.

The small Nyakabanda flow, about 3 km long, is perhaps a branch of the Buyinga flow but will be treated separately as long as the eventual identity with the Buyinga flow is not established. The name is for Nyakabanda, a knoll surrounded by this lava. The flow is of pahoehoe type and originates between the foot of Shaheru and the Buyinga-Luyaka-Buhonogo group of cones where relationships are not clear. Different tongues of the flow invade the depressions in the hilly terrain N of Kibati and stop short off the Goma-Rutshuru road. The Nyakabanda flow is the youngest flow in this area, butting into or covering all other flows.

Specimen S. 10 was collected at the tip of the tongue outcropping immediately NW of the Kibati Rest House.

Specimen S. 10.

Dark leucite-nephelinite. (f, S). The chemical composition of this specimen is summarized in Table I, No. 20. The chemical composition and the microscopic characteristics of the rock are virtually identical with the Buyinga flow lava. Therefore, no closer description is needed here. The only difference between specimens S. 12 and S. 10 is in the texture. The graphic intergrowth of nepheline, clinopyroxene and glass is less pronounced in specimen S. 10. The composition of nepheline was found to be identical with that of nepheline of specimen S. 12.

NOT INDIVIDUALIZED OLDER LAVA FLOWS NORTH OF GOMA.

The flows briefly described above are the youngest flows of the gigantic pile filling the Rift Valley. A systematic study of ejected blocks in Mt. Goma, where road and harbour building operations have provided exceptionally good outcrops, has shown that fragments of leucite-bearing older flows are most commonly ejected. The results of the study of that mountain will be published in another paper by one of us (A. M.). In the lava plain rising from the shore of Lake Kivu towards N and NE, there is a maze of flows the origins of which are hidden by the individualized flows. Some of them can be correlated with visible cones, such as the Bushwaga massif. However, much detailed field work dealing with these older flows is still needed, but must be postponed untill the general mapping in other parts of the region has been completed.

A major part of the older lavas of that area are represented by very leucocratic melilite-nephelinites, usually poor in olivine and sometimes containing only traces of clinopyroxene. In several instances the rocks contain aggregates of phenocrysts that consist of microperthitic nepheline-kalsilite, melilite and small amounts of olivine. Melilite and nepheline are quantitatively most important. The groundmass is medium-grained with characteristically euhedral nepheline crystals.

Three of the specimens collected have been subjected to chemical analyzing, viz. specimens S. 68 (SE of Bukanda hill), S. 75 (Kibati Rest House) and S. 16 (SE foot of the Kabashambara crater). The results of the analyses are given in Table I, Nos. 22, 23 and 24, respectively.

Specimen S. 68 represents a kalsilite-bearing olivine-melilite-nephelinite with large aggregates of perthitic nepheline-kalsilite crystals. Under the microscope, the rock resembles much the specimen FEAE No. 83 of the Kabfumu lava. Further X-ray work with the complex nepheline-kalsilite crystals is in progress. Melilite is abundant as phenocrysts. The composition of the rare olivine phenocrysts is 75,7 mol. % Fo.

Specimen S. 75 is a representative of a melilite-nephelinite with abundant phenocrysts of melilite. Nepheline occurs only in the groundmass. For determining the composition of nepheline, a small batch of the mineral was separated from the rock. The powder pattern indicated the composition 28,7 mol. % Ks. Traces of leucite and olivine and no kalsilite were detected. The composition of olivine is 66,2 mol. % Fo.

Specimen S. 16 is olivine-melilite-leucite-nephelinite containing phenocrysts of titanian clinopyroxene, olivine and melilite in a very fine-grained groundmass rich in nepheline. Leucite is scarce.

The leucocratic olivine-melilite-nephelinites and melilite-nephelinites mentioned above are mostly characterized by a medium-grained groundmass in which the microscopic identification of the constituents can be readily made. In addition to these rock types, similar rocks were found S of Kabashambara underlying the Buyinga flow and W of Buhama that are

more melanocratic. Relatively large phenocrysts of titanian clinopyroxene and olivine are numerous and small phenocrysts of melilite detectable. The almost cryptocrystalline groundmass is very rich in clinopyroxene and magnetite. Small rounded crystals of leucite and, in some instances, nepheline may be identified.

Small craters between Goma and Kibati.

Several small craters mark the line joining the Nyiragongo massif to the main E scarp of the Rift that makes the E shore of Lake Kivu. The most important of these craters are : the Bushwaga complex, 2 ½ km long and built on both sides of a crack in N-S direction, the neighboring Mugara and the smaller Lemera, Buhama, Badgiru, Kabashambara and Kinyunzo. Specimens from these craters studied in thin section are all very melanocratic. They contain phenocrysts of olivine and titanian clinopyroxene in a more or less cryptocrystalline, sometimes partly glassy, groundmass. The crystalline part of the groundmass consists mainly of clinopyroxene and magnetite with small amounts of olivine. Leucite is constantly present in small rounded crystals sometimes reaching a grain size above that of the groundmass. In some of the specimens also nepheline is detectable in the groundmass.

According to their mineralogical composition, the rocks may be termed dark olivine-leucitites or dark olivine-leucite-nephelinites. Two of the specimens, both olivine-leucitites, were chemically analyzed, viz. specimens S. 9 b from the bottom of the Mugara crater and S. 69 from a point W of the small Kanyamagashu crater in the N end of the Bushwaga massif. The results of these analyses are presented in Table I, Nos. 25 and 26, respectively.

Mudja.

Mudja, also spelled Mutsa, is a composite cone more than 100 m high, situated 8 km NW of Goma. It is completely surrounded by younger flows coming from the foothills of Shaheru. The structure of the massif is rather exceptional because of the presence of alternating layers of olivine-rich and leucite-rich lava. The olivine-rich type is the rock by far richest in this mineral discovered in the Virunga area.

The specimens S. 13 and S. 14 were taken on the NW slope.

Specimen S. 13.

Dark olivine-leucitite. (vf, L). Phenocrysts of leucite, olivine and titanian clinopyroxene in an almost cryptocrystalline groundmass. Some small phenocrysts of magnetite and apatite occur. The groundmass consists mainly of clinopyroxene with small amounts of olivine, leucite and traces of nepheline.

Specimen S. 14.

Picrite. (vf, L). The specimen was chemically analyzed and the result is summarized in Table I, No. 27. The rock is characterized by large and very abundant phenocrysts of olivine of composition 90,2 mol. % Fo. Among the phenocrysts only a few crystals of titanian clinopyroxene and no leucite were detected. The groundmass is cryptocrystalline in which olivine, clinopyroxene and magnetite could be identified. A few quartz inclusions were noticed.

KAHEMBWE FLOWS.

The E scarp of the Rift Valley that forms the E shore of Lake Kivu ends in the Rubavu hill N of Kisenyi. This hill represents a pegmatite massif rising 400 m above the lake. Lavas emitted by numerous small volcanoes NE of the hill have filled the depression of that area termed the Nyundo Bay. Flows coming from N follow the W foot of it. The small Nyabutwa ridge, continued by the bigger Uashungwe ridge, form the prolongation of Rubavu towards NNE. These ridges consist of pegmatites and mica-schists and are completely surrounded by flows. The small volcanoes Kakombe, Kakombe Mudogo, Bugu, Uashungwe South and Uashungwe North are arranged along these ridges in a pattern that strongly suggests their eruption along faults that border the ridges. The ridges probably represent the crest of a small horst, nearly completely submerged by recent flows.

Between the Nyabutwa and Uashungwe ridges on one side and a group of volcanic cones on the E side of the Nyundo Bay, there occurs a depression called the Kahembwe plain. This depression has collected virtually all the flows coming from N and NE. In an area of ca. 4 km^2, not less than 14 different flows have been recognized. Specimens of only two of them will be described here : the Bugu flow emitted from the breach of the S crater of the Bugu volcano, represented by specimen S. 59, and Kahembwe flow No. 1 from which specimen S. 55 was taken at the terminal N spur of Nyabutwa ridge.

Specimen S. 59.

Olivine-melilite-nephelinite. (m, L). Very vesicular, dark grey rock containing numerous large (up to 1 cm) prismatic phenocrysts of titanian clinopyroxene. Phenocrysts of olivine (80,3 mol. % Fo) are less abundant. The groundmass contains laths of melilite, subhedral nepheline, violet brownish or partly greenish clinopyroxene, magnetite and traces of green glass. The result of a bulk chemical analysis of the rock is presented in Table I, No. 28.

Specimen S. 55.

Dark olivine-melilite-nephelinite. (vf, S). Phenocrysts of titanian clinopyroxene and olivine (77,6 mol. % Fo) in an almost cryptocrystalline groundmass. For the clinopyroxene the following optical properties were determined : $\alpha = 1{,}696\text{-}1{,}724$; $\gamma = 1{,}721\text{-}1{,}744$; $2V_{\gamma} = 56°\text{-}69°$; $c\Lambda\gamma = 38°\text{-}50°$. The groundmass consists mainly of clinopyroxene and magnetite and contains some melilite and nepheline (26,0 mol. % Ks). The result of a bulk chemical analysis is given in Table I, No. 29.

Muti crater.

Muti is a conspicuous isolated volcano on the edge of the Bugoyi plateau. The crater is breached towards NE. The Muti cone heralds the feldspar-bearing small volcanoes of Bugoyi and Tamira, forming the E part of the ring of basanitic lavas surrounding the all-feldspathoidal Nyiragongo massif.

Specimen S. 51, a block collected on the NE slope of the cone, is representative for Muti.

Specimen S. 51.

Olivine-rich kivite B. (vf, M). Phenocrysts of titanian clinopyroxene and smaller phenocrysts of olivine and leucite in a very fine-grained, almost cryptocrystalline groundmass consisting of the same minerals and, in addition, of magnetite and basic plagioclase. The result of a bulk chemical analysis of the rock is presented in Table I, No. 30.

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