LOWENSTEIN (Peter Leslie)

SECTION III

APPENDICES

APPENDIX I

DETAILED DESCRIPTIONS OF REPRESENTATIVE EXAMPLES OF THE MAIN PEGMATITE GROUPS

CONTAINS PULLOUTS

APPENDIX I.

Detailed descriptions of representative examples of the main pegmatite groups

Group 1. The Mungenyi, fully-zoned microcline-muscovite pegmatite

Mungenyi pegmatite is situated 1 mile to the W.N.W. of Mungenyi village on the S.E. slope of Mungenyi Hill (5052') in Kajara county, Ankole. (Map ref. Sheet 85/III 868942). A single opencast working 200 ft. in length and 85 ft. in maximum width has exposed a lenticular quartz-microcline-muscovite pegmatite intrusion.

General Geology

The Mungenyi pegmatite is situated in K-A country rocks approximately ¼ of a mile to the north of the Rwabaramira post-tectonic pegmatitic granite intrusion. The country rocks are altered mica schists and phyllites of the lower division of the K-A system which strike at a bearing of 40°, dip steeply to the S.E. and are underlain at shallow depth by granite. Injection of the Mungenyi pegmatite has caused considerable displacement of the strike of the country rock schistosity which varies from 35° to 110°. The country rocks adjacent to portions of the pegmatite have been strongly tourmalinised and contain porphyroblastic aggregates of black schorlite. (see plan enclosure 11). A massive cross cutting quartz vein 7 ft. in maximum thickness has been intruded into the country rocks approximately 30 ft. to the N.E. of the pegmatite.

Geology of the pegmatite

The opencast workings have partly exposed an elongate lenticular intrusion over 150 ft. in length and 60 ft. in maximum width which strikes at a bearing of 40° and has a near vertical dip. The pegmatite which is well zoned, has been mined to a depth of over 40 ft. below surface outcrop and the following zones have been recognised.

a.	Zone of aplite-like pegmatite.	Border Zone
b.	Zone of medium to coarse grained pegmatite.	Wall Zone
c.	Zone of massive microcline	Intermediate Zone
d.	Zone of block quartz	Quartz Core
e.	Limited quartz-muscovite and albite-muscovite replacement zones	Discontinuous replacement zones

a. Zone of aplite-like pegmatite. (Border Zone)

The border zone of the pegmatite consists of coarse quartz-feldspar aplite which lies in sharp contact with tourmalinised country rock. The zone is discontinuous and narrow and coarsens rapidly inwards to form medium-grained pegmatite.

b. Zone of medium to coarse grained pegmatite. (Wall Zone)

The wall zone consists of medium to coarse grained quartz-microcline-muscovite pegmatite which has suffered sporadic replacement. On the northern side of the intrusion the wall zone is very thin but on the S.E. side it reaches 3 ft. in thickness and has been partly replaced by granular albite and coarse books of muscovite. Small quantities of coarse biotite have been found in the wall zone on the S.E. side of the pegmatite.

c. Zone of massive microcline feldspar. (Intermediate Zone)

A massive microcline zone has developed in the pegmatite and forms the bulk of the intrusion. The zone consists of large masses of pale brown partially altered microcline and contains occasional wedges and stringers of quartz. Muscovite is scarce except where late replacement has taken place. The microcline zone on the N.E. end of the quartz core is muscovite rich and is reported to have contained a giant, tapered, funnel shaped crystal of beryl over 26 ft. in length which yielded 28 tons of pure pale blue to green-blue beryl. The beryl is believed to have crystallised towards the end of formation of the microcline zone and growth may have continued during the early stages of muscovite replacement. Only small quantities of beryl have been found elsewhere in the microcline zone.

d. Zone of block quartz

A quartz core of unknown dimensions has been partially uncovered at depth in the central and N.E. part of the opencast workings. The core which consists of almost pure white massive quartz, is flanked by microcline feldspar and a zone of weak muscovite replacement.

e. Limited replacement zones

Sporadic weak muscovite replacement has affected portions of the wall and intermediate zones of the pegmatite and at the S.W. end of the quartz core a clearly defined quartz muscovite replacement zone has developed which consists of coarse broken quartz and muscovite. Small quantities of beryl are reported to have been obtained from adjacent to the replacement zone.

Weak albite-muscovite replacement has affected the wall zones on the N.W. and S.E. sides of the intrusion and has resulted in the formation of patches of albite and coarse books of muscovite.

Miscellaneous minerals from the Mungenyi pegmatite

1. Green Tourmaline

A single porphyroblastic crystal of dark green tourmaline 3 inches in length, which contains numerous small inclusions of muscovite has been found in spoil taken from the pegmatite. The crystal is believed to have formed by replacement.

2. Meta-Ankoleite

Meta-Ankoleite - a hydrated potassium uranyl phosphate has been reported to have been obtained from the Mungenyi pegmatite by M.J. Gallacher (1966), and occurs in the form of yellow scaly aggregates of thin flakes up to 1 mm. in diameter together with phosphuranylite minerals and grayite. The meta-ankoleite fluoresces yellow-green under ultra-violet light.

3. Iron/manganese phosphates

A small block of maroon coloured heterosite on quartz was found amongst spoil taken from the N.E. part of the pegmatite but none has been observed in situ.

Paragenesis of the Mungenyi Pegmatite

The Mungenyi pegmatite formed by crystallisation of an injection of residual granitic magma. Crystallisation resulted in the formation of a discontinuous chilled border zone, a wall zone, a massive intermediate zone and a small quartz core. Concentration of residual fluids during primary crystallisation resulted in the formation of beryl in the microcline zone adjacent to the quartz core and limited replacement finally affected portions of the pegmatite to produce weak replacement zones containing quartz, albite and muscovite. Insufficient replacement occurred to warrant classifying the pegmatite as a replaced muscovite-albite type. Weak alteration has affected the microcline feldspar but little or no kaolin occurs.

Group 2. The Nyakabingo, muscovite-albite replaced pegmatite

The Nyakabingo pegmatite has been exposed at Nyakabingo Mine which is situated about ½ a mile south of the Rufuha Swamp and lies approximately 4½ miles to the E.S.E. of the Ntungamo/Rwentobo - Kafunzo/Rwentobo road junction in Kajara County, Ankole. (Map ref. Sheet 94/1 938893). Nyakabingo "mine" is a single opencast working 360 ft. in length, 50 ft.

in maximum width and 40 feet in maximum depth, which has exposed an elongate fissure pegmatite intrusion.

The main opencast which has been mapped in detail (see plan enclosure 12) runs N.W.-S.E. and is approached from the N.E. by a deep cutting 140 ft. in length and 20 ft. in maximum depth. A shallow trench 60 feet long approaches an upper bench at the S.W. end of the workings and a shallow prospect trench was excavated 30 ft. to the S.W. of the main workings to try to locate the strike continuation of the pegmatite.

General Geology

The country rocks around Nyakabingo Mine consist of partially granitised injection schists which contain veins and lenticular masses of medium grained and pegmatitic quartz-microcline granite. A good section of the country rocks on the footwall side of the pegmatite vein is exposed in the approach cutting on the N.E. side of the main opencast (see section enclosure 13). Here medium to fine grained, crumpled, biotite and muscovite schists occur, which strike at a bearing of 350°, dip steeply at 70° to the E.N.E., and have been permeated and invaded by granite which crops out as irregular veins and injections at intervals along the cutting. The granite consists of quartz, microcline-feldspar and muscovite and is very variable in texture from medium-grained, granular and gneissose, to coarse grained, weakly foliated and pegmatitic.

Adjacent to the granite veins, transitions from schists containing laminae of granular quartz and microcline, to medium or coarse grained quartz-microcline granite containing occasional muscovite foliae can be observed. The schists show progressive muscovitisation, permeation and injection by quartzo-feldspathic material as the 'granite' masses are approached and have been hydrothermally altered and weathered.

Adjacent to the footwall contact of the pegmatite the country rocks have been tourmalinised and contain a high proportion of granitic material. The country rocks adjacent to the hanging wall side of the pegmatite are similar in appearance, contain abundant quartzo-feldspathic material and show considerable variation in the strike of their foliation. The strike varies from 350° at the S W. end of the pegmatite, to a bearing of 300° adjacent to the central portion of the pegmatite (see plan enclosure 12), and where it lies parallel to the pegmatite contact.

Geology of the Pegmatite

The Nyakabingo pegmatite is an elongate, zoned, cross-cutting fissure intrusion which strikes for over 300 ft. at a bearing of 305° and has a steep but irregular dip to the south-west. The pegmatite has a shallow plunge to the S.W. and lies in sharp contact with altered and permeated country rocks which show shearing adjacent to the contacts.

Zones

The following zones have been recognised in the Nyakabingo Pegmatite.

a.	Zone of medium to coarse grained pegmatite.	Wall zone
b.	Zone of microcline pegmatite	Intermediate Zone
c.	Zone of block quartz	Quartz Core
d.	Muscovite replacement complex	Replacement Zones
e.	Albite replacement complex	

a. Zone of medium to coarse grained pegmatite

The outermost zone of the Nyakabingo pegmatite consists of a medium grained pegmatitic intergrowth of quartz, white microcline, greenish muscovite and occasional black tourmaline which gradually becomes coarser away from the pegmatite margin. The zone contains irregular wedges and fragments of quartz which sometimes show graphic intergrowth with microcline feldspar and a little muscovite occurs as small books up to 1" in diameter. The zone is best developed at the N.E. end of the pegmatite where it reaches 10 ft. in maximum thickness, but elsewhere extensive albite replacement has reduced it to a band less than 2 ft. in thickness.

b. Zone of microcline pegmatite

Only traces of this zone are still preserved in the pegmatite owing to extensive albitisation of its inner portions, but 'ghost blocks' of albitised microcline and quartz wedges up to 1 ft. in diameter can be found on the footwall side of the quartz core at the S.E. end of the vein.

c. Zone of block quartz

The quartz core is an irregular dyke like body from 2 to 4 ft. in thickness which strikes at a bearing of 305°, has an irregular dip to the S.W., and plunges gently to the S.E. The core has a shallow dip of 45° to the S.W. at the N.W. end of the pegmatite, a steep dip of 85° in the middle portion of the vein and a shallow dip again at the S.E. end of the workings. The change in dip of the quartz core must have played a part in localising late stage replacement, as replacement and mineralisation tend to have been concentrated on the hanging and footwall sides of shallow dipping portions of the core. Portions of the core margin are not sharp and quartz then extends into the surrounding replacement zones.

d. The muscovite replacement complex

Muscovite has concentrated along the hanging wall contact of the pegmatite where it forms a replacement zone containing plumose aggregates of pale-green mica up to several inches in diameter. The replacement zone formed as a result of accumulation of volatiles under the hanging wall contact of the pegmatite. Muscovite replacement selvages have also been formed close to the margins of the albite replacement complex.

In the N.W. part of the pegmatite there has been sporadic replacement to produce patches of medium grained greenish yellow muscovite rock ("greisen"), and a replacement body of cryptocrystalline green "oncosine" rock several feet in diameter, has been produced on the hanging wall side of the quartz core. The "oncosine" rock contains inclusions of quartz, cleavelandite feldspar, and small grains of orange-red garnet.

e. The Albite replacement complex

Albitisation has affected most of the pegmatite vein to produce cleavelandite replacement zones along the footwall and hanging wall sides of the quartz core. Replacement was most intense on the footwall side of the core where a zone up to 15 ft. in maximum thickness was produced.

The outer margins of the cleavelandite replacement zones are scalloped in appearance and are often marked by a line of dark staining. The zones consist mainly of bladed, radiating aggregates of white to pale buff cleavelandite feldspar and contain wedges of quartz, rounded nodules of fine grained saccharoidal albite, and occasional corroded relic crystals of white microcline feldspar. As the quartz core margins are approached quartz increases in abundance to form over 50% of the matrix and the cleavelandite forms large, patchy, radiating aggregates.

Minerals of the cleavelandite replacement zone

Muscovite

Coarse pale to olive green tinted muscovite has accumulated particularly adjacent to the margins of the cleavelandite replacement zones and forms books up to 8" in diameter. Smaller books of muscovite occur throughout the replacement zones and often accompany beryl. Very fine grained pale apple green muscovite or sericite is very common in the cleavelandite feldspar and often imparts a green colour to the feldspar. The green coloured feldspar is frequently found together with thin stringers of green fine grained muscovite in the vicinity of beryl crystals and is often difficult to distinguish from the beryl at first glance.

Beryl

Beryl occurs throughout the cleavelandite replacement zones as pale green crystals from ½" to over 6" in diameter which have truncated, pyramidal, conical and skeletal habits. The crystals often contain cores of albite and quartz showing apographic structure and are known as 'stuffed' beryl crystals (Beus, 1966, pp.77-83). The 'stuffed' crystals commonly have continuous margins of green beryl up to 1" in thickness or which sometimes consist of several flattened beryl crystals lying adjacent to each other which assume a hexagonal form and partially or completely enclose a core of apographic quartz and cleavelandite containing further plates of green beryl. Some of the larger crystals are built up of a large number of regularly orientated tabular crystals in parallel intergrowth with albite and sometimes cone in cone structure occurs, in which one, two, or three crystals of beryl nest inside each other and are separated by sheaths of albite. The crystals all have very uneven outer faces and are separated from each other by irregular and poorly defined margins.

Small inclusions of muscovite are common in the crystals particularly at their outer margins. Not all the beryl crystals in the pegmatite are of the 'stuffed' variety and some subhedral prismatic crystals of pure green beryl also occur. The mode of occurrence and habit of the beryl crystals at Nyakabingo are typical for that of(alkali)beryl. The largest concentrations of beryl were found (in the cleavelandite replacement zones) adjacent to the portions of the quartz core which have a shallow dip.

Garnet

Large anhedral crystalline masses of dark red almandine garnet up to 1 ft. in diameter are found on the hanging wall side of the quartz core. The garnet which is extensively fractured occurs in a matrix of broken quartz and cleavelandite feldspar, and contains quartz stringers and inclusions of quartz, altered feldspar and apatite.

Small patches of granular red garnet are also found in the cleavelandite zone in the footwall side of the pegmatite.

Manganese oxide staining is common in the pegmatite matrix adjacent to garnet where alteration or weathering has occurred.

Apatite

Pale dirty green apatite is found in association with garnet adjacent to the hanging wall side of the quartz core and occurs as broken platy or columnar crystals up to 2" in length which are partially or totally enclosed by garnet.

Paragenesis of the Nyakabingo Pegmatite

The Nyakabingo pegmatite is situated in an area where mica schists have undergone extensive permeation and injection by pegmatitic granite. The pegmatite formed by crystallisation of an intrusion of residual magma which was derived from the surrounding pegmatitic granite.

Primary crystallisation resulted in the formation of a well differentiated pegmatite consisting of an outer zone of medium to coarse grained pegmatite, an intermediate zone of small block microcline and a quartz core. During primary crystallisation, concentration of volatiles occurred which then reacted with the primary zones of crystallisation to form the muscovite and cleavelandite replacement zones. During replacement, early formed microcline feldspar was converted to cleavelandite albite, and muscovite concentrated along the hanging wall contact of the pegmatite and at the margins of the cleavelandite replacement zones.

Large quantities of alkali-beryl crystallised in albitised portions of the pegmatite and formed stuffed crystals which contain cores of quartz and cleavelandite. Garnet also formed in aggregates along the hanging wall side of the quartz core, together with small quantities of apatite.

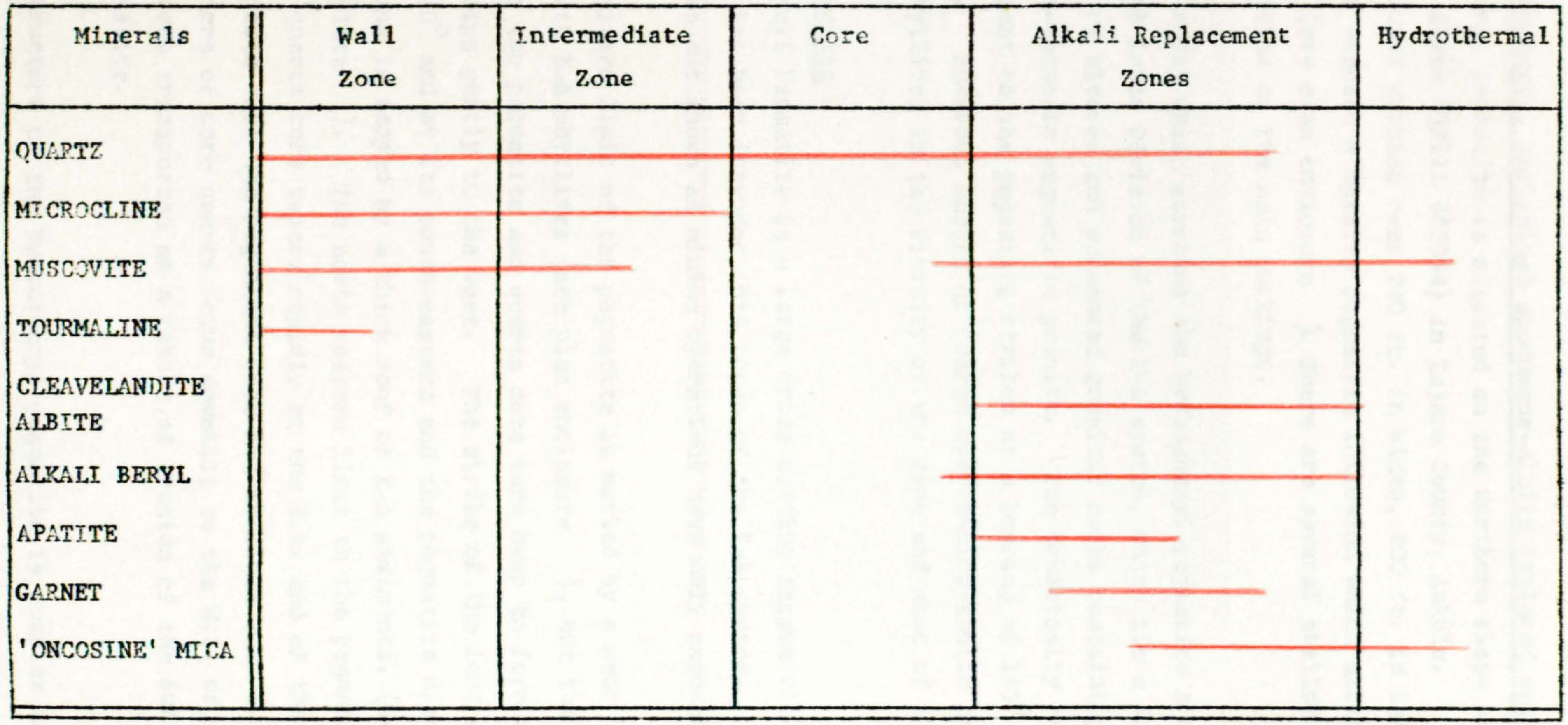
The final stages of replacement in the pegmatite were marked by the formation of small amounts of muscovite 'greisen' and "oncosine" mica rock.

No lithian muscovite replacement or concentration of lithium took place in the pegmatite.

A summary of the paragenetic sequence for the Nyakabingo pegmatite appears in table 38 .

Table 38.

Composite Paragenetic Sequence for the Nyakabingo Pegmatite



Group 3. The Nyabushenyi, kaolinised spodumene-albite replaced pegmatite

The Nyabushenyi pegmatite is situated on the northern slope of a hill near Rwembogo (Map sheet 85/111 885994) in Kajara County, Ankole.

A large opencast working over 240 ft. in width, 200 ft. in length, and 80 ft. in depth has exposed a massive pegmatite intrusion which strikes at a bearing of 150°, (see plan enclosure). There are several shallow prospect pits around the margins of the main workings.

General Geology

The country rocks which surround the Nyabushenyi pegmatite are schists and phyllites of the Lower Division of the K-A system, which lie a few hundred yards to the north of altered and permeated granitic rocks containing patchy development of post-tectonic pegmatitic granite. The schistosity of the country rocks adjacent to the pegmatite strikes at a bearing of 145° and dips steeply to the S.W. Numerous masses of coarse quartz-mica-kaolin pegmatite occur in the K-A phyllites in the vicinity of the mine and some of these are beryl-bearing.

Geology of the Pegmatite

The Nyabushenyi Pegmatite is a large cross cutting assymetric "mushroom-shaped" body which has been intruded into rocks of the K-A system. The exact dimensions are not known as mining operations have only exposed a portion of the intrusion.

The north eastern limit of the pegmatite is marked by a near vertical footwall contact with K-A phyllites (see plan enclosure), but the western limit is unknown as the pegmatite and quartz core turn over to form a flat lying sheet which dips gently to the west. The strike of the long axis of the pegmatite is 150° and at its south-eastern end the pegmatite disappears into the hillside and is capped by a thick roof of K-A sediments, (see section enclosure and plate). The north western limit to the pegmatite is not known, but the quartz core tapers rapidly at the N.W. end of the mine workings which suggests that the pegmatite does not continue much further. Massive loose boulders of core quartz occur downhill to the N.W. of the mine workings but have been transported as a result of erosion of the surface outcrop of the pegmatite.

Zones

The zonal structure of the Nyabushenyi pegmatite is complex and late

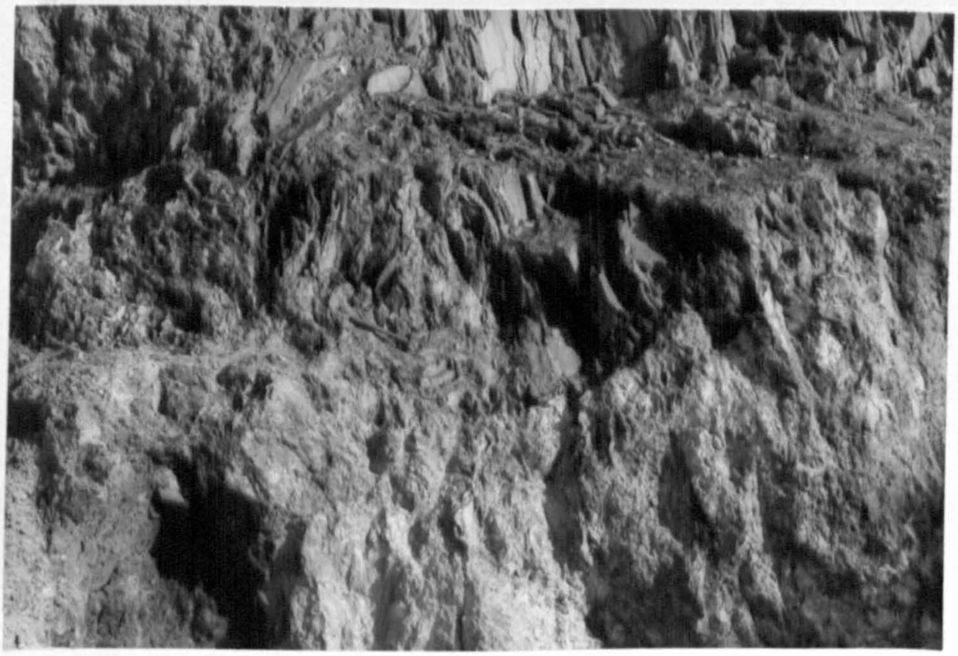


PLATE 50.

Roof contact of the Nyabushenyi pegmatite with K-A schist country rock.

stage hydrothermal alteration has so extensively kaolinised the feldspars that it is often impossible to determine the original nature of the pegmatite matrix. The following zones are however represented in the pegmatite, (see enclosures 14+15).

a.	Altered zone of medium to coarse grained pegmatite	Wall Zone
b.	Remnants of zone of massive microcline	Intermediate Zone
c.	Zone of block quartz	Quartz Core
d.	Extensive muscovite replacement complex consisting of: Quartz muscovite replacement zones, and Albite muscovite replacement zones	Replacement Zones
e.	"Greisen" replacement complex	Mica rock units

a. Altered zone of medium to coarse grained pegmatite

The only occurrence of the original wall zone in the Nyabushenyi pegmatite is in the eastern quarry, where a zone of medium to coarse grained pegmatite which varies from 5 to over 20 ft. in width, forms the N.E. footwall margin of the pegmatite. The zone has been hydrothermally altered and partially replaced and consists of brown, ironstained, porous, altered microcline in a matrix of broken quartz and muscovite. At the S.E. end of the quarry the zone becomes progressively altered and replaced to produce quartz-muscovite-kaolin pegmatite, in which no trace of microcline feldspar can be found. The quartz mica-kaolin pegmatite contains a large xenolith of altered, K-A schist.

b. Remnants of zone of massive microcline

One large remnant of an originally extensive zone of microcline is present on the footwall side of the pegmatite in the eastern quarry, and consists of massive soft altered microcline feldspar and wedges of broken quartz. The remnant which has been hydrothermally altered and partially replaced passes gradationally into medium to coarse grained pegmatite on its outer side, and is flanked on its inner side by late replacement zones.

c. Zone of Block Quartz - The quartz core

A massive quartz core has developed which takes the form of a near vertical elongate plug of quartz which turns over near the crest of the pegmatite to form a flat lying sheet which strikes at a bearing of 150° and dips gently to the west.

The quartz is massive to granular in texture, grey to white in colour, and contains numerous joint and fracture planes. The eastern footwall margin contains kaolinised spodumene laths up to 2 ft. in length. The upper margin of the core contains pockets of pure cream coloured broken beryl.

Mineralisation associated with late stage replacement has resulted in the formation of abundant beryl, columbite-tantalite and amblygonite in the footwall and underside margins of the core (see plan and sections of the pegmatite). A few large blocks of microcline feldspar have been preserved in the core at the S.E. end of the western opencast and indicate the original widespread occurrence of massive microcline.

d. The Muscovite replacement complex

The wall and intermediate zones of the Nyabushenyi pegmatite have almost entirely been affected by quartz-muscovite or albite-muscovite replacement followed by intense hydrothermal alteration.

There is no sharp division between the quartz-muscovite and albite-muscovite replacement zones which overlap or merge gradationally. The texture of the replacement zones is variable. In the central portions of the pegmatite, kaolinised spodumene laths up to 2 ft. in length and large irregular wedges and masses of quartz, occur adjacent to pockets of kaolin which contain stringers and aggregates of coarse pale yellowish - green muscovite. Muscovite-albite replacement appears to have concentrated close to the quartz core margins and in the adjacent pegmatite. The kaolin close to the quartz core is soft, white and unctuous and is of a type that is typically formed as a result of hydrothermal alteration of albite feldspar.

The outer portions of the replacement zones are similar in appearance to the inner ones but contain no spodumene laths. The kaolin in the outer portions has a gritty texture which is characteristic of kaolin that has formed from microcline feldspar rather than albite. The outer replacement zones are believed to have formed by quartz-muscovite replacement as there is no evidence for the formation of albite before kaolinisation took place.

The quartz-muscovite replacement zone frequently reaches the margins of the pegmatite and has formed selvages of coarse muscovite up to 2 ft. in thickness along the pegmatite contacts. The selvages are particularly well developed along the roof contact of the pegmatite at the S.E. end of the opencast workings, (see plan and section enclosures 14+15).

Economic Minerals

The pegmatite was very strongly mineralised during late stages of crystallisation and the following minerals were deposited.

Beryl

Beryl occurs in large amounts throughout the replacement zones in irregular pockets up to several feet in diameter, and increases in abundance as the core of the pegmatite is approached. The beryl usually forms anhedral broken crystals adjacent to massive quartz or occurs as coarse intergrowths with broken quartz and books of pale-green muscovite. The colour varies from yellow brown to pure white and large pockets of almost pure, pale-cream, coloured beryl have been found in the upper margin of the quartz core. Small hexagonal-prismatic, or truncated-pyramidal beryl crystals occasionally occur in the replacement zones. The hexagonal prismatic crystals have rough outer margins and contain numerous small inclusions of muscovite. The truncated pyramidal crystals are of a form typical for alkali-beryl and contain quartz and marginal inclusions of coarse muscovite. Adjacent to the pegmatite quartz core, beryl is often found partially enclosing bladed crystals of columbite, and is later in formation.

Columbite

Columbite is of widespread occurrence and has concentrated particularly along the quartz core margins and adjacent to quartz masses in the inner replacement zones. In the quartz core margin the columbite forms bladed aggregates up to several inches in length which often contain veinlets of quartz and stringers of muscovite. The core margin columbite crystallised before final consolidation of the quartz core, and is frequently found adjacent to kaolinised spodumene laths or partially enclosed by later formed beryl, (Plate 51).

Aggregates of massive, bladed columbite have also been found in quartz muscovite and kaolin replacement pegmatite a short distance from the core margin.

Amblygonite

Giant rounded boulders of massive amblygonite averaging 3 ft. in diameter occur along the footwall and lower quartz-core margins. The amblygonite boulders are usually surrounded by brown stained crusts of a white chalky alteration product which has been identified by O. von Knorring (1962)

PLATE 51.

Columbite in beryl in quartz core footwall margin, Nyabushenyi.

as hydrated aluminium phosphate isostructural with the plumbogummite series. When freshly broken the amblygonite is subtranslucent, pale grey to white in colour, and has a greasy to sub-vitreous lustre. Small hexagonal prismatic crystals of pale blue-green apatite and bladed crystals of columbite have been found as inclusions in amblygonite. Fresh massive amblygonite has also been found to partially enclose fractured granular core quartz and the presence of inclusions of core quartz, columbite and apatite in the amblygonite indicates that it is late in formation and probably formed towards the end of replacement at the core margin. Hydrothermal alteration and weathering are responsible for the porous earthy crust which surrounds most of the amblygonite boulders and the crusts have been found to contain cavities with skeletal frameworks of alteration products inside.

Albite amblygonite rock

Occasional large boulders similar in external appearance to amblygonite have been found which consist of an intimate mixture of very fine grained albite and amblygonite, (O. von Knorring - personal communication). The boulders when freshly broken are pale grey to buff in colour and are frequently also stained green along internal fractures by very fine grained secondary phosphate minerals. One or two boulders have been found in which pure massive amblygonite passes gradationally into a marginal selvage of albite amblygonite rock.

Accessory Minerals

Altered Iron/Manganese Phosphates

Dark green cryptocrystalline Fe/Mn phosphates occur as thin films along fracture planes in amblygonite or amblygonite-albite rock and an altered fibrous brown phosphate has been found coating altered amblygonite.

Manganese oxides

Thin black films of maganese oxide have been found staining amblygonite and have been derived by alteration of Mn bearing phosphates.

Crystal quartz

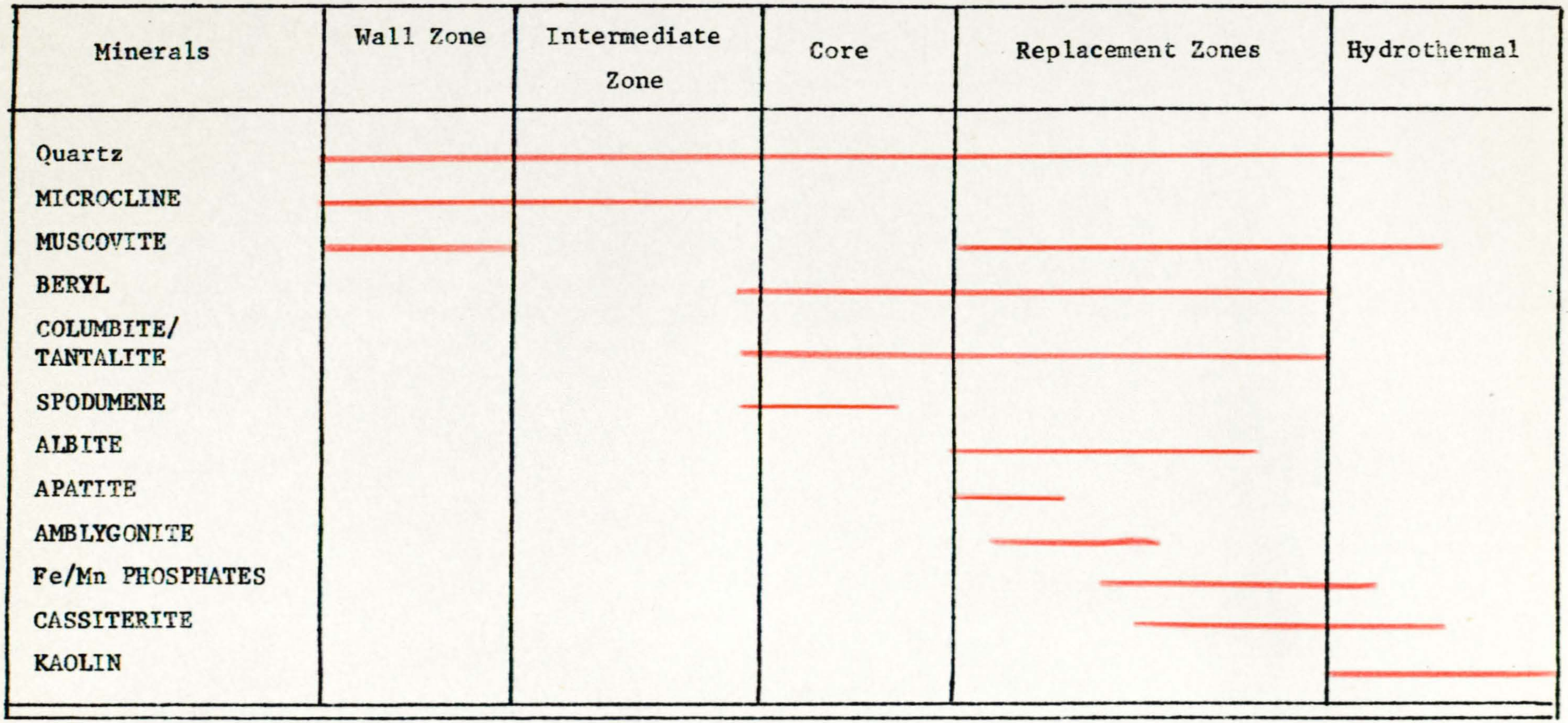
Occasional multiple twinned crystals of pale smoky quartz which have corroded and etched faces have been found in the replacement zones. Some of the crystals also show internal growth rims.

e. The'Greisen' replacement complex

Several narrow elongate "greisen" replacement zones (i.e. mica rock

Table 39

Composite Paragenetic Sequence for the Nyabushenyi Pegmatite



units) occur on the eastern footwall side of the pegmatite. They consist of dyke like masses of medium grained greenish-yellow mica replacement rock, from a few inches to over 4 ft. in thickness, which strike parallel to the long axis and core of the pegmatite.

The innermost mica rock unit which lies adjacent to the quartz core footwall, is strongly mineralised and contains aggregates of columbite up to 3 inches in length. Small crystals of black cassiterite and tiny fragments of columbite have been found in some of the mica rock units which lie further from the quartz core.

Paragenesis of the Nyabushenyi Pegmatite. (Table 39)

The Nyabushenyi pegmatite formed by crystallisation of residual granitic magma which was intruded into Karagwe Ankolean country rocks.

Primary crystallisation took place in a relatively closed system to form a wall zone and an intermediate zone, and silica and volatiles accumulated in the central part of the pegmatite. After crystallisation of the intermediate zone beryl, columbite and spodumene laths crystallised in the core margin, and extensive replacement affected the bulk of the pegmatite to form albite-muscovite and quartz-muscovite replacement zones. Concentration of rare elements and volatiles during replacement resulted in the formation of abundant beryl throughout the replacement zones and amblygonite was deposited adjacent to the quartz core.

Mica rock replacement zones containing columbite and traces of cassiterite were formed during the final stages of replacement and the pegmatite was then subjected to intense alteration which altered nearly all the feldspars to kaolin. The hydrothermal alteration is believed to have taken place as a result of accumulation of hydrothermal fluids in the pegmatite during late-stage replacement, but it is also possible that hydrothermal fluids were introduced from outside.

Group 4. The Rwemeriro lithian* muscovite - albite replaced pegmatite

The Rwemeriro pegmatite has been exposed at Rwemeriro Mine which is situated 1 mile to the west of the junction between the Ntungamo/Rwentobo

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* (Lithian = lithium bearing - see p. 48)

and Kafunzo/Rwentobo roads in Kajara County, Ankole, (Map ref. sheet 85/III 874910).

Rwemeriro Mine consists of a series of large opencast quarries with underground stopes at depth, which have served to expose the footwall side of a large elongate pegmatite body. The main workings extend for over 1,000 ft. strike length, exceed 100 ft. in maximum width and are reported to have followed the pegmatite for over 150 ft. in depth in the underground stopes.

The two most important opencasts have been mapped in detail and these appear on enclosure 16 . They cover the western and best exposed portion of the pegmatite and have been called the Central and Western opencasts respectively. The eastern end of the pegmatite vein has been less well exposed by smaller workings which include the eastern opencast, and a cross cutting prospecting trench at the eastern end of the pegmatite which failed to intersect pegmatite, marks the eastern limit to the vein. The western limit of the vein has not been determined as the pegmatite plunges gently down and disappears underground at its western end. A series of deep parallel cuttings approach the main portion of the pegmatite from the north and have exposed country rocks situated to the north of the pegmatite intrusion.

General Geology

The country rocks in the area to the north of the mine consist predominantly of an east-west striking succession of quartzites, schists and phyllites of the K-A System which have been permeated, partially granitised and then injected by post-tectonic pegmatitic granite. In the drives to the north of the mine (see sections I - V , enclosures 17-21),quartz-microcline-muscovite pegmatitic granite has invaded and intruded permeated schists a short distance from the main pegmatite body. The pegmatitic granite crops out at intervals in the approach cuttings where it occurs in the form of veins and masses which vary in shape and size from stringers a few inches in width to irregular bosses and stock-like masses over 30 ft. in diameter. All exposures consist of quartz, microcline feldspar with tourmaline and muscovite in varying proportions. The microcline forms pegmatitic intergrowths with quartz and sometimes mica, and occasionally becomes blocky in texture. The tourmaline occurs sporadically and tends to concentrate at the margins of the veins and masses.

The country rock consists of muscovite, or biotite schists which have been permeated to varying degrees by quartzo-feldspathic material to produce gneisses and granitic rocks. As the main vein is approached the permeation becomes more intense and portions of the country rock appear to have achieved quartzo-feldspathic (granitic) composition before intrusion of the main pegmatite and associated masses of pegmatitic granite. Some small masses of strongly foliated amphibolite occur adjacent to a part of the northern margin of the main pegmatite vein in the Central Opencast.

To the south of the pegmatite vein the country rock is altered quartz-oligoclase-muscovite-biotite-microcline 'granite' of a type commonly found in the Rufuha Arena and the pegmatite appears to have been intruded along a fissure in the contact zone between the northern margin of the Rufuha Arena granite and the mantling sediments (see geological enclosure 1).

Intrusion of the pegmatite was associated with the emplacement of the Rwabaramira post-tectonic pegmatitic granite intrusion which cross cuts K-A country rocks to the north and older 'granite' to the E. and S.E. of Rwemeriro Mine. The Rwemeriro pegmatite passes gradationally into quartz-microcline-muscovite pegmatitic granite at its eastern end and is a differentiate of this granite. Pegmatitic granite probably also underlies the pegmatite at Rwemeriro Mine and it is believed that the pegmatite vein passes gradationally into pegmatitic granite at depth.

Geology of the Pegmatite

The Rwemeriro pegmatite is an elongate intrusion approximately 1000 ft. in length and 100 ft. in width which strikes at a bearing of 280° and dips steeply to the south. The pegmatite lies in sharp contact with granitic rocks to the south and permeated and granitised schists to the north. The northern or footwall contact of the pegmatite is well exposed and can be followed on the plan (see enclosure 16) and in Sections I to V (which are visible in the approach cuttings to the pegmatite). The footwall country rocks include permeated schists (section II), amphibolite (section V), sheared and foliated 'granite' (section III) and co-magmatic intrusive pegmatitic granite (section IV).

The southern or hanging wall contact of the pegmatite is poorly exposed but at one point along the S. margin of the western opencast (section III), a sharp contact between the pegmatite and altered granite can be observed.

The contacts are generally sharp and sinuous, and in places are sheared and show signs of movement, (see section III). In section II minor faulting and displacement of early pegmatitic granite veins can be seen in the country rocks adjacent to the pegmatite footwall.

Zones

The following zones have been recognised in the Rwemeriro Pegmatite.

a.	Contact Zone	(outer wall zone)
b.	Zone of graphic pegmatite	Wall Zones
c.	Zone of medium to coarse grained pegmatite	
d.	Zone of massive microcline	Intermediate Zone
e.	Zone of block quartz	Quartz Core
f.	Muscovite replacement complex	Replacement Zones
g.	Albite replacement complex	
h.	Lithian (Li bearing) muscovite replacement complex	

a. The contact zone

The outermost or contact zone of the Rwemeriro pegmatite consists of quartz, microcline feldspar and muscovite, and is best exposed along portions of the footwall margin of the intrusion, (Sections II, III and IV). Here the contact zone contains abundant prismatic crystals of black tourmaline up to 9" in length set in a medium grained pegmatitic matrix of milky quartz, pale cream microcline feldspar and numerous books of muscovite. Muscovite has concentrated in aggregates along portions of the contact zone and garnet can be found occasionally as small pink anhedral crystals. The contact zone is usually narrow and rarely exceeds 2 ft. in width.

In Section IV the contact zone is indistinct and the pegmatite appears to pass gradationally into pegmatitic granite. Although no sharp change in the texture of the rock matrix occurs, the boundary of the pegmatite is here marked by a line of black tourmaline crystals.

b. The graphic pegmatite zone

This zone occurs along portions of the footwall side of the pegmatite (see sections III and IV) where it either lies adjacent to the contact zone or occurs partially surrounded by medium or coarse grained pegmatite. The graphic pegmatite zone is discontinuous and patchy, varies from one or two feet to 15 feet in maximum thickness, and passes gradationally into the surrounding zones. The graphic pegmatite consists of graphic intergrowths of quartz and pale-cream microcline feldspar, in which the quartz forms angular wedges a few centimetres in length. Muscovite is only present in small amounts in this zone. Portions of the graphic pegmatite zone have been affected by late-stage replacement and have been albitised.

One specimen showing graphic intergrowth between quartz and tourmaline has been obtained in which black tourmaline occurs as prismatic crystals and small graphic fragments, in a matrix of quartz and microcline feldspar.

c. Zone of medium grained and coarse grained pegmatite

This zone forms the bulk of the pegmatite which has escaped late stage replacement and consists of coarse white microcline, milky quartz and silver-grey books of muscovite. The minerals which vary in size and may exceed 10 cms. in diameter show apographic and pegmatoid texture. The zone of medium or coarse grained pegmatite has developed mainly on the footwall side of the pegmatite. Some portions have been replaced by albite when relict pegmatoid textures preserved in albite can occasionally be observed. On the hanging wall side of the pegmatite only small portions of a thin selvage of coarse grained pegmatite occur as most of the original rocks have suffered complete replacement by late muscovite or albite.

d. Zone of massive microcline

An intermediate zone of small block pegmatite and massive microcline has been preserved in portions of the Rwemeriro pegmatite and may best be seen at the western end of the western opencast, (Section I). Here massive, pink and red-stained microcline containing occasional wedges of quartz may be seen to flank the western end of the quartz core which plunges beneath the feldspar. The microcline (which here constitutes the bulk of the pegmatite) has been preserved almost intact and only partial replacement by albite has occurred on the footwall side of the zone. Fresh white microcline has been found flanking the quartz core in other exposures of the pegmatite (see sections III and IV), and occurs as large crystals up to several feet in diameter in the core quartz. An analysis of the fresh microcline is presented in table 42f. p.176 . Although major development of microcline is now restricted to the western end of the Rwemeriro pegmatite its original distribution is believed to have been much more widespread. Late stage albitisation of the pegmatite to form a cleavelandite replacement "complex" has obliterated most of the original microcline zone.

e. The quartz core

Three separate masses of quartz have been recognised in the Rwemeriro pegmatite, and occur in the Western, Central and Eastern opencasts respectively. They are all massive elongate bodies of quartz, which are situated on the hanging wall side of the pegmatite and dip steeply to the south. The cores all consist of milky white to pale brown (ironstained), vitreous to granular quartz which is well jointed and has been shattered by earth movements.

The western core is an elongate tapered body of quartz over 300 ft. in exposed length and 30 ft. in maximum width which plunges gently to the west. It is widest at its western end and tapers towards the east to form a long dyke of jointed quartz from 2 to 4 ft. in thickness which runs for over 100 ft. close to the hanging wall contact of the pegmatite (see map). At its widest point the core contains giant radiating laths of fine grained, white, clay-like material. These laths often exceed 10 ft. in length and 2 ft. in width and occur as stellate groups growing into and along the margins of the core from loci situated at intervals along the core margin. The laths which sometimes contain cores of pink montmorillonite may originally have been composed of spodumene (O. von Knorring - personal communication). Their formation is believed to have accompanied crystallisation of the quartz core and preceded the main phase of albite-cleavelandite replacement.

The Central Core of the pegmatite is a large "boat-shaped" mass of quartz over 200 ft. in length and 50 ft. in maximum width, which tapers at depth (see section III), and has formed at a higher level in the pegmatite than the other cores. It has an irregular undulating surface and contains blocks of white microcline feldspar. Occasional groups of large kaolinised spodumene laths occur along the footwall margin and at the eastern end of the core. The central core was the only mass of quartz to crop out at the surface before mining of the Rwemeriro pegmatite started and erosion has removed the pegmatite that lay on top of it. Occasional crystals of columbite have been found in the foot wall margin of the core and several tons of detrital columbite have been recovered from overburden on the downhill side of the core outcrop, indicating that the core may originally have been capped by a substantial accumulation of columbite.

The Eastern Quartz Core

This has similar features to the other cores but has only been poorly exposed in a large pit and a small opencast quarry near the eastern end of the pegmatite intrusion. The'core' is irregular in outline and its true extent has not been determined. It is believed to consist of a number of separate stringers and masses of quartz surrounded by partially albitised coarse - grained pegmatite.

f. Muscovite replacement complex

Muscovite replacement has occurred throughout the Rwemeriro pegmatite in association with formation of the cleavelandite replacement complex. Muscovite replacement selvages are found along the margins of the quartz core and along the margins of the cleavelandite replacement zones, (sections I, IV and V). The most important muscovite replacement zone occurs along the entire hanging wall contact of the pegmatite where coarse grained monocline pegmatite containing large prismatic tourmaline crystals has been almost entirely replaced by large books of "ruby" muscovite up to 18" in diameter.

The muscovite books form a continuous selvage up to two feet in thickness which lies a short distance in from the hanging wall contact of the pegmatite. The muscovite has been introduced together with cleavelandite which forms a matrix. Particularly large books of "ruby" muscovite over 2 feet in diameter have formed where the muscovite replacement zone flanks the massive microcline zone at the western end of the pegmatite and a chemical analysis is presented in table 42 .

Concentration of volatiles under the hanging wall contact of the pegmatite during replacement is thought to have been responsible for the formation of the "ruby" muscovite.

g. The Albite Replacement Complex

The albite replacement complex contains a number of replacement zones, G1 - G4 showing different textures.

G1. Albitised medium and coarse grained pegmatite

Along portions of the footwall side of the pegmatite coarse quartz microcline muscovite pegmatite partially replaced by albite or cleavelandite feldspar occurs, (see section V). The degree of replacement varies from

Table 40. To show difference in chemical composition between pure albite and the cleavelandite - "oncosine" replacement rock from Rwemeriro

SiO_2	68.17	65.08
TiO_2	-	n.d.
Al_2O_3	19.71	21.07
Fe_2O_3	0.05	0.13
FeO		-
MnO	tr.	0.02
MgO	n.d.	n.d.
CaO	0.36	0.18
Na_2O	11.22	7.39
K_2O	0.11	5.86
Li_2O	-	0.14
H_2O^+	0.16	0.45
H_2O^-	0.12	0.05
P_2O_5	tr.	tr.
Total:	99.90	100.37

Analyst: J. R. Baldwin

n.d. = not detected

partial permeation where most of the original pegmatoid textures are still preserved - to almost complete replacement by albite or cleavelandite. The margins of the replacement zone are gradational and the zone passes into pure cleavelandite feldspar towards the quartz cores of the pegmatite.

G2. Albitised graphic pegmatite

In many parts of the pegmatite the inner portions of the normal footwall graphic pegmatite zone have suffered albitisation and partial replacement by cleavelandite and in places the original graphic texture can be seen preserved in albite feldspar.

In the Rwemeriro pegmatite the limit of replacement of the graphic, medium, and coarse grained pegmatite zones by albite or cleavelandite, is frequently marked by the occurrence of a line of large black prismatic tourmaline crystals.

G3. Cleavelandite - "oncosine" replacement rock

In the western opencast there is an extensive development of massive replacement rock which consists of medium grained platy white albite which is intimately intergrown with pale green cryptocrystalline oncosine mica. The rock contains a sporadic distribution of small irregular pieces of quartz, and forms a mass over 240 ft. in length and 40 ft. in width. The cleavelandite "oncosine" mass appears to occur instead of a massive quartz core in the eastern portion of the western opencast and has gradational contacts with the adjacent pegmatite zones. No mineralisation (beryl) has been found within the rock mass, but late cleavelandite-lithian muscovite replacement zones containing abundant pink beryl have formed adjacent to the footwall margin of the rock mass which acted as a barrier against which volatiles could concentrate.

Chemical analyses of the cleavelandite 'oncosine' replacement rock and pure cleavelandite albite are presented ~~opposite~~ (table 40) for comparison and show that the replacement rock contains considerably more K_2O (5.86%) than the pure albite (0.11%). The K_2O is probably contributed by the 'oncosine' mica present in the replacement rock.

G4. Cleavelandite replacement zones

Massive cleavelandite replacement zones have formed adjacent to most of the quartz cores in the Rwemeriro pegmatite and are particularly well developed along their footwall margins. The cleavelandite zones consist of massive aggregates and radiating clusters of pure platy white cleavelandite feldspar which contain irregular wedges and stringers of quartz. In the eastern opencast the cleavelandite replacement zone has developed along the footwall margin of the quartz core as an irregular zone from 2 to 12 ft. in thickness. On the hanging wall side of the quartz core only local development of a cleavelandite zone has occurred owing to the presence of extensive muscovite replacement.

In the western opencast a cleavelandite replacement zone has developed along the footwall margin of the cleavelandite-oncosine rock mass but a major development of cleavelandite up to 20 ft. in maximum thickness occurs adjacent to the quartz core footwall in the western part of the quarry. Sporadic distribution of cleavelandite may also be found on the hanging-wall side of the quartz core together with the muscovite replacement zone.

At the eastern end of the pegmatite, formation of the cleavelandite replacement zone has been patchy and very irregular and has resulted from albitisation of coarse grained pegmatite adjacent to masses of core quartz. A chemical analysis of pure cleavelandite from one of the replacement zones is presented in table 42.fp 176.

The cleavelandite zones in the Rwemeriro pegmatite have often formed at the expense of earlier minerals and the original textures have been obliterated.

Mineralogy of the Cleavelandite Replacement Zones

Muscovite

Muscovite occurs as coarse aggregates and stringers throughout the cleavelandite replacement zones, and the margins of the replacement zones are frequently marked by a concentration of muscovite forming books up to 10 inches in diameter.

At the eastern end of the central opencast (section V) muscovite has concentrated along the hanging wall contact between the cleavelandite replacement zone and the quartz core. In the western opencast there has been extensive concentration of muscovite along the margins of a tongue-like mass of cleavelandite that has formed by replacement of the footwall part of the massive microcline zone.

Several varieties of muscovite have formed in association with the cleavelandite replacement zones and include "ruby" mica and a number of pale grey to lilac micas that have been found to be lithium bearing, (see table 44 for chemical analyses). Concentration of alkalis and volatiles occurred throughout the formation of the cleavelandite replacement zones and culminated in the formation of lithian muscovite during the final phases of replacement in the pegmatite (see p.172).

Beryl

Beryl has formed abundantly throughout the albite replacement complex and has concentrated particularly along the quartz core and outer margins of the cleavelandite replacement zones. The beryl found at the outer margins of the main replacement zones is usually pale blue in colour and forms groups of subhedral prismatic crystals from ½ an inch to a few inches in diameter which often occur together with muscovite. In places substantial concentrations of beryl have been found where pure cleavelandite feldspar passes gradationally into albitised coarse grained pegmatite.

Larger anhedral crystals of coloured beryl which may exceed 1 ft. in diameter are found within the cleavelandite zones and are concentrated particularly adjacent to the quartz core footwalls. The beryl is coarsely crystalline, glassy and often transparent, but most of the crystals have been shattered by movement. The colour of the beryl which is commonly pale-blue is however variable and green, white, pink and even orange varieties have been found.

At the western end of the western opencast the beryl is green and a substantial concentration of anhedral crystals have been found associated with muscovite at the margin of the cleavelandite replacement zone. In the eastern opencast large crystals of green beryl with bluish margins have been found associated with cleavelandite in albitised coarse grained pegmatite (see plate 52). These crystals contain marginal inclusions of garnet, apatite, columbite and cleavelandite and were later in formation than these minerals.

In the central opencast a zoned, multicoloured, beryl crystal over 2 ft. in length was found which was pale blue at the base, white in its central portion and pale to strong pink in its upper portion. The colours merged gradationally and the pink zone, which partially enclosed the blue and white zones, was the last zone to form.

From observations on the colours of beryl throughout the cleavelandite

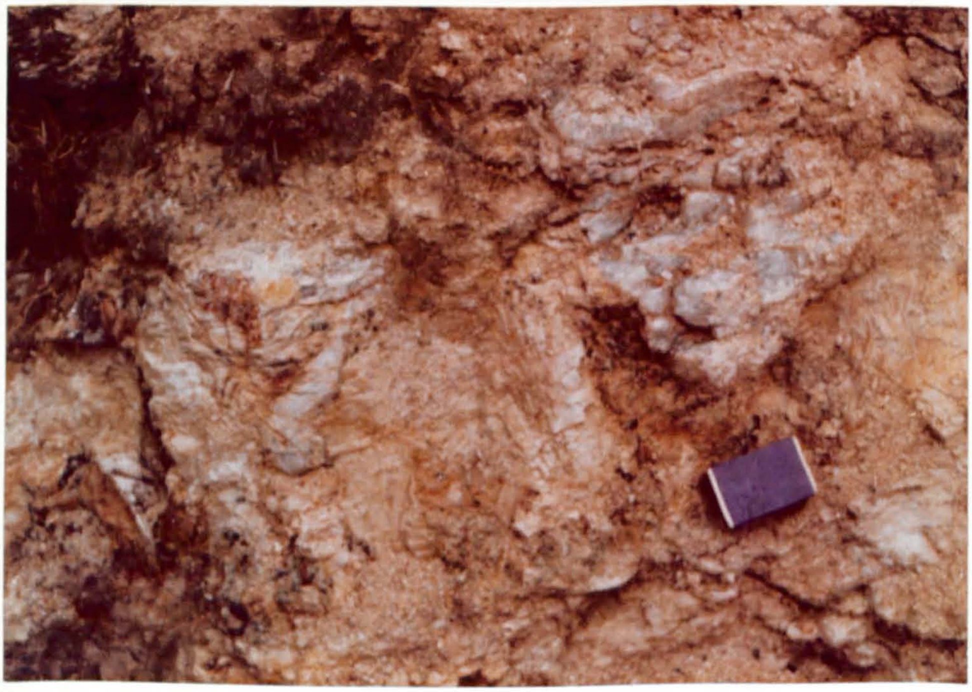

PLATE 52.

Tapered anhedral crystals of pale blue alkali beryl in cleavelandite feldspar, Rwemeriro.

replacement zones the series: Green - greenish blue - blue - pale blue - white - pale pink - pink - orange beryl can be recognised where the green beryl was early in formation and the orange beryl was the latest to form.

The orange beryl is usually confined to portions of the replacement zones that have suffered a final phase of lithian muscovite replacement (see p. 174).

Columbite

Columbite has crystallised in small amounts at various stages in the formation on the cleavelandite replacement zones. Some small black prismatic 'skeletal' crystals of columbite up to 1" in length have been found within the cleavelandite replacement zone in the eastern opencast and contain cores of granular albite.

In the central opencast a few pounds of crystalline columbite are reported to have been obtained from between the core margin and the cleavelandite replacement zone.

Columbite has also been found in those parts of the cleavelandite zones that have suffered late stage lithian muscovite replacement, and occurs as small prismatic crystals together with laths of greenish blue apatite and radiating aggregates of lilac-grey lithian muscovite.

Garnet

Garnet is common in portions of the cleavelandite replacement zones and in the eastern opencast can be found as anhedral straight fractured crystals adjacent to core-quartz. The garnet is dark red in colour, vitreous, and contains occasional inclusions of columbite.

In the western opencast garnet has also been found along the footwall margin of the quartz core and at the western margin of the cleavelandite-oncosine replacement mass. Here the garnet is an anhedral pale peach coloured variety and occurs as irregular masses up to 2" in diameter, together with cleavelandite small enhedral crystals of orthoclase feldspar, and manganese oxides. Small amounts of peach coloured garnet have also been found associated with lithian muscovite. Where late stage replacement has occurred, chemical analyses show that this is a Mn rich (37.07% MnO) spessartine variety (see table 42,fp.176).

Apatite

Apatite is frequently found in the cleavelandite zones and several types have been recognised.

Dark blue manganoan apatite

Large broken crystals of deep blue mangan-apatite up to 6" in length have been found adjacent to the central quartz core and the cleavelandite oncosine replacement zone at the eastern end of the western opencast. The crystals are very fractured and veined with cleavelandite and occur in a matrix of quartz, cleavelandite "oncosine" rock and partly replaced white microcline.

Blue-green apatite

Small groups of blue-green apatite laths have been found in portions of the cleavelandite zones which have suffered late stage albite replacement. The apatite laths which average 3" in length and $\frac{1}{2}$" in thickness contain small inclusions of columbite and occur intergrown with cleavelandite, green tourmaline and radiating globular aggregates of pale lilac-grey lithian muscovite.

Pale green apatite

Granular aggregates of pale green and yellow green (strongly fluorescent) apatite one or two inches in diameter have been found in a matrix of granular quartz and cleavelandite feldspar in an adit at the eastern end of the western opencast, (Section III). A few highly shattered platy crystals of pale green apatite which contain small granular inclusions of peach coloured garnet have also been found.

The apatites have kindly been analysed by M.H. Kerr and J.R. Baldwin to see whether there is any relationship between the intensity of colouration and the manganese content (see table 42,(p.176). It was expected that the dark blue apatite (ARL1) would contain the highest concentration of manganese but the results show that it does in fact contain the least manganese (2.36% MnO). The blue-green apatite (ARL2) has been found to contain the most manganese (5.94% MnO) and the lightest coloured apatite (ARL4) which was expected to contain the least manganese contains more (3.89% MnO) than the darkest one (2.36% MnO).

Tourmaline. (Schorlite)

Black tourmaline is a common accessory mineral in the cleavelandite replacement zones and forms prismatic crystals up to several inches in diameter and length. Fringes of black tourmaline crystals are often found along the footwall margins of the replacement zones (see sections III, IV, V) and appear to mark the limits of successive 'waves' of replacement in the cleavelandite replacement "complex". Large subhedral broken crystals of black tourmaline containing thin stringers of muscovite and infilled fractures are also common at the margins of the replacement zones along the hanging wall contact of the pegmatite.

Green Tourmaline. (Verdelite)

Small quantities of olive green, vitreous, tourmaline occur in portions of the cleavelandite zones in association with lilac grey lithian muscovite and other late replacement minerals. The tourmaline either forms small broken striated prismatic crystals or occurs as overgrowths on earlier black tourmaline. One good specimen in which green tourmaline partially surrounds black tourmaline as a massive crystalline selvage up to 1 inch in thickness, was found among spoil taken from the western opencast. The green tourmaline is in turn overgrown by radiating globose aggregates of pale lilac grey lithian muscovite (approximately 1" in radius) which partly replace or form intergrowths with the tourmaline, (see photo. pl 36).

Chemical analyses of schorlite and verdelite appear in table 42 and show that the schorlite from Rwemeriro is iron rich (11.02% 'total iron' Fe_2O_3) and contains unusually high magnesium (4.3% MgO), and the verdelite is rich in manganese (1.66% MnO) and contains relatively high lithium (1.25% Li_2O) and fluorine (1.46% F).

h. The Lithian muscovite replacement complex

Late stage albite - lithian muscovite replacement has occurred in many parts of the cleavelandite complex in the Rwemeriro pegmatite. The replacement resulted in the introduction of additional cleavelandite, recrystallisation of early cleavelandite, and the formation of lithium bearing micas. A final phase of economic mineralisation accompanied the late stage replacement and involved the formation of abundant orange-coloured beryl and small quantities of cassiterite.

Minerals of the lithian muscovite replacement complex

Lithian muscovites

a) Coarse aggregates

On the hanging wall side of the pegmatite lithian muscovites occur on the footwall side of the muscovite replacement zone, in the form of globose aggregates with radiating internal structure which fringe large books of earlier formed "ruby" muscovite. On the footwall side of the pegmatite sporadic development of radiating clusters of "lithian" muscovite occur around small crystals of columbite, apatite, garnet and tourmaline and form 'nodules' in the cleavelandite feldspar. Many of the clusters of "lithian" muscovite appear to have formed around nucleation centres and grown towards replacing cleavelandite feldspar. Sometimes small clusters of mica have acted as growth centres for much larger radiating aggregates. The aggregates vary in size and shape from small pear-shaped bodies to large irregular globose aggregates with radiating internal structure and a mammillated form. The colour of the "lithian" muscovite aggregates is very variable. Some of the aggregates are silver-grey with a brown or ruby red tint whereas others are silver grey with a pale lilac pinkish hue.

b) <u>"Lithian"- muscovite rock</u>

"Lithian" muscovite rock consisting of compact medium to fine grained lithium bearing mica occurs in the form of elongate replacement bodies along portions of the footwall cleavelandite zone at the western end of the pegmatite. Large masses of deep lilac to purple coloured lithian muscovite rock have been found in the Western opencast. The "lithian" muscovite masses are usually monomineralic but sometimes contain inclusions of bladed white cleavelandite feldspar particularly at their margins. The texture of the rock is usually medium grained with flakes of "lithian" muscovite averaging $\frac{1}{8}$" in diameter, but fine grained cryptocrystalline masses of "lithian" muscovite (in which individual flakes are too small to distinguish without a hand lens) have also been found. The lithian muscovites from Rwemeriro are very similar in appearnce to true lepidolites, but chemical analyses (see tables 42 , 44), and X-ray powder diffraction data (p. 48) show that they are 3T, trigonal, lithium bearing muscovites.

In this thesis the term lithian muscovite has been employed to describe these muscovites (see p. 48), and is used in a chemical sense as a name for any polymorph of muscovite containing $>$ 0.5% Li_2O.

The Rwemeriro lithian muscovites are interesting in that they contain unusually high concentrations of fluorine (up to 5% F in MO_{R3}) and 'manganese' (1.7% MnO in MO_{R3}). The manganese is believed to be responsible for theirsilver-grey to lilac and mauve colour.

Orange Beryl

Orange beryl has been concentrated along portions of the quartz core footwall margins where late stage albite - lithian muscovite replacement has occurred. The main occurrences (still in situ) in the Rwemeriro pegmatite are situated at the western end of the keel of the central quartz core in the western opencast and along the footwall margin of the core quartz exposed in the eastern opencast.

The orange beryl which is an alkali ~~rich~~ variety of beryl is deep pink to orange in colour and forms tabular crystals from 1" to 2" in thickness and up to 6" in length. The crystals are frequently found adjacent to kaolinised spodumene laths in the core margin and occur in a matrix of quartz and cleavelandite feldspar. Many of the crystals are partially transparent and have a beautiful colour, but intense shattering has rendered them useless as gem-cutting material.

Cassiterite

Minor amounts of cassiterite have crystallised together with late stage cleavelandite and "lithian" muscovite at the eastern end of the pegmatite vein. A few pounds of cassiterite have been recovered from a mineralised 'pocket' in cleavelandite close to the footwall of the quartz core in the eastern opencast. The cassiterite forms subhedral to anhedral crystals up to 4" in diameter which replace, and are intergrown with, cleavelandite feldspar. The crystals are black in colour and show multiple twinning and occasional well developed pyramid faces. Some crystals of cassiterite have been found to enclose small prismatic crystals of columbite indicating that the cassiterite is later in formation.

Minor minerals from the Rwemeriro pegmatite

1. Native Bismuth

A small piece of metallic bismuth weighing less than an ounce is reported to have been found in the pegmatite during early stages of mining.

2. Cassiterite

Apart from the occurrence in the eastern opencast (see p. 174) the only cassiterite seen by the writer is as small black crystals approximately

¼" in diameter on a loose fragment of quartz with a thin "greisen" (green mica rock) selvage. The specimen was found on the mine dumps and its original position in the pegmatite is not known.

3. Manganese oxides

Manganese oxides occur in portions of the cleavelandite replacement zones as black staining which has formed thin films along the cleavage planes of coarse grained cleavelandite feldspar.

4. Muscovite rock

Small fragments of pale yellow green medium grained muscovite rock or greisen have been found on the spoil tips to the north of the pegmatite but none has been observed in situ.

5. Orthoclase feldspar

A few euhedral crystals of orthoclase feldspar approximately ½" in diameter showing many crystal faces have been obtained from the footwall side of the western quartz core at the western end of the cleavelandite-oncosine rock mass. The crystals occur in a matrix of cleavelandite-oncosine rock, partially replaced white microcline and pale peach coloured garnet.

6. "Oncosine" and sericite rock

"Oncosine" and sericite mica are quite common in the pegmatite but occasional 'xenoliths' of altered crumpled oncosine or sericite rock have been found in albitised pegmatite on the mine dumps.

7. Zinc Blende and Pyrite

A small stringer of dark coloured sphalerite ¼" in thickness which contains traces of pyrite has been found in a fragment of granular quartz from spoil taken from the western opencast.

Paragenesis of the Rwemeriro pegmatite (table 41)

The Rwemeriro pegmatite has formed by progressive crystallisation of a body of residual magma which was derived from the Rwabaramira pegmatitic granite intrusion.

Crystallisation of the pegmatite took place in a relatively closed system to form a fully differentiated pegmatite with well developed paragenetic zones of primary crystallisation. Extensive late stage replacement then took place as a result of interaction of the primary zones of crystallisation with residual fluids which separated out from the pegmatite melt at various levels during primary crystallisation. (The possibility that material entered or escaped from the pegmatite during crystallisation and replacement cannot be ruled out).

During primary crystallisation the contact zone, graphic pegmatite zone, zones of medium and coarse grained pegmatite, and the massive microcline zone, containing the minerals quartz, microcline, muscovite and schorlite (tourmaline) were formed. As crystallisation progressed residual fluids and volatiles concentrated in the pegmatite and silica accumulated at intervals along the central portion of the pegmatite. At a late stage of primary crystallisation large spodumene laths formed along the core margins and replacement commenced in the pegmatite, Columbite is believed to have crystallised adjacent to some of the quartz cores at this stage.

During early stages of replacement, microcline feldspar was replaced by albite in portions of nearly all the primary paragenetic zones in the pegmatite and resulted in the formation of the albite replacement complex. Albitisation culminated in the formation of almost pure zones of cleavelandite feldspar adjacent to the quartz cores. A massive body of cleavelandite "oncosine" rock was also produced in the pegmatite.

Muscovite replacement frequently accompanied the early stages of albite replacement and resulted in the formation of muscovite replacement zones and muscovite selvages at the margins of the cleavelandite replacement zones.

Abundant green and blue beryl crystallised during the early stages of replacement and concentrated along the quartz core margins and at the margins of the replacement zones. Other minerals were formed in the replacement zones and included columbite, garnet, apatite, and black tourmaline. During the later stages of cleavelandite replacement the spodumene laths in the quartz core margin were altered, concentration of alkalis (esp. lithium) and volatiles reached a peak resulting in the formation of lithian muscovite, and verdelite, and late alkali-rich orange beryl crystallised along the quartz - core margins.

Small quantities of cassiterite and hydrothermal zinc blende were formed towards the close of replacement in the pegmatite. The paragenetic sequence for the Rwemeriro pegmatite is summarised in the following table.

Table .

Composite Paragenetic Sequence for the Rwemeriro Pegmatite

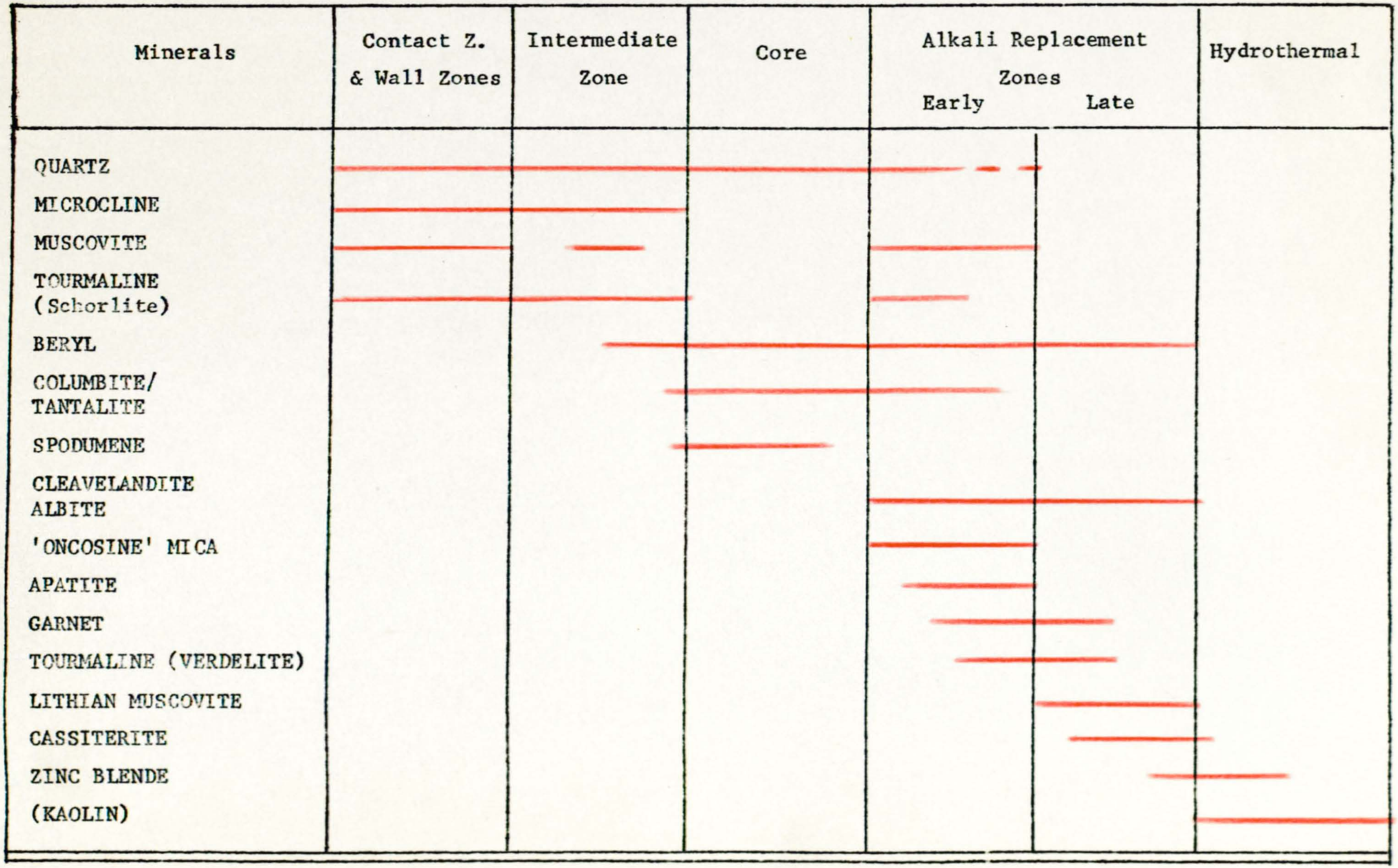

TABLE 42. CHEMICAL ANALYSES OF MINERALS FROM RWEMERIRO

A. Manganoan Apatites

	ARL 1 (Dark blue)	ARL 4 (Pale yellow-green)	ARL 3 (Pale blue-green)	ARL 2 (Dark blue-green)
MnO	2.36	3.89	5.16	5.94
CaO	53.15	51.80	50.23	49.10
P_2O_5	42.05	41.61	42.28	41.66
F	1.48	1.63	1.65	2.91
H_2O^+ H_2O^-	0.43	-	-	0.50
	99.47	98.93	99.32	100.~~4~~11
Less O ≡ F	0.62	-	-	1.22
	98.85	98.93	99.32	98.89 ~~99.19~~
Insolubles	-	0.52	-	0.30
Total	98.85	99.45	99.32	99.~~4~~19

ARL 1 & 2 Analyst. M.H. Kerr
ARL 3 & 4 Analyst J.R. Baldwin

Table 42. Cont'd.

B. Garnet (Spessartine)

	GRL 1
SiO_2	36.48
TiO_2	n. d.
Al_2O_3	20.66
Fe_2O_3	0.37
FeO	2.53
MnO	37.07
MgO	tr.
CaO	2.16
Na_2O	0.14
K_2O	0.09
Li_2O	0.05
Total	99.55

C. Feldspars

	FRL 2 (Albite)	FRL 1 (Microcline)
SiO_2	68.17	64.69
TiO_2	-	n.d.
Al_2O_3	19.71	18.58
Fe_2O_3	0.05	0.03
FeO		n.d.
MnO	tr.	tr.
MgO	n.d.	n.d.
CaO	0.36	0.10
Na_2O	11.22	1.31
K_2O	0.11	15.04
Li_2O	-	0.29
H_2O^+	0.16	0.21
H_2O^-	0.12	0.03
P_2O_5	tr.	tr.
	99.90	100.28

Analyst: J.R. Baldwin

n.d. = not detected

Table 42. Cont'd.

D. Micas

	MRL 1 (Greenish Yellow Mica)	MRL 2 (Lithian muscovite)	MRL 4 ("Ruby"Mica)
SiO_2	46.02	48.09	47.81
TiO_2	tr.	0.00	n.d.
Al_2O_3	34.68	30.40	32.92
Fe_2O_3	0.67	0.45	0.80
FeO	2.18	1.97	1.08
MnO	0.22	1.71	0.16
MgO	0.32	0.31	0.69
CaO	0.00	0.00	n.d.
Na_2O	0.07	0.06	0.30
K_2O	10.60	10.64	10.82
Li_2O	0.26	0.26	0.40
H_2O^+	3.95	2.60	4.01
H_2O^-	0.08	0.00	0.32
P_2O_5	0.02	0.06	tr.
F	1.86	5.14	1.10
	100.93	101.69	100.41
Less O $\equiv$ F	0.78	2.16	0.46
Total	100.15	99.53	99.95

MRL 1 & 2 Analyst: M.H. Kerr.

MRL 3 Analyst: J.R. Baldwin

n.d. = not detected

Table 42. Cont'd.

E. Tourmalines

	TRL 2 (Schorlite)	TRL 1 (Verdelite)
SiO_2	34.95	36.69
TiO_2	0.41	0.21
B_2O_3	10.33	10.21
Al_2O_3	34.80	39.04
Fe_2O_3	6.15	3.94
FeO	4.39	3.47
MnO	0.31	1.66
MgO	4.30	0.46
CaO	0.00	0.00
Na_2O	1.35	2.58
K_2O	0.00	0.25
Li_2O	0.00	1.25
H_2O^+	3.00	3.38
H_2O^-	0.07	0.00
F	0.60	1.46
	100.66	100.66
$O \equiv F$	0.30	0.61
Total	100.36	100.05

Analyst: M. H. Kerr

TABLE 42.

CHEMICAL ANALYSIS OF ALBITIC REPLACEMENT ROCK FROM RWEMERIRO

SiO_2	65.08
TiO_2	n. d.
Al_2O_3	21.07
Fe_2O_3	0.13
FeO	-
MnO	0.02
MgO	n. d.
CaO	0.18
Na_2O	7.39
K_2O	5.86
Li_2O	0.14
H_2O^+	0.45
H_2O^-	0.05
P_2O_5	tr.
Total:	100.37

Analyst: J. R. Baldwin

n.d. = not detected

APPENDIX II

ANALYTICAL DATA

APPENDIX II.

ANALYTICAL RESULTS

IIa. TIN AND BERYLLIUM CONTENTS OF GEOCHEMICAL (ROCK) SAMPLES FROM S.W. ANKOLE, UGANDA

Table 43 .

GROUP 1. Unaltered foliated granites, granodiorites, gneisses and migmatites

Sample Field No.	Rock Type	Map Reference		Sn ppm. (Spectrographic)	Sn ppm. (Colorimetric)	Be ppm. (Spectrographic)	Sub-Group
		Sheet No.	Co-ordinates				
GNL 1A	Foliated granite	85/3	890906	<5		<2	
GNL 3	Foliated granite	85/3	942894	<5		<2	
GNL 4	Gneissose granite	94/1	905890	5		7	
GNL 7	Foliated granite	85/3	874965	<5		3	
GNL 8	Foliated granite	85/3	873964	<5		2	
GNL 9	Augen Gneiss	85/3	876962	<5		5	
GNL 10	Augen gneiss	85/3	876959	<5		4	
GNL 12	Granite (aplite)	85/3	878963	<5		2	1B
GNL 20	Augen Gneiss	85/3	866986	<5		3	
GNL 21	Augen gneiss	85/3	804949	<5		4	
GNL 22	Foliated granite	85/3	803953	<5		3	
GNL 23	Granite	85/3	782932	<5		2	
GNL 24	Granite	85/3	784928	<5		3	
GNL 25	Aplite	85/3	888923	7	10	6	1B
GNL 31	Granite gneiss	85/3	919986	<5		<2	

Group 1 Cont'd.

Sample Field No.	Rock Type	Map Reference Sheet No.	Co-ordinates	Sn ppm. (Spectro-graphic)	Sn ppm. (Colori-metric)	Be ppm. (Spectro-graphic)	Sub-Group
GNL 36	Porphyroblastic granodiorite	94/1	827773	< 5	5	< 2	1A
GNL 40	Porphyroblastic granodiorite	94/1	828788	< 5	5	6	
GNL 41	Aplite	94/1	825787	< 5		7	1B
GNL 43A	Foliated granite	85/3	706920	< 5		< 2	
GNL 43D	Foliated granite	85/3	706920	< 5		< 2	
GNL 43E	Gneissose granite	85/3	706920	< 5		< 2	
GNL 46	Porphyroblastic biotite granite (granodiorite)	94/2	943690	< 5		3	1A
GNL 47A	Augen gneiss	94/1	921660	< 5		3	1A
GNL 47B	Aplite	94/1	921660	< 5		3	1B
GNL 48B	Foliated aplite	94/1	893726	< 5		< 2	1B
GNL 51A	Foliated granite	85/4	977033	< 5		< 2	
GNL 52A	Foliated granite	85/4	978031	< 5		3	
GNL 52B	Granite	85/4	978031	< 5		3	
GNL 55	Foliated granite	85/4	978040	< 5		< 2	
GNL 59	Porphyroblastic granodiorite	85/4	205945	5		< 2	1A
GNL 62	Lineated granite	85/3	904947	< 5		< 2	
GNL 64	Lineated granite	85/3	904950	< 5		< 2	

Group 1 cont'd.

Sample Field No.	Rock Type	Map Reference		Sn ppm. (Spectrographic)	Be ppm. (Spectrographic)	Sub-Grou
		Sheet No.	Co-ordinates			
GNL 67	Porphyroblastic gneissose granite	85/3	797913	5	2	
GNL 68	Foliated granite	85/3	904908	<5	<2	
GNL 70	Foliated granite	85/3	903913	<5	<2	
GNL 70A	Aplite	85/3	903913	<5	2	1B
GNL 71	Foliated granite	85/3	903915	<5	<2	
GNL 76	Augen gneiss	85/3	806949	5	2	
GNL 76A	Foliated granite	85/3	806949	<5	4	
GNL 77	Augen gneiss	85/3	807957	10	<2	
GNL 78A	'Granite'	85/3	806959	<5	<2	
GNL 79A	Foliated granite	85/3	810966	<5	2	
GNL 79B	Contaminated granite	85/3	810966	<5	<2	
GNL 81	Foliated granite	85/3	814970	<5	<2	
GNL 90A	Foliated aplite	85/4	947057	<5	<2	1B
GNL 90C	Foliated granodiorite	85/4	947057	<5	<2	
GNL 90G	Aplite	85/4	947057	<5	13	1B
GNL 91	Foliated granite	85/3	881972	5	3	
GNL 92	Foliated granite	85/3	881973	5	2	
GNL 94	Foliated granite	85/3	882977	<5	<2	

Group 1 con'td.

Sample Field No.	Rock Type	Map Reference		Sn ppm. (Spectro-graphic)	Be ppm. (Spectro-graphic)	Sub-Group
		Sheet No.	Co-ordinates			
GNL 94A	Biotite augen gneiss	85/3	882977	5	3	
GNL 102	Foliated granite	85/3	906905	<5	<2	
GNL 104	Granite	85/3	913907	<5	2	
GNL 106	Foliated granite	85/3	911899	<5	<2	
GNL 109	'Granite'	94/2	948885	<5	<2	
GNL 110	Foliated granite	94/2	952880	<5	<2	
GNL 115½	Foliated porphyroblastic granite	85/4	972965	<5	<2	
GNL 122	Microgranodiorite	85/4	116920	7	2	1A
GNL 123	Sericitised 'granite'	85/4	114921	10	<2	
GNL 123A	Sericitised 'granite'	85/4	114921	<5	<2	1A
GNL 130	Porphyroblastic biotite-granite (granodiorite)	85/4	156968	10	4	1A
GNL 131	Porphyroblastic biotite granite (granodiorite)	85/4	176961	5	3	1A
GNL 131A	Porphyroblastic biotite granite (granodiorite)	85/4	176961	5	3	1A
GNL 131B	Microgranite	85/4	176961	5	3	1A
GNL 133	Porphyroblastic biotite-granite	----	------N. Ibanda Arena	28	2	1A

Group 1 Cont'd.

Sample Field No.	Rock Type	Map Reference		Sn ppm. (Spectrographic)	Be ppm. (Spectrographic)	Sub-Group
		Sheet No.	Co-ordinates			
GNL 135	Foliated porphyroblastic gneiss	94/1	767890	< 5	< 2	
GNL 137	Foliated biotite granite	85/3	773926	< 5	2	
GNL 145A	Banded gneiss	85/3	803026	< 5	< 2	
GNL 146	Feldspathised gneiss	85/3	------ Nr Nkongoro	< 5	2	
GNL 149	Biotite granite	85/3	687917	< 5	6	
GNL 151	Granite gneiss	85/3	697972	< 5	< 2	
GNL 152	Foliated granite	85/3	687987	15	< 2	
GNL 153	Augen gneiss	85/3	684992	< 5	< 2	
GNL 158	Granite	85/3	782955	< 5	3	
TGNL 1	Biotite granite	----	Kasanyi, N.W. Tanzania	17	2	1A
TGNL 2	Porphyroblastic biotite granite	----	Murongo, N.W. Tanzania	5	3	1A
TGNL 3	" "	----	" "	5	3	1A

Group 1A Granodiorites and porphyroblastic microcline-biotite granites.

Sample Field No.	Rock Type	Map Reference		Sn ppm.	Sn ppm.	Be ppm.
		Sheet No.	Co-ordinates	(Spectro-graphic)	(Colori-metric)	(Spectro-graphic)
GNL 36	Porphyroblastic granodiorite	94/1	827773	< 5	5	< 2
GNL 40	" "	94/1	828788	< 5	5	6
GNL 46	Porphyroblastic biotite granite	94/2	943690	< 5		3
GNL 47A	Augen gneiss (biotite rich)	94/1	921660	< 5		3
GNL 59	Porphyroblastic granodiorite	85/4	205945	5		< 2
GNL 122	Microgranodiorite	85/4	116920	7		2
GNL 123A	Sericitised 'granite'	85/4	114921	< 5		< 2
GNL 130	Porphyroblastic biotite granite (granodiorite)	85/4	156968	10		4
GNL 131	" "	85/4	176961	5		3
GNL 131A	" "	85/4	176961	5		3
GNL 131B	Microgranite	85/4	176961	5		3
GNL 133	Porphyroblastic biotite-granite (granodiorite)	----	------ N.Ibanda Arena	28		2
TGNL 1	Biotite granite	----	Kasanyi, N.W. Tanzania	17		< 2
TGNL 2	Porphyroblastic biotite granite	----	Murongo, N.W. Tanzania	< 5		3
TGNL 3	" "	----	Murongo, N.W. Tanzania	< 5		3

Group 1B. Aplites

Sample Field No.	Rock Type	Sheet No.	Co-ordinates	Sn ppm. (Spectrographic)	Sn ppm. (Colorimetric)	Be ppm. (Spectrographic)
GNL 12	Granite (aplite)	85/3	878963	< 5		2
GNL 25	Aplite	85/3	888923	7	10	6
GNL 41	Aplite	94/1	825787	< 5		7
GNL 47B	Aplite	94/1	921660	< 5		3
GNL 48	Foliated aplite	94/1	893726	< 5		< 2
GNL 70	Aplite	85/3	903913	< 5		< 2
GNL 90A	Foliated aplite	85/4	947057	< 5		< 2
GNL 90G	Aplite	85/4	947057	< 5		13

Group 2. Hydrothermally altered marginal granitoid rocks and altered granitic wall-rocks

Sample Field No.	Rock Type	Map Reference Sheet No.	Map Reference Co-ordinates	Locality	Sn ppm. (Spectrographic)	Sn ppm. (Colorimetric)	Be ppm. (Spectrographic)
GNL 30	Altered porphyroblastic granodiorite	94/1	896726	Ngoma-Rwentobo	238	213	3
GNL 37	Altered porphyroblastic granodiorite	94/1	825772	Kaina	<5	9	32
GNL 38	Altered crushed granodiorite	94/1	823773	"	<5	5	6
GNL 42	Granitic crush rock	94/1	830771	"	<5		7
GNL 43A	Foliated granite	85/3	706920	Kyabakazi-Ihunga	<5		<2
GNL 43D	Foliated granite	85/3	706920	"	<5		<2
GNL 43F	Schistose gneiss	85/3	706920	"	42	50	7
GNL 66	Gneissose granite	94/1	789889	Rukira	<5		7
GNL 116	Altered granite	85/4	062987	Mugwa	17		4
GNL 134B	Altered tourmaline muscovite granite	94/1	927768	S.Kabiga-Rukanda	<5		2
GNL 138	Foliated biotite granite	85/3	780923	Kitokye	17		4
GNL 138A	Altered granite gneiss	85/3	780923	"	35		18
GNL 138B	Metasomatised granite	85/3	780923	"	175		12
GNL 138C	Albitised granite	85/3	780923	"	35		17
GNL 138D	Foliated biotite granite	85/3	780923	"	10		6

Group 2 cont'd.

Sample Field No.	Rock Type	Map Reference Sheet No.	Map Reference Co-ordinates	Locality	Sn ppm. (Spectrographic)	Sn ppm. (Colorimetric)	Be ppm. (Spectrographic)
GNL 138J	Albite rock	85/3	780923	Kitokye	< 5		23
GNL 143	Muscovite gneiss	85/3	836994	"	25		2
GNL 149	Biotite granite	85/3	687917	N.W. of Kakomero	< 5		6
GNL 162	Altered granitoid rock	94/1	858788	Rusojwa	5		< 2
GNL 163	Hydrothermally altered granite	85/4	042977	Kazumo	25		7
SPL 164A	Hydrothermally altered and sheared porphyroblastic granodiorite	94/1	831773	Kaina Mine	32	33	2
SPL 164B	" "	"	"	"	10	13	2
SPL 164C	" "	"	"	"	28	20	6
SPL 164E	" "	"	"	"	15	13	7
SPL 164F	" "	"	"	"	5	5	5
SPL 164G	" "	"	"	"	5	2	2
SPL 164H	" "	"	"	"	22	8	3
SPL 164I	" "	"	"	"	6	10	2
SPL 164J	" "	"	"	"	7	1	6
SPL 164K	" "	"	"	"	5	3	3

Group 3. Post-tectonic pegmatitic granites

Sample Field No.	Rock Type	Map Reference		Sn ppm.	Sn ppm.	Be ppm.
		Sheet No.	Co-ordinates	(Spectrographic)	(Colorimetric)	(Spectrographic)
GNR	Pegmatitic Granite	85/3	874910	18	23	6
GNL 1B	" "	85/3	890906	< 5		12
GNL 2A	" "	94/1	912889	6	6	2
GNL 2B	" "	94/1	912889	< 5		3
GNL 5	" "	85/3	892898	< 5		< 2
GNL 6	" "	85/3	896896	< 5		8
GNL 8A	" "	85/3	873964	6	14	7
GNL 17	" "	85/3	858977	< 5		3
GNL 18	" "	85/3	860984	12	10	6
GNL 26	" "	85/3	886928	40	38	50
GNL 27	" "	85/3	877927	13	10	3
GNL 28	" "	85/3	873925	15		2
GNL 29	" "	85/3	873924	12	10	3
GNL 43B	" "	85/3	706920	< 5		7
GNL 43C	" "	85/3	706920	78	80	15
GNL 43H	" "	85/3	706920	68	50	100
GNL 44	" "	85/3	703923	38	33	58
GNL 48A	" "	94/1	893726	22	35	35
GNL 50	"Luxullianite"	94/1	742840	< 5		< 2

Group 3 cont'd.

Sample Field No.	Rock Type	Map Reference		Sn ppm. (Spectrographic)	Sn ppm. (Colorimetric)	Be ppm. (Spectrographic)
		Sheet No.	Co-ordinates			
GNL 82	Pegmatitic Granite	85/3	809974	< 5		2
GNL 84	" "	85/3	812977	< 5		3
GNL 90E	" "	85/4	947057	< 5		13
GNL 98	" "	85/3	885969	5	5	
GNL 98A	" "	85/3	885969	< 5	6	
GNL 103	" "	85/3	907905	<5	42	
GNL 107	" "	94/1	938893	<5	< 2	
GNL 112	" "	94/2	954876	<5	<2	
GNL 115	" "	85/3	728022	<5	<2	
GNL 117	" "	85/4	051992	<5	7	
GNL 138J	" "	85/3	780923	<5	23	
GNL 143C	" "	85/3	836994	<5	7	
GNL 143D	" "	85/3	836994	20	4	
GNL 150A	" "	85/3	699929	62	135	
GNL 154	" "	85/3	683993	<5	3	
GNL 159	" "	85/3	764974	17	7	
GNL 160	" "	85/3	762976	<5	2	
GNL 161	" "	85/3	760984	< 5	< 2	
TGNL 1A	" "	----	Kasan$\overset{y}{z}$i, Tanzania	35	82	

Miscellaneous granitoid rocks

Sample Field No.	Rock Type	Map Reference		Sn ppm. (Spectro-graphic	Be ppm. (Spectro-graphic
		Sheet No.	Co-ordinates		
GNL 13	'Aplite'	85/3	878957	< 5	3
GNL 14	Coarse greisen	85/3	838998	12 (10)*	8
GNL 15	Schistose biotite gneiss	85/3	838997	< 5	3
GNL 31	Granite gneiss	85/3	919986	< 5	< 2
GNL 33	Metasomatised arenite	85/3	915985	65	7
GNL 34	'Granite'	85/3	917983	< 5	4
GNL 35	Metasomatised arenite	85/3	920988	48	8
GNL 48	Biotite gneiss	94/1	893725	< 5	2
GNL 83	Biotite augen gneiss	85/3	813975	< 5	< 2
GNL 90B	Microgranodiorite xenolith	85/4	947057	12	< 2
GNL 107A	Granite vein from injection schist	94/1	938893	< 5	7
GNL 107B	Injection schist	94/1	938893	< 5	3
GNL 107C	Mica schist	94/1	938893	< 5	< 2
GNL 144	Biotite gneiss	85/3	833024	< 5	6
GNL 150	Schistose biotite gneiss	85/3	699929	< 5	< 2
GNL 151A	Biotite gneiss	85/3	697972	17	< 2
GNL 161A	Coarse greisen	85/3	750984	20	2

* Sn ppm. Colorimetric

Group 4. Unaltered Karagwe-Ankolean sedimentary rocks

Sample Field No.	Rock Type	Map Reference Sheet No.	Map Reference Co-ordinates	Sn ppm. (Spectrographic)	Be ppm. (Colorimetric)
SPL 125	Quartzite	85/3	916963	5	2
SPL 125A	Impure quartzite	85/3	916963	5	2
SPL 125B	Schistose quartzite	85/3	916963	5	2
SPL 126	Banded phyllite	85/3	907965	5	2
SPL 128	Quartzite	85/3	887037	-	2
SPL 136½	Schist	85/3	768922	5	3
SPL 163F	Schists and phyllites	94/1	830772	5	2
SPL 163G	" "	"	"	5	2
SPL 163H	" "	"	"	5	2
SPL 164 O	" "	94/1	831773	5	2
SPL 164P	" "	94/1	831773	5	2
SPL 165	Mica schist	85/3	897943	5	2
SHL 10	Phyllite	94/1	793805	5	4
SHL 139	Phyllite	85/4	954075	6	2
SHL 141	Garnet - staurolite schist	85/3	884054	5	2
SHL 141A	" "	85/3	884054	7	2
SHL 142	Schist	85/3	876069	5	2
SHL 147	Phyllite	94/1	730883	5	3

Group 5A

Hydrothermally altered (tourmalinised and/or sericitised) K-A country rocks found remote from granite or mineral deposits

Sample Field No.	Rock Type	Map Reference Sheet No.	Co-ordinates	Sn ppm. (Spectrographic)	Be ppm. (Spectrographic
SPL 127C	Hydrothermally altered garnet staurolite schist	85/3	903964	5	2
SPL 127D	" "	85/3	903964	5	2
SPL 129H	Tourmalinised arenaceous garnet-sericite schist	94/1	920703	5	9
SPL 129I	" "	"	"	5	3
SPL 163B	Schists and hydrothermally altered schists	94/1	830772	5	4
SPL 163C	" "	"	"	5	3
SPL 163D	" "	"	"	5	2
SPL 163E	" "	"	"	5	2
SPL 163I	" "	"	"	12	4
SPL 164L	Schists and altered schists	94/1	831773	5 (8*)	6
SPL 164M	" "	"	"	6 (10*)	3
SPL 164N	" "	"	"	8	2

* Sn ppm. Colorimetric

Group 5A cont'd.

Sample Field No.	Rock Type	Map Reference Sheet No.	 Co-ordinates	Sn ppm. (Colorimetric)
L4	Tourmaline schist	85/3	868918	5
L20	" "	85/3	823932	8
L28	Tourmalinised garnet schist	85/3	763924	8
L36	Tourmaline schist	85/3	896951	8
L38	" "	85/3	903944	10
L48	" "	94/1	910691	25
L75	Tourmalinised quartzite	85/4	965928	13
L76	" "	85/4	958939	5
L77	Tourmaline-hematite rock	94/1	733840	3

Group 5B. Hydrothermally altered K-A country rocks from adjacent to granite pegmatites and quartz veins (excluding cassiterite bearing veins)

Sample Field No.	Rock Type	Map Reference Sheet No.	Map Reference Co-ordinates	Locality	Sn ppm. (Spectro-graphic)		Be ppm. (Spectro-graphic)
SPL 98B	Schist	85/3	886968	Kaguro	7		6
SPL 98C	Schist	85/3	886968	"	5		4
SPL 113	Tourmalinised gneiss	85/3	751958	Kibaare	12		8
SPL 163A	Schist (altered)	94/1	830772	Kaina	28		7
SPL 164D	Schist xenolith	94/1	831773	"	25	(16*)	4
SHL 2	Muscovitised arenaceous schist	85/3	857942	E. of Kagugu	5		2
SHL 7	Muscovite schist	85/3	886925	E. of Rwabaramira	20	(40*)	7
SHL 8	Tourmalinised mica schist	94/1	897725	Ngoma-Rwentobo	175	(150*)	18
SHL 11	Muscovite schist	85/3	901935	Mishenyi	32		7
SHL 12	Arenaceous sericite schist	85/4	117917	N. of Kyabakonjo	25		2
SHL 13	Altered schist	85/4	939997	Kashaka	5		3
SHL 142A	Schist (xenolith)	85/3	877070	Kamaremba	28		6
SHL 148	Altered schist	85/3	562901	W. of Omwinero	12		3
SHL 154	Schist	85/3	684993	Kihungye	5		3
SHL 157	Altered schist	85/3	885994	Nyabushenyi	175		7

x = Sn colorimetric.

Group 5B cont'd.

Sample Field No.	Rock Type	Map Reference		Locality	Sn ppm. (Spectrographic)
		Sheet No.	Co-ordinates		
L8	Altered tourmaline schist	85/3	864915	Ramadidi Hill	30
L9	Tourmaline schist	85/3	863913	" "	25
L13	" "	85/3	858907	Mutojo	13
L23	" "	85/3	827930	Nyanga N.W.	18
L24	" "	85/3	833926	Nyanga-Rwentare	50
L25	" "	85/3	834928	Nyanga N.E.	13
L27	" "	85/3	768922	Lr. Rwenkanga	10
L29	" "	85/3	769921	U. Rwenkanga	20
L30	" "	85/3	769922	" "	13
L32	" "	85/3	854928	Sheshe	23
L39	" "	85/3	868942	Mungenyi	18
L42	" "	85/3	780917	Kamuha	13
L44	" "	85/3	868955	S.E. of Rutooma	30
L57	Altered tourmalinised injection schist	94/1	938893	Nyakabingo	5
L66	Tourmaline-mica schist	85/4	026966	Bitaka	175
L70	Tourmaline schist	85/3	853074	Luwabo-Ihunga	25
L71	Tourmalinised quartzite	85/4	043974	Kazumo	6
L79	Tourmaline schist	85/3	868998	Kakoki I.	0
L91	" "	94/1	903667	Kigara	10

Group 5C. Hydrothermally altered K-A country rocks from adjacent to cassiterite-bearing quartz-mica- and hydrothermal quartz-veins

Sample Field No.	Rock Type	Map Reference		Locality	Sn ppm. (Spectrographic)	Be ppm. (Spectrographic)
		Sheet No.	Co-ordinates			
SPL 123½	Tourmalinised quartzite	85/3	903972	Kyamugashe	17	2
SPL 124	Altered and tourmalinised quartzites, staurolite schists and phyllites	85/4	094903	Mwirasando Mine	150	8
SPL 124A	" "	"	"	"	75	7
SPL 124B	" "	"	"	"	65	5
SPL 124C	" "	"	"	"	152	6
SPL 124D	" "	"	"	"	88	7
SPL 124E	" "	"	"	"	162	6
SPL 124F	" "	"	"	"	100	7
SPL 124G	" "	"	"	"	88	6
SPL 124H	" "	"	"	"	85	6
SPL 124I	" "	"	"	"	175	6
SPL 124J	" "	"	"	"	100	7
SPL 124K	" "	"	"	"	375	7
SPL 124L	" "	"	"	"	200	8
SPL 127A	Hydrothermally altered garnet-staurolite schists	85/3	903964	Kyamugashe Mine	42	3
SPL 127B	" "	"	"	"	45	3

Group 5C cont'd.

Sample Field No.	Rock Type	Map Reference		Locality	Sn ppm. (Spectrographic)	Be ppm. (Spectrographic)
		Sheet No.	Co-ordinates			
SPL 127E	Hydrothermally altered garnet-staurolite schist	85/3	903964	Kyamugashe Mine	130	12
SPL 127F	" "	"	"	" "	42	6
SPL 127G	" "	"	"	" "	210	12
SPL 127H	" "	"	"	" "	188	6
SPL 127I	" "	"	"	" "	235	8
SPL 129A	Tourmalinised arenaceous garnet and sericite schists	94/1	920703	Burama Mine	210	7
SPL 129B	" "	"	"	"	144	8
SPL 129C	" "	"	"	"	142	7
SPL 129D	" "	"	"	"	162	6
SPL 129E	" "	"	"	"	100	4
SPL 129F	" "	"	"	"	125	8
SPL 129G	" "	"	"	"	75	3
SPL 164Q	"Greisenised" schist	94/1	831773	Kaina Mine	350	13
SHL 5	Altered schist	94/1	907685	Burama	50 (50*)	4
SHL 6	Schist	94/1	907685	"	13 (15*)	2
SHL 9	Mica schist	94/1	827773	Kaina	375	17

* Sn ppm. (Colorimetric)

Group 5C cont'd.

Sample Field No.	Rock Type	Map Reference		Locality	Sn ppm. (Spectrographic)	Be ppm. (Spectrographic)
		Sheet No.	Co-ordinates			
SHL 140	Micaceous schist	85/3	888056	S. of Rutunguru	65	7
SHL 140A	Micaceous schist	85/3	888056	" " "	88	8
L15	Tourmaline schist	85/3	845908	Byasha	35	
L34	" "	85/3	903965	Kyamugashe	38	
L46	" "	94/1	911693	Burama	40	
L47	" "	94/1	911963	"	45	
L49	" "	94/1	918698	"	100	
L50	" "	94/1	918698	"	25	
L56	" "	85/3	878053	Rutunguru	60	
L60	" "	85/4	094904	Mwirasando	75	
L72	Tourmalinised quartzite	85/4	043974	Kazumo	13	
L73	" "	85/4	043974	"	30	
L74	" "	85/4	967926	Kashojwa	13	
L86	Tourmaline schist	85/4	107896	Rwemikoma	75	
L87	Tourmalinised quartzite	85/4	008905	Namaherere	15	
L88	" "	86/3	------	Kikagati Mine	20	
L89	" "	86/3	389874	Nyarabungu-Kikagati	23	
L90	" "	86/3	------	" "	20	

Table 43 cont'd.

Key to Map Sheets covering S. W. Ankole, Uganda

D.O.S. 426 (Series Y 732) 1:50,000 (1964)

Sheet 85/III	Rwashamaire
Sheet 85/IV	Ntungamo
Sheet 86/III	(Kikagati)
Sheet 94/I	(Mpalo)
Sheet 94/II	(Kafunzo)

Also New Edition (1965)

Series Y 732 Edition 4 - U.S.D.

Sheet 85/3	Rwashamaire

IIb. Partial analyses of micas for alkalis, fluorine and tin

Table 44 .*

Group 1. Muscovites from pegmatitic granites

	GNL 14/M	GNL 18/M	GNL 25/M	GNL 26/M	GNL 27/M
Li_2O	0.02	0.07	0.02	0.02	0.07
Na_2O	0.68	0.46	0.66	0.75	0.85
K_2O	9.95	10.42	10.30	10.03	10.00
Rb_2O	0.07	0.08	0.14	0.24	0.20
Cs_2O	tr	tr	0.01	0.01	0.01
$Rb_2O + Cs_2O$	0.07	0.08	0.15	0.25	0.21
$Na_2O + Rb_2O + Cs_2O$	0.75	0.54	0.81	1.00	1.06
F	0.11	0.27	0.23	0.25	-
'Total' Sn ppm.	18	100	50	125	100
'Acid Soluble' Sn ppm.	13	88	50	125	75
Difference ppm.	5	12	0	0	25

	GNL 28/M	GNL 29/M	GNL 43C/M	GNL 43H/M	GNL 44/M
Li_2O	0.03	0.05	0.03	0.03	0.02
Na_2O	0.62	0.57	0.60	0.59	0.61
K_2O	10.35	10.38	10.41	10.47	10.39
Rb_2O	0.18	0.09	0.20	0.21	0.23
Cs_2O	0.01	tr	0.02	0.02	0.02
$Rb_2O + Cs_2O$	0.19	0.09	0.22	0.23	0.25
$Na_2O + Rb_2O + Cs_2O$	0.81	0.66	0.82	0.82	0.86
F	0.24	0.17	0.03	0.13	0.02
'Total' Sn ppm.	60	35	550	600	450
'Acid Soluble' Sn ppm.	55	30	500	600	450
Difference ppm.	5	5	50	0	0

* See Table 45 for location index.

Group 1 cont'd.

	GNL 143D/M	GNL 150A/M	GNL 159/M	GNL 161A/M
LiO_2 -----------------	0.04	0.04	0.05	0.03
Na_2O -----------------	0.66	0.65	0.49	0.53
K_2O ------------------	10.47	10.36	10.58	10.27
Rb_2O -----------------	0.07	0.28	0.07	0.06
Cs_2O -----------------	tr	0.02	tr	0.03
$Rb_2O + Cs_2O$ ----------	0.07	0.30	0.07	0.09
$Na_2O + Rb_2O + Cs_2O$ ---	0.73	0.95	0.56	0.62
F --------------------	0.20	0.07	0.19	0.12
'Total' Sn ppm. ------	-	-	-	-
'Acid Soluble' Sn ppm.	-	-	-	-
Difference ppm. ------	-	-	-	-

Group 2. Muscovites from granite pegmatites (excluding late mica-rock or greisen units

	MO	MOA	M1	M8	M9	M10	M15
Li_2O	0.22	0.16	0.18	0.13	0.23	0.03	0.08
Na_2O	0.79	0.86	0.72	0.80	0.49	0.68	0.67
K_2O	9.80	9.84	9.87	10.01	10.53	9.96	10.19
Rb_2O	0.47	0.38	0.37	0.37	0.55	0.37	0.31
Cs_2O	0.02	0.02	0.01	0.01	0.09	0.02	0.01
$Rb_2O + Cs_2O$	0.49	0.40	0.38	0.38	0.64	0.39	0.32
$Na_2O + Rb_2O + Cs_2O$	1.28	1.26	1.10	1.18	1.13	1.07	0.99
F	0.85	0.52	0.41	0.46	1.37	0.20	0.77
'Total' Sn ppm.	150	138	130	175	375	70	8
'Acid Soluble' Sn ppm.	125	125	130	60	375	70	8
Difference ppm.	25	13	0	15	0	0	0

	M16	M17	M18	M19	M20	M26	M32
Li_2O	0.01	0.05	0.22	0.05	0.13	0.17	0.15
Na_2O	0.64	0.71	0.72	0.63	0.69	0.62	0.73
K_2O	10.27	10.07	10.02	10.08	10.12	10.24	10.15
Rb_2O	0.18	0.07	0.65	0.58	0.58	0.40	0.27
Cs_2O	0.02	tr	0.05	0.03	0.03	0.02	0.01
$Rb_2O + Cs_2O$	0.32	0.07	0.70	0.61	0.61	0.42	0.28
$Na_2O + Rb_2O + Cs_2O$	0.84	0.78	1.42	1.24	1.30	1.04	1.01
F	0.02	0.26	1.08	0.56	0.52	0.82	0.75
'Total' Sn ppm.	45	-	500	400	400	200	125
'Acid Soluble' Sn ppm.	45	-	500	400	250	188	100
Difference ppm.	0	-	0	0	150	12	25

Group 2 cont'd.

	M33	M44	M45	M46	M56	M59	M60
Li_2O	0.43	0.02	0.02	0.02	0.03	0.03	0.02
Na_2O	0.62	0.90	0.90	0.93	0.67	0.51	0.58
K_2O	10.30	9.86	9.93	9.88	10.09	10.47	10.53
Rb_2O	0.39	0.41	0.40	0.40	0.22	0.49	0.09
Cs_2O	0.02	0.02	0.02	0.02	0.01	0.02	tr
$Rb_2O + Cs_2O$	0.41	0.43	0.42	0.42	0.23	0.51	0.09
$Na_2O + Rb_2O + Cs_2O$	1.03	1.33	1.32	1.35	0.90	1.02	0.67
F	1.11	0.65	0.36	0.50	0.28	0.16	0.21
'Total' Sn ppm.	275	41	40	40	88	500	53
'Acid Soluble' Sn ppm.	250	41	40	40	88	475	53
Difference ppm.	25	0	0	0	0	25	0

	M61	M64	M73
Li_2O	0.02	0.25	0.07
Na_2O	0.53	0.58	0.67
K_2O	10.64	10.18	10.21
Rb_2O	0.09	0.45	0.41
Cs_2O	tr	0.06	0.01
$Rb_2O + Cs_2O$	0.09	0.51	0.42
$Na_2O + Rb_2O + Cs_2O$	0.62	1.09	1.09
F	0.17	0.97	0.65
'Total' Sn ppm.	28	325	163
'Acid Soluble' Sn ppm.	20	325	150
Difference ppm.	8	0	13

Group 3. Muscovites from quartz-mica veins and mica rock or greisen units in pegmatites

	MOC	MOR2	M6	M7	M28	M29	M30
Li_2O	<0.01	0.29	0.15	0.21	0.11	0.22	0.15
Na_2O	1.00	0.30	0.64	0.61	0.55	0.40	0.35
K_2O	9.88	10.71	10.55	10.65	10.37	10.14	10.39
Rb_2O	0.66	0.59	0.43	0.66	0.91	1.28	0.71
Cs_2O	0.03	0.04	0.04	0.03	0.25	0.27	0.27
$Rb_2O + Cs_2O$	0.69	0.63	0.47	0.69	1.16	1.55	0.98
$Na_2O + Rb_2O + Cs_2O$	1.69	0.93	1.11	1.30	1.71	1.95	1.33
F	0.33	1.86	0.46	0.22	0.28	0.57	0.26
'Total' Sn ppm.	500	175	375	450	212	237	150
'Acid Soluble' Sn ppm.	500	175	350	450	212	237	150
Difference ppm.	0	0	25	0	0	0	0

	M34	M35	M36	M39	M40	M41	M47
Li_2O	0.15	0.02	0.03	0.04	0.15	0.09	0.05
Na_2O	0.48	0.91	0.55	1.15	1.42	0.74	0.69
K_2O	10.01	9.93	10.13	9.55	9.44	9.82	10.10
Rb_2O	1.01	0.90	0.83	0.84	0.48	1.13	0.48
Cs_2O	0.30	0.09	0.06	0.05	0.11	0.14	0.06
$Rb_2O + Cs_2O$	1.31	0.99	0.89	0.89	0.59	1.27	0.50
$Na_2O + Rb_2O + Cs_2O$	1.79	1.90	1.44	2.04	2.01	2.01	1.23
F	0.52	0.60	0.31	0.54	0.37	0.48	0.48
'Total' Sn ppm.	550	200	400	375	375	425	475
'Acid Soluble' Sn ppm.	550	200	400	350	375	375	400
Difference ppm.	0	0	0	25	100	50	75

Group 3 cont'd.

	M52	M53	M54	M55	M57	M58	M72
Li_2O	0.07	0.14	0.06	0.04	0.04	0.05	0.07
Na_2O	0.75	0.75	1.36	1.33	0.50	0.38	0.66
K_2O	10.03	9.99	9.47	9.41	10.34	10.47	9.82
Rb_2O	0.70	0.76	0.59	0.32	0.58	0.52	0.99
Cs_2O	0.04	0.04	0.08	0.05	0.11	0.21	0.36
$Rb_2O + Cs_2O$	0.74	0.80	0.67	0.37	0.69	0.73	1.35
$Na_2O + Rb_2O + Cs_2O$	1.49	1.55	2.03	1.70	1.19	1.11	2.01
F	0.45	0.79	0.29	0.44	0.20	0.24	0.47
'Total' Sn ppm.	300	300	400	350	400	287	450
'Acid Soluble' Sn ppm.	188	100	400	250	300	287	425
Difference ppm.	112	200	0	100	100	0	25

Group 4. Muscovites from hydrothermal quartz cassiterite-bearing veins

	M2	M4	M5	M13	M14	M21	M22
Li_2O	0.03	0.04	0.02	0.15	0.05	0.12	0.13
Na_2O	1.15	1.28	1.60	1.27	0.99	0.76	0.79
K_2O	9.37	9.13	8.81	9.31	9.96	9.72	9.70
Rb_2O	0.33	0.24	0.19	0.29	0.85	0.97	0.91
Cs_2O	0.02	0.01	0.00	0.02	0.07	0.18	0.17
$Rb_2O + Cs_2O$	0.35	0.25	0.19	0.31	0.92	1.15	1.08
$Na_2O + Rb_2O + Cs_2O$	1.50	1.53	1.79	1.58	1.91	1.91	1.87
F	0.40	0.32	0.31	0.47	0.20	0.69	0.60
'Total' Sn ppm.	450	500	275	338	500	425	400
'Acid Soluble' Sn ppm.	400	450	250	338	450	400	400
Difference ppm.	50	50	25	0	50	25	0

	M23	M25	M37	M42	M43	M62	M65
Li_2O	0.19	0.08	0.03	0.04	0.04	0.08	0.06
Na_2O	1.06	1.13	1.62	1.06	1.02	1.39	0.86
K_2O	9.23	9.22	8.87	9.64	9.77	9.26	9.34
Rb_2O	0.67	0.46	1.06	0.95	0.82	0.36	1.42
Cs_2O	-	0.05	0.16	0.09	0.03	0.04	0.24
$Rb_2O + Cs_2O$	0.67	0.51	1.22	1.04	0.85	0.40	1.66
$Na_2O + Rb_2O + Cs_2O$	1.73	1.64	2.84	2.10	1.87	1.79	2.52
F	0.85	0.44	0.29	0.49	0.40	0.36	0.53
'Total' Sn ppm.	-	400	375	250	375	300	475
'Acid Soluble' Sn ppm.	300	350	350	250	250	300	400
Difference ppm.	-	50	25	0	25	0	75

Group 4 cont'd.

	M66	M67	M68	M69	M70*	M71
Li_2O ------------------	0.09	0.08	0.09	0.05	0.05	0.02
Na_2O ------------------	0.76	0.73	0.60	0.83	0.39	1.13
K_2O -------------------	9.55	9.48	9.53	9.63	9.76	9.05
Rb_2O ------------------	1.34	1.37	1.39	1.21	0.17	0.12
Cs_2O ------------------	0.19	0.16	0.21	0.17	0.03	0.03
$Rb_2O + Cs_2O$ -----------	1.53	1.53	1.60	1.38	0.20	0.15
$Na_2O + Rb_2O + Cs_2O$ ----	2.29	2.26	2.20	2.21	0.59	1.28
F ---------------------	0.76	0.76	0.53	0.54	0.67	0.25
'Total' Sn ppm. -------	350	350	450	450	500	350
'Acid Soluble' Sn ppm.	200	350	450	350	475	325
Difference ppm. -------	150	100	0	100	25	25

* M70 = K (Kikagati)

Group 5. Lithian muscovites from granite pegmatites

	MOR1	MOR3	M11	M12	M27	M31	M31A
Li_2O	1.98	2.20	1.05	0.95	0.66	2.21	1.05
Na_2O	0.29	0.17	0.46	0.42	0.28	0.38	0.29
K_2O	(11.27)	10.57	10.61	10.71	10.29	10.32	10.45
Rb_2O	0.87	0.85	0.58	0.46	0.79	1.16	0.85
Cs_2O	0.10	0.10	0.10	0.04	0.12	0.72	0.04
$Rb_2O + Cs_2O$	0.97	0.95	0.68	0.50	0.91	1.88	0.89
$Na_2O + Rb_2O + Cs_2O$	1.26	1.12	1.14	0.92	1.19	2.26	1.18
F	4.30	5.14	1.69	1.63	1.06	3.28	1.93
'Total' Sn ppm.	125	400	450	500	412	212	175
'Acid Soluble' Sn ppm.	125	350	400	500	412	212	175
Difference ppm.	0	50	50	0	0	0	0

IIC. GEOCHEMICAL SAMPLE LOCATION INDEX - MICAS

(Table 45 .)

Group 1. Muscovites from pegmatitic granites

Sample No.	Locality	Map Reference	
		Sheet No.	Co-ordinates
GNL 14M*	S.W. Nyabugongi	85/3	838998
GNL 18M	S. of Nyabugongi	85/3	860984
GNL 25M	S.E. of Kakungu	85/3	888984
GNL 26M	E. of Kakungu	85/3	886928
GNL 27M	Kakungu-Rwabaramira	85/3	877927
GNL 28M	" "	85/3	873925
GNL 29M	" "	85/3	873924
GNL 43C/M	Kyabakazi-Ihunga	85/3	706920
GNL 43H/M	" "	85/3	706920
GNL 44M	" "	85/3	703923
GNL 143D/M	Rweibango	85/3	836994
GNL 150A/M	Nr Kyabakazi River	85/3	699929
GNL 159/M	Rwengondo	85/3	764974
GNL 161A/M*	E. of Einoni Hill	85/3	760984

* Greisenised pegmatitic granites

Group 2. Muscovites from granite pegmatites (excluding late mica rock or greisen units)

Sample No.	Locality	Locality No.*	Map Reference	
			Sheet No.	Co-ordinates
MO	Nyanga-Rwentare	32	85/3	833926
MOA	Sheshe	34	85/3	854928
M1	Burama-Kabezi	54	94/1	913693
M8	Nyabushenyi	8	85/3	885994
M9	Kabiga-Rukanda	51	94/1	930772
M10	Kaguro (Karabuga)	42	85/3	875967
M15	Nyakabingo	49	94/1	938893
M16	Kyobugombe	4	94/1	818933
M17	Rweibango	5	85/3	837994
M18	Ntungamo (beryl prospect)	13	85/4	970037
M19	Omukeijenge I.	16	85/4	005973
M20	Omukeijenge II.	16	85/4	002971
M26	Kihumuro	47	85/3	938934
M32	Irenga	-	85/3	912011
M33	Bitaka	17	85/4	026966
M44	Kakoki I.	6	85/3	863998
M45	Kakoki II.	6	85/3	864998
M46	Kakoki III	6	85/3	864000
M56	Nyabushenyi West	8	85/3	885994
M59	Ruyonza	25	85/3	797897
M60	Lr. Kihungye	1	85/3	688991
M61	Lr. Kihungye	1	85/3	688991
M64	Murambi I.	50	94/2	------
M73	Kigara	55	94/1	903667

* see fig. 4 .

Group 3. Muscovites from quartz-mica veins and mica rock or greisen units in pegmatites

Sample No.	Locality	Locality No.	Map Reference Sheet No.	Map Reference Co-ordinates
MOC	Kyamugashe (new columbite prospect)	43*	85/3	901958
MOR2	Rwemeriro	37*	85/3	874910
M6	Nyabushenyi	8*	85/3	885994
M7	Nyabushenyi	8*	85/3	885994
M28	Kazumo North	18*	85/4	042977
M29	Kazumo North	18*	85/4	042977
M30	Kazumo South	18*	85/4	041976
M34	Bitaka	17*	85/4	026966
M35	Rwenyena	6**	85/4	011972
M36	Lwata II	9**	85/4	053975
M39	Kashojwa (columbite workings)	5**	85/4	967928
M40	" " "	5**	"	"
M41	Kashojwa (tin-columbite workings)	5**	85/4	967932
M47	Kanyina	11**	85/4	174015
M52	Ruhuma (tantalite prospect)	56*	94/1	885663
M53	Ruhuma	56*	94/1	887665
M54	Kyamugasi-Kamira	44*	85/3	896950
M55	Kyamugasi-Kamira	44*	"	"
M57	Nyamarebe	40*	85/3	866937
M58	Nyamarebe	40*	"	"
M72	Kitofa	57*	94/3	------

* = pegmatite locality see fig. 4 .

** = quartz-mica vein see fig. 6 .

Group 4. Muscovites from hydrothermal quartz cassiterite-bearing veins

Sample No.	Locality	Locality No.*	Map Reference	
			Sheet No.	Co-ordinates
M2	Burama Ridge	16	94/1	909691
M4	" "	16	"	"
M5	" "	16	"	"
M13	Rutunguru	1	85/3	878053
M14	"	1	"	"
M21	Mwirasando	7	85/4	095905
M22	"	7	"	"
M23	"	7	"	"
M25	"	7	"	"
M37	Kashojwa (tin workings)	3	85/4	965926
M42	Muti	-	85/1	820205
M43	"	-	"	"
M62	Rwemikoma	10	85/4	107896
M65	Namaherere	5	85/4	005910
M66	"	5	"	"
M67	"	5	"	"
M68	"	5	"	"
M69	"	5	"	"
M70 (K)	Kikagati	11	86/3	-------
M71	Kyabwato	8	85/4	216024

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* see fig. 9 .

Group 5. Lithian muscovites from granite pegmatites

Sample No.	Locality	Locality No.*	Map Reference Sheet No.	Map Reference Co-ordinates
MOR1	Rwemeriro	37	85/3	874910
MOR3	"	37	"	"
M11	Mutaka - Kabira	-	"	"
M12	" "	-	"	"
M27	Kazumo North	18	"	"
M31	Kazumo (road location)	18	85/4	040077
M31A	" " "	18	"	"

* See fig. 4 .

Miscellaneous micas

Sample No.	Locality	Locality No.*	Map Reference Sheet No.	Map Reference Co-ordinates
M48	Kanyina	11	85/4	174015
TGNL 1/M	Kasanyi, N.W. Tanzania	-	----	------
GNL 48A/M	Ngoma-Rwentobo	-	94/1	893726

* See fig. 6 .

APPENDIX III

ANALYTICAL TECHNIQUES

APPENDIX III

ANALYTICAL TECHNIQUES

IIIa. SAMPLE PREPARATION

1. ROCKS

a. Collection

Over 240 samples of rock were collected for geochemical analysis. Care was taken to ensure that the material collected was as fresh as possible and that the samples were truely representative. A sledge hammer and chisel were used to obtain most of the samples but explosives were used to blast open large boulders of granite to obtain fresh material. Approximately 3 kg. of rock was collected from each locality together with representative hand specimens.

b. Preparation for analysis

Initial preparation

The samples were broken into fragments using a hammer and were then hand crushed to approximately - 2 mm. particle size using a mild steel pestle and a flat steel plate as a mortar. The crushed samples were then quartered and 2 500 g. portions of each were packed into 10" x 4" paper geochemical sample bags for transport to the lab.

Preparation for Spectrographic analysis (by Uganda Geological Survey)

The samples were quartered to obtain 20 gram portions and these were presented to the Uganda Geological Survey for final hand-grinding prior to analysis.

Preparation for X-ray fluorescence and wet chemical analysis

The crushed samples were quartered to obtain 50 - 100 gram portions and these were ground to - 150 mesh in a 'Tema' mill (with a Colmonoy lined barrel). The high speed setting was used and the time required for grinding varied from 2-10 mins. depending on the amount of mica present. The sample powders were sieved to check that they were sufficiently finely ground and any coarse material left in the sieves was returned to the 'Tema' mill for regrinding. Nylon sieve sheets in plastic frames were used instead of brass sieves to avoid the possibility of tin contamination (N.B. solder which contains tin is used in securing the mesh to the sieve frame).

2. MUSCOVITES

a. Collection

Over 100 samples of muscovite bearing material were collected which included:-

I. Muscovite books - from granite pegmatites

II. Mica rock or "greisen" - (compact aggregates of medium to coarse grained muscovite containing variable amounts of quartz) - from pegmatites, quartz mica cassiterite bearing veins and hydrothermal quartz cassiterite bearing veins.

III. Pegmatitic granite - containing small books of muscovite.

Approximately 500 grams of fresh material were collected from each locality and the samples were packed in 6" x 6" cloth sample bags for transport to the lab.

b. Preparation for analysis. (Disaggregation and separation)

I. Muscovite books

These were split along cleavage planes into numerous thin sheets and any stained or weathered sheets were discarded. The remaining sheets were then trimmed with shears to remove frayed or stained edges and only transparent, inclusion free portions were retained. The selected sheets were cut into small squares (2 x 2 mm. in diameter) and the cuttings were washed three times in distilled water and then oven-dried at 110°C. 10 to 30 grams of pure material was obtained from each sample treated.

II. Mica rock and "greisen"

The samples were broken into $\frac{1}{2}$"-1" fragments using a hammer and steel plate, and mica - rich fragments were separated from quartz-rich fragments by hand picking. The mica rich material was then carefully crushed using a roller crusher with the rollers set close together. (1/16" gap). A roller crusher was used in preference to any other type because it was found that the rollers crushed any quartz and other brittle minerals to fine powder while allowing the mica to pass through unharmed. As a result the mica flakes remained large and could be separated from the crushed quartz by means of a single sieving. Polyethylene sieves (made by drilling holes of suitable diameter in the base of plastic food containers) were used (to avoid tin contamination) and the coarse mica fractions collected were found to be about 99% pure. About 50-100 grams of pure mica were obtained from each sample treated.

The mica concentrates were washed three times with distilled water, oven dried, and any quartz fragments still present in the samples were removed by hand picking before final grinding.

In a few cases the mica released on disaggregating the samples was found to be too fine grained to allow separation from the quartz by sieving only and an electrostatic method (devised by the writer) was employed instead. The crushed samples were spread out on large sheets of paper and the micas were separated as follows:

The apparatus consisted of an ex-army 10"x8" map case with a hinged celluloid cover sheet and a "Paxoline" back-board. It was found that the celluloid cover sheet could be strongly charged by rubbing with a 'flannellette' cloth. If the celluloid cover sheet was then slowly pulled away from the back board while holding the map case face down, 2 to 3 inches above the sample to be separated, the muscovite was found to be electrostatically attracted to the celluloid sheet and could be selectively lifted from the sheet of paper. If a little quartz was also attracted to the celluloid sheet this could be removed by tapping the map case gently. When the celluloid cover sheet was then returned to its original position the charge was found to disappear and the mica collected could be shaken off. It was found that by repeating the operation several times substantial amounts of muscovite could be separated from quartz or any other mineral with a low dielectric constant.

III. Pegmatitic Granites

In order to separate mica from the pegmatitic granites the samples were crushed to 2 mm. maximum grain size using a flat ended steel pestle and a steel plate as a mortar. The crushing was carried out using vertical strokes only and the resulting action was found to reduce the brittle minerals to powder leaving larger muscovite flakes undamaged. The samples were then sieved and the coarse fractions were found to contain up to 60% of muscovite. Hand picking was then used to complete the separations and the muscovite concentrates were washed and dried before final grinding.

Final grinding of the separated muscovite samples.

The method of grinding employed depended on the amount of pure muscovite obtained after separation.

Small samples (1 - 10 grams) were ground to - 100 mesh using a 'Glen Creston' mixing mill with a tungsten carbide grinding cylinder and the time required was 30 minutes to 1 hour per sample.

Large quantities of material (10 - 100 grams) were ground using a 'Tema' mill with a colmonoy lined barrel. It was found that 100 grams of ¼ inch flakes of muscovite could be ground to an impalpable powder in 20 minutes using the high speed setting.

Samples which were required completely free from any contamination from grinding machinery (chromium, nickel and boron from the 'colmonoy' barrel of the 'tema' mill, and tungsten and carbon from the tungsten carbide grinding cylinder of the 'Glen Creston' mill) were ground to - 100 mesh using an agate pestle and mortar. The time required was three to four hours for a 5 gram sample.

IIIb. ANALYSIS

1. ROCKS

a. Spectrographic Analysis

Over 240 samples of rock were analysed spectrographically by the Uganda Geological Survey for fourteen elements including tin and beryllium. (Cu, Pb, Mn, Sn, Co, Ni, Mo, Ag, V, Ti, Cr, Ga, Nb, Be).
The precision of the method employed expressed as relative deviation was approximately 25% and the results were sufficiently accurate to be used to show the (approximate) distribution of these elements in the rocks of S.W. Ankole.

b. X-Ray fluorescence analysis

Thirteen samples of pegmatitic granite were analysed for - SiO_2, TiO_2, Al_2O_3, Fe_2O_3, MnO, MgO, CaO, Na_2O, and P_2O_5.

Sample preparation

The powdered rock samples were prepared for analysis by briquetting the neat powders with a 2:1 cellulose/stearic acid backing in a hydraulic press. A relatively low pressure (10-15 tons) was used as the samples contained a high percentage of silica. If higher pressures were used (15-25 tons) the briquettes cracked or burst on removing from the press.

Standards

12 samples of chemically analysed rock ranging from 'acid' (74% SiO_2)

to 'intermediate' (50% SiO_2) composition were used as standards and were similarly prepared to the samples.

Procedure

The standards were run through the X-ray machine prior to the samples for each element analysed and standard calibration lines were plotted from which the concentrations of the elements in the samples could then be obtained. The standard samples when plotted were often found to show an appreciable scatter and the "best fits" for the calibration lines were worked out using the method of least quares (see Table 24).

The samples were run through the machine in batches of four and the standard containing the highest concentration of the element being analysed was inserted after each batch to enable corrections to be made for instrument drift. The number of counts/minute obtained for each sample were corrected for drift and the percentages of the elements present were obtained either graphically by direct reference to the calibration lines or were calculated using the formula: $y = mx + c$ for each of the least square calibration lines

where: $y =$ percentage of element (oxide) required
$m =$ slope of the least square calibration line
$x =$ number of counts/minute above background obtained for sample
$c =$ a constant

(see also table 46).

The results were not corrected for mass absorption effects as they were only required to be sufficiently accurate to show any major variations in the chemical compositions of the samples.

Experimental conditions

The apparatus used was a Siemens 'Kristalloflex - 4', X-ray fluorescence machine linked to a direct printout for recording counts and counting time.

Pulse height discrimination was used to cut out unwanted background for the determination of all the 'light' elements (Na - Ca) and was found particularly useful in the case of phosphorous where it is necessary to separate the $K\alpha$ P line 2θ 29.5° from the second order $K\alpha$ Ca line - 2θ 27.0°.

The operating conditions (for the X-ray machine) used in determining

TABLE 46 . FORMULAE FOR CALCULATION OF LEAST SQUARE LINES

$$m = \left[\frac{N\Sigma xy - \Sigma x\Sigma y}{Nx^2 - (\Sigma x)^2}\right]$$

$$c = \left(\frac{\Sigma y}{N}\right) - m\left(\frac{\Sigma x}{N}\right)$$

$$y = mx + c$$

m = Slope of least square line.

x = Number of counts/minute above background obtained for sample.

y = Percentage of element (oxide) in standard.

N = Number of standards.

c = Intercept of least square line on y axis.

TABLE 47. OPERATING CONDITIONS USED FOR DETERMINING MAJOR AND MINOR ELEMENTS IN GRANITES

ELEMENT	Na	Mg	Al	Si	P	K	Ca	Ti	Mn	Fe
TUBE	CHROMIUM							TUNGSTEN		
ANALYSING CRYSTAL	KAP						GYPSUM	LiF (200)		
COLLIMATOR	COARSE 0.4°				FINE 0.15°			FINE 0.15°		
SPECTROMETER MEDIUM	VACUUM							AIR PATH		
COUNTER	GAS-FLOW PROPORTIONAL 90% ARGON 10% METHANE							SCINTILLATION		
EMISSION LINES USED	K (K_1, K_2 UNRESOLVED)									
2θ (MEAN)	53.2	43.7	36.5	31.1	26.7	16.3	25.6	86.1	63.0	57.5
ACTUAL GONIOMETER SETTING PEAK°	53.52	43.92	36.82	31.36	27.12	16.50	25.41	86.10	62.92	57.46
GONIOMETER SETTING BACKGROUND	54.50	44.94	37.90	31.54	26.10	15.80	24.40	85.00	64.50	59.00
X-RAY TUBE VOLTAGE KV	40	40	40	40	40	40	40	40	40	20
X-RAY TUBE CURRENT m/a	50	50	50	40	50	40	40	40	40	20
COUNTER VOLTAGE	1,905	1,905	1.860	1,940	1,910	1,770	1,755	1,170	1,120	1,110
WINDOW V.	15	10	10	12	6	10	10	10	10	10
BASELINE V.	5	8	5.0	100	10	5.0	5.0	5.0	5.0	5.0
COUNTING TIME PEAK MINUTES	2 x 1	2 x 1	2 x 1	2 x 1	2 x 1	2 x 1	2 x 1	2 x 1	2 x 1	1 x 1
COUNTING TIME BACKGROUND MINUTES	2 x 1	2 x 1	2 x 1	2 x 1	2 x 1	2 x 1	2 x 1	2 x 1	2 x 1	-

each element are presented in table 47.

c. Colorimetric analysis

Over 50 samples of rock were analysed colorimetrically for total and/or 'acid soluble' tin using the writers method of analysis (see p.231).

2. MINERALS

a. Spectrographic analysis

91 samples of mica were analysed for lithium using a method employing internal standardisation. Potassium (which had been determined by chemical and x-ray flourescence analysis) was used as a variable internal standard for the determination of lithium.

The apparatus and experimental conditions can be summarised as follows:

Spectrograph	Hilger and Watts Large Automatic Quartz-Glass E.478 Spectrograph.
Optics	Arc focussed on slit with a Hilger F.958 lens, the lens incorporated in the step sector was removed. Glass prism, simple slit; mask at collimator with a rectangular aperture 6.3 cms. wide and 1 cm. high.
Slit Width	10 μ.
Step Sector	Seven step; 2:1 ratio; Hilger and Watts No. 698.
Wavelength Recorded	6,700 - 8,900 Å (approx.).
Exitation	D.C. arc, sample electrode as anode.
Electrodes	ANODE. $\frac{1}{4}$" diameter ordinary grade graphite rod; crater $\frac{3}{32}$" inside diameter x $\frac{1}{8}$" outside diameter x 2 mm. deep. CATHODE. $\frac{1}{8}$" diameter machined carbon rod with flat end.
Sample	Undiluted powdered mica (over dried 110°C, 3 hours).
Current	$2\frac{1}{2}$ amps for first five seconds then 3 amps.
Plate	Kodak IR:ER 10 x 4" cut into quarters ($2\frac{1}{2}$ x 4"); developed 6 minutes in 'Kodak' D.19b diluted 1:2 with water, fixed 10 minutes, washed at least 30 minutes rinsed with 'Photo-Flo' solution.
Exposure	Until end of alkali distillation phase. Average 3 minutes at 3 amps.

Densitometer Hilger and Watts L 459 recording microphotometer.

Spectral lines measured Li 8126, K 6911

Standards

Six standards covering the range 0-7000 ppm. Li_2O were prepared using the addition method. 'Specpure' Li_2CO_3 was added to a muscovite (of known K_2O content and very low lithium content) to produce a 10,000 ppm. Li_2O standard and this was then diluted with further aliquots of muscovite to produce the required standards.

Procedure

A standard plate was prepared and the optical density of the Li 8126 and K 6911 lines were measured using a recording microphotometer and the microphotometer readings were coverted to their Seidel functions. The self calibration method of Ahrens and Taylor (1961, Chapter 11) was used to obtain the relative intensities of the Li and K lines.

The intensity ratios of the Li 8126 and K 6911 lines were plotted against the amount of Li_2O added for each standard and the resulting straight line graph was extrapolated to obtain the amount of Li_2O in the mica used in preparing the standards. The result obtained was then added to each of the standards to obtain their total Li_2O contents.

The intensity ratios $I \frac{\text{Li } 8126}{\text{K } 6911}$ were then plotted against the ratios of concentration of Li_2O and K_2O for each standard (on log/log graph paper) to obtain a working curve.

Sample plates were next prepared and the optical density of the Li 8126 and K 6911 lines were measured and the intensity ratios obtained as for the standards. The intensity ratios $I \frac{\text{Li } 8126}{\text{K } 6911}$ for the samples were then plotted on the working curve and the ratio of the concentration in ppm $\frac{Li_2O}{K_2O}$ for each sample was read off the graph.

This ratio was then multiplied by the potassium content of the sample (known from chemical or X-ray fluorescence analysis) to obtain the concentration of Li_2O present.

b. X-ray fluorescence analysis

62 samples of mica were analysed for sodium and potassium and 91 samples were analysed for rubidium and caesium using x-ray fluorescence techniques.

Sample preparation

Finely powdered micas (-150 mesh) were prepared for analysis by briquetting with a backing of cellulose and strearic acid (2:1 mixture) at 15 tons pressure in a hydraulic press.

Standards

Sodium and potassium

These elements were determined by using samples previously analysed by flame photometry as standards.

The standards were run through the x-ray machine prior to the samples and calibration 'lines' were plotted, from which the amount of the elements (oxides) present in the samples could be obtained.

In the case of potassium there was an appreciable scatter of points on the calibration graph and the calibration line was drawn after calculating the best fit by the method of least squares.

Rubidium and caesium

Standards were prepared for these elements using the addition method. Concentrated standards containing 100,000 ppm Rb and 10,000 ppm Cs were first made by mixing appropriate quantities of 'specpure' rubidium carbonate and caesium carbonate with a muscovite known to contain only small quantities of these elements. The concentrated standards were then diluted with further aliquots of muscovites until standards covering the required concentration ranges of Rb and Cs had been obtained (0 - 20,000 ppm Rb and 0 - 5,000 ppm Cs).

The standards were run through the x-ray machine prior to the samples and the number of counts obtained were plotted against the amounts of Rb and Cs added for each standard. The resulting straight line graphs were extrapolated to obtain the amount of Rb and Cs originally present in the micaused in preparing the standards. The figures obtained were then added to the standards to obtain their total Rb and Cs contents, and a calibration 'line' was then plotted from which the concentrations of Rb and Cs in the samples could be obtained. (The values of Rb and Cs obtained for the samples were converted to Rb_2O and Cs_2O by multiplying by the appropriate gravimetric factors Rb - Rb_2O = 1.0936. Cs - Cs_2O = 1.0602).

Procedure

The procedure used for analysis of the mica samples was the same as that used for rocks (see p. 215). The operating conditions used in determining each alkali element are presented in table 48.

c. Flame photometry

29 samples of mica were analysed for sodium, potassium and lithium using an 'Eel' flame photometer. The method used was that normally employed in 'rapid' analysis of silicates.

Balanced standards were used which contained Na_2O, K_2O, and Li_2O in the same proportions as are found in natural muscovites. This was to minimise any possible enhancement effects of one alkali on another.

The results obtained for sodium and potassium were good and the precision of the method for these elements expressed as relative deviation was found to be better than 5%. The results obtained for lithium were unsatisfactory except in the case of lithian muscovites containing $> 0.5\%$ LiO. The sensitivity of the flame photometer was found to be insufficient to determine the concentration of Li_2O present in the majority of samples, (0-0.3% Li_2O).

d. Colorimetric Analysis

Tin

82 samples of mica were analysed colorimetrically for total and 'acid soluble' tin using the writers method of analysis (see p. 231).

Fluorine

91 samples of mica were analysed for fluorine using a rapid spectrophotometric method developed by W.H. Huang and W.D. Johns (1966). The samples were decomposed by fusion with a mixture of sodium carbonate and zinc oxide and the fluorine was determined without separation utilising zirconium-eriochrome cyanine R. Standard solutions containing 0-80 μg F were prepared using anhydrous sodium fluoride and these were used to construct a working curve. The accuracy and reproducibility of the method were checked by carrying out replicate analysis on a lithian muscovite known to contain 4.37% Li_2O and the results (4) were all found to lie within 5% of this value.

Notes on experimental procedure

I. Owing to the relatively high concentrations of fluorine (up to 4.5%) present in some of the micas it was found necessary to use smaller quantities of samples and higher dilutions of sample solutions than were recommended by Huang and Johns. 0.1 - 0.2 grams of sample were weighed out with

TABLE 48. OPERATING CONDITIONS USED IN DETERMINING ALKALIS IN MICAS

ELEMENT	Na	K	Rb	Cs
TUBE	CHROMIUM		TUNGSTEN	
ANALYSING CRYSTAL	KAP	GYPSUM	LiF (200)	
COLLIMATOR	COARSE 0.40	FINE 0.15°	FINE	
SPECTROMETER MEDIUM	VACUUM		AIR PATH	
COUNTER	GAS FLOW Proportional	90% ARGON 10% METHANE	SCINTILLATION	
EMISSION LINES USED	K (K_1, K_2 UNRESOLVED)			
2θ° (MEAN)	53.2	28.54	26.64	11.43
ACTUAL GONIOMETER SETTING PEAK°	53.49	28.45	26.58	11.41
GONIOMETER SETTING BACKGROUND	54.80	-	25.84* 27.31	11.10* 11.70
X-RAY TUBE VOLTAGE KV	45	45	30	50
X-RAY TUBE CURRENT m/a	46	44	30	38
COUNTER VOLTAGE	1,935	1,860	1,075	980
WINDOW V	15	13	10.0	10.0
BASELINE V	5	10	9.5	5.0
COUNTING TIME PEAK MINUTES	5 x 1	2 x 0.4	2 x 1	2 x 1
COUNTING TIME BACKGROUND MINUTES	5 x 1	-	1 x 1 1 x 1	2 x 1 2 x 1

* Sloping background required readings to be taken above and below 2θ for the peak.

1.75 grams of sodium carbonate and 0.30 grams of zinc oxide and the sample solutions were diluted to 250 or 500 mls. before taking a 5 ml aliquot for determination.

II. A steady drift in the optical density of the standard and sample solutions with time was observed to occur. It was therefore necessary to measure the absorbances of the standard and sample solutions after a fixed interval of time. The optimum time was found to be 1¼ hours after addition of the colorimetric reagents, and was sufficient to allow for elimination of aluminium interference (see Huang and Johns p. 510).

A New Method for the Determination of Small Amounts of Tin in Rocks and Minerals

IVa. Research and Development

In 1965 the writer carried out tin determinations on about 25 samples of tourmalinised K-A country rocks (which included tin bearing material collected from adjacent to mineral deposits), using R.E. Stanton and Alison J.Mc. Donald's 1961 field method of analysis. The range of results obtained was 0.0 - 22.5 ppm. of tin.

In 1966, the Uganda Geological Survey carried out spectrographic determinations of tin on over 70 similar samples of K-A schists (which were collected by the writer as part of a regional reconnaissance survey) and the range of values obtained was 5.0 - 240 ppm.Sn. The spectrographic results were on average so much higher than those obtained using Stanton and Mc Donald's method, that it was concluded that their method had failed to detect a large proportion of the tin present in the samples analysed.

Tests were therefore carried out on a granite (GNL 48A) known to contain 32.0 ppm. Sn ± 5 ppm*, to determine the proportion of tin detectable using Stanton and McDonalds method.

100 grams of the granite GNL 48A, were ground to -120 mesh in a 'Tema' disc mill and a small portion was analysed for tin using the procedure recommended by Stanton and McDonald, 1961 and 1966. The result obtained was 4.0 ppm.Sn. The remainder of the 100 gram sample was then returned to the Tema mill and ground for six successive five minute periods and the results for samples taken after each grinding period appear on table 49. The maximum value of tin obtained was 19.0 ppm. - still well below the true tin content of the sample. Repeat analyses were also carried out on the finest ground portion of the sample using finely powdered ammonium iodide flux instead of coarse crystals and the sample was also titurated with the ammonium iodide before analysis to ensure intimate mixing. The results obtained remained at 19.0 ppm.Sn.

The tests were repeated on a second sample containing 38 ppm.Sn (GNL 44), and in this case a maximum of 29 ppm was detected, (see table).

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* Sample analysed spectrographically by Dr. J.M. Rooke, Department of Earth Sciences, Leeds University.

TABLE 49 SHOWING INCREASE IN THE AMOUNT OF TIN RELEASED BY PROGRESSIVE GRINDING OF ROCK SAMPLES

Sample No.	GNL 48A/1	48A/2	48A/3	48A/4	48A/5	48A/6	48A/7
Grinding Time (Minutes)	10	15	20	25	30	35	40
Particle Size (Microns)	-125	-	-	-37	-	-20	-
Tin Detected (ppm.)	4.0	6.0	7.5	11.0	15.0	16.0	19.0

Sample No.	GNL 44/1	44/2	44/3	44/4	44/5	44/6	44/7
Grinding Time (Minutes)	10	15	20	25	30	35	40
Particle Size (Microns)	-125	-	-	-37	-	-20	-
Tin Detected (ppm.)	12.5	12.5	21.0	21.0	21.0	25.0	29.0

The results show that Stanton and McDonald's method failed to detect the full tin content of the samples even when ground to -800 mesh. The method was however primarily designed as a field technique for determining tin in geochemical soil and stream sediment surveys. The sample attack using ammonium iodide is designed to attack free cassiterite present in the samples and cannot release any tin trapped in the lattices of silicate minerals.

An attempt was therefore made to increase the effectiveness of the sample attack by carrying out two successive heatings each with 1.0 gram of ammonium iodide. At the end of the second heating (when the sublimation of iodides had nearly ceased) the temperature at the base of the test tube was raised to bright red heat in an oxy-coal gas flame to cause the sample to melt.

The results were no improvement on those obtained using the recommended technique of Stanton and McDonald. Apart from the failure to detect all the tin present in the samples another difficulty that was encountered with the method was that samples containing high concentrations of iron could not be analysed as yellow tinted colours were produced with gallein which could not be matched properly with the standards.

It was therefore decided to abandon the method of analysis and to try to find an alternative technique for determining tin in the samples collected.

A sensitive method was required particularly for the granitoid rocks as they normally contain very low concentrations of tin (3-5 ppm) and tin bearing granites are distinguished from non tin bearing granites if they contain 15-32 ppm.Sn, (V. Barsukov 1957, G.F. Ivanova 1963, and J.H. Rattigan 1963).

Optical spectrography could possibly have been used (maximum sensitivity) 10 ppm. for Sn) but facilities were not available at the time. X-ray fluorescence analysis was ruled out as being insufficiently sensitive and the minimum quantity of tin that can be quantitatively determined was found to be 40 ppm.

A search of the literature revealed that several chemical methods of analysis exist for the determination of traces of tin in rocks, soils and minerals, but none take into consideration the fact that in some cases, tin may be present both as cassiterite and lattice or other forms of tin.

Agrinier, H. 1963
Carmicheal, S.E. 1961
Curtis, P.G. 1961
Lounamaa, K. 1957
Martinet, B. 1961
McDonald, A.J. and Stanton, R.E. 1962
Stanton, R.E. 1961 and 1966
Ward, F.N. et.al. 1963
Wood, G.A. 1956 and 1959

The methods of sample attack either involve heating with ammonium iodide which only attacks cassiterite, or solution of the sample in a mixture of hydrofluoric and sulphuric acids which releases tin from the silicates but leaves any cassiterite undissolved (The writer has confirmed by experiment that cassiterite is almost insoluble in hydrofluoric and sulphuric acids. see p.229).

The writer therefore decided to try out various forms of sample attack which would decompose both cassiterite and the silicates present in the samples. Before carrying out the various forms of sample attack it was necessary to find a method of separating the tin from other elements released on decomposition of the sample which would seriously interfere with the colorimetric determination of the tin.

A search of the literature revealed many methods for the separation of small quantities of tin. The most rapid, selective and efficient method available at the time (February 1967) was that of D.D. Gilbert and E.B. Sandell 1960, which involved separation of tin by benzene extraction of stannic iodide. It was also found that this method of extraction could be easily linked to Stantons and McDonalds colorimetric method of tin using gallein.

Several methods of sample decomposition were tried out, followed by extraction of the tin using benzene and colorimetric determination with gallein.

Alkali fusions were tried first as these attack both silicates and cassiterite, The fusions do not however remove silica and it was found that as soon as the sample solutimn was acidified for extraction with benzene (with perchloric acid) a silica gel formed which interfered with the successful extraction of the tin. It was found that very low results were obtained for sample GNL 48 A (12-17 ppm) and the low results are believed to be due to adsorption of the tin onto the silica gel.

It was realised that the only method of sample attack which could be used is one in which silica is removed during decomposition of the sample. A new and very effective method of sample decomposition devised by V.S. Biskupsky 1965, was tried next and involved fusion of the samples (GNL 48 A) with lithium fluoride and boric acid at bright red heat. Tin was separated from the resulting solution by means of an ammonia precipitation (co pptn of Sn with $Fe(OH)_2$ carrier), followed by benzene extraction, and was then colorimetrically determined using gallein. (Preliminary separation of tin using the ammonia precipitation was necessary as the sample solution contained large amounts of sulphates (Li_2SO_4) derived from the fusion mixture which would otherwise have interfered with the benzene extraction).

The results obtained were again low < 20 ppm. which was surprising in view of the efficiency of the fusion method. Examination of the conditions involved in the fusion however revealed that it is possible that tin might be lost by volatilisation. During the fusion the sample is heated to 800-850°C and reaction between the lithium fluoride and boric acid in the flux forms lithium tetraborate and generates hydrogen fluoride. The HF reacts with the silica present to form SiF_4 which volatilises. Unfortunately any tin present will also react with the hydrogen fluoride to form SnF_4 which has a boiling point of 705°C. As the fusion requires a high temperature (800-850°C tin is probably lost by volatilisation as SnF_4) The results show that the Biskupsky fusion cannot be used as tin is probably lost by volatiliaation. The only remaining method of sample decomposition which could be tried was digestion of the sample in a mixture of hydrofluoric and sulphuric acids at 100°C (to remove SiO_2) followed by some other form of attack on any cassiterite left behind.

Two possibilities were considered

1. Digestion of sample in hydrofluoric and sulphuric acids followed by a bisulphate fusion, (J.P. Riley, 1958). In this method the solution obtained in stage 1 is centrifuged, decanted off, and any residue remaining in the centrifuge tube is washed and then transferred back to a platinum crucible and fused with potassium pyrosulphate.

   This method was not tried as it was thought to be impracticable to try to carry out two transfers of microgram quantities of cassiterite without incurring some loss.

2. Digestion of sample in hydrofluoric and sulphuric acids followed by reduction of any cassiterite present with nascent hydrogen in the presence of zinc. This method was devised by the writer and operates on the principle of the qualitative 'tinning test' for cassiterite. It is well known that if cassiterite is treated with dilute hydrochloric acid in the presence of metallic zinc it rapidly becomes coated with a layer of metallic tin which can then be dissolved in excess acid. The writer considered that if cassiterite were present in the sample solution in finely divided form it might be possible to obtain complete solution by means of the above reaction. Tests were carried out to see if the method would work.

Two samples of GNL 48 A were first dissolved in a hydrofluoric - sulphuric acid mixture and the tin released was separated from the resulting solution (using benzene) and was determined colorimetrically. The results obtained were 22.5 and 25.0 ppm.

A further two samples were then dissolved in hydrofluoric and sulphuric acids but the solutions obtained were also treated by adding half a gram of metallic zinc and five mls. of concentrated hydrochloric acid. The zinc was added slowly fragment by fragment over a period of $\frac{1}{2}$ an hour allowing evolution of hydrogen to cease before each new addition. (This was to allow alternate formation and solution of metallic tin to take place on the surface of any cassiterite grains present thus causing them to be completely dissolved).

The resulting solution was then warmed to ensure complete solution of any metallic tin present and after the addition of ferric alum (to raise the iron content of the solution) the tin was separated by means of an ammonia precipitation (Sn pptd on $Fe(OH)_2$ as a carrier), followed by benzene extraction. (An ammonia precipitation had to be carried out to remove zinc and chlorides present (including HCl) as these seriously interfere with benzene extractions). The tin recovered was then determined colorimetrically in the usual way. The results were most encouraging and both samples were found to contain 35.0 ppm.Sn - a value very close to that obtained spectrographically (32 ppm. ± 5 ppm.) Repeat analyses all managed to produce results lying within 5 ppm of the spectrographically determined value. Reagent blanks were also analysed for tin and none were found to contain more than 5 ppm.Sn.

The method was also tested on several samples of another granite (GNL 43 C) which contains 78 ppm of tin and from which macroscopic fragments of cassiterite have also been obtained. The following results were obtained.

Sample No.	Treatment	Result
GNL 43C/1	HF/H_2SO_4only	
	Benzene Extraction	50 ppm
	Colorimetric Determination	
GNL 43C/2	HF/H_2SO_4	80 ppm
GNL 43C/3	ZN/HCl	80 ppm
	Ammonia pptn (Fe carrier)	
	Benzene Extraction	
	Colorimetric Determination	

The results prove that a good method of decomposing rocks and minerals containing small quantities of cassiterite, is solution in a mixture of hydrofluoric and sulphuric acids followed by reduction of any cassiterite present using zinc and hydrochloric acid.

It was decided to adopt this method for all the rock and mineral samples collected by the writer which required analysis for tin and the results are presented in tables 50-54 In each case both total tin, and the amount of tin released by decomposition in HF and H_2SO_4 only, were determined to enable the amount of cassiterite present to be calculated. The results (see tables 50 - 54) show that a substantial proportion of the samples analysed contain small quantities of cassiterite that would have escaped detection if the treatment of the sample solutions with Zn/HCl had been omitted. In some cases where the total and 'acid soluble' tin contents of the sample are very close the difference must be attributed to experimental error. It is of interest that most of the tin detected in the samples analysed, occurs in a form which is released when the samples are dissolved in hydrofluoric and sulphuric acids.

The writers method of sample decomposition has been found to be a substantial improvement on that of Stanton and McDonald (for rocks and minerals) in that the total tin content of the samples analysed can be obtained. Comparison of the results obtained with those obtained using Stanton and McDonalds method (see table 55 and 56), shows that only a small proportion of the tin

TABLE 50. RESULTS OF TOTAL AND 'ACID SOLUBLE' TIN DETERMINATIONS ON K-A COUNTRY ROCKS FROM S.W. ANKOLE

Rock No.	Total Tin ppm.	'Acid soluble' Tin ppm.	Difference ppm. (cassiterite)
SHL 5	50	40	10
SHL 6	15	15	0
SHL 7	40	25	15
SHL 8	150	113	37

TABLE 51. RESULTS OF TOTAL AND 'ACID SOLUBLE' TIN DETERMINATIONS ON GRANITOID ROCKS FROM S.W. ANKOLE

Rock No.	Total Tin ppm.	'Acid Soluble' Tin ppm.	Difference ppm. (Cassiterite)
GNL 2A	6	6	0
GNL 8A	14	5	9
GNL 14	10	8	2
GNL 18	10	10	0
GNL 25	10	8	2
GNL 26	38	25	13
GNL 27	10	6	4
GNL 29	10	10	0
GNL 30	213	200	13
GNL 36	5	5	0
GNL 37	9	9	0
GNL 38	5	5	0
GNL 40	5	6	0
GNL 43C	80	50	30
GNL 43F	50	40	10
GNL 43H	50	35	15
GNL 44	33	25	8
GNL 45B	90	90	0
GNL 48A	35	24	11
GNR	23	16	7

TABLE 52. RESULTS OF TOTAL AND 'ACID SOLUBLE' TIN DETERMINATIONS ON MICAS FROM THE MINERAL DEPOSITS OF S.W. ANKOLE

Mica No.	Total Tin ppm.	'Acid Soluble' Tin ppm.	Difference ppm. (Cassiterite)
MO	150	125	25
MOA	138	125	13
MOC	500	500	0
MOR1	125	125	0
MOR2	175	175	0
MOR3	400	350	50
M1	130	130	0
M2	450	400	50
M4	500	450	50
M5	275	250	25
M6	375	350	25
M7	450	450	0
M8	175	60	115
M9	375	375	0
M10	70	70	0
M11	450	400	50
M12	500	500	0
M13	338	338	0
M14	500	450	50
M15	8	8	0
M16	45	45	0
M18	500	500	0
M19	400	400	0
M20	400	250	150
M21	425	400	25

Table 52. cont'd.

Mica No.	Total Tin ppm.	'Acid Soluble' Tin ppm.	Difference ppm. (Cassiterite)
M22	400	400	0
M24	600	425	175
M25	400	350	50
M26	200	188	12
M27	412	412	0
M28	212	212	0
M29	237	237	0
M30	150	150	0
M31	212	212	0
M31A	175	175	0
M32	125	100	25
M33	275	250	25
M34	550	550	0
M35	200	200	0
M36	400	400	0
M37	375	350	25
M39	375	350	25
M40	475	375	0
M41	425	375	50
M42	250	250	0
M43	375	250	125
M44	41	41	0
M45	40	40	0
M46	40	40	0
M47	475	400	75
M52	300	188	112
M53	300	100	200

TABLE 53. RESULTS OF TOTAL AND 'ACID SOLUBLE' TIN DETERMINATIONS ON MICAS FROM TIN BEARING PEGMATITIC GRANITE VEINS

Mica No.	Total Tin ppm.	'Acid soluble' Tin ppm.	Difference ppm. (cassiterite)
GNL 43C/M	550	500	50
GNL 43H/M	600	600	0
GNL 44 M	450	450	0
GNL 48A/M	350	275	75

TABLE 54. RESULTS OF TOTAL AND 'ACID SOLUBLE' TIN DETERMINATIONS ON MICAS SEPARATED FROM PEGMATITIC GRANITES

Mica No.	Total Tin ppm.	'Acid soluble' Tin ppm.	Difference ppm. (cassiterite)
GNL 14 M	18	13	5
GNL 18 M	100	88	12
GNL 25 M	50	50	0
GNL 26 M	125	125	0
GNL 27 M	100	75	25
GNL 28 M	60	55	5
GNL 29 M	35	30	5

TABLE 55. TO SHOW INCREASE IN THE AMOUNT OF TIN RELEASED FROM MUSCOVITES BY USING TOTAL SAMPLE DECOMPOSITION INSTEAD OF AMMONIUM IODIDE ATTACK

Sample No. M	Ammonium Iodide attack ppm. Sn.	Total decomposition ppm. Sn.	Sample No. M	Ammonium Iodide attack ppm. Sn.	Total decomposition ppm. Sn.
MO	18	150	M10	13	70
MOa	18	138	M11	138	450
MOc	50	500	M12	75	500
MOR1	25	125	M13	50	338
MOR2	6	175	M14	63	500
M1	50	130	M15	6	8
M2	63	450	M16	6	45
M4	88	500	M19	88	400
M5	33	275	M21	50	425
M6	75	375	M22	75	400
M7	100	450	M23	163	-
M8	25	175	M24	225	600
M9	83	375	M25	225	400

TABLE 56. TO SHOW INCREASE IN THE AMOUNT OF TIN RELEASED FROM K-A COUNTRY ROCKS BY USING TOTAL SAMPLE DECOMPOSITION INSTEAD OF AMMONIUM IODIDE ATTACK

Sample No. L	Ammonium Iodide attack ppm. Sn.	Total decomposition ppm. Sn.	Sample No. L	Ammonium Iodide attack ppm. Sn.	Total decomposition ppm. Sn.
L9	0	25	L28	0	10
L13	1	13	L41	1	-
L15	2	35	L42	1	13
L20	1	8	L44	2	30
L23	2	18	L46	10	40
L24	6	50	L47	6	45
L27	1	10	L48	3	25
L28	1	8	L49	14	100
L29	1	20	L50	4	25
L32	5	23	L56	9	60
L34	6	38	L57	0	5
L36	1	8	L60	23	25

present was being released by their method of sample decomposition.

Stanton and McDonalds method was however primarily designed for analysis of tin in soil and stream sediment samples in which most of the tin is present as finely divided free cassiterite, and the method has proved to be very effective in dealing with such samples.

A summary of the writer's original method for the decomposition of the samples and subsequent separation and analysis of tin appears below.

	'Acid Soluble' Tin	Total Tin
DECOMPOSITION OF SAMPLE	HF/H_2SO only	HF/H_2SO followed by ZN/HCl
SEPARATION OF TIN	Benzene Extraction (of Sn as SnI)	Ammonia precipitation (of Sn on Fe(OH) carrier) and Benzene Extraction (of Sn as SnI)
DETERMINATION	Colorimetric with gallein	Colorimetric with gallein

Modifications. An alternative Method for Separation of Tin

In practice it was found that the procedure for separating tin using benzene was tedious as three extractions were required to remove all the tin from sample solutions containing high concentrations. The extractions were also unsatisfactory as they required the use of large quantities of reagents to provide optimum conditions for separation of the tin. In addition benzene is toxic and it was found to be difficult to avoid coming into contact with the liquid or vapour.

During 1966 a paper was published by E.J. Newman and P.D. Jones in which they described the use of toluene instead of benzene for separation of small amounts of tin. Their method was tried out on a variety of samples and excellent results were obtained. It was found that at least 600 µg of tin could be extracted from sample solutions by means of a single extraction and that repeated extractions were unnecessary over the range of tin concentrations from 0 to 600 ppm (see table 57).

Toluene extraction is much more effective than benzene extraction, uses a solvent which is much less toxic, and does not require nearly such

TABLE 57. RESULTS OF TOLUENE EXTRACTION TESTS

1. Sample No. M34.

Number of extractions	1	2	3	4	5	6
No. of mls. toluene used	20	20	20	20	10	10
No. of mls. 5M KI used	5	5	5	5	5	5
Amount of tin extracted (ppm.)	600	0	0	0	0	0

2. Sample No. M34.

Number of extractions	1	2	3	4	5	6
No. of mls. toluene used	20	20	20	20	10	10
No. of mls. 5M KI used	10	10	10	10	10	10
Amount of tin extracted (ppm.)	550	0	0	0	0	0

large quantities of reagents for successful operation. It was therefore decided to use toluene extraction for the separation of tin in the final revision of the writer's proposed analytical scheme.

Alternative Methods for Colorimetric Determination of Tin

The method of determination of tin used by the writer was that employed by R.E. Stanton and A.J. McDonald, and relies on visual comparison of the sample with a series of mixed colour standards (Ref. Stanton, R.E. and McDonald Alison J. 1961 and Stanton, R.E. 1966).

In practice it was found that good and consistent matches could be obtained between sample solutions and the standard series and a precision of ± 10% could be obtained.

If greater precision is required then it is recommended that the spectrophotometric method of determination devised by A.J. McDonald and R.E. Stanton (1962) is employed. In this method the tin gallein complex is extracted with pentyl alcohol and the amount present is determined spectrophotometrically.

Alternatively the tin can be determined spectrophotometrically using phenyl fluorone as described by D.D. Gilbert and E.B. Sandell (1960) in their paper on the 'Separation of Tin by Benzene Extraction of Stannic Iodide', or catchetol violet as described by E.T. Newman and P.D. Jones (1966) in their paper on the 'Separation and Determination of Small Amounts of Tin'.

Time did not permit the writer to make comparisons between the various methods.

IVb. Experiment to Determine the Solubility of Cassiterite in Hydrofluoric and Sulphuric Acids

The experiment was conducted to determine the solubility of cassiterite in the hydrofluoric - sulphuric acid mixtures normally used in decomposing rocks and minerals.

A single fragment of pure, semi-transparent, honey coloured cassiterite which was free from any visible inclusions was selected and ground to -90 mesh.

10 mg. were weighed into a platinum basin, and were digested in a mixture of 9 ml of 40% hydrofluoric acid and 6 mls of 50% sulphuric acid for 12 hours at 80°C. The solution was stirred periodically to assist attack of the sample. When the volume of liquid present had been reduced to $\frac{1}{3}$,

a further 6 ml of hydrofluoric acid and 20 drops of concentrated nitric acid were added and the solution was allowed to evaporate to a minimum volume.

The sample was then transferred to a hot plate, heated until white fumes were evolved and then allowed to fume until nearly dry. At this stage it could be seen that the original quantity of cassiterite remained and there was no evidence for solution having taken place.

As only pure cassiterite had been used it was unnecessary to separate the tin before determining the amount released by the sample attack. 5 ml of 1N hydrochloric acid were added to the almost dry residue in the platinum basin, and after stirring the solution and allowing to stand for a few minutes, a 1 ml aliquot was pipetted for colorimetric determination with gallein, (for procedure see p. 235).

The result was a complete blank (no tin detected) and showed that no cassiterite had dissolved.

It was however decided to repeat the experiment but this time in the presence of a rock sample, (GNL 1 - known to contain 5 ppm of tin), to determine whether the presence of rock powder undergoing decomposition could have any effect on the solubility of the cassiterite.

10 mg. of cassiterite and 1 g. of finely powdered rock were weighed into two platinum basins (to simulate rocks containing 1% cassiterite) and the mixtures were subjected to the same decomposition procedure as described above.

After decomposition it was necessary to carry out separation of any tin present from interfering elements derived from the rock powders. Toluene extractions were employed and the procedure adopted was as described for 'soluble tin' on p. 234.

After extraction the quantities of tin present were determined colormetrically (for procedure see p. 235), and the results obtained were 35 ppm. and 15 ppm. respectively.

The results show that very slight solution of cassiterite had taken place in the presence of rock powder but considering that the samples contained 1% cassiterite the proportion of tin released was negligible. It can therefore be concluded that for all practical purposes (i.e. over a period of 12 hours) cassiterite is insoluble in hydrofluoric-sulphuric acid mixtures, and that tin is unlikely to be released from cassiterite present in rock samples undergoing decomposition in these acids.

IVc. Experimental Procedure

Reagents

All reagents should be of analytical reagent quality.

Water - de-ionised or distilled and de-ionised water is used throughout.

For sample decomposition

Hydrofluoric acid - 40%

Sulphuric acid - 50%. Cautiously mix an equal volume of concentrated sulphuric acid, sp.gr. 1.84, with cold water, adding acid to water, and allow to cool.

Nitric acid - conc. sp.gr. 1.42

Granulated zinc - small fragments

Hydrochloric acid - conc. sp.gr. 1.18

For separation of tin

a. Ammonia precipitation

Ammonium Hydroxide - conc. sp.gr. 0.880

Ferric ammonium sulphate (ferric alum)

Sulphuric acid - 50%

Hydrogen peroxide - 100 vol.

b. Toluene Extraction

Sulphuric acid 9 N - Cautiously mix 250 ml. of sulphuric acid, sp.gr. 1.84, with 500 ml. of water, cool to room temperature, and dilute to 1 litre with water

Potassium iodide, approximately 5 M - Dissolve 83 g. of potassium iodide in water to produce 100 ml. Prepare freshly each day.

Toluene

Dilute sulphuric acid 0.25M - Mix 14 mls. 50% sulphuric acid with 500 mls. water and dilute to 1 litre.

Hydrochloric acid 1 N - Mix 40 ml. of the concentrated acid (sp.gr. 1.18) with 400 ml. of water.

For determination of tin

Chloroacetic acid

Ethyl alcohol - Absolute

Gallein

Gelatine (powder)

Hydrochloric acid. Sp.gr. 1.18

Hydroxylamine hydrochloride

Methylene blue

Sodium hydroxide - pellets

Tin metal - finely powdered

Hydrochloric acid 1 N - Mix 40 ml. of the concentrated acid with 400 ml. water.

Buffer solution. Dissolve 26 g. of sodium hydroxide in 400 ml. of water, and when cold mix this solution with a cold solution of 106 g. of chloroacetic acid and 20 g. of hydroxylamine hydrochloride in 400 ml. of water. Dilute to 1 litre with water and mix. This solution should have a pH value of 2.55 ± 0.1.

Stock reagent solution. Dissolve 0.1 g. of gallein in 100 ml. of ethyl alcohol by warming gently, then filter through a Whatman No. 1 paper (11 cm. diam.). Dissolve 0.03 g. of methylene blue in 200 ml. of water, warming gently. Combine these two solutions in equal proportions.

Gelatine solution. Dissolve 0.5 g. of gelatine in 100 ml. of water by heating gently. Prepare freshly each day.

Standard Tin solutions

100 µg of tin per ml.

Dissolve 50 mg. of tin powder in 50 ml. of concentrated hydrochloric acid and dilute to 500 ml. with water.

5 µg of tin per ml.

Dilute 5 ml. of the 100 µg per ml. solution to 100 ml. with 1 N hydrochloric acid.

Procedure. For Total and 'Acid soluble' Tin

1. Weigh 1 g. of sample into a platinum basin and add 9 mls. of 40% hydrofluoric acid and 6 mls. 50% sulphuric acid and allow sample to digest on a water bath at 80°C. The sample should be stirred periodically with a platinum rod to assist solution.

2. When the volume of the liquid in the basin has been reduced to $\frac{1}{3}$ of the original amount, add a further 6 mls. of hydrofluoric acid and 20 drops of concentrated nitric acid, stirring well. Allow the sample to digest for several hours and evaporate to a minimum volume with the water bath boiling (100°C).

3. Transfer the platinum basin to an asbestos sheet on a hot plate turned on 'full' and heat until dense white fumes are evolved. Allow to fume thoroughly for at least 15 minutes.

4. Remove from hotplate, allow to cool and then cautiously add approximately 20 mls. of water stirring continuously. Cover with a watch glass and allow to stand on a water bath (at 80°C) until all salts have dissolved and a clear solution is obtained.

For total tin

5. Uncover basin and allow solution to evaporate until basin is $\frac{2}{3}$ full (checking that no crystallisation occurs). Add 5 ml. concentrated hydrochloric acid and allow solution to cool.

6. Weigh out 0.5 g. of granulated zinc ensuring that several pieces are present. Add the granulated zinc to the sample solution fragment by fragment over a period of at least 30 minutes, allowing evolution of hydrogen to cease between each addition. Ensure that the basin is covered while effervescence occurs.

7. On completion of the reaction between the zinc and hydrochloric acid (and when no residue remains), add 0.25 grams of ferric-alum to the solution and place on a water bath for 15 minutes.

8. Transfer solution to a 250 ml. beaker washing with hot water, make up the volume to 200 mls., and place on water bath.

9. Slowly add 15-20 mls. of 0.880 ammonium hydroxide to the hot solution stirring continuously, until a precipitate forms. At this stage the precipitate will be bulky and gelatinous in appearance due to the presence of zinc hydroxide. Continue to add ammonium hydroxide until the solution is definitely alkaline and the precipitate changes in appearance indicating that the zinc hydroxide has redissolved. Allow the solution to remain on the water bath until the precipitate coagulates and settles.

10. Filter through a Whatman 541 (hardened) filter paper (11 cms. diam.) washing the precipitate with warm slightly alkaline water (5 drops of 0.880 ammonia per 250 mls. water in wash bottle). Discard filtrate.

11. Dissolve precipitate using 10 mls. of hot 9 N sulphuric acid, collecting filtrate in a 100 ml. beaker. If residue remains on filter paper (usually due to the presence of manganese in sample), add a few drops of 100 vol. hydrogen peroxide to the filtrate, warm, and pass through filter paper again. Wash filter paper with several small aliquots of warm water.

12. Slowly add 10 mls. of concentrated sulphuric acid (sp.gr. 1.84) to filtrate, allow to cool and transfer to a calibrated* 100 ml. separating funnel washing with a few mls. of water. Dilute to 50 mls. when the solution should be 9 N in sulphuric acid.

* The separating funnel should be calibrated with a 50 ml. mark.

13. Add 5 mls. of freshly prepared 5 M. potassium iodide solution and 20 mls. of toluene. Stopper funnel and shake vigorously for two minutes, allow phases to separate and then run lower layer into a second separating funnel.

14. Add 10 ml. of toluene to solution in second funnel, stopper and shake for two minutes. Allow layers to separate and draw off the lower layer and discard. Run the toluene layer from the second funnel into the first, washing with a few mls. of toluene.

(N.B. Solutions containing less than 100 μg Sn do not require the second extraction)

15. Wash the combined toluene extracts without shaking with 12 ml. of a wash solution prepared by mixing 25 ml. of 9 N sulphuric acid with 2.5 ml. of 5 M potassium iodide and discard the washings.

16. Add 25 mls. of 0.25 N sulphuric acid, stopper funnel and shake for two minutes. Allow layers to separate and run both into a 50 ml. beaker washing with a little water.

17. Place beaker on water bath at 100°C in a fume cupboard, and allow the toluene layer to evaporate. When the toluene has almost evaporated add 10 drops of concentrated nitric acid and allow the aqueous layer to evaporate to minimum volume.

18. Place beaker on an asbestos sheet on a hot plate and fume almost to dryness. Remove and allow to cool.

19. Add 5 mls. of 1 N hydrochloric acid, cover beaker with a strip of paraffin wax sheet (to seal) and allow to stand for 30 minutes.

The sample is then ready for colorimetric determination.

For 'Acid soluble' Tin only

Omit steps 5 to 12.

Transfer the solution obtained in stage 4. to a 100 ml. beaker washing with a small quantity of hot water. Allow solution to cool and add slowly 12.5 mls. of concentrated sulphuric acid (sp.gr. 1.84) and cool again.

Transfer solution to 100 ml. calibrated separating funnel washing with a few mls. of water and dilute to 50 mls.

The solution should be 9 N in sulphuric acid.

Continue as for total tin

Colorimetric determination of tin (Total and acid soluble)

Preparation of Standards

1. To twelve test tubes (18 x 180 mm) add respectively 0.0, 0.25, 0.5, 1.0, 1.25, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 5.0 µg of tin using a standard solution containing 5 µg of tin per ml. (Line 1, table 58).

(The quantities of the various solutions which must be added to each of the test tubes appears in table 58).

2. To each of the first six test tubes add 0.5 ml. 1 N hydrochloric acid (line 2).

3. Add 0.2 ml. of gelatine solution (line 3), and then the necessary quantity of buffer solution required to make up the volume of solution in each test tube to 5 ml. (line 4).

4. Add 0.1 ml. of stock reagent solution to each tube, stopper, shake and allow to stand 1 hour before using.**

Determination* - by visual comparison with standards

1. Pipette an aliquot*/ of the sample solution obtained in step 19. into an 18 x 180 mm. test tube (The test tube must be of a similar type to those used in preparation of the standards).

   * The amount of solution pipetted depends on the amount of tin present in the sample. The range of the standards is 0.0 - 5.0 µg and the amount of tin in the aliquot of sample solution taken must not exceed 5 µg. Trial and error may be necessary to find the amount of solution to be pipetted to obtain a reading in the range of the standards. In the case of muscovite and samples which contain more than 200 ppm of tin it may be necessary to dilute 1 ml of the sample solution to 10 mls. with 1 N hydrochloric acid and use an aliquot of this solution for determination.

   ** The standards can be used for up to 5 days if kept in a fridge. The colours obtained should range from green at 0.0 µg through to grey at 2.0 µg to pink at 5.0 µg. Sn.

2. If the aliquot taken is less than 0.5 ml. add 0.5 ml. 1 N hydrochloric acid. If more than 0.5 ml. then no addition is necessary.

TABLE 58. QUANTITIES OF REAGENTS REQUIRED FOR PREPARATION OF STANDARDS

Test tube No.	1	2	3	4	5	6	7	8	9	10	11	12
No. of mls. Sn soln. containing 5 g/ml.	0.00	0.05	0.10	0.20	0.25	0.30	0.40	0.50	0.60	0.70	0.80	1.00
No. of mls. 1 N hydrochloric acid	0.50	0.50	0.50	0.50	0.50	0.50	-	-	-	-	-	-
No. of mls. gelatine soln.	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
No. of mls. buffer soln.	4.30	4.25	4.20	4.10	4.05	4.00	3.90	4.30	4.20	4.10	4.00	3.80
No. of mls. stock reagent soln.	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Total volume mls.	5.10	5.10	5.10	5.10	5.10	5.10	5.10	5.10	5.10	5.10	5.10	5.10
Tin content ug.	0.00	0.25	0.50	1.00	1.25	1.50	2.00	2.50	3.00	3.50	4.00	5.00

3. Add 0.2 mls. of gelatine and sufficient buffer solution to make up the total volume of solution in the test tube to 5.0 mls.

4. Add 0.1 ml. of stock reagent solution, mix allow to stand for at least 30 minutes and compare the colour obtained with those in the standard set. The tin content of the sample in ppm:-

$$\text{Tin in ppm.} = \frac{\mu\text{g of matching standard} \times 5\text{ ml}}{\text{ml of aliquot}}$$

If the sample solution was diluted (e.g. 1 ml. to 10 mls) before taking an aliquot for determination then the result obtained must be multiplied by the number of times dilution employed.

$$\text{Tin in ppm.} = \frac{\mu\text{g of matching standard} \times 5\text{ ml}}{\text{ml of aliquot}} \times \text{dilution}$$

APPENDIX IV

INDEX OF UNPUBLISHED REPORTS AND MAPS OF MINES AND CLAIMS OF S.W. ANKOLE

UNPUBLISHED REPORTS AND MAPS OF MINES AND CLAIMS OF S.W. ANKOLE

1. GRANITE PEGMATITES

BITAKA

Unpublished Reports

No.	Author	Title of Report	Date
PFM/7	P.F. Meal	Bitaka Mine Claim 2148	1953
--	U.K.A.E.A.*	Bitaka and Dwata Report	

* United Kingdom Atomic Energy Authority. Unpubl. Rep.

Unpublished Maps

U.G.S. No.	Title of Map	Scale	Date
1436	Bitaka. Claim 2146	1:500	1954

BYASHA

Unpublished Reports

No.	Author	Title of Report	Date
Columbite-Tantalite File			
5.	R.C. Pargeter	The Lyasa Tin-Columbite-Tantalite Occurrence, Katuba Valley Area, Kazara, Ankole.	1950
6.	"	The Lyasa Government Prospect.	1950
PFM/23	P.F. Meal	The Geology of Lyasa Mine, Ankole.	1955
Mineralogical Report			
1067	G.S.G.B. - A.E.D.*	Notes on the Byasha beryl workings, Ankole, Uganda	1961

* Geological Survey of Great Britain, Atomic Energy Division. Unpubl. Rep.

Unpublished Maps

U.G.S. No.	Title of Maps	Scale	Date
1534	Lyasa Mine	1:500	1955

KAKANENA

Unpublished Reports

No.	Author	Title of Report	Date
ADC/3/76	A.D. Combe	The Kakanena Tantalite Deposits, South West Ankole.	1944
ADC/3/92	"	The Kakanena Tantalite Deposit, South-West Ankole	1944
BCK/41	B.C. King	Visits to Kakanena Tantalite Workings	1944
KAD/43	K.A. Davies	Brief report on Kakanena Mine up to 26th Sept., 1944	1944
PFM/24	P.F. Meal	The geology of Kakanena Mine	1955

Unpublished Maps

U.G.S. No.	Title of Map	Scale	Date
669	Kakanena Ankole, Tantalite Mining Claim No. 1083	1:1,250	--
670	Kakanena Ankole, Tantalite. Development Map - Mining Claim 1083	1:1,250	--
671	Kakanena - Ankole Tantalite Mining Claim No. 1083	1:200	--
674	Kakanena - Ankole Tantalite	1:12,500	--
708	Plan showing the outcrop of the Kakanena Tantalite Deposit	1:500	1944
1535	Kakanena	1:500	1955

KASHOJWA. (Columbite workings)

Unpublished Reports

No.	Author	Title of Report	Date
129/3/90	A.D. Combe	The Kahsozwa Columbite deposit	1944
129/3/98	"	The Kashojwa Tin and Columbite Deposit	1944

RCP/25	R.C. Pargeter	The Kashozo (or Kashozwa) Columbite Deposit South-West Uganda	1950
Col/Tant File			
8.	"	" "	1950
13.	"	The Kashozo Columbite Occurrence	1951
LJD/1	L.J. Dyke	Vertical field magnetometer measurements across columbite-bearing reefs at Kashozo in S.W. Ankole	1952
LJD/5	"	Geiger counter measurements in and above a columbite-bearing kaolin reef at Kashozo in S.W. Ankole	1953

KAVUSANAMI. (KABUSANAMI)

Unpublished Reports

No.	Author	Title of Report	Date
ADC/3/99	A.D. Combe	The Kavusanami Tantalite Deposits	1944

KAZUMO

Unpublished Reports

No.	Author	Title of Report	Date
PFM/33	P.F. Meal	The geology of Kazumo Mine	1956
Mineralogical Report			
941	G.S.G.B. - A.E.D.*	Mineralogy of beryl-bearing pegmatites at Kazumu Mine, Ankole, Uganda Protectorate	1959
Geological Report			
	U.K.A.E.A.** D.A.O. Morgan	Kazumo Beryl Mine	1959

* Geological Survey of Great Britain, Atomic Energy Division. Unpubl.Rep.

** United Kingdom Atomic Energy Authority. Unpubl. Rep.

Unpublished Maps

U.G.S. No.	Title of Map	Scale	Date
1624	Kazumo Mine	1:1,000	1956
1625	Kazumo Mine. Geology and Workings	1:500	1956

United Kingdom Atomic Energy Authority - East African Office. Beryllium Assessment

U.K.A.E.A. No.	Title of Map	Scale	Date
1.	Kazumo Detailed Block	--	--
3.	General Geology - Plan.	--	--
7.	Surface Geology - Plan.	--	--

KITOFA

Unpublished Report

No.	Author	Title of Report	Date
FWR/15	F.W. Roe	The Tantalite and Tin Ore at Kitofa Hill, South east Kigezi, Uganda	1943

MUTAKA

Unpublished Report

No.	Author	Title of Report	Date
AGO/5	A.G. Otika	Mutaka Mine. Claim No. 2560	1962

Unpublished Maps

U.G.S. NO.	Title of Map	Scale	Date
1909	Geological and Topographic Map of Mutaka Mine	1:1,000	1962
1909B	Mutaka Mine (Western Hill)	1:500	1962

NYABAKWERI

Unpublished Reports

No.	Author	Title of Report	Date
129/4/110	A.D. Combe.	(The Nyabakweri Beryl-Columbite Deposit).	1946

129/4/138	A.D. Combe	(The Nyabakweri Beryl-Columbite Deposit)	1947
129/4/14-	"	The Nyabakweri Beryl-Columbite-Deposit, South-West Ankole	1948

Mineralogical Report

976	G.S.G.B. - A.E.D.*	Mineralogical notes on the Nyabakweri beryl-pegmatites, Ankole, Uganda	1962

* Geological Survey of Great Britain, Atomic Energy Division. Unpubl.Rep.

Unpublished Maps

U.G.S. No.	Title of Report	Scale	Date
814	Plan of the Nyabakweri Columbite Deposit	1:500	1947
1082	Nyabakweri Beryl-Columbite pegmatite		

NYABUSHENYI

Unpublished Reports

No.	Author	Title of Report	Date
ROR/16	R.O. Roberts	Report on a visit to the Nyabushenyi Tantalite-Columbite and Tinstone Occurrence	1943

NYANGA - RWENTALI (RWENTARE)

Unpublished Reports

No.	Author	Title of Report	Date
129/4/111	A.D. Combe	The Rwentali Tantalite-Columbite Deposit, Kazara, S.W. Ankole	1946

Col/Tant File

2	R.C. Pargeter	The Rwentali Columbite Occurrence	1950
PFM/25	P.F. Meal	The Geology of Nyanga (Ruwentali) Mine	1955

Mineralogical Report

1055	G.S.G.B.- A.E.D.*	Notes on the Nyanga pegmatites, Ankole, S.W. Uganda.	1960

* Geological Survey of Great Britain. Atomic Energy Division. Unpubl.Rep.

Unpublished Maps

U.G.S. No.	Title of Map	Scale	Date
675	Nyanga Ankole Columbite	1:12,500	
1533	Nyanga Mine (Ruwantali)	1:500	1955

RUHUMA

Unpublished Report

No.	Author	Title of Report	Date
ACD/3/43	A.D. Combe	The Ruhuma Tin-Tantalite Deposits, South-West Uganda	1941

RWEMIRIRO

Unpublished Report

No.	Author	Title of Report	Date
Mineralogical Report			
1084	G.S.G.B.- A.E.D.*	Notes on specimens from the Rwemiriro Pegmatite, Ankole, Uganda	1961

* Geological Survey of Great Britain, Atomic Energy Division.Unpubl.Rep.

RWENKANGA

Unpublished Reports

No.	Author	Title of Report	Date
ADC/ /	A.D. Combe	The Tantalite-Columbite Deposits in South-Western Uganda	1937
RCP/26	R.C. Pargeter	The Rwenkanga (near Kakanena) Columbite deposit, Kazara County, S.W. Ankole	1950

Col/Tant File

3	R.C. Pargeter	The Kakanena East (or Rwenkanga) Columbite occurrence	1950
PFM/22	P.F. Meal	The Geology of Rwenkanga Mine	1954

Mineralogical Reports

962	G.S.G.B.- A.E.D.*	Beryl and Chrysoberyl from the Rwemkanga Mine pegmatite, Ankole, Uganda Protectorate	1959
1073	"	Notes on specimens from Rwemkanga Pegmatite, Ankole, Uganda	1961

* Geological Survey of Great Britain, Atomic Energy Division. Unpubl.Rep.

Unpublished Maps

U.G.S. No.	Title of Map	Scale	Date
1078, 1079	Rwenkanga. (4 diagrams)	--	--
1121	Rwenkanga (Nr.Kakanena) Columbite Workings	1:250	1950
1540	Rwenkanga Mine Location 2140	1:500	1954

2. QUARTZ-MICA CASSITERITE BEARING VEINS

DWATA (LWATA)

Unpublished Reports

No.	Author	Title of Report	Date
129/3/61	A.D. Combe	The Dwata Tine-Tantalite Deposits	1941
RCP/24	R.C. Pargeter	The Dwata Tin-Columbite Deposit, South West Ankole	1950
PFM/6	P.F. Meal	Dwata Mine Claim 1958	1953

Unpublished Maps

U.G.S. No.	Title of Map	Scale	Date
1033	Dwata Mine Claim 1958	1:500	1951
1067	Dwata No. 2 Deposit	1:500	1950

KYAMUGASHE

Unpublished Reports

No.	Author	Title of Report	Date
129/2/41	A.D. Combe	The Kyamugasha Tin Deposits	1936
129/3/64	"	The Kyamugasha Tin Deposits	1942
129/4/133	"	The Kyamugasha Tin Deposits, Rwampara, South-West Ankole, S.W. Uganda	1947
PFM/18	P.F. Meal	Kamugasha Cassiterite Mine. Claim 290	1954

Unpublished Maps

U.G.S. No.	Title of Map	Scale	Date
469			
469A	Kyamugasha Tin Deposits		1939
469B	" " "		
469C	" " "		
787	Kyamugasha Mine, Ruampara, Ankole Claims 1392 & 290 (retraced 793)	1:500	--
788	Kyamugasha Mine Ankole. Section of Claims 1392 & 290. a) Facing North	1:500	1946
789	" " " b) Facing West	1:500	1946
790	Kyamugashe Mine, Ruampara, Ankole	1:2500	1946
806	Kyamugasha Mine. New adit cross-section	1:500	1947

NYANGA

Unpublished Reports

No.	Author	Title of Report	Date
ROR/19	R.O. Roberts	Notes on a visit to the Tinstone-Tantalite-Columbite Deposit at Nyanga, South-West Ankole	1943
ROR/28	"	Report on the Nyanga Tinstone and Columbite-Tantalite Deposit	1943

FWR/9	F.W. Roe	Report on the occurrence of tantalite and cassiterite at Nyanga, Kazara, S.W. Ankole	1943

Unpublished Maps

U.G.S. No.	Title of Map	Scale	Date
675	Nyanga Ankole. (Columbite)	1:12,500	

LWEMIKOMA. (RWEMIKOMA)

Unpublished Reports

No.	Author	Title of Report	Date
129/3/66	A.D. Combe	The Lwemikoma Tin Deposit, Mwirasando Area, South-West Ankole, South-West Uganda	1942
129/3/94	"	The Lwemikoma Tin Deposits	1944
129/3/104	"	The Lwemikoma Tin Deposits	1945
129/4/120	"	The Lwemikoma Tin Deposits, Rwampara, South-West Ankole, S.W. Uganda	1946
129/4/134	"	The Cassiterite Deposits, Shear's Mine, Lwemikoma, S.W. Ankole, S.W. Uganda	1947
129/4/139	"	The Lwemikoma (Reno's) Tin Deposits	1947

RWAKIRENZI

Unpublished Reports

No.	Author	Title of Report	Date
129/3/49	A.D. Combe	The Wakirenze Tantalite Vein	1941
ROR/15	R.O. Roberts	Report on a visit to the Kakanena (Ruacharenze) Tantalite-Columbite Occurrences, S.W. Ankole	1943

Unpublished Maps

U.G.S. No.	Title of Map	Scale	Date
672	Ruacharenze. Ankole Tantalite, Mining Claim 1191	1:1250	--

HYDROTHERMAL QUARTZ CASSITERITE-BEARING VEINS

BURAMA RIDGE

Unpublished Reports

No.	Author	Title of Report	Date
129/2/1	A.D. Combe	Inspection of Kaina Mine and the workings of claims 5 & 6 Burama Ridge	1933
129/3/21	"	Further notes on the Cassiterite Deposits No. 1. Adit, Burama, South-West Ankole	1940
129/2/43	"	The geology of some of the Tin Deposits near Kavezi, South-Western Uganda	1936
RCP/19	R.C. Pargeter	Report on the Cassiterite-Bearing Pegmatite at depth in the Burama Ridge Mine	1950
	"	Report on No. 4 Adit Deposit - Burama Ridge Mine. (Supplement to Report No. 19)	1950
HGP/9	H.G. Plummer	Report on the Burama Ridge Area	1965

Unpublished Maps

U.G.S. No.	Title of Map	Scale	Date
747	Burama Ridge Mine, Kazara, Ankole	1:500	--
748	Burama Ridge Mine	1:2,000	--

KABEZI

Unpublished Reports

No.	Author	Title of Report	Date
ROR/22	R.O. Roberts	Notes on a visit to the Kabezi Tinstone Mine	1943
ROR/26	"	Report on the Kabezi Tin Mine, Kazara County, South-West Ankole	1943

KAINA MINE

Unpublished Reports

No.	Author	Title of Report	Date
129/2/1	A.D. Combe	Inspection of Kaina Mine and the workings of claims 5 & 6. Durama Ridge	1933
129/2/42	"	Report on the Kaina Tin Deposit	1936
129/ /	"		1938
129/3/28	"	Further notes on the Kaina Tin Mine South-West Ankole	1940
129/3/70	"	The Kaina Tin Deposits, South-West Ankole, S.W. Uganda	1942
129/3/115	"	The Kaina Tin Deposits, Kazara, South-West Ankole, South-West Uganda	1946
PFM/9	P.F. Neal	Kaina Mine Ankole. Claims 480, 861, and 1409	1954
PFM/44	"	Kaina Mine	1958

Unpublished Maps

U.G.S. No.	Title of Map	Scale	Date
1719	Kaina Mine. (Geology)	1:1000	--

KASHOJWA

Unpublished Reports

No.	Author	Title of Report	Date
129/2/4	A.D. Combe	Report on mine inspections at Kashozo Claims	1933
129/4/116	"	The Kashozwa Tin Deposits, Rwampara, South-West Ankole, South-West Uganda	1946

Unpublished Maps

U.G.S. No.	Title of Map	Scale	Date
1077	Kashozo Mine		

KIKAGATI

Unpublished Reports

No.	Author	Title of Report	Date
129/3/3	A.D. Combe	The stanniferous quartz veins of Kikagati, S.W. Uganda	1938
129/3/45	"	The Kikagati Tin Deposits	1944
129/3/97	"	The Kikagati Tin Deposits	1944
129/4/140	"	The Kikagati Tin Deposits, S.Ankole	1947
ROR/68	R.O. Roberts	Notes on rock samples from Kakagati Mines	1946
JWB/42	J.B. Barnes	Nyarabungu Hill, Kikagati. Adit 4 and East Adit, Kagera Mines Ltd.	1955
JWB/60	"	Notes on Kikagati Mine, Kikagati	1955
PFM/42	P.F. Meal	Report on the Kikagati Ratemeter Survey	1958
MJH/9	M.J. Hooper	Report on Location 2829	1965
MJH/11	"	Report on Location 2819 and 2821 on Nyarabungu Ridge, Kikagati, Ankole	1965
MJH/14	"	Report on Locations 2800, 2810, 2819, and 2821	1965
HGP/11 MJH/15	H.G. Plummber & M.J. Hooper	Investigation and evaluation of Kikagati Mine	1965

Unpublished Maps

U.G.S. No.	Title of Map	Scale	Date
2906	Kikagati Tin Mine	1:1,000	1965
2907	Kikagati Tin Mine, Surface veins, surface and underground workings	1:360	1965

KYABWATO

Unpublished Reports

No.	Author	Title of Report	Date
129/3/39	A.D. Combe	The Kyabwato Tin Deposits	1941
PFM/11	P.F. Meal	Kichwamba Tin Mine, Ankole	1954

MWIRASANDO MINE

Unpublished Reports

No.	Author	Title of Report	Date
129/1/21	A.D. Combe	Short note on the nature of the Mwirasando Tin Deposits	1930
129/1/25	"	Report on an examination of Mwirasando Mine (28.12.31 - 19.3.32)	1932
129/2/48	"	The Mwirasando Tin Deposits South-West Ankole. General statement	1937
ROR/29	R.O. Roberts	Notes on the Vandenbroek Reef workings, Mwirasando Mine	1943

Mineralogical Report

932	G.S.G.B.- A.E.D.*	Beryl in mill tailings of Mwirasandu Tin Mine, Ankole, Uganda Protectorate	1959

* Geological Survey of Great Britain, Atomic Energy Division. Unpubl.Rep.

Geological Report

--	G.C. Wade U.K.A.E.A.**	Beryllium in the Mwirasandu Tin Mine and neighbouring mineral deposits, Ankole, Uganda	1960

** United Kingdom Atomic Energy Authority. Unpubl. Rep.

Unpublished Maps

U.G.S. No.	Title of Map	Scale	Date
56	Geological Map of the Mwirasando Mine showing the Ore Bodies developed until July 1930	1:360	1930
166	Plan showing surface geology of No.2 & 3 Hills Mwirasando Mine, Western Part	1:360	--
167	Plan showing surface geology of No. 1 Hill, Mwirasando Mine, Western Part	1:360	--
169	Plan showing surface geology of No. 3 Hill, Mwirasando Mine, Western Part	1:360	--

NAMAHERERE

Unpublished Reports

No.	Author	Title of Report	Date
129/1/20	A.D. Combe	Short note on the nature of Namaherere Tin Deposits	1930
129/2/44	"	The Cassiterite Deposits of Namaherere	1930
129/3/29	"	Further notes on the Namaherere Tin Deposits	1940
129/3/73	"	The Namaherere Tin Deposits	1942
Mineralogical Report			
MJH/12	M.J. Hooper	Report on Locs. 640, 641 and 729	1965
954	G.S.G.B.- A.E.D.*	Beryllium minerals from a hydrothermal cassiterite-vein at Namaherere Mine, Ankole, Uganda Protectorate	--

* Geological Survey of Great Britain, Atomic Energy Division. Unpubl.Rep.

Unpublished Maps

U.G.S.No.	Title of Map	Scale	Date
1080	Namaherere. No. 1 Adit	1:500	--
1081	Namaherere. No. 6 Adit	1:500	--

NYABUBALE. (NYABUBARE)

Unpublished Reports

No.	Author	Title of Report	Date
PFM/19	P.F. Meal	Nyabubale Cassiterite Mine	1954

RUZINGA

Unpublished Reports

No.	Author	Title of Report	Date
129/4/131	A.D. Combe	The Ruzinga Tin Deposits, Southern Ankole	1947

JWB/1	J.W. Barnes	Preliminary report on the Ruzinga Tin Mine, Kikagati, Ankole	1949
PFM/4	P.F. Meal	Ruzinga Mine -Claim 315	1953

Unpublished Maps

U.G.S. No.	Title of Map	Scale	Date
1431	Geology of the country adjacent to Ruzinga Mine	1:5,000	1953
1432	Ruzinga Mine Claim 315	1:500	1953
1501	--		
1503	--		

4. OTHER TIN DEPOSITS

(These were not visited by the writer and include both quartz-mica, and hydrothermal quartz, cassiterite-bearing veins)

KICHWAMBA

Unpublished Report

No.	Author	Title of Report	Date
PFM/11	P.F. Meal	Kichwamba Tin Mine. Claim 958	1954

Unpublished Maps

U.G.S. No.	Title of Map	Scale	Date
808	Kichwamba Mine, Claim 958, Ruampara Ankole	1:2,500	
809	Kichwamba Mine. No. 1. Shaft and Adit. Location Map. Plan. Vertical Section		
810	Kichwamba Mine, Ruampara, Ankole. Plan of No. 1. Adit. Plan of No. 5. Adit.		

KITEMBI

Unpublished Reports

No.	Author	Title of Report	Date
ADC/74	A.D. Combe	The Kitembi Tin Deposits, South-West Ankole, South-West Uganda	1942

PFM/14	P.F. Meal	The Geology of Kitembi Mine	1954
PFM/36	"	" "	1956

Unpublished Maps

U.G.S. No.	Title of Map	Scale	Date
1648	Kitembi		1956

LWAMUIRE

Unpublished Report

No.	Author	Title of Report	Date
PFM/10	P.F. Meal	Lwamuire Cassiterite Mine, Ankole	1954

Unpublished Maps

U.G.S. No.	Title of Map	Scale	Date
792	Lwamuire Mine, Ankole. Claim 1358	1:500	--
801	Lwamuire Mine, Ankole	1:500	--
1463	Lwamuire Mine	1:1000	1954

MURAMBAJI. (MURAMBAGI)

Unpublished Report

No.	Author	Title of Report	Date
129/4/114	A.D. Combe	The Murambaji Tin Deposit, Rwampara, South-West Ankole, South-West Uganda	1946

NACHANGA

PFM/15	P.F. Meal	The Geology and Reserves of Nachanga Mine Location 2130	1946

NANIANKOKO

129/3/68	A.D. Combe	The Naniankoko Tin Deposits, Southern Ankole, South-West Uganda	1942
129/3/100	"	Veins in Claim 1293, Naniankoko Hill	1944

129/4/113	A.D. Combe	The Naniankoko Tin Deposits, Rwampara, Southern Ankole, S.W. Uganda	1946
129/4/132	"	The Naniankoko Tin Deposits, Southern Ankole	1947
PFM/3	P.F. Meal	Naniankoko Tin Mine, Ankole. Claim 1293	1953
PFM/	"	" "	1958
JWB/33	J.W. Barnes	Some observations on the geology of Naniankoko Tin Mine Ankole	1954

Unpublished Maps

U.G.S. No.	Title of Map	Scale	Date
553	Naniankoko Mine Plan, showing outcrops of veins and underground workings	1" = 30'	1942
1422	Naniankoko - Geology of the Country adjacent to the Mine Area	1:5,000	
1423	Naniankoko. Mine Claim 1293	1:500	1954

NINGOMA

Unpublished Report

No.	Author	Title of Report	Date
129/3/41	A.D. Combe	The Ningoma Tin Deposits, South-West Ankole, S.W. Uganda	1941

NTUNDU and RWENTALI (RWENTARE)

129/3/4	A.D. Combe	The Cassiterite Deposits of Ntundu and Rwentali, Southern Ankole	1938
PFM/12	P.F. Meal	Ntundu Tin Mine, S. Ankole. Claim 1854	1954

NYAKABALE. (NYAKABARE)

129/3/12	A.D. Combe	The Stanniferous Veins of Nyakabale, near Kavezi, South-West Ankole	1939

NYAKAGONDO

129/3/91	A.D. Combe	A tin deposit at Nyakagondo, near Mwirasando	1944

NYAKAHOKO, BUGAMBA

129/3/11	A.D. Combe	The Stanniferous Deposits of Nyakahoko, and Bugamba, South-Western Ankole	1939

RUBIMBIRI

129/3/46	A.D. Combe	The Rubimbiri Tin Deposits, South-West Ankole, S.W. Uganda	1941

RWEIKINIRO

PFM/16	P.F. Meal	Rweikiniro Cassiterite Mine. Location 628	1954

RWENTALI (RWENTARE) (Lopez's Mine) Claim 1278

PFM/5	P.F. Meal	Lopez's Mine - Claim 1278	1953

TABALO

PFM/20	P.F. Meal	The Geology of Tabalo Tin Mines (Kilimatatu and Ruiyinza Mines Claims 1109 and 1909)	1954

TWEMENGO

129/3/67	A.D. Combe	The Twemengo Tin Deposits, South-West Ankole, S.W. Uganda	1942
PFM/17	P.F. Meal	Twemengo Cassiterite Mine	1954

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A. A.D. Combe - Geological Survey of Uganda

1.	Geological Map of part of South-West Ankole and Rukiga Sheet 1. Lake Karenge	Scale 1:50,000
2.	Geological Map of part of South-West Ankole Sheet 2. Igurrua	Scale 1:50,000
3.	Geological Map of part of South-West Ankole and Rukiga Sheet 3. Kaina	Scale 1:50,000
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Sheet 85/IV	Ntungamo
Sheet 86/III	(Kikagati)
Sheet 94/I	(Mpalo)
Sheet 94/II	(Kafunzo)

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Sheet 85/3	Rwashamaire

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APPENDIX V

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APPENDIX V.

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KEY TO ABBREVIATIONS USED IN ~~TABLES~~ ENCLOSURES 2 - 10.

COUNTRY ROCKS

Gn = Granitoid rocks
Gn(c) = Granitoid rocks situated in the centre of an arena granite.
Gn(m) = Granitoid rocks situated at the margins of an arena granite.
Gn(Peg) = Pegmatitic granite.
IS = Injection schists - possibly Igara (Toro System).
K-A = Karagwe Ankolean sediments (schists, phyllites and quartzites).
K-A/Csr = Calc silicate rocks of the Karagwe-Ankolean System.

WALL ROCK ALTERATION

H = Hydrothermal alteration
K = Kaolinisation
M = Muscovitisation
T = Tourmalinisation
Gr = Greisenisation

NATURE OF INTRUSION

C = Concordant
D = Displacive
F = Fissure
X = Cross cutting

NATURE OF CONTACTS

Gr = Gradational
S = Sharp

PRIMARY ZONING

a. Degree of development

V.P. = Very poor
P. = Poor
G. = Good
V.G. = Very good

b. Zones present

B.Z. = Border Zone
W.Z. = Wall Zone
I.Z. = Intermediate Zone
C. = Quartz Core
Q.M. = Quartz muscovite pegmatite
Q.M.K. = Quartz-muscovite-kaolin pegmatite

REPLACEMENT ZONES

a. Type

Ab = Albite replacement zone(s)
Gr = 'Greisen' replacement zone(s)
Ab/M = Albite-muscovite replacement zone(s)
Li/M = Lithian muscovite replacement zone(s)
M = Muscovite or muscovite rock replacement zone(s)
Q.M. = Quartz-muscovite replacement zone(s)

b. Distribution

C = Central
C.M. = Core margin
F.W.M. = Footwall margin (of pegmatite)
H.W.M. = Hanging wall margin (of pegmatite)
L = Limited
M = Marginal (selvages)
W = Widespread (throughout pegmatite)

ALTERATION

K = Kaolinisation
S = Sericitisation

Distribution of alteration

Abbreviations as for replacement zones.

MAJOR MINERALS

Ab = Albite
Ab/Cl = Cleavelandite albite
K = Kaolin

MAJOR MINERALS Cont'd.

Li/M = Lithian muscovite
Micro = Microcline feldspar
Musc = Muscovite
Q = Quartz
S = Sericite
Sp/a = Altered spodumene

MINOR AND ACCESSORY MINERALS

A = Apatite
Ab = Albite
Fe/O = Iron oxides
Fe-Mn/P = Iron-manganese phosphates
G = Garnet
Li/M = Lithian muscovite
Li-Fe-Mn/P = Lithium-iron-manganese phosphates
Mn/O = Manganese oxides
O = 'Oncosine' Mica
S = Sericite
Sp/a = Altered spodumene
T = Tourmaline
T/m = Tourmaline at margin of pegmatite only
T/cm = Tourmaline at core margin only
Z = Zircon

ECONOMIC MINERALS

Be = Beryl
Cb,Ta = Columbite
Sn = Cassiterite
Ta,Cb = Tantalite
Li = Amblygonite

N.B. When abbreviations are enclosed in brackets ( ) the feature represented is poorly developed, present in small quantities, or of minor importance only.

\+ = Deposits described in unpublished reports (see appendix
pp. 237-255

ENCLOSURE 1

GEOLOGICAL MAP OF PART OF SOUTH-WEST ANKOLE, UGANDA.

SCALE : 1" = 1 Mile. 1:50,000.

P.L.L. 1969.

ENCLOSURE 2

GROUP 1. 1a: POORLY-ZONED UNALTERED MICROCLINE-MUSCOVITE PEGMATITES

NAME LOCALITY Nº *	MAP REFERENCE		COUNTRY ROCK	DIP°	STRIKE°	WALL ROCK ALTERATION	NATURE OF INTRUSION	SIZE OF INTRUSION		DIP & STRIKE OF INTRUSION		NATURE OF CONTACTS	PRIMARY ZONING		REPLACEMENT ZONES		ALTERATION	MAJOR MINERALS	MINOR AND ACCESSORY MINERALS	ECONOMIC MINERALS	OTHER MINERALS (RARE)	MINERAL PRODUCTION (tons)		
	SHEET NO.	CO-ORDINATES						LENGTH (ft)	WIDTH (ft)	DIP°	STRIKE°		Degree of development	Zones present	Type	Distribution						Beryl	Columbite/tantalite	Other
BITAKA 17	85/4	026 966	Gn(m) K-A			T, H, K	x/F					S	P	W.Z. I.Z.			(K)	Q Micro Musc	T/m	Be (Ta,Cb)				
IVARE (Lugalama) 29	85/3	794 851	Gn			H	C			Near vert.	250	Gr	V.P.	C.P.				Q Micro Musc	T	Be				
KARAMBI 14	85/4	988 996	Gn			H,K	x/F		10		275	S	P	W.Z. I.Z.				Q Micro	T (Musc)	Be		1·1		
KIBAARE (Kigezii) 3	85/3	740 953	Gn				x/F					S	P	W.Z. I.Z.				Q Micro Musc		Be				
KYABAKAZI (Ihunga) 19	85/3	705 920	Gn	Steep S.	270	M	x/F	300+	2	60 W.S.W.	330	S/Gr	V.P.	W.Z. I.Z.	Q. M Ab/M	L		Q Micro Musc	Ab A G	Be (Sn)		Few lbs.		
KYEMPISI N.E. 31	85/3	825 932	K-A	Steep S.	260		C/D	200		Steep S.	260	S	P	W.Z. I.Z.				Q Micro Musc	T	Be (Ta,Cb)				
KYENKEBEBE 15	85/4	975 965	Gn/m			T, M, H, K	x/F				255	S	V.P.	C.P.				Q Micro	(Musc)	Be				
MURAMBI II 50	94/2		Gn			H,K	x/F		12		260	S	P	W.Z. I.Z.	M	M	(K)	Q Micro Musc		Be (Cb,Ta)				
MUYOGO (South) 12	85/3	917 983	Gn	65 W.	175	T, M	C/F		12	65 W.	175	S	P	W.Z. I.Z.				Q Micro	(Musc)	Be		0·1		
MUYOGO 12	85/3	920 988	Gn Gn(Peg)				x/F					S	V.P.	C.P.			(K)	Q Micro Musc		Be		5·3		
NGOMA (U.Location) 53	94/1	897 723	Gn(m)			H,K	x/F			80 N.E.	145	S	P	W.Z. I.Z.			(K)	Q Micro Musc		Be				
NYARWANYA 27	94/1	814 875	K-A/Csr		N-S		x/F	600+	160	Near vert.	E-W	S	P	(B.Z) W.Z. I.Z.				Q Micro Musc	T	Be (Cb,Ta)				
OMUKINONI N 39	85/3	858 913	Gn(m) Gn(Peg)				C					Gr	P	W.Z. I.Z.				Q Micro Musc		Be				
RUHOKO 29	94/1	793 854	Gn			H	C					Gr	V.P.	C.P.				Q Micro Musc	T	Be				
RUHOKO II 29	94/1	793 854	Gn			H	C					Gr	V.P.	C.P.				Q Micro Musc	T	Be				
RUKIRA –	85/3	788 888	Gn	75			x/F		2		300	S	P	W.Z. I.Z. } C.P.	Ab/M	L		Q Micro Musc	Ab T/m	Be	Apatite	Few lbs.		
RWEMPUNGU W. 14	85/4	978 994	Gn (m)				F				275	S	P	W.Z. I.Z.				Q Micro Musc	T	Be				

* See fig. 4.

GROUP 1. 1b. KAOLINISED POORLY-ZONED MICROCLINE-MUSCOVITE PEGMATITES

ENCLOSURE 3

NAME LOCALITY Nº *	MAP REFERENCE		COUNTRY ROCK	DIP°	STRIKE°	WALL ROCK ALTERATION	NATURE OF INTRUSION	SIZE OF INTRUSION		DIP & STRIKE OF INTRUSION		NATURE OF CONTACTS	PRIMARY ZONING		REPLACEMENT ZONES		ALTERATION	MAJOR MINERALS	MINOR AND ACCESSORY MINERALS	ECONOMIC MINERALS	OTHER MINERALS (RARE)	MINERAL PRODUCTION (tons)		
	SHEET NO.	CO-ORDINATES						LENGTH (ft)	WIDTH (ft)	DIP°	STRIKE°		Degree of development	Zones present	Type	Distribution						Beryl	Columbite/ tantalite	Other
BURAMA-KABEZI 54	94/1	927 712	K-A	65SE	45	T	C/D		12	65SE	45	S	P	W.Z. I.Z.	M	H.W.M	K	Q Micro Musc K	T/m	Be				
KIGARA 55	94/1	903 667	K-A			T. M	C/D	90	20	Steep N.N.W	70	S	P	W.Z. I.Z.	Q.M	M	K	Q Micro Musc K		Be	Mn/O			
KIKOBA (U.Eastern) 24	85/3	793 927	K-A	85SE	59	T	C/D	40	15	Steep S.E	59	S	P	W.Z. I.Z.			K	Q Micro Musc K		Be		5·5		
KIKOBA (Western) 24	85/3	797 926	K-A	85SE	72	T	C					S	P	W.Z. I.Z.			K	Q Micro Musc K		Be (Cb/Ta)	Schist inclusions			
KYAMUGASI EAST 44	85/3	906 953	K-A & Gn(m)			K	x/F	260+	2-8	Near vert.	360	S	P	W.Z. I.Z.			K	Q Micro Musc K		Be (Ta/Cb)	Microlite			
KYEMPISI (Prospects) 31	85/3	822 931	K-A	Near vert. S	260	T	C/D		3"-6'	Near vert.	260	S	P	W.Z. I.Z.			K	Q Micro Musc K		Be				
KYEMPISI (N.W.) 31	85/3	823 935	K-A		E-W approx.			20+	6					W.Z. I.Z.			K	Q Micro Musc K		Be				
MURAMBI I 50	94/2		Gn			K	x/F	60+	10		280	S	P	W.Z. I.Z.	M	M	K	Q Micro Musc K	Sp/a T	Be (Cb/Ta)				
MUTOJO EAST 35	85/3	861 907	K-A	Steep N.W.	60	H	C/D			Steep N.W	60	S	P	W.Z. I.Z.			K	Q Micro Musc K		Be		33·0		
MUTOJO WEST 35	85/3	858 907	K-A	Steep N.W.	60	T. H	C/D x	210	55	Steep N.W	60	S	P	W.Z. I.Z. Quartz veins	Q.M	M	K	Q Micro Musc K	Sp/a T/m	Be (Cb/Ta)				
OMUKEIJENGI II 16	85/4	002 971	K-A	85E	180		C/D	50	20	85E	180	S	P	W.Z. I.Z.	M	M	K	Q Micro Musc K		Be (Ta/Cb)				
OMUKINONI 39	85/3	857 913	K-A	75SE	240		C/D	150	50		240	S	P	W.Z. I.Z.			K	Q Micro Musc K	T.	Be	Limonite			
OMUNGYENYI E. 46	85/3	903 943	Gn(m)	50W	185	H. K	x/F	200	50	85E	175	S	P	W.Z. I.Z.	M	M	K	Q Micro Musc K		Be		10·0		
RWAMAHUNGU (Valley prospect) 45	85/3	897 946	K-A		N-S		C/D	40	15		N-S	S	P	W.Z. I.Z.			K	Q Micro Musc K		Be				

* See fig. 4.

GROUP 1. 1c. UNALTERED FULLY-ZONED MICROCLINE-MUSCOVITE PEGMATITES

ENCLOSURE 4

NAME LOCALITY Nº *	MAP REFERENCE		COUNTRY ROCK	DIP°	STRIKE°	WALL ROCK ALTERATION	NATURE OF INTRUSION	SIZE OF INTRUSION		DIP & STRIKE OF INTRUSION		NATURE OF CONTACTS	PRIMARY ZONING		REPLACEMENT ZONES		ALTERATION	MAJOR MINERALS	MINOR AND ACCESSORY MINERALS	ECONOMIC MINERALS	OTHER MINERALS (RARE)	MINERAL PRODUCTION (tons)		
	SHEET NO.	CO-ORDINATES						LENGTH (ft)	WIDTH (ft)	DIP°	STRIKE°		Degree of development	Zones present	Type	Distribution						Beryl	Columbite / tantalite	Other
KAGANGO 38	85/3	880 897	Gn(c) Gn(Peg)			H								C	M	L		Q Micro Musc		Be Cb, Ta				
KANTOKYE 48	94/1	923 887	Gn(m)			H	F	200+	40+					C				Q Micro Musc		Be				
KIBAARE (3veins) 3	85/3	752 957	Gn(c)			T, H, K	x/F	200 100 100	30 20 10	75 E	185 to 205	S	G	C.P C	M	M		Q Micro Musc	T/m Fe-Mn/P Li-Fe-Mn/P	Be (Cb,Ta)		2·2		
KIHUMURO 47	85/3	940 930	Gn(c)			H, K	x/F			Vert	175	S	V.G.	(B.Z.) W.Z. I.Z. C	M	M C.M.		Q Micro Musc	T/m Fe-Mn/P Li-Fe-Mn/P	Be		1·4		
L. KIHUNGYE 1	85/3	688 991	Gn(c)			T, M	x/F	65			85	S	V.G.	W.Z. (I.Z.) C	M	M		Q Micro Musc	T	Be				
U. KIHUNGYE 1	85/3	685 989	Gn(Peg) in Gn(c)			T	C					S/Gr	G	C.P C				Q Micro Musc	T/m G	Be				
KITINDA	85/3	700 005	Gn										G	C.P C				Q Micro Musc		Be		0·5		
KYOBUGOMBE II 30	85/3	817 977	Gn(c) Gn(Peg)								245	Gr						Q Micro Musc		Be		53·4		
MUNGENYI (Main) 40	85/3	868 942	K-A Nr Gn(m)	Steep SE	40	T	C/D	150+	60	Vert	40	S	V.G.	(B.Z.) W.Z. I.Z. C	Q.M Ab	C.M. L M		Q Micro Musc	Fe-Mn/P	Be	Biotite Verdelite	5·0		
MUNGENYI (Prospects) 40	85/3	873 935	K-A Nr Gn(m)				C/D	100	20		10		G	C.P C				Q Micro Musc		Be				
MURAMBI III 50	94/2		Gn(c)			H, K	x/F	40+	15		290	S	G	C.P C.				Q Micro Musc		Be (Cb,Ta)				
NGOMA-RWENTOBO 53	94/1	895 725	K-A Gn(m)	70 W	200	T, H, K	x/F	200	10	Vert	200	S	V.G.	(B.Z.) W.Z. I.Z. C	M Ab?	L C M	(K)	Q Micro Musc		Be		5·8		
NTUNGAMO 13	85/4	970 037	Gn(m)					100					G	C.P C				Q Micro Musc	T	Be Cb, Ta		26·4	1·0+	
+NYABAKWERI 28	94/1	814 871	K-A/Csr	Vert	N-S		x/F	1000	60	Vert	100	S	V.G.	W.Z. I.Z. C	Ab?	L?		Q Micro Musc	T/m	Be Cb, Ta				
+NYABAKWERI S. 28	94/1	813 870	K-A/Csr	Vert	N-S		x/F	400	30	Vert	90	S	V.G.	W.Z. I.Z. C				Q Micro Musc		Be				
NYAMAREBE 40	85/3	866 937	Gn(Peg) Gn(m)				C	200	20		130	Gr	G	W.Z. I.Z. C	M Gr	M C	(K)	Q Micro Musc		Be				
NYARWANYA N. 26	85/3	808 897	K-A/Csr Gn(m)			H	x/F	50	25		90	S	V.G.	W.Z. I.Z. C				Q Micro Musc	T	Be				
RUTOOMA 41	85/3	867 959	Gn(c)			T	C/F	100+	2-8	20-30 S	290	Gr	V.G.	W.Z. I.Z. C				Q Micro Musc	T/cm	Be		6·4+		
RUYONZA 25	85/3	797 897	Gn(c)	Near vert	45		x/F	1500	1-3	75 S.S.W.	117	S	V.G.	W.Z. I.Z. C	Q. M	C.M.		Q Micro Musc	T	Be Cb, Ta		4·2		
RUYONZA-KYOBUGOMBE 30	85/3	817 897	K-A	55 S	85	T	C/D	40	20	55 S	85	S	G	C.P C				Q Micro Musc	T	Be (Ta)	Tapiolite	0·3		
RWABARAMIRA E. 39	85/3	877 922	Gn(m) Gn(Peg)				C	100	20		E-W	Gr	G	C.P C				Q Micro Musc		Be				
RWABARAMIRA S. 39	85/3	973 917	Gn(m) Gn(Peg)				C	150+	100+	Steep S	E-W	Gr	V.G.	W.Z. I.Z. C				Q Micro Musc	T	Be Ta, Cb				
RWEIBAGIRO-RAMADIDI 39	85/3	867 915	K-A Nr Gn(m) Gn(Peg)	Steep S	250		C/D	10+	6	Steep S	250	S	G	C.P C				Q Micro Musc		Be				
RWEIBANGO 5	85/3	837 996	IS Gn(m) Gn(Peg)		N-S	T	C	150+		80 S.W.	355	S/Gr	G	C.P C				Q Micro Musc	T/cm G	Be	Smoky quartz	2·9		
RWEMPUNGU 14	85/4	984 996	Gn(m) Nr K-A			H	F	100	6		275	S	V.G.	W.Z. I.Z. C				Q Micro Musc	T	Be				
RWENGONDO 2	85/3	761 975	IS	80SW	310		C/D	100+	40		310	S/Gr	G	C.P C				Q Micro Musc	T G	Be		0·1		

* See fig. 4.

ENCLOSURE 5

GROUP 1d. KAOLINISED FULLY-ZONED MICROCLINE-MUSCOVITE PEGMATITES

NAME LOCALITY Nº *	MAP REFERENCE		COUNTRY ROCK	DIP°	STRIKE°	WALL ROCK ALTERATION	NATURE OF INTRUSION	SIZE OF INTRUSION		DIP & STRIKE OF INTRUSION		NATURE OF CONTACTS	PRIMARY ZONING		REPLACEMENT ZONES		ALTERATION	MAJOR MINERALS	MINOR AND ACCESSORY MINERALS	ECONOMIC MINERALS	OTHER MINERALS (RARE)	MINERAL PRODUCTION (tons)		
	SHEET NO.	CO-ORDINATES						LENGTH (ft)	WIDTH (ft)	DIP°	STRIKE°		Degree of development	Zones present	Type	Distribution						Beryl	Columbite/ tantalite	Other
KABIGA-RUKANDA 51	94/1	930 772	Gn(m) IS	85 SW	295	H K	C/F	300+	70+	85SW	120	S	V.G.	W.Z. I.Z. C	M	L C.M. H.W.M.	K	Q Micro Musc K	T Cassiterite alt. zircon Li-Fe-Mn/P	Be (Cb,Ta) (Sn)		30·0		
KAGURO (KARABUGA) 42	85/3	875 967	Gn(m)			T H	F	300+			E-W	S	V.G.	W.Z. I.Z. C			K	Q Micro Musc K	T/cm	Be Cb,Ta		31·6	0·8	
KIHUMURO SOUTH 47	85/3	838 927	Gn			T H K	F	70+	20	75 W	20	S	V.G.	W.Z. I.Z. C	M	C.M.	K	Q Micro Musc K		Be				

* See fig. 4.

GROUP 2. ALBITE-MUSCOVITE REPLACED PEGMATITES

NAME LOCALITY Nº *	MAP REFERENCE		COUNTRY ROCK	DIP°	STRIKE°	WALL ROCK ALTERATION	NATURE OF INTRUSION	SIZE OF INTRUSION		DIP & STRIKE OF INTRUSION		NATURE OF CONTACTS	PRIMARY ZONING		REPLACEMENT ZONES		ALTERATION	MAJOR MINERALS	MINOR AND ACCESSORY MINERALS	ECONOMIC MINERALS	OTHER MINERALS (RARE)	MINERAL PRODUCTION (tons)		
	SHEET NO.	CO-ORDINATES						LENGTH (ft)	WIDTH (ft)	DIP°	STRIKE°		Degree of development	Zones present	Type	Distribution						Beryl	Columbite/ tantalite	Other
KITOKYE 23	84/3	780 923	Gn(m)	Vert	E-W	Ab T S	x/F	300	20	45SW	140	S	V.G.	B.Z. W.Z. I.Z. C	Ab M	W M	(K)	Q Micro Musc Ab	T,G,A Fe-Mn/P Li-Fe-Mn/P	Be (Cb,Ta)	ZnS FeS_2			
NGOMA (S.Location) 53	94/1	897 722	Gn			H K	F							I.Z. C	Ab	W	K			Be				
NYAKABINGO 49	94/1	938 893	IS	70 ENE	350	T	x/F	300	30	Steep & irreg. S.W.	305	S	V.G.	W.Z. I.Z. C	Ab/Cl M Gr	W L C.M.			G A S O	Be				

* See fig. 4.

ENCLOSURE 6

GROUP 3. KAOLINISED SPODUMENE-ALBITE REPLACED PEGMATITES

NAME LOCALITY No. *	MAP REFERENCE		COUNTRY ROCK	DIP°	STRIKE°	WALL ROCK ALTERATION	NATURE OF INTRUSION	SIZE OF INTRUSION		DIP & STRIKE OF INTRUSION		NATURE OF CONTACTS	PRIMARY ZONING		REPLACEMENT ZONES		ALTERATION	MAJOR MINERALS	MINOR AND ACCESSORY MINERALS	ECONOMIC MINERALS	OTHER MINERALS (RARE)	MINERAL PRODUCTION (tons)		
	SHEET NO.	CO-ORDINATES						LENGTH (ft)	WIDTH (ft)	DIP°	STRIKE°		Degree of development	Zones present	Type	Distribution						Beryl	Columbite/ tantalite	Other
+BYASHA 36	85/3	847 907	K-A	60 S	290	T	x/C D			75 S	110	S	G	W.Z. I.Z. C	M Gr	W	K	Q Micro Musc Sp/a K	T	Be (Cb Ta) (Sn)	Blue altered T.	77·0		
+KAZUMO N. 18	85/4	042 977	Gn(m)			H,K	x/F		20		N-S	S	V.G.	W.Z. I.Z. C	Ab/M M Gr	W	K	Q Micro Musc Sp/a K	Ab	Be (Cb,Ta) Li		72·0	0·5	
+KAZUMO S. 18	85/4	041 976	Gn(m)			H,K	x/F	150+	20		N-S	S	G	W.Z. I.Z. (C)	Ab/M M Gr	L W	K	Q Micro Musc Sp/a K	T A Ab	Be (Cb,Ta) Li (Sn)	Wavellite phosphates goyazite gp. & plumbogummite series			
+NYANGA-RWENTARE 32	85/3	833 926	K-A	85 S	285	T	x/C D	300+	200+	Steep NW	NW-SE	S	V.G.	W.Z. I.Z. C	M Gr	W	K	Q Micro Musc Sp/a K		Be (Cb,Ta) Li	(Schist xenoliths)	90·0	0·8	
+NYABUSHENYI 8	85/3	885 994	K-A	Steep SW	145	T H	x/C D/F	300+	300+	Vert & small SW	150	S	G	W.Z. I.Z. C	Ab/M Q.M. Gr	L W	K	Q Micro Musc Sp/a K	A Ab	Be Cb,Ta Li (Sn)	Fe/Mn/P Mn/O (Schist xenoliths)	295·0	2·3	Amblygonite 107·0+
+RUHUMA C. 56	94/1	887 665	K-A	80 SE	245	M	x/F	100	40		305	S	G	W.Z. I.Z. C	M		K	Q Micro Musc Sp/a K		Ta, Cb				
RWANZA			Schist			H	x/F	1000+				S	V.G.	W.Z. I.Z. C	M	W	K	Q Micro Musc Sp/a K	T/cm Fe-Mn/P Li-Fe-Mn/P	Be Cb,Ta Li Sn	Altered zircon	396·0	3·0+	Cassiterite 0·5+
+RWENKANGA Lr. 21	85/3	768 922	K-A	85 SW	290	T	C/D			Steep SW	NNW-SSE	S	G	W.Z. I.Z. C	M	W	K	Q Micro Musc Sp/a K	Ab	Be (Cb,Ta)	Chrysoberyl	73·0	0·03	
+RWENKANGA U. 21	85/3	770 922	K-A	Near vert.	305	T	C/D	250		Steep SW	NNW-SSE	S	G	W.Z. I.Z. C	M	W	K	Q Micro Musc Sp/a K	Ab	Be (Cb,Ta)				

* See fig. 4.

ENCLOSURE 7

GROUP 4. LITHIAN MUSCOVITE-ALBITE REPLACED PEGMATITES

NAME LOCALITY Nº ✱	MAP REFERENCE		COUNTRY ROCK	DIP°	STRIKE°	WALL ROCK ALTERATION	NATURE OF INTRUSION	SIZE OF INTRUSION		DIP & STRIKE OF INTRUSION		NATURE OF CONTACTS	PRIMARY ZONING		REPLACEMENT ZONES		ALTERATION	MAJOR MINERALS	MINOR AND ACCESSORY MINERALS	ECONOMIC MINERALS	OTHER MINERALS (RARE)	MINERAL PRODUCTION (tons)		
	SHEET NO.	CO-ORDINATES						LENGTH (ft)	WIDTH (ft)	DIP°	STRIKE°		Degree of development	Zones present	Type	Distribution						Beryl	Columbite/ tantalite	SnO_2
+MUTAKA	85/1	745 185	IS (Gn)	Steep N	280	H K	C/F	3,000+	150+	S	50	S	G	(W.Z.) I.Z. C	Ab	W F.W.C.M.	K	Q Sp/a Micro Li/M K	G T Musc S	Be Cb,Ta Sn	Smoky quartz, green tourmaline	200+	2	1+
+RWEMERIRO 37	85/3	874 910	K-A Gn(m)	45 N	E-W	T	C/F	1,000+	100	Steep S	280	S	V. G.	B.Z. W.Z. I.Z. C	Ab M	W. H.W.M. C.M.		Q Micro Ab/Cl Sp/a Li/M	A, G Musc T O Mn/O S	Be Cb,Ta (Sn)	Bismuth, orthoclase, Zn S FeS_2	446+	5+	

✱ See fig. 4.

GROUP 5. 5a. POORLY-ZONED QUARTZ-MICA-KAOLIN PEGMATITES

ENCLOSURE 8

NAME LOCALITY Nº *	MAP REFERENCE		COUNTRY ROCK	DIP°	STRIKE°	WALL ROCK ALTERATION	NATURE OF INTRUSION	SIZE OF INTRUSION		DIP & STRIKE OF INTRUSION		NATURE OF CONTACTS	PRIMARY ZONING		REPLACEMENT ZONES		ALTERATION	MAJOR MINERALS	MINOR AND ACCESSORY MINERALS	ECONOMIC MINERALS	OTHER MINERALS (RARE)	MINERAL PRODUCTION (tons)		
	SHEET NO.	CO-ORDINATES						LENGTH (ft)	WIDTH (ft)	DIP°	STRIKE°		Degree of development	Zones present	Type	Distribution						Beryl	Columbite/ tantalite	Other
KAGAMBA (Localities) 9	85/3	855 073 855 076 842 098	K-A			T	C/D	Few yards	Few" to few'			S	V.P	QM			K	Q Musc K	Micro T	Be ?				
KAKOKI I 6	85/3	863 998	K-A	80-85 NNW	60	T	C/D	30	10	80-85 NNW	60	S	V.P	QMK	M	M	K	Q Musc K		Be (Cb,Ta)		6·5		
KAKOKI II 6	85/3	864 998	K-A	65 SSE	240		C/D	100	3	65 SSE	240	S	V.P	QMK			K	Q Musc K						
KAKOKI III 6	85/3	864 000	K-A	Near Vert.	90	M	x/C F	100	15	Near vert.	90	S	V.P	QM			K	Q Musc K		Be				
KAMUHA 22	85/3	780 917	K-A	75 NE	NW-SE	T						S	V.P	QM			K	Q Musc K						
KISAKO 7	85/3	876 997	K-A	35 NE	130		C/D	50+	50+	NE	130	S	V.P	QMK			K	Q Musc K		Be (Ta,Cb)		0·7		
KISAKO N. 7	85/3	873 100	K-A										V.P	QM			K	Q Musc K						
+KITOFA 57	94/3		K-A	Near Vert.	N-S		C/D approx.	200	20	75 W	10	S	V.P	QMK	M		K	Q Musc K		Ta,Cb (Sn)				
KITOKYE (Nyanga W.) 23	85/3	827 927	K-A	85 S	253		X F/D				50	S	V.P	QMK	QM	M	K	Q Musc K	T	Be Cb,Ta				
KYOBUGOMBE 4	85/3	818 933	K-A		E-W								V.P	QMK			K	Q Musc K	T	Be				
~~MISHENYI (45)~~	~~85/3~~	~~900 934~~	~~K-A~~	~~75 ESE~~	~~25~~	~~M~~	~~C/D~~	~~20+~~	~~10+~~	~~75 ESE~~	~~25~~	~~S~~	~~V.P~~	~~QMK~~	~~QM~~	~~M~~	K	Q Musc K		Be?				
NYABUSHENYI S. 8	85/3	889 989	K-A										V.P	QM			K	Q Musc K		Be				
NYABUSHENYI W. 8	85/3	882 982	Gn(m)		90	H K	C/F	150	10		90	S	V.P	QM			K	Q Musc K	G	Be				
NYANGA E. 32	85/3	835 927	K-A	Steep S	E-W		C/D	Small		Steep S	E-W	S	V.P	QMK			K	Q Musc K		Be?				
NYANGA N.W. 32	85/3	827 930	K-A	Steep S	E-W	T						S	V.P	QMK			K	Q Musc K	T	Be? (Cb,Ta)				
OMUKEIJENGI I (Main) 16	85/4	005 973	K-A				x/F	60	15		255	S	V.P	QMK	M	M	K	Q Musc K		Be		(18·8)		
OMUNGYENYI I (West) 46	85/3	962 943	K-A	Vert Steep W	200	M	C/D	300	40	Near vert.	175	S	V.P	QMK			K	Q Musc K		Be	(Schist xenoliths)	30·0		
RWAMADIDI (3 Prospects) 39	85/3	863 912	K-A	Steep S	250	T	C/D	200+		Steep S	250	S	V.P	QMK			K	Q Musc K	T	Be (Cb,Ta)		6·0		
RUKUTO 11	85/3	920 995	K-A										V.P	QMK			K	Q Musc K		Be				
RUTUNGURU (Be prospect) 10	85/3	890 055	K-A	Steep W	145	T	x/F	50	5		305	S	V.P	QMK			K	Q Musc K		Be (Cb,Ta)		1·7		
RWAMAHUNGU S. 45	85/3	898 942	K-A	65 W	15		C/D	40	5	Steep W	15	S	V.P	QM			K	Q Musc K	T	Be				
RWABARAMIRA 39	85/3	873 920	K-A	Steep W	185	M	C/D			Steep W	185	S	V.P	QMK			K	Q Musc K	T	Be				
SHESHE 34	85/3	854 928	K-A	87 NNE	295	T	x/C F	60+	15	85 NNE	295	S	V.P	QMK	QM	M	K	Q Musc K		Be				

* See fig. 4.

ENCLOSURE 9

GROUP 5. 5b. FULLY-ZONED QUARTZ-MICA-KAOLIN PEGMATITES

NAME LOCALITY Nº *	MAP REFERENCE		COUNTRY ROCK	DIP°	STRIKE°	WALL ROCK ALTERATION	NATURE OF INTRUSION	SIZE OF INTRUSION		DIP & STRIKE OF INTRUSION		NATURE OF CONTACTS	PRIMARY ZONING		REPLACEMENT ZONES		ALTERATION	MAJOR MINERALS	MINOR AND ACCESSORY MINERALS	ECONOMIC MINERALS	OTHER MINERALS (RARE)	MINERAL PRODUCTION (tons)		
	SHEET NO.	CO-ORDINATES						LENGTH (ft)	WIDTH (ft)	DIP°	STRIKE°		Degree of development	Zones present	Type	Distribution						Beryl	Columbite / tantalite	Other
+KAKANENA 20	85/3	763 923	K-A	40 NW	240-290	T M	x C/F	Unknown, very large		Irregular S	280	S	P	QMK C	M Gr	W	K	Q Musc K	T Micro	(Be) Ta,Cb	Mn/O	6·38	10·3+	
+KABUSANAMI (Kavusanami) 32	85/3	838 934	K-A		E-W	M		50			NW-SE	S	P	QMK C			K	Q Musc K	T	Be	Fe-Mn/O	0·69		
KYAMUGASHE (Columbite location) 43	85/3	901 958	K-A	75 ENE	100	T H	C/D	200+		60 ENE	100	S	G	W.Z. I.Z. C	Ab M Gr	L W	K	Q Musc K		Be (Sn) Cb,Ta		1·0	2·2	
KYAMUGASHE (Road location) 43	85/3	896 967	K-A										V.P.	QM C			(K)	Q Musc K		Be Ta,Cb				
KYAMUGASHE-KAMIRA 45	85/3	896 950	K-A	70 NE	325	T M		200+				S	P	QM C	M Gr	M C	(K)	Q Musc K	Micro	Be	(Schist xenoliths)	35·4		
NYANGA N.E. (Ruyanza) 32	85/3	834 928	K-A	Steep S	E-W	T H	x/C	200+	100+	Flat sheet	E-W	S	P	QMK C	Gr	W	K	Q Musc K	Fe-Mn/O	(Be) Ta,Cb			5·0	
OMUKEIJENGI I (Middle prospects) 16	85/4	005 973	K-A	85 E	180		x/F	100	2-20		275	S	P	QMK C	M	M	K	Q Musc K		Be (Cb,Ta)		18·8	0·18	
OMUKEIJENGI I (Road location) 16	85/4	005 973	K-A	85 E	180		x/F	30	15		130	S	P	QMK C			K	Q Musc K		Be				
RWAMAHUNGU (René prospect) 45	85/3	897 945	K-A	Steep W	N-S	T	C/D	100	25	Steep W	N-S	S	P	QM C			(K)	Q Musc K	T	Be				
RWAMAHUNGU 45	85/3	901 947	K-A	80 W	10		C/D	30 45	10 10			S	P	QM C	M	M	(K)	Q Musc K		Be				
+BITAKA 17	85/4	026 966	K-A Gn(m)			T,M, H,K	x/F C/F				N-S	S	P	QMK C	Gr	L	K	Q Musc K	T	Be (Ta,Cb) (Sn)				

NON BERYL-BEARING QUARTZ-MICA-KAOLIN PEGMATITES

+KASHOJWA	85/4	967 928	K-A				x/C F	300+	7	70 SSW	295	S	VP	QMK C	Gr	W	K	Q Musc K		Cb,Ta				
+RUHUMA A 56	94/1	890 660	K-A	70 SE	245		C/D	50+	30		345	S	VP	QMK C			K	Q Musc K		Ta,Cb (Sn)				
+RUHUMA B 56	94/1	890 660	K-A				x/F	20+	25			S	VP	QMK C			K	Q Musc K	Rose musc.	Ta,Cb (Sn)				

* See fig. 4.

ENCLOSURE 10

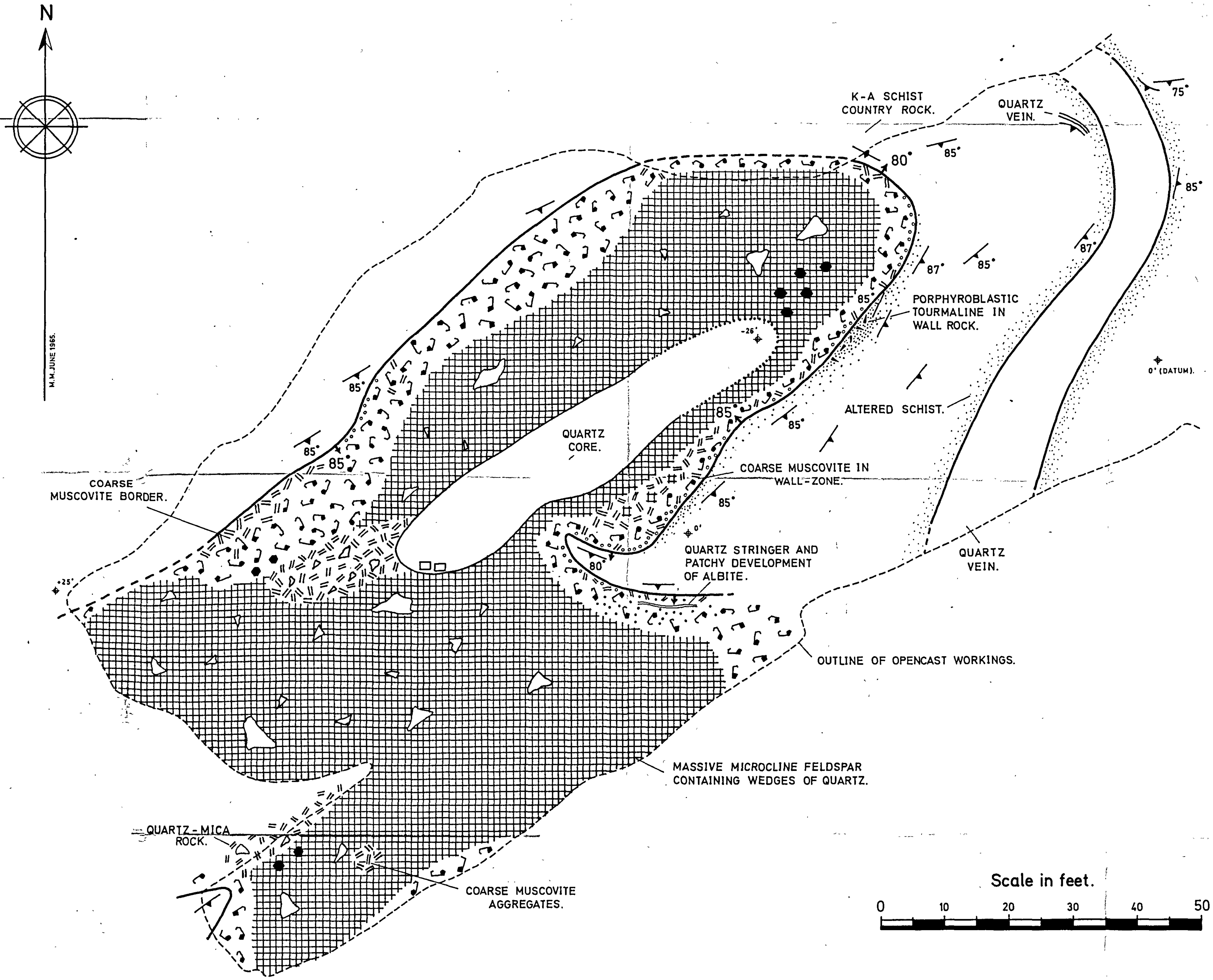
QUARTZ-MICA VEINS

NAME LOCALITY Nº *	MAP REFERENCE		COUNTRY ROCK	DIP	STRIKE	WALL ROCK ALTERATION	NATURE OF INTRUSION	SIZE OF INTRUSION		DIP & STRIKE OF INTRUSION		NATURE OF CONTACTS	"ZONES" PRESENT	ALTERATION	MAJOR MINERALS	MINOR AND ACCESSORY MINERALS	ECONOMIC MINERALS	OTHER MINERALS (RARE)	MISCELLANEOUS FEATURES
	SHEET NO.	CO-ORDINATES						LENGTH (ft)	WIDTH (ft)	DIP°	STRIKE°								
+ LWATA I (Dwata) 9	85/4	057 975	K-A Quartzite			M	x/C F	?	2-4	Steep W	355	S	Quartz-mica aggregate	K	Q Musc K		Sn Cb, Ta		
+ LWATA II (Dwata) 9	85/4	053 975	K-A Schist	Steep S	265		x/F	?	2	Steep W	360	S	Quartz-mica aggregate	K	Q Musc K		Sn		
KANYINA 11	85/4	174 015	K-A Quartzite	75 N	280	T M	C/F		8"	75 N	280	S	Quartz-mica stringers		Q Musc		Sn Cb, Ta		
KASHOJWA (Tin-columbite wkngs.) 5	85/4	967 932	K-A Schist & quartzite			T	x/F					S	Quartz vein Mica rock selvages	K	Q Musc K		Sn Cb, Ta		
KAZUMO (Tin prospect) 7	85/4	043 976	K-A Quartzite		140	T	C/F	500+	1-2		140 approx	S	Quartz vein Mica rock selvages		Q Musc		Sn		Clay present
+ KYAMUGASHE 4	85/3	903 964	K-A Schist			T H K	x/F		1-2	40 S	E-W	S	Quartz vein. Quartz-mica-kaolin zone Mica rock selvages	K	Q Musc K		Sn		
+ NYANGA (Cassiterite-tantalite prospect) 2	85/3	830 920	K-A Schist		NW-SE	T Gr	C/F	60+	16+	82 NE	NW-SE	S	Composite intrusion Quartz vein Quartz-mica units		Q Musc	T	Sn Ta, Cb		Mica schist xenoliths in mica rock
+ RWAKIRENZI 1	85/3	750 912	K-A Schist	85 E	210	T Gr	x/F		14+	75 S	115	S	Quartz vein Mica rock units		Q Musc		Sn Cb. Ta	Mn Oxides	
RUTUNGURU 3	85/3	878 053	K-A Schist	Steep SW	320	T	C/D	100+	2-3	Steep SW	320	S	Quartz veins Mica rock units Quartz-mica-kaolin zone	K	Q Musc K	Amblygonite (altered)	Sn Cb, Ta Li		Schist inclusions
RWEBITOOMA 8	85/4	055 977	K-A Schist	40 S	E-W	T H K	x/F	150+	1+	40 SW	140	S	Quartz vein Quartz-mica-kaolin zone	K	Q (Musc) K		Sn		Mica scarce
+ RWEMIKOMA 10	85/4	107 896	K-A Schist		140	T	C/F			Near vert.	140	S	Quartz vein Mica rock units	K	Q Musc K		Sn		
RWENYENA 6	85/4	011 972	K-A Schist & quartzite				x/F	500+	1-3		100	S	Quartz vein Mica rock units		Q Musc		Sn		

* See fig. 6.

ENCLOSURE 11

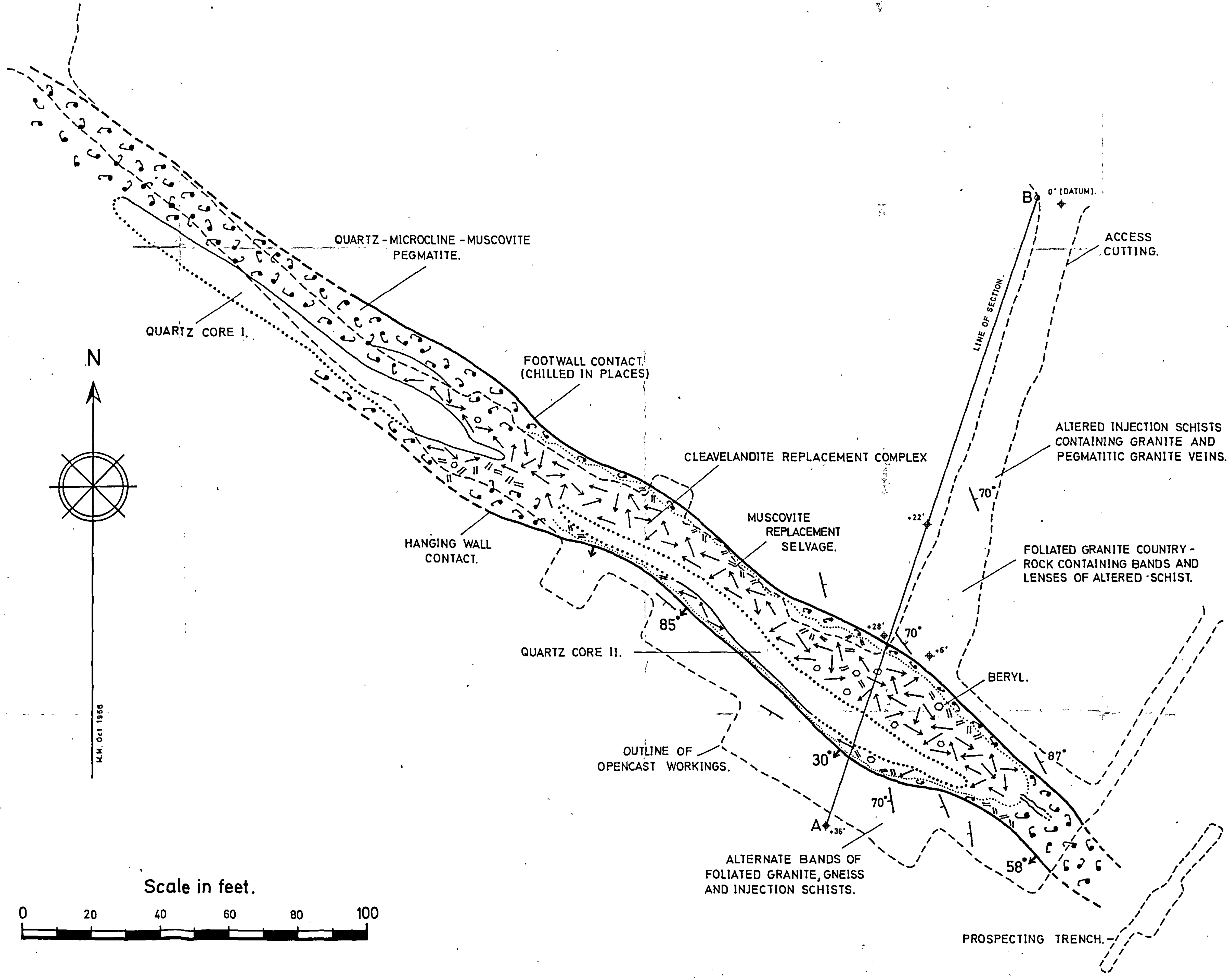
PLAN OF THE MUNGENYI PEGMATITE.



P.L.L.

ENCLOSURE 12

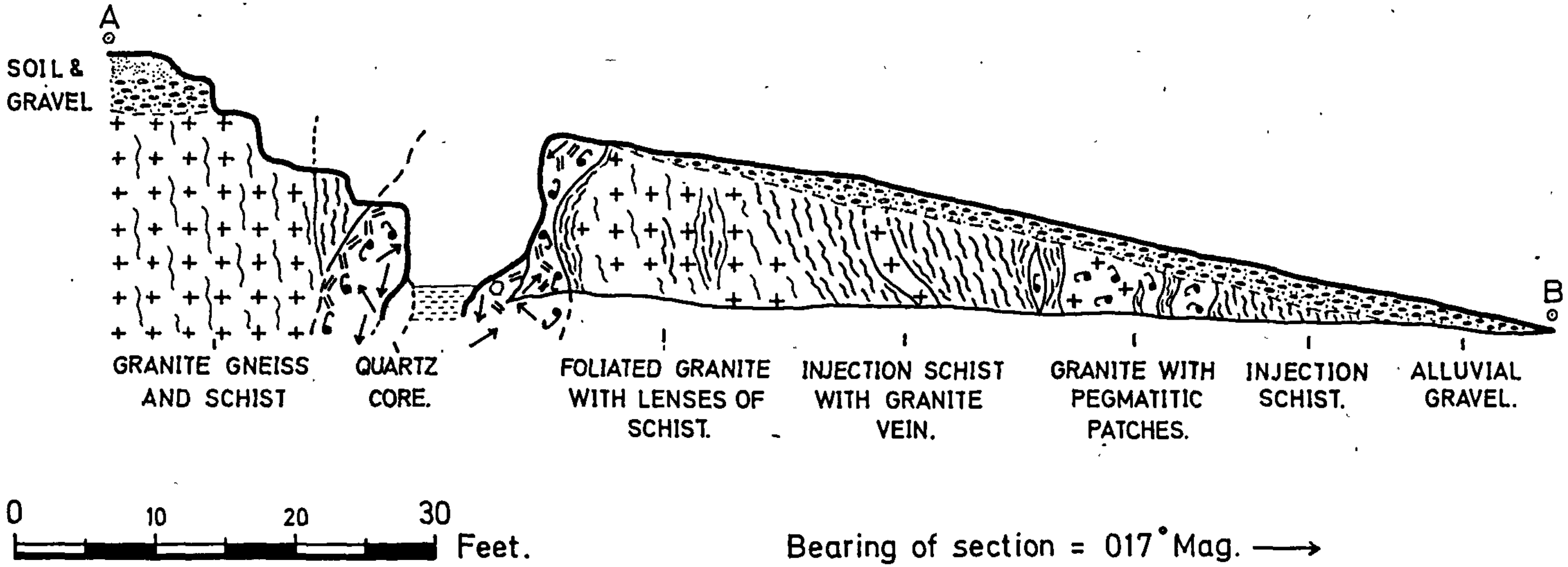
PLAN OF THE NYAKABINGO PEGMATITE.



P.L.L. Oct 1966.

ENCLOSURE 13

SECTION THROUGH PEGMATITE AND COUNTRY ROCKS AT NYAKABINGO.

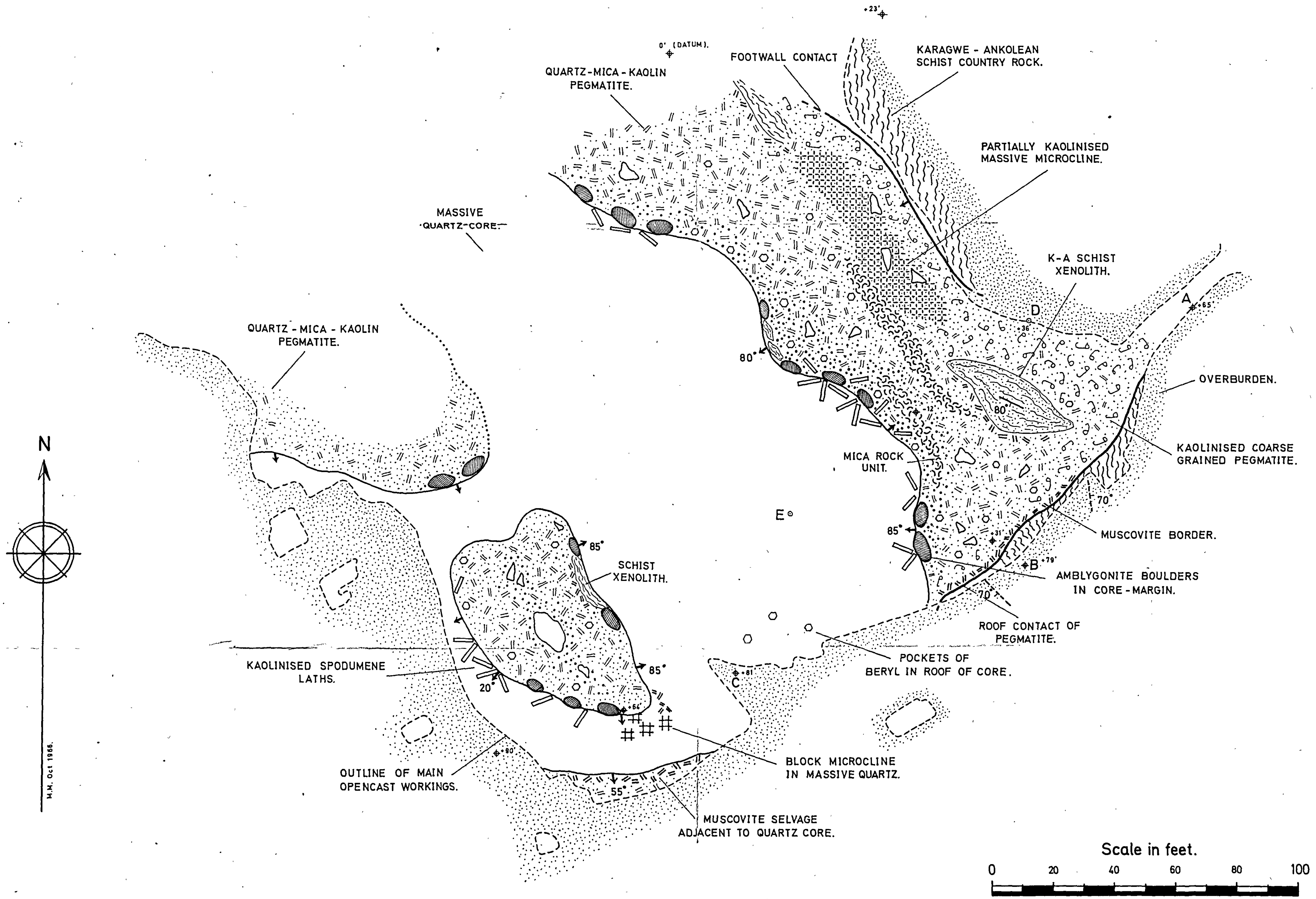


Bearing of section = 017° Mag. ⟶

P.L.L. Oct 1956.

ENCLOSURE 14

PLAN OF THE NYABUSHENYI PEGMATITE.



P.L.L.

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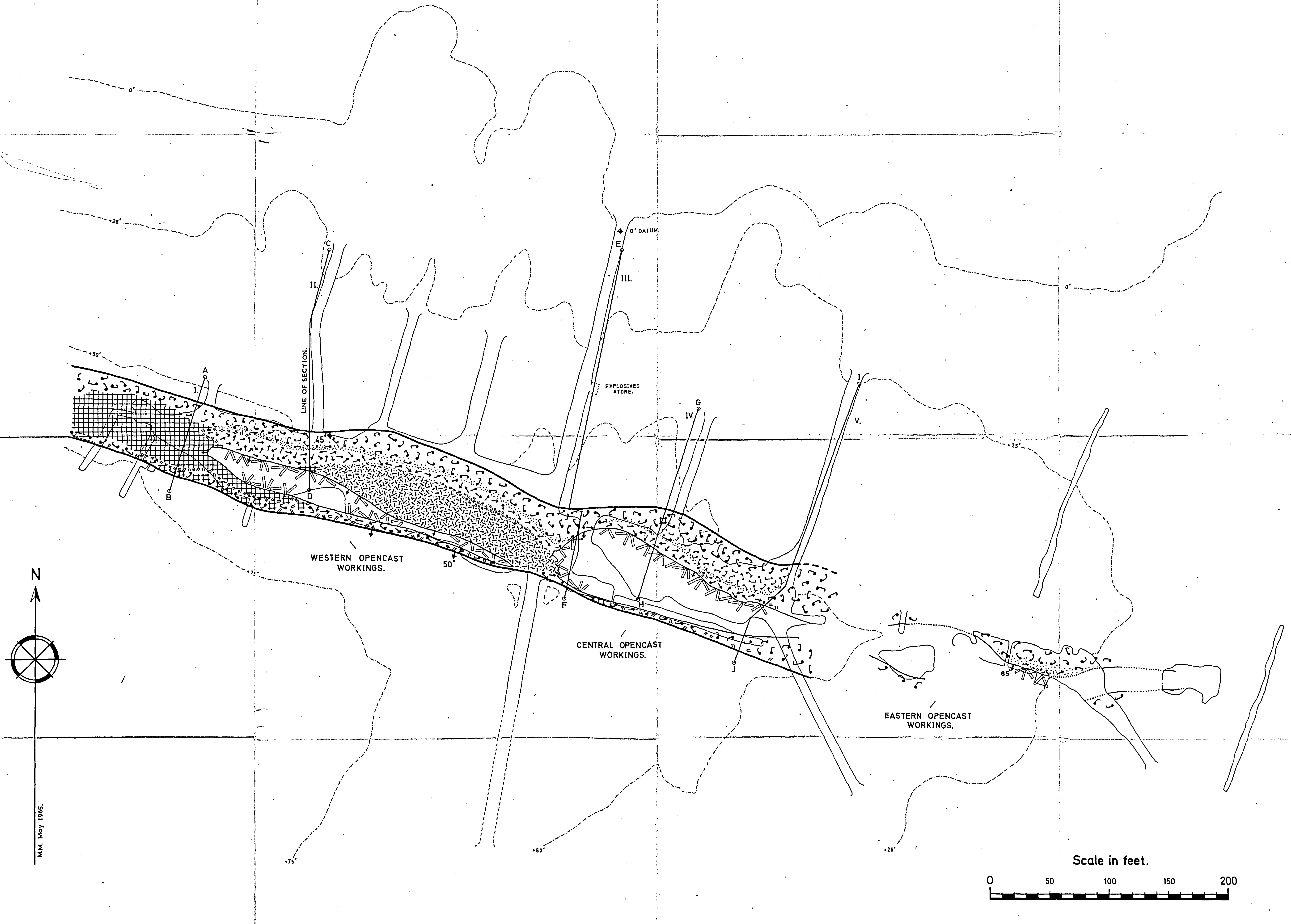
ENCLOSURE 16

PLAN OF THE RWEMERIRO PEGMATITE.

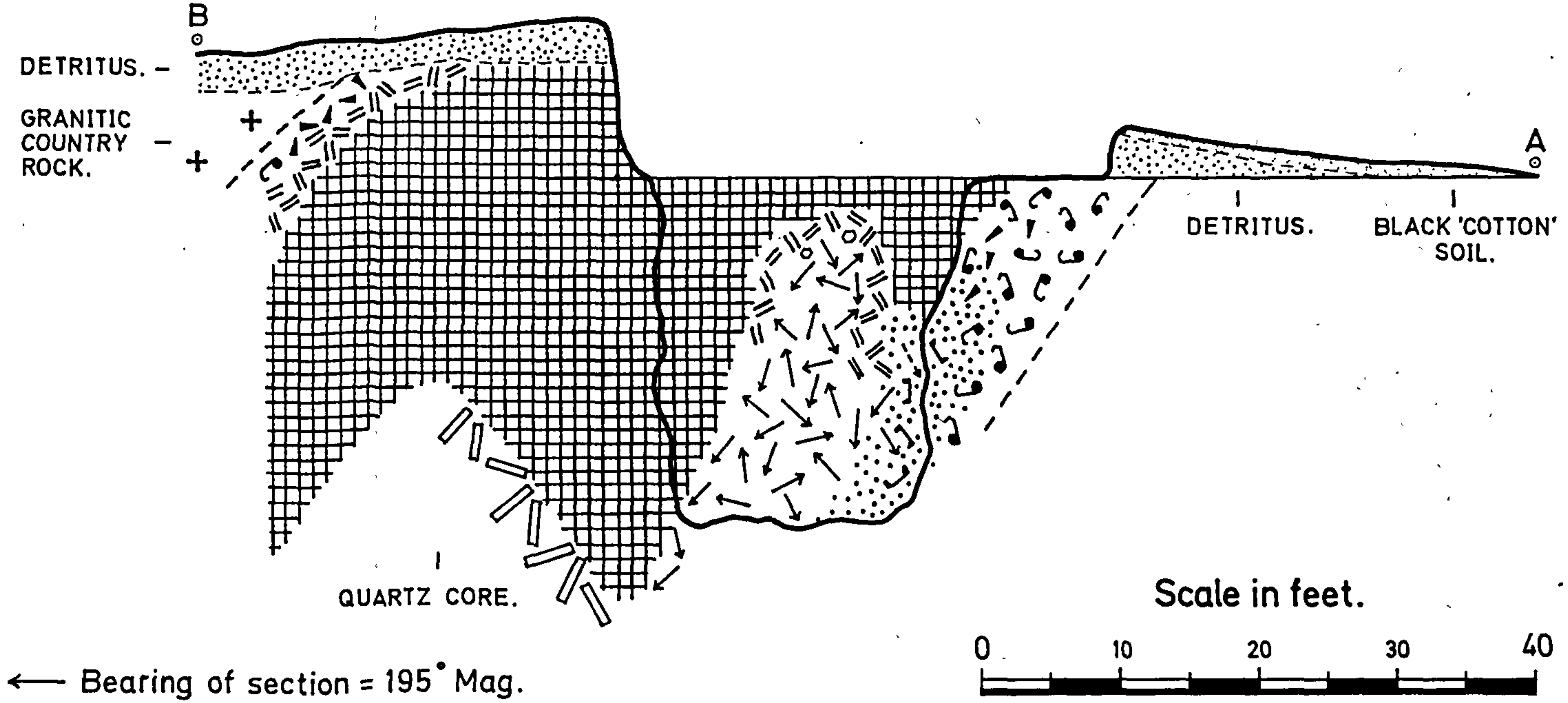


P.L.L.

ENCLOSURE 17

RWEMERIRO SECTION I.

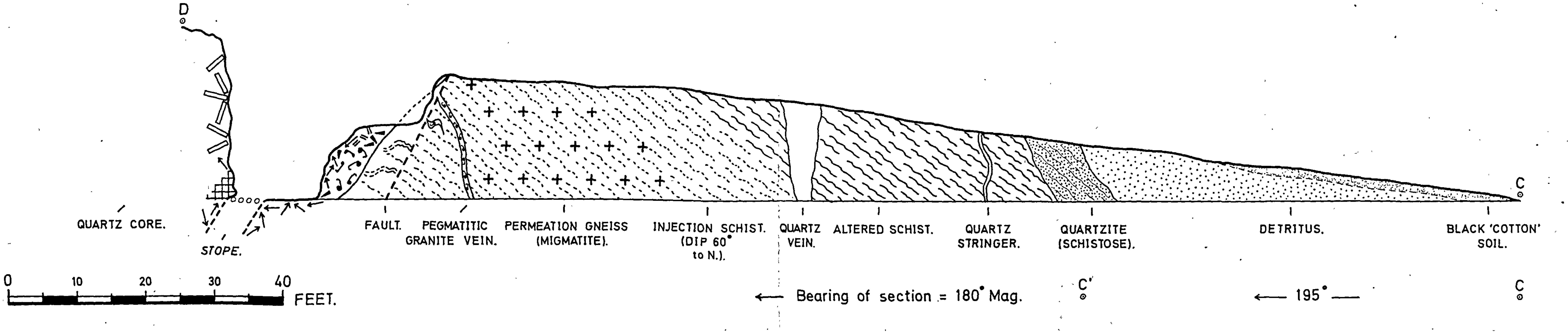
(FACING WEST).



P.L.L. Nov. 1966.

ENCLOSURE 18

RWEMERIRO SECTION II.
(FACING WEST).



P.L.L. Nov. 1966.

ENCLOSURE 19

RWEMERIRO SECTION III.

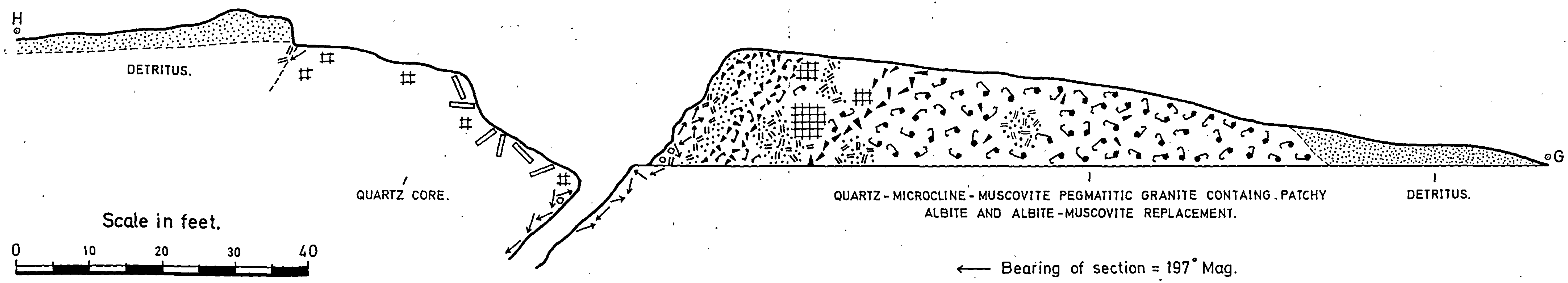
(FACING EAST).

Bearing of section = 191° Mag ⟶

P.L.L. Nov. 1966.

ENCLOSURE 20

RWEMERIRO SECTION IV.
(FACING WEST).



P.L.L. Nov. 1966.

ENCLOSURE 21

RWEMERIRO SECTION V.
(FACING EAST).

P.L.L. Nov. 1966.

ENCLOSURE 22

KEY TO ACCOMPANY THE PEGMATITE PLANS AND SECTIONS.

⁘	Aplitic pegmatite.
⌒	Medium to coarse grained pegmatite.
⁙	Albitised medium to coarse grained pegmatite.
⁙	Kaolinised medium to coarse grained pegmatite.
⌒	Graphic pegmatite.
⁙	Albitised graphic pegmatite.
▦	Massive or block microcline feldspar.
▦	Block quartz in microcline feldspar.
▦	Partially albitised massive microcline feldspar.
▦	Kaolinised massive or block microcline.
□	Core quartz or blocks of massive quartz.
▨	Kaolinised spodumene laths in quartz core margins.
▨	Muscovite aggregates, selvages and quartz - muscovite replacement zones.
▨	Albite - muscovite replacement complex (zones).
▨	Quartz - muscovite - kaolin (altered) pegmatite.
⁙	Fine grained (saccharoidal) albite.
↗	Cleavelandite replacement complex (zones).
▨	Massive cleavelandite - 'oncosine' rock.
↗	Kaolinised cleavelandite feldspar.
⁙	Kaolin.
∽	Mica - rock ('greisen') replacement zones.
∽	Lithian muscovite replacement zones.
⬡ ⬢	Beryl.
⟋	Tourmaline.
⬮	Amblygonite (massive).
□	Lithium - iron - manganese phosphates.

(Geological symbols modified after A. A. Beus, 1956.)