Transfusion of quartz xenoliths in alkali basic and ultrabasic lavas, south-west Uganda.

(With Plate XIII.)

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(With micro-chemical analyses by
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Contents.

I. The Problem.

The occurrence in basic lavas of quartz xenocrysts and xenoliths and the various types of reaction phenomena which they exhibit have been well described by Lacroix (1893, pp. 17–48). The modified quartz is often surrounded by a zone of pyroxene granules or prisms and on the inner side of this zone the quartz may be replaced by glass, both peripherally and through an anastomosing system of vein-like channels. The glass may be clear or charged with gas inclusions; some examples contain minute quartz-pseudomorphs after tridymite, while in others microliths of alkali-felspar occur. In the basanitoid of Hirzstein, Hesse, nepheline occurs around quartz in place of the usual vitreous shell (Fromm, 1891, pp. 58, 65, and 70). Despite these observations, it seems to have been tacitly supposed that the glass is a more or less hydrous variety of vitreous silica. The only alternative suggestion which I have been able to trace—one which foreshadows the results of the present investigation—was made by

Campbell and Stenhouse (1907, p. 133). Referring to their observation that only a thin peripheral zone of vitrification is produced when a fused basic rock acts on a piece of sandstone in a crucible, they write : 'This results because the alteration is due, not so much to the heat as to the acquisition of alkalies from the basic rock, which have acted as fluxes and converted the quartz practically into glass.'

While investigating the lavas of Bufumbira and the melilite-rich lava of Katunga in western Ankole, I was impressed by the abundance of transfused quartz xenoliths in many of the specimens (pl. XIII, fig. 1). The refractive index of the glass, in all the cases tested, proved to be higher than that of any member of the opal–silica-glass series. The data for the three examples described in this paper are assembled in table I, together with other figures which are listed for comparison.

TABLE I. Refractive indices of glasses.

Material.	Refractive index.	Reference.
Opal	1·41—1·46	—
Pure silica-glass ...	1·45845 (Na)	R. B. Sosman, Internat. Crit. Tables, 1929, vol. 6, p. 341.
Lechatelierite, Meteor Crater, Arizona ...	1·460 (orange-yellow)	A. F. Rogers, Amer. Journ. Sci., 1930, vol. 19, p. 197.
Silica-glass, Libyan Desert	1·4624 (Na)	L. J. Spencer, Min. Mag., 1934, vol. 23, p. 505.
Glass from transfused quartz:		
Murambite, Kigoma	1·472—1·484	
Murambite, Kigezi	1·480—1·497	
Katungite, Katunga	1·476—1·486	
Orthoclase-glass ...	1·485	G. W. Morey and N. L. Bowen, Amer. Journ. Sci., 1922, vol. 4, p. 2.
Acid obsidians ...	1·48—1·50	C. E. Tilley, Min. Mag., 1922, vol. 19, p. 278; W. O. George, Journ. Geol., 1924, vol. 32, pp. 356–357.

It thus appeared that the glass from the transfused quartz might be more akin to obsidian than to silica-glass, and it therefore became important to ascertain what constituents had been introduced from the lava into the quartz. The quantity of glass available in each case was so small that quantitative analysis by ordinary methods was impracticable. Fortunately, however, I was able to enlist the co-operation of Dr. F. Hecht, whose skill in the technique of micro-chemical analysis is unrivalled. The methods devised by Dr. Hecht for the analysis of the three samples of glass, checked by work on silicate powders of known composition, mark a signal advance in micro-chemical analysis. The methods, which will be described in a forthcoming paper by Dr. Hecht, have obvious applications to the investigation of minerals when only minute quantities can be separated in a pure state.

II. The Lavas and their Inclusions.

The Murambite of Kigoma.—Kigoma is one of the minor extinct volcanoes of Bufumbira. It is described by Combe (1933, p. 94) as a prominent truncated ash-cone situated at the foot of a ridge of Karagwe-Ankolean sediments that forms part of the eastern wall of the Bufumbira depression. The specimens investigated represent a highly scoriaceous lava-flow which issued from a vent near the foot of the cone.

The rock, C.2805, is coarsely vesicular and xenoporphyritic, being rich in fragmental forms of perfectly fresh olivine (2V *c.* 90°), many of which are corroded and deeply embayed. In section, similar forms of augite are seen, together with sparse euhedral crystals. The groundmass consists of finely granular olivine, augite, and ores, interspersed with minute laths of plagioclase (near An_{60}), rare ring-like specks suggestive of leucite, and a little interstitial material. The latter contains alkali-felspar and ore-sprinkled glass which here and there is biscuit-coloured like that generated by the transfusion of quartz. The proportion of felsic material varies considerably, even from section to section.

The chemical composition (table II, C) shows that the rock is a melanocratic absarokite of the type for which I have proposed the term *murambite* (Holmes and Harwood, 1936, p. 14). The analysis of the type murambite of Murambe (a breached crater $1\frac{3}{4}$ miles north of Kigoma) is given under A for comparison.

The lava contains friable and minutely vesicular xenoliths of partially vitrified or transfused quartzite, up to 3 cm. across. In section much smaller inclusions of phyllite and granite are also found. The quartzite and phyllite are obviously derived from the underlying Karagwe-Ankolean formations. Combe (1933, p. 9) has suggested that granitic rocks may be present in the Kigoma neighbourhood, since the adjoining Karagwe-Ankolean rocks are locally tourmalinized and traversed by quartz-tourmaline veins. The xenoliths confirm this inference. The quartz of the granite is transfused like that of the quartzite, but the felspar, whether perthite or oligoclase, is but little affected. The phyllite tends to be transformed into glass and grey, opaque, fibrous material consisting in part of sillimanite. It is hoped to investigate the transfusion of argillaceous xenoliths later; the present communication is confined to purely siliceous xenoliths.

In section the quartzite xenoliths are found to be of three main types: (*a*) unaltered quartzite made up of quartz grains which are either closely interlocked or cemented by a fine-grained mosaic of quartz; (*b*) examples in which narrow vein-like channels of glass form a more or less uniformly distributed network (cf. pl. XIII, fig. 3); and (*c*) examples in which transfusion has spread until only rounded or angular relics of quartz remain, standing out sharply in virtue of their higher refractive index, in a continuous or vesicular base of pale, cloudy, or biscuit-coloured glass (pl. XIII, fig. 6).

It is particularly notable that in any one example the glass channels tend to be of nearly uniform width throughout, and so distributed as to subdivide the quartzite into grains of the same order of size. The channels follow, for the most part, the intergranular boundaries, but as the transfusion develops they also traverse individual grains, sometimes cutting sharply through them, sometimes ending abruptly as blind, lobe-like ducts. In the last case, the proof is complete that the glass is a metasomatic replacement of quartz. Between crossed nicols the quartz shows no sign of strain shadows such as characterize the partly felspathized quartz grains of the Colonsay xenoliths described by Doris Reynolds in the preceding paper (p. 384). This difference is probably to be correlated with the fact that glass was formed in the Kigoma xenoliths, whereas felspar developed directly in those of Colonsay.

Near the junction of a xenolith with the enclosing lava the groundmass material of the latter invades the transfused channels in sinuous tongues. From being nearly opaque with swarms of ore-specks, these pass rapidly into brown glass which fades imperceptibly, both laterally and terminally, into the pale grey glass of the quartzite. From some examples the brown or biscuit-coloured glass of the peripheral region invades the groundmass of the lava, and in the vicinity of such xenoliths liberated grains of quartz may be seen in the groundmass. Around these the characteristic rim of augite gradually develops as they float away from their source. This evidence shows that many of the inclusions must originally have been much larger and that the lava itself must have been modified by assimilation of the transfusion product of quartz.

By successive separations in diluted bromoform a small sample of nearly pure glass was obtained from clean, crust-free material broken from several of the larger white xenoliths which preliminary examination had shown to be suitable for the purpose. The separated glass was found to contain only rare traces of quartz, while in the residue the only minerals seen, besides quartz and glass, were accessory ores and zircon. Dr. Hecht's analysis of the glass, carried out on a series of samples of about 20 mg. each (amounting in all to less than 0·2 gram) is given in table III, F; it shows that the glass is essentially equivalent to a potash-rich acid obsidian.

The Murambite of Kigezi.—Kigezi is a small extinct volcano, 2½ miles west-by-north of Kigoma, situated in a strike valley in the Karagwe-Ankolean country on the edge of the volcanic field of Bufumbira (Combe, 1933, p. 107). The lava, as represented by specimen C.2817, is a dark grey vesicular rock with irregular grains of xenoporphyritic olivine and augite which vary widely in size and distribution. In section (pl. XIII, fig. 2) these minerals are seen to be corroded and embayed like those of the Kigoma lava. Some of the olivine xenocrysts are reduced to skeletal grids, whereas the new olivine which crystallized in the groundmass consists of minute rhombic forms enclosing dense, ore-sprinkled cores. Tiny spots of leucite, dusky with inclusions, are easily recognized. The remaining characters of the rock are like those of the Kigoma lava. Both mineralogically and chemically (table II, D) the rock is a typical murambite.

Combe mentions the abundance of 'inclusions of varying size up to two inches, but mostly smaller, of white silicate minerals'. The specimen sent to me contains numerous white xenoliths of transfused quartzite, themselves vesicular, which range in size from fragments an inch long down to oval specks and minute relics recognizable only in thin section. Occasional bits of granite and shreds of phyllite also occur. The glass immediately surrounding and cutting across the residual quartz of the quartzites is like that of the Kigoma examples, but within the more continuous areas of glass there are darker streaks and patches showing flow structure. These have a refractive index up to 1·497, while that of the pale glass is 1·480. Some of the inclusions—both unaltered and transfused—contain sillimanite, sometimes in interlacing wisps associated with bottle-green spinel. The glass, however, presents the same features whether sillimanite is present or absent.

The sample of glass analysed by Dr. Hecht (table III, G) was separated from the interior of a single xenolith about an inch across, in the powder of which no sillimanite could be detected. The composition of the glass is closely similar to that of the Kigoma sample.

The Katungite of Katunga.—Katunga is an isolated extinct volcano in northern Igara, western Ankole, situated about twelve miles SSE. of the southern limit of the volcanic field south-east of the Kazunga Channel, and about sixty miles north-east of the Bufumbira volcanoes referred to above (see maps in recent Annual Reports of the Geological Survey of Uganda). At Katunga, Combe (1934) discovered the first true lava flows recognized in the Toro-Ankole fields. The two flows—eastern and western—are over a mile long and consist of a rock akin to potash-rich olivine-melilitite (but free from augite) for which I have proposed the name *katungite*.[1] Katungite may be defined as an alkali ultrabasic rock with more potash than soda, the essential minerals of which are olivine and melilite; the potash may be present in glass, zeolites, leucite, biotite, or potash-nepheline. As ejected blocks, katungite and biotite-katungite are known from several explosion craters in the Toro-Ankole fields, while as tuffs with lapilli they are widely distributed in the same province.

At Katunga the minerals present are tabular crystals of ferric melilite (about 40 per cent.); euhedral and corroded crystals of olivine (about 20 per cent.); golden brown octahedra and grains of perovskite (about 7 per cent.); and occasional grains of magnetite; in an ore-sprinkled groundmass of cryptocrystalline or glassy material which is interrupted by vesicular infillings of phillipsite, natrolite, and, possibly, ashcroftine. Leucite is rare and has been detected in only a few of the specimens. Apatite and nepheline occur as accessories. In both flows natrolite is most abundant near the source, corresponding to which the specimens from near the source are richer in soda than the fully analysed specimen from near the end of the western flow (table II, E).

Bombs of phillipsite-bearing varieties of katungite, practically free from natrolite, occur on the north face of Katunga, above the source

[1] Papers dealing respectively with the Katunga volcano and the petrology of its rocks will shortly appear in the Geological Magazine by A. D. Combe and myself.

TABLE II. Analyses of Murambite (A–D) and Katungite (E).

	A	B	C	D	E
	Murambe.	Mikeno.	Kigoma.	Kigezi.	Katunga.
SiO_2	46·78	44·74	46·70	45·20	35·37
Al_2O_3	13·24	11·82	10·86	11·26	6·50
Fe_2O_3	2·64	3·89	3·34	3·66	7·23
FeO	7·85	7·06	8·67	8·67	5·00
MgO	11·64	14·28	13·00	11·80	14·08
CaO	8·59	9·61	9·76	9·90	16·79
Na_2O	2·20	2·16	0·96	1·90	1·32
K_2O	2·72	2·51	1·56	2·02	4·09
H_2O+	0·57	0·40	0·80	0·86	2·78
H_2O-	0·26	0·10	0·10	0·06	1·15
CO_2	0·03	0·21	trace	trace	0·09
ZrO_2	trace	0·02	—	—	nil
TiO_2	2·47	2·10	2·45	2·73	3·87
P_2O_5	0·55	0·66	0·79	0·95	0·74
Cl	0·01	—	0·03	0·04	0·02
F	0·07	—	0·02	0·02	0·16
S	0·03	0·14	0·05	0·05	0·35
Cr_2O_3	0·11	—	0·16	0·11	0·01
V_2O_3	0·04	—	0·02	0·02	0·03
NiO	0·04	—	0·05	0·05	0·19
MnO	0·18	0·19	0·16	0·17	0·24
BaO	0·12	0·07	0·18	0·21	0·25
SrO	0·09	0·05	0·12	0·12	0·04
CuO	—	—	0·02	0·02	0·06
Li_2O	trace	—	—	—	nil
	100·23	100·01	99·80	99·82	100·36
Less O	0·04	0·05	0·03	0·04	0·24
	100·19	99·96	99·77	99·78	100·12

A. Murambite. C.2803. Lava of Murambe, Bufumbira, south-west Uganda. Analyst, H. F. Harwood. A. Holmes and H. F. Harwood. Mem. Geol. Surv. Uganda, 1936, no. 3, part II, p. 138.

B. Murambite. Kanemagufa valley, south of Mikeno, Birunga, Belgian Congo. Analyst, see under D. A. Holmes and H. F. Harwood, ibid., p. 140.

C. Murambite. C.2805. Lava of Kigoma, Bufumbira. Analyst, see under D. A partial analysis of another specimen by H. F. Harwood gave SiO_2 48·34, Na_2O 1·97, K_2O 2·74 (ibid., p. 146).

D. Murambite. C.2817. Lava of Kigezi, Bufumbira. B, C, and D are analyses by Messrs. Imperial Chemical Industries (Fertilizer and Synthetic Products) Limited, Research Department, Billingham, Co. Durham.

E. Katungite. C.4407. Near end of western lava-flow of Katunga, Bunyaruguru, western Ankole, Uganda. Analyst, A. W. Groves.

Additional alkali determinations by W. H. Herdsman:

		Na_2O.	K_2O.
C.3949.	Near source, eastern flow	2·65	3·66
C.4412.	Near source, western flow	2·96	3·55
C.4411.	50 feet below source, western flow	2·91	3·84

of the western flow. Three specimens of these are of immediate interest in containing xenoliths of biotite- and muscovite-schists, more or less transfused vein-quartz, and occasional fragments of alkali-felspar. The source of these is clearly the Igara Schist Series (broken through by the volcano) and the quartz and pegmatite veins seen to be associated with it in the ejected blocks thrown out from the crater.

TABLE III. Micro-chemical analyses of glass from transfused quartz. (By Friedrich Hecht.)

	F Glass, Kigoma.	G Glass, Kigezi.	H Glass and quartz, Katunga.	H′ Glass alone, Katunga.
SiO_2 ...	79·99	79·68	86·35	74·51
Al_2O_3 ...	7·13	8·02	5·27	9·78
Fe_2O_3 ...	0·44	0·26	0·03	0·06
FeO ...	0·38	0·49	0·19	0·35
MgO ...	0·15	0·11	0·87	1·61
CaO ...	0·54	0·35	0·64	1·19
Na_2O ...	0·99	0·80	0·49	0·91
K_2O ...	5·53	5·76	3·32	6·16
H_2O+ ...	2·71	2·28	2·43	4·51
H_2O- ...	1·47	1·16	0·25	0·46
CO_2 ...	nil	nil	0·13	0·24
TiO_2 ...	0·78	0·14	0·09	0·17
P_2O_5 ...	0·13	0·12	nil	nil
SO_3 ...	0·87	1·13	nil	nil
MnO ...	0·48	0·17	0·14	0·26
	101·59	100·47	100·20	100·21

F. Glass separated from transfused quartzite xenoliths in the murambite lava of Kigoma, Bufumbira, south-west Uganda. C.2805. *n* 1·472—1·484. Sp. gr. 2·27—2·30 (18° C.).

G. Glass separated from a transfused quartzite xenolith in the murambite lava of Kigezi, Bufumbira. C.2817. *n* 1·480—1·497. Sp. gr. 2·30—2·33 (18° C.).

H. Mixture of glass (54 per cent. by weight) and quartz from a transfused vein-quartz xenolith in a bomb of katungite from the north face of Katunga, western Ankole, Uganda. C.4418.

H′. Composition of glass alone, calculated from H. *n* 1·476—1·486.

The transfused quartz has the appearance illustrated in pl. XIII, fig. 3. In some of the wider channels of glass a composite structure can be detected, an inner channel with a refractive index of 1·486 being sharply separated from marginal zones, adjacent to quartz, with a refractive index of 1·476. Very rarely, the place of the inner zone is taken by wisps of muscovite. It was found impossible to separate pure glass from the material available in sufficient quantity for even micro-chemical analysis. The material analysed by Dr. Hecht in this case (table III, H) was found by micrometric estimation to consist of approximately 54 per cent. glass and 46 per cent. quartz. Allowing for this, the composition of the glass is approximately as given under H′.

The Katunga glass can be matched with silica-rich dopotassic acid rocks (pitchstone, rhyolite, quartz-porphyry, and granite) more closely than the other two. Excess of alumina (1·16 per cent.) over the amount required to make felspars is a feature which it shares with the natural rocks most like it in composition.

III. Chemistry of the Transfusion Process.

It is clear from the data presented in tables II and III that glass produced by the transfusion of quartz in the examples studied is neither fused silica nor a solution of silica in the material of the enclosing lava. It is a metasomatic replacement-product of quartz due to the introduction into the latter of various constituents in proportions surprisingly different from those in which they could have been present in the magmatic part of the lava. Silica may have migrated from quartz to lava—though there is no evidence that it did so—but there is no reason to suspect that silica migrated from lava to quartz. Assuming that there was no transfer of magmatic silica, the average composition of the introduced material can easily be calculated. (H_2O- is omitted.)

Table IV. Composition of material introduced into quartz.

	Kigoma.	Kigezi.	Katunga.
Al_2O_3	35·65	40·65	38·05
Fe_2O_3	2·20	1·32	0·23
FeO	1·90	2·49	1·36
MgO	0·75	0·56	6·26
CaO	2·70	1·77	4·63
Na_2O	4·95	4·05	3·54
K_2O	27·65	29·59	23·97
H_2O+	13·55	11·56	17·55
CO_2	—	—	0·93
TiO_2	3·90	0·71	0·66
P_2O_5	0·65	0·61	—
SO_3	4·35	5·73	—
MnO	2·40	0·87	1·01
	100·65	99·91	98·19

The data show that in all three cases the chief materials introduced were alumina, potash, and water. SO_3 was a notable contribution from murambite, while unusually high amounts of magnesia and lime migrated from katungite. The variation diagram, text-fig. 1, illustrates the differential migration of the major constituents in the Katunga example, and comparison with the corresponding Colonsay diagram in the preceding paper (Reynolds, p. 396) shows the essential similarity of the respective phenomena, the main difference being the

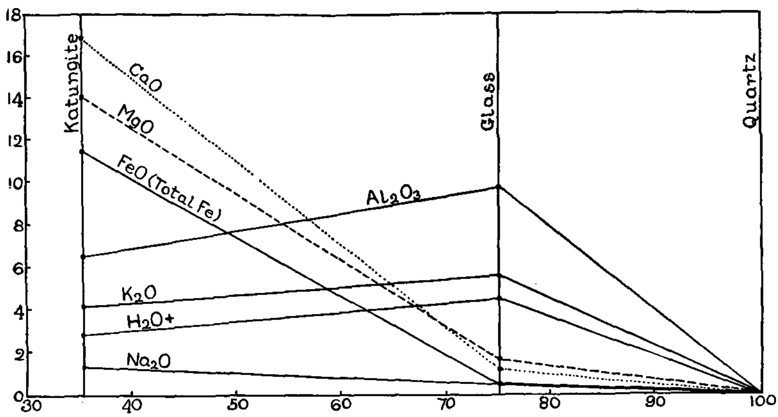

FIG. 1. Variation diagram: percentages of oxides plotted against silica.

relatively feeble diffusion of soda from katungite. The formation of glass corresponds chemically to the felspathization of quartzite in Colonsay, while the augitic rims correspond in sequence and limited amplitude of migration to the later introduction of cafemic constituents (with production of appinite) in Colonsay.

The diffusibilities of the various constituents, judged relatively to the concentrations of the latter in the respective lavas, are as follows, in decreasing order of magnitude from left to right:

Kigoma: SO_3, H_2O, K_2O, MnO, Na_2O, Al_2O_3, TiO_2, P_2O_5, FeO, CaO, MgO.
Kigezi: SO_3, H_2O, K_2O, MnO, Al_2O_3, Na_2O, P_2O_5, FeO, TiO_2, CaO, MgO.
Katunga: CO_2, H_2O, K_2O, Al_2O_3, MnO, Na_2O, MgO, CaO, TiO_2, FeO.

It must be remarked, however, that the composition of the lavas is no more than a rough guide to the composition of the magmatic material from which the migrating emanations were actually given off. Moreover, as Doris Reynolds has pointed out (p. 397), there is no evidence that the migrating units were oxides. The development of transfusion through and from a network of intergranular films suggests that the process is one involving ionic movements and reactions along boundary surfaces. Unfortunately, investigations of surface chemistry are not yet sufficiently advanced to justify any attempt at 'explanation'. Moreover, the products of alkali-alumina metasomatism of siliceous materials are themselves so varied from one locality to another—ranging from syenite to granite, micropegmatite, and obsidian—that more exact data must be accumulated before even empirical petrological generalizations can be attempted. Nothing can yet be profitably added to the stimulating summary of the possibilities recently presented by Wegmann (1935).

IV. Analogous Examples.

Braefoot outer sill, Fife.—Day and Stenhouse (1930, p. 250) describe quartzite xenoliths at the top of the teschenitic sill at Braefoot Point and state, 'Exchange of material between the fragments of quartzite and the dolerite has gone on, until the edges of the quartzite were converted into a band of igneous glass, possibly more basic externally. This crystallized into a band of granular augite, inside which the less basic glass has crystallized as felspar and invades the cracks in the centre core of quartzite.' After further investigation of this xenolithic horizon, Campbell and Stenhouse (1930, p. 360) find that 'The evidence indicates that, in the neighbourhood of the quartzite xenoliths, there has been migration of the quartzo-felspathic material of the middle zone, not only along fissures into the quartzite, but also out into the adjacent crystal mesh and into vesicular cavities.' These authors also point out that the phenomena conclusively demonstrate 'the silicification of the Braefoot teschenite and the consequent production of a dolerite which approaches a quartz-dolerite in character'. A further significant observation is made by Campbell, Day, and Stenhouse (1933, p. 167) in their description of the xenolithic horizon exposed along the western shore of Dalgety Bay. They write, 'Quite frequently this outer augite zone [i.e. of the quartzite xenoliths] has been disrupted, and there has been a migration of the contents of the felspathic zone, which has an "intrusive" relation to the augite band.' It is abundantly proved, not only that there has been extensive assimilation of quartzite by teschenite magma, but also that, as a preliminary to assimilation, the quartz was transfused by emanations from the magma to mobile material from which alkali-rich felspars afterwards crystallized.

Drevain, France.—In an account of the nephelinite of Drevain, Saône-et-Loire, Lacroix (1903) records the felspathization of xenoliths of quartz-granulite by emanations from the magma. In some examples quartz has entirely disappeared and the inclusions are represented by alkali-syenite.

Karelia.—Levinson-Lessing (1935) has recently re-described a glassy lava from Yalguba, Karelia, composed of varioles of acid glass in a groundmass of basic glass, both of which contain a small proportion of microphenocrysts of augite. Omitting the latter, the calculated mineral compositions of the two types of glass are as follows:

Varioles.		*Groundmass.*	
Quartz	23	Olivine	24
Oligoclase	75	Bytownite	70
Magnetite	1	Magnetite	5

Levinson-Lessing suggests that after the crystallization of pyroxene the magma split into two immiscible liquids represented by the varioles and groundmass. He points out that this mechanism of differentiation stands in contradiction to 'the generally admitted sequence of events'. In the light of the Uganda evidence it seems probable that the varioles represent xenoliths which were transfused into glass by emanations from the basic magma.

Franklin district, British Columbia.—Drysdale (1915) describes from this district a Miocene intrusion in which shonkinitic pyroxenite was followed, almost simultaneously, by syenite. He suggests that the two contrasted magmas were immiscible products of a deep-seated differentiation of a hypothetical parental magma. In the same memoir, however, he describes the formation of syenite in situ by metasomatism of Lower Tertiary conglomerate and grit (p. 82). The plates illustrating the phenomena (e.g. X, XI, and XVI) show that the latter are closely comparable with those of the Colonsay occurrences.

Isle Cadieux, Quebec.—It is possible that the 'aplitic' inclusion described by Bowen (1922, p. 11) from the monticellite-alnöite of Isle Cadieux, near Montreal, may be partially metasomatized quartzite. The composition of the 'aplite' is very like that of the transfused quartz from katungite (table III, H). Streaks of melilite-biotite-rock occur in the alnöite and have been produced from the latter by metasomatism. If the emanations responsible for this change had acted on quartz, the 'aplite' would have been a possible product.

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VII. Description of Plate XIII.

Micro-sections illustrating transfusion phenomena from Uganda and Colonsay.

(Photomicrographs by G. W. O'Neill.)

Fig. 1. Transfused quartz xenocryst in kivite (a variety of leucite-basanite), Mabungo volcano, Bufumbira, south-west Uganda. C.2836. The xenocryst is fringed with a dense criss-cross felt of green augite needles, which appears as a black border in the figure. Towards the periphery the needles are radially distributed and merge without a break into the fawn prismoids of the groundmass augite. On the inner side of the augitic border the needles become less crowded and are embedded in glass of pale buff colour. The interior of the xenocryst is made up of pale biscuit-coloured glass which surrounds and cuts through relics of quartz, all of which are in optical continuity. × 31.

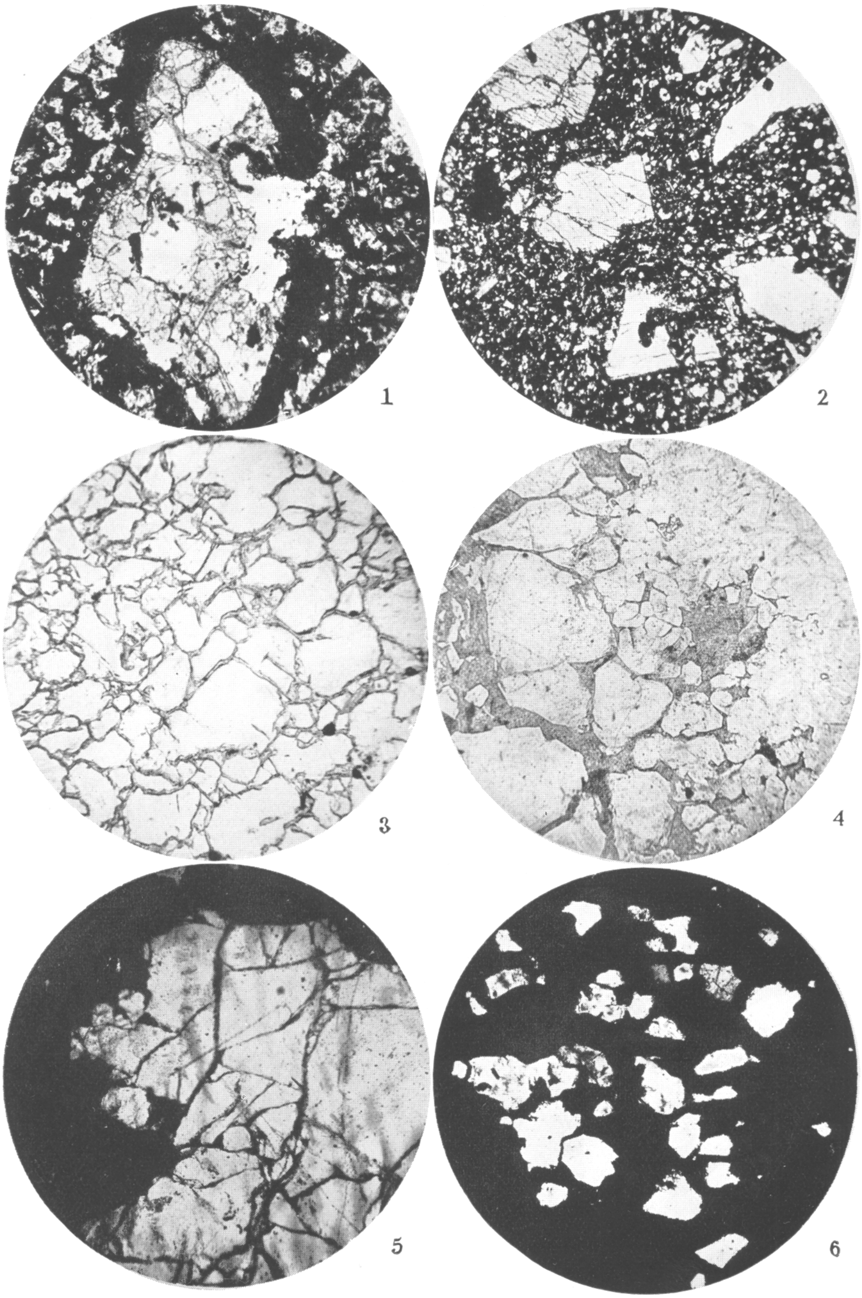
Fig. 2. Murambite lava of Kigezi, Bufumbira. C.2817. Showing xenoporphyritic olivine and augite in a groundmass of olivine, augite, plagioclase, leucite, and ores. × 12½.

Fig. 3. Transfused vein-quartz from a xenolith in katungite (potash-rich augite-free olivine-melilitite), Katunga, 60 miles north-east of Bufumbira. C.4418. In addition to the intergranular film of glass, vein-like and tubular channels of glass cut across individual crystals, while others terminate within single crystals (e.g. the tack-shaped example to the right of the centre of the field) without distorting them, thus showing that the process of transfusion is one of replacement. × 23.

Fig. 4. Felspathized quartzite in hornblendite, Port Easdale, Colonsay. Showing contact between a residual core of quartzite (right) and its metasomatized rim. The felspathized channels extend and develop along the intergranular boundaries of the quartzite and here and there traverse individual grains. Compare with fig. 3. × 29.

Fig. 5. Transfusion of a single grain of quartz from a xenolith in murambite, Kigezi, Bufumbira. C.2817. The channels and the continuous area of glass appear black in the figure. Notice the metasomatic granulation of the quartz grain, the separated parts of which remain in optical continuity. Crossed nicols. × 23.

Fig. 6. Transfused quartzite xenolith in murambite, Kigezi, Bufumbira. C.2817. Most of the relics of quartz belong to what were originally three individual grains, the separate parts of which still remain in perfect optical continuity. The elongated group of eight relics on the right of the field represent one such grain. Crossed nicols. × 23.



ARTHUR HOLMES: TRANSFUSION OF QUARTZ