

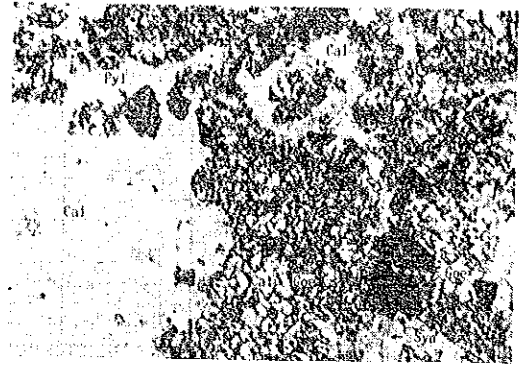
Appendix 3

Microscopic observations and
microphotographs (Thin section)

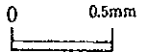
①

Sample No. : S0110
Sector : Songwe Locality : JMS-1 30.4m
Rock name : Carbonatite

This rock is light brown massive carbonatite with vein of dark brown calcite-goethite aggregate. The rock consists of calcite with subordinate amounts of apatite and goethite. Rare metal-rich minerals are synchisite and pyrochlore. The former one is fine acicular minerals commonly forming an aggregate. The latter is subhedral grain with diameter of about 0.2 mm. Goethite occurs usually with calcite, apparently suggesting a presence of ankerite as an original mineral. Therefore, it can be concluded that original assemblage in this rock is calcite-ankerite. In this sense, a part of calcite is also secondary mineral as is goethite.



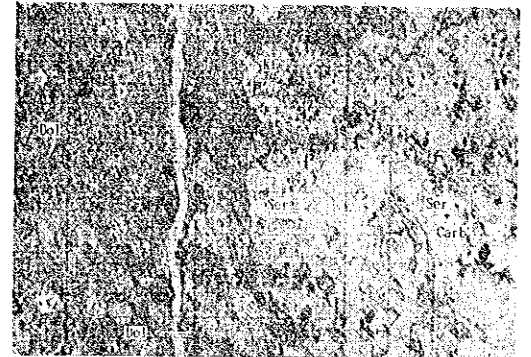
Plain polarized light



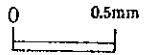
②

Sample No. : S0308
Sector : Songwe Locality : JMS-2 40.2m
Rock name : Carbonatite

This rock is light brick red dolomite carbonatite, including feldspar like a phenocryst in a porphyritic rock. It consists mainly of dolomite and apatite with a subordinate amount of K-feldspar. Rare metal-rich minerals are trace. They are pyrochlore, synchisite and parisite. Opaque minerals occur sporadically. Sericite, associated with carbonate, replaces strongly fine-grained K-feldspar.



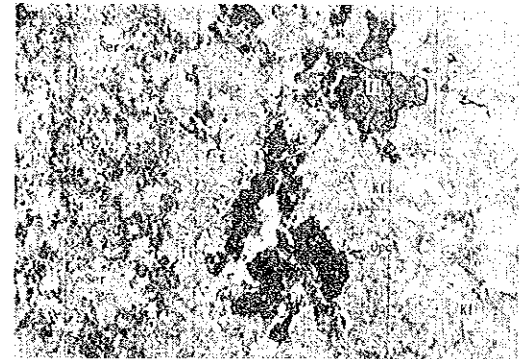
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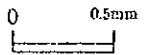
③

Sample No. : S0310
Sector : Songwe Locality : JMS-3 52.5m
Rock name : Carbonate silicate rock

This rock is composed essentially of white carbonatite with mosaic texture and light brown feldspathic part with porphyritic texture and consists mainly of K-feldspar, calcite and dolomite. There are many rare metal-rich minerals, such as synchisite, pyrochlore and parisite, but they are usually trace in amount. Pyrochlore is less than 0.2 mm in diameter. Parisite is euhedral crystal with diameter of around 0.3 mm. Other accessory minerals are biotite, saponite and pyrite. Chlorite, sericite and goethite, secondary minerals, are small in amount. These secondary minerals occurs only in a K-feldspar-rich part.



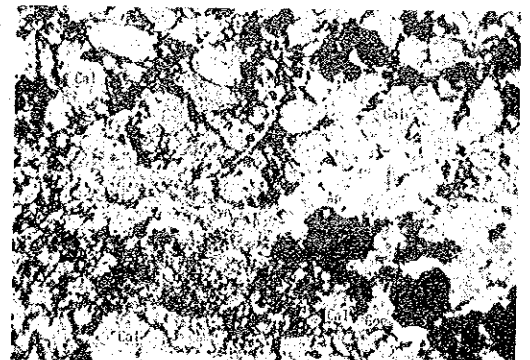
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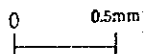
④

Sample No. : S0403
Sector : Songwe Locality : JMS-4 29.0m
Rock name : Carbonatite

This rock is dark brown carbonatite with abundant goethite. Calcite and goethite usually make an aggregate, suggesting that they are derived from ankerite. Apatite and synchisite are small in amount. The latter one is tabular crystal, occurring comonly as an aggregate in clear calcite patch(or vein). Barite and opaque minerals are rare.



Plain polarized light



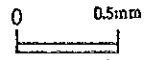
⑤

Sample No. : S0808
Sector : Songwe Locality : JMS-8 21.5m
Rock name : Carbonate silicate rock

This rock is dark brown carbonatite including feldspar phenocrysts. It consists mainly of K-feldspar, calcite and goethite with a subordinate amount of apatite. Sericite is common, occurring mostly at the grain boundaries among K-feldspar phenocrysts and partly replacing K-feldspar. Opaque minerals are common. Siderite, probably secondary mineral, is also common.



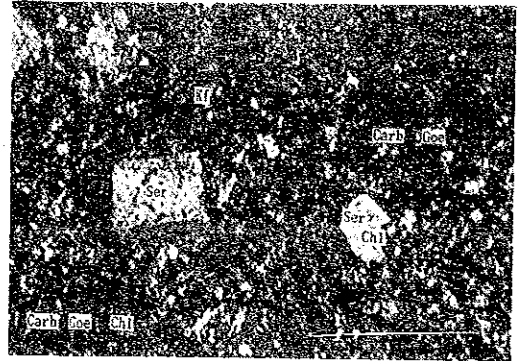
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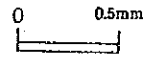
⑥

Sample No. : JMS-9
Sector : Songwe Locality : JMS-9 13.2m
Rock name : Syenitic rock

This is light brick red rock, probably syenitic rocks, with light yellow carbonate. It has porphyritic texture and consists mainly of K-feldspar, calcite and goethite with a subordinate amount of dolomite. Biotite and parisite are small in amount. Chloritization and sericitization are common. Palygorskite, white veinlet, is very minor.



Crossed polarized light



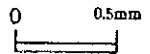
⑦

Sample No. : S1007
Sector : Songwe Locality : JMS-10 27.0m
Rock name : Carbonatite

This rock is white laminated carbonatite with mosaic texture. It consists mostly of calcite and dolomite. Stronchianite, checked by X-ray, is not uncommon. Accessary minerals are apatite, K-feldspar, synchisite and pyrite. Synchisite is strongly altered into brown to black minerals. Goethite and sericite, not common, occurs as secondary minerals.



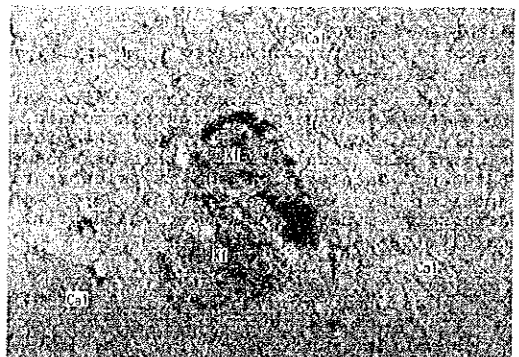
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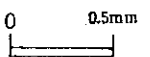
⑧

Sample No. : S1012
Sector : Songwe Locality : JMS-10 43.3m
Rock name : Carbonatite

This rock is light brown carbonatite with white non-carbonatitic parts. It has mosaic texture and consists mostly of calcite with subordinate amounts of K-feldspar and apatite. The latter two minerals occur as phenocryst and patch in a calcite matrix, respectively. Stronchianite and opaque minerals occur as accessory minerals.



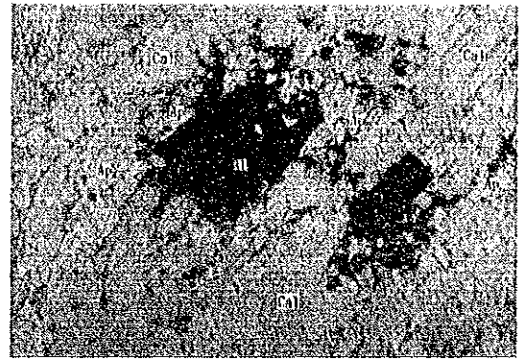
Plain polarized light



9

Sample No. : T0103
Sector : Tundulu Locality : JMT-1 10.4m
Rock name : Carbonatite

This rock is composed of light brick red carbonate-poor and white carbonate-rich parts with mosaic texture. It consists mainly of calcite and K-feldspar with a subordinate amount of quartz. Synchisite, parisite and saponite are trace in amount. Goethite is common, probably formed by a decomposition of ankerite.



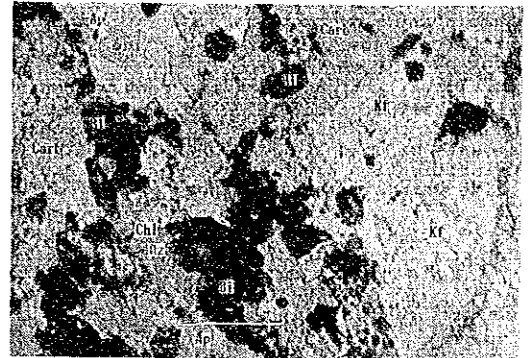
Plain polarized light

0 0.5mm

10

Sample No. : T0106
Sector : Tundulu Locality : JMT-1 22.6m
Rock name : Carbonate silicate rock

This rock is a gabbro-looking moderate-grained carbonatite with mosaic texture. It consists of calcite, dolomite, K-feldspar and biotite(or phlogopite). Apatite, quartz and pyrite are subordinate in amount. Chlorite and sericite are secondary minerals. They are common occurring at the grain boundaries among fine-grained K-feldspar laths and quartz. Parisite is subhedral grain with diameter of about 0.3 mm.



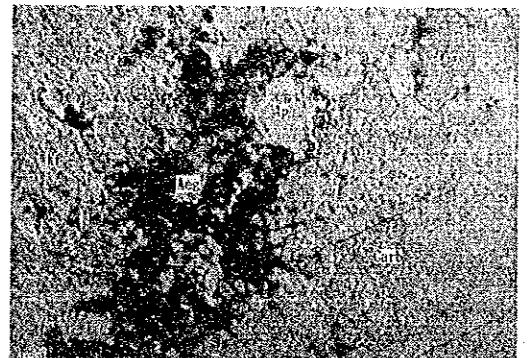
Plain polarized light

0 0.5mm

11

Sample No. : T0112
Sector : Tundulu Locality : JMT-1 39.5m
Rock name : Sovite

This rock is composed of white carbonatitic and light brick red feldspathic parts with mosaic texture. It consists mainly of calcite and K-feldspar with subordinate amounts of quartz, biotite, dolomite, apatite and aegirine. Biotite occurs mostly at the boundary between calcite-rich and K-feldspar-rich parts. Aegirine occurs mostly as an aggregates in a K-feldspar-rich part. Coarse-grained one is strongly replaced by chlorite. Chlorite and sericite are also common as secondary minerals.



Plain polarized light

0 0.5mm

12

Sample No. : T0113
Sector : Tundulu Locality : JMT-1 42.7m
Rock name : Sovite

This rock is composed of white carbonate-rich and light brick red feldspathic parts with mosaic texture. It consists mainly of calcite, K-feldspar and biotite. Biotite makes a cluster in a calcite-rich part or as a fine-grained aggregate between calcite-rich and K-feldspar-rich part. Dolomite, apatite, pyrite and aegirine are common. Stronchianite is a accessory mineral occurring as a fine exsolution phase in calcite (checked by EDS).



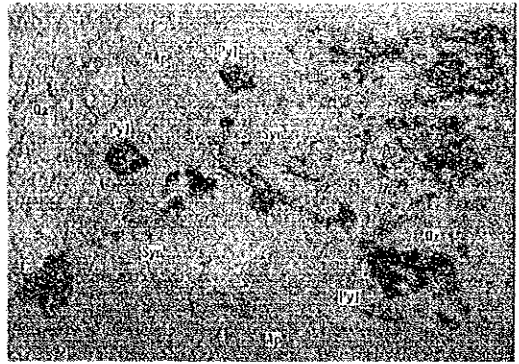
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0 0.5mm

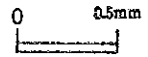
13

Sample No. : T0702
Sector : Tundulu Locality : JMT-7 7.0m
Rock name : Apatite rock

This rock is composed essentially of apatite in idiomorphic laths, with a subordinate amount of quartz. There are two kinds of rare metal-rich minerals, such as pyrochlore and synchisite, but they are small in amount. Pyrochlore is in idiomorphic crystal with diameter of about 0.2mm. Synchisite is fine acicular mineral commonly forming an aggregate.



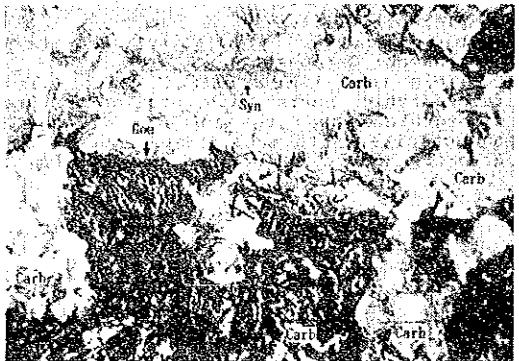
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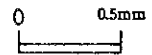
14

Sample No. : T0707
Sector : Tundulu Locality : JMT-7 21.0m
Rock name : Carbonatite

This rock is reddish brown carbonatite with white carbonate-poor part. It has mosaic texture and consists mainly of kuthnaholite, checked by X-ra, and goethite, with subordinate amounts of quartz and barite. It contains many kinds of carbonate minerals, except kuthnaholite, which are calcite, strontianite, and synchisite. Synchisite occurs as acicular minerals forming an aggregate.



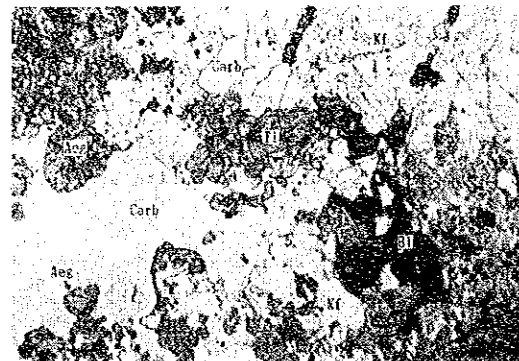
Plain polarized light



15

Sample No. : JMT-7
Sector : Tundulu Locality : JMT-7 50.1m
Rock name : Carbonatite

This rock is pale greenish carbonatite and has been partially sericitized. It consists mainly of calcite and k-feldspar, with subordinate amounts of aegirine and biotite (or phlogopite). A small amount of florencite, rare metal-rich mineral, is checked by X-ray.



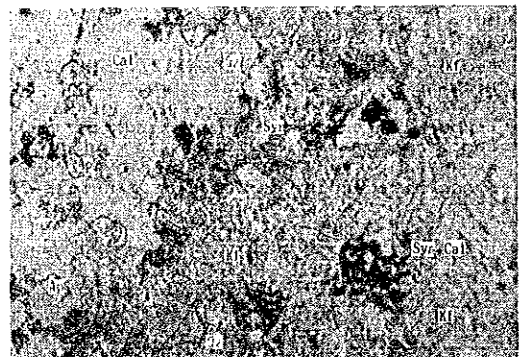
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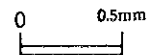
16

Sample No. : T0903
Sector : Tundulu Locality : JMT-9 10.0m
Rock name : Carbonatite

This rock is composed of light brick red carbonatite with vein-like brown part. It has mosaic texture and consists mainly of calcite, goethite and K-feldspar. Calcite-goethite aggregate mostly makes a pseudomorph of, probably, ankerite. Quartz is subordinate in amount. Synchisite, apatite and opaque minerals are accessory. Synchisite is not altered and occurs mostly at the boundaries between calcite and K-feldspar. Parisite is a rare mineral.



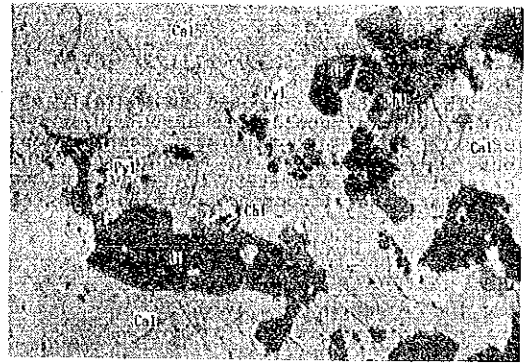
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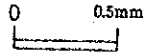
①7

Sample No. : T1202
Sector : Tundulu Locality : JMT-12 8.1m
Rock name : Carbonatite

This is carbonatite with mosaic texture. It consists mainly of calcite, biotite and opaque minerals with subordinate amounts of K-feldspar and apatite. pyrochlore is very fine-grained, less than 0.1 mm, commonly occurring as an aggregate. Synchisite is small in amount. Chlorite and sericite are not uncommon. Chlorite aggregate sometimes forms a pseudomorph of subhedral to anhedral minerals.



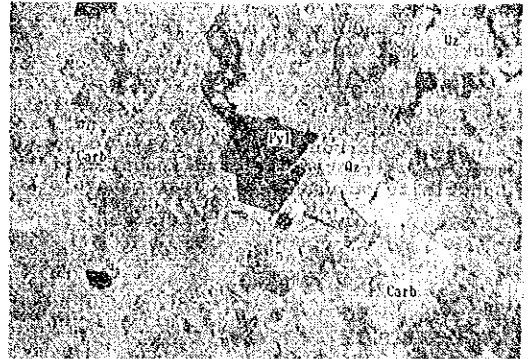
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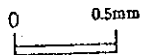
①8

Sample No. : T1610
Sector : Tundulu Locality : JMT-16 45.2m
Rock name : Carbonatite

This rock is composed of white carbonatite and pale brown feldspathic parts with mosaic texture. The later is more fine-grained than the former. It consists mostly of ankerite and calcite, with subordinate amounts of quartz and k-feldspar. Brookite and pyrochlore are also common, but in small amount.



Plain polarized light

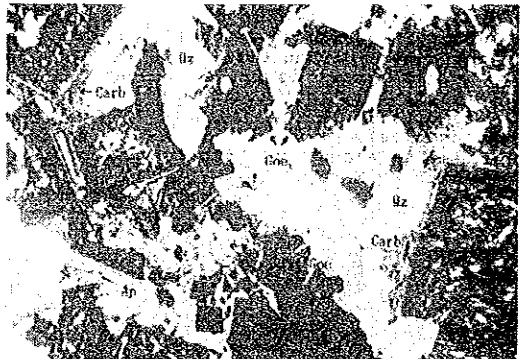


①9

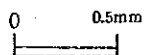
Sample No. : T1905
Sector : Tundulu Locality : JMT-19 34.3m
Rock name : Carbonatite

This rock is dark brown carbonatite with abundant goethite. It is composed mainly of calcite, goethite usually make an aggregate, suggesting that they are derived from ankerite.

Quartz is anhedral crystal with wavy extinction and occupies the matrix. Apatite and barite are also common in small amount.



Plain polarized light



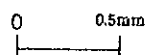
②0

Sample No. : T2210
Sector : Tundulu Locality : JMT-22 41.6m
Rock name : Carbonatite

This is medium to coarse grained carbonatite with mosaic texture. It contains many kinds of carbonate minerals, which is composed mainly of ankerite and calcite, with subordinate amounts of synchisite (checked by X-ray). Synchisite occurs as acicular minerals forming an aggregate.



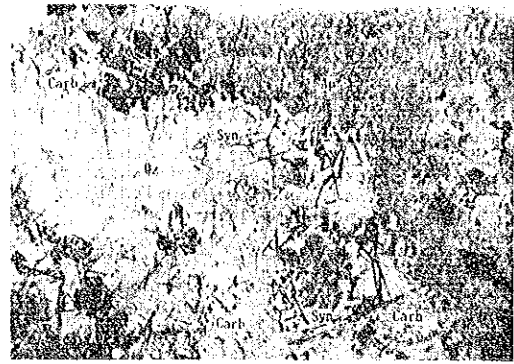
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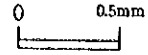
②1

Sample No. : T2402
Sector : Fundulu Locality : JMT-24 3.2m
Rock name : Carbonatite

This rock is composed of apatite-rich and carbonate-rich parts. It has partially mosaic texture and consists of apatite and calcite, with a subordinate amount of quartz. Synchisite and strontianite, rare metal-rich minerals, are also common, but in small amount.



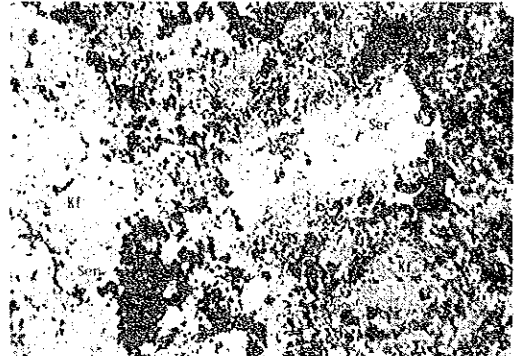
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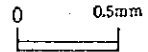
②2

Sample No. : 7YR4
Sector : Songwe Locality : Surface
Rock name : Carbonate silicate rock

This rock is strongly altered syenitic breccia. Some blocks have porphyritic texture with phenocrysts of K-feldspar or its pseudomorph. It consists mainly of apatite, goethite and K-feldspar. Sericitization is common. Chlorite is also common secondary mineral. Rare earth minerals are synchisite and parisite, but they are rare.



Plain polarized light



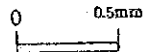
②3

Sample No. : 7YR5
Sector : Songwe Locality : Surface
Rock name : Syenite

This rock is syenite with subgranular texture. It consists mainly of K-feldspar and plagioclase with a subordinate amount of aegirine and magnetite. Aegirine shows strong pleochroism from yellow to dark green. Quartz, apatite and sphene are small in amount. Scapolite is rare mineral.



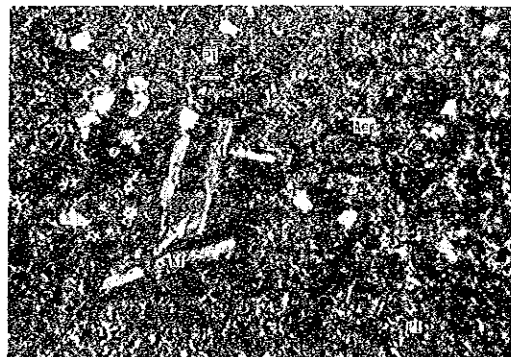
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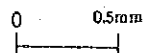
②4

Sample No. : 7YR8
Sector : Songwe Locality : Surface
Rock name : Phonolite

This rock is phonolite with porphyritic texture. It consists mainly of K-feldspar and plagioclase with a subordinate amount of aegirine. K-feldspar occurs as a phenocryst. Aegirine is mostly fine acicular and is ubiquitous in a matrix. It has pleichroism from dark yellow to deep green. Apatite, sphene and opaque minerals are small in amount.



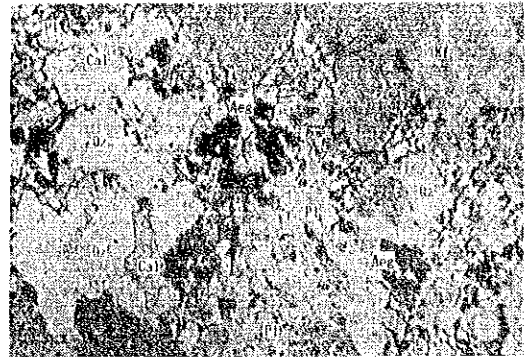
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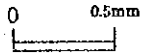
25

Sample No. : 7YR17
Sector : Songwe Locality : Surface
Rock name : Syenite

This rock is alkali granite with subgranular texture. It consists of quartz, plagioclase, K-feldspar with a subordinate amount of aegirine. Aegirine, showing faint pleochroism, occurs usually as an aggregate. Other minerals such as biotite, apatite, sphene and opaque minerals are small in amount. Biotite is fine-grained, occurring only as an aggregate. Carbonate and goethite are also small in amount.



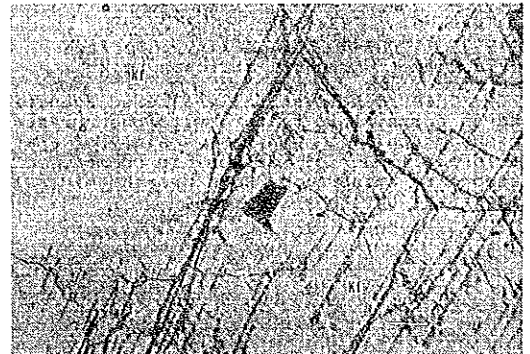
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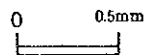
26

Sample No. : 7Y030
Sector : Songwe Locality : Surface
Rock name : K-feldspar rock

This rocks is composed of large piece of orthoclase with quartz vein. Very small amount of opaque minerals are present.



Plain polarized light



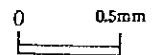
27

Sample No. : 7Y052
Sector : Songwe Locality : Surface
Rock name : Carbonatite

This is dark brown goethite-rich carbonatite and white carbonatite. It has mosaic texture and consists mainly of calcite and goethite, Calcite-goethite aggregate is common, probably derived by a decomposition of ankerite. Original assemblage of this rock will be calcite-ankerite. Monazite, apatite, synchisite and pyrochlore are subordinate in amount. The Rare metal-rich minerals are quite fresh, occurring in a clear calcite-rich part. Monazite is subhedral grain with diameter of 0.3 mm. Synchisite usually forms radial aggregate. Pyrochlore is rounded grain and occurs as an aggregate. Chloritization is uncommon.



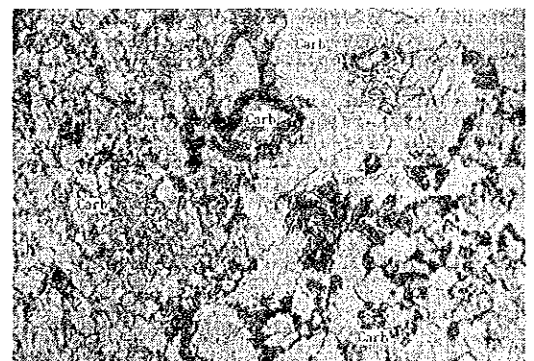
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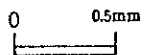
28

Sample No. : 7Y160
Sector : Tundulu Locality : Surface
Rock name : Carbonatite

This rock is light yellowish brown carbonatite locally with mosaic texture. Grain-size changes largely from part to part. White patchy coarse-grained carbonate is common. It consists mostly of calcite and dolomite. Goethite, closely associated with carbonate, are common as a secondary mineral. Opaque minerals, hematite, is rare.



Plain polarized light



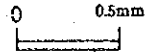
29

Sample No. : 7Y178
Sector : Tundulu Locality : Surface
Rock name : Solvsbergite

This rock is partly altered solvsbergite, consisting mainly plagioclase with subordinate amounts of biotite, magnetite, apatite and quartz. Plagioclase are replaced strongly by albite. Alteration minerals are common. They are carbonate, chlorite, goethite and sericite. Chlorite replaces interstices. Carbonate-goethite aggregate forms a pseudomorph of the former present euhedral mineral. Saponite are rare mineral.



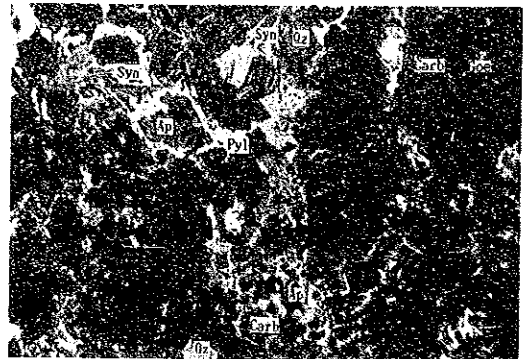
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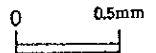
30

Sample No. : 7Y179
Sector : Tundulu Locality : Surface
Rock name : Apatite rock

This is a rock laminated by carbonate-goethite-rich and apatite-rich parts. It consists of calcite, goethite, apatite and quartz with subordinate amounts of plagioclase and biotite. Synchronite and pyrochlore is small in amount. The former one is acicular to tabular and occurs mostly in quartz-rich part. The latter one is corroded in form, up to 1 mm in diameter. Alteration mineral, except goethite, is chlorite.



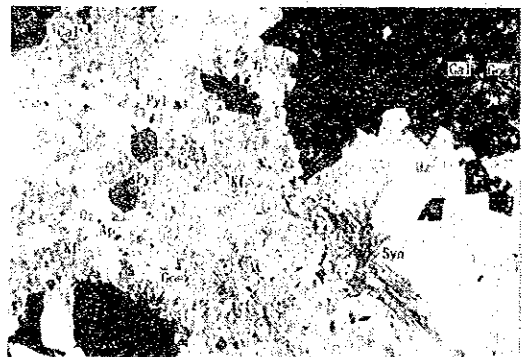
Crossed polarized light



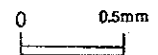
31

Sample No. : 7Y181
Sector : Tundulu Locality : Surface
Rock name : Apatite rock

This rock is composed of porphyritic carbonate-goethite aggregate and siliceous groundmass, which is composed of light pinkish brown and pinkish brown parts. Light pinkish brown part is rich in apatite. This rock consists of calcite, apatite, quartz, goethite and opaque minerals. K-feldspar is subordinate in amount. Synchronite is an acicular mineral. It is common, but small in amount. Biotite and pyrochlore are rare minerals.



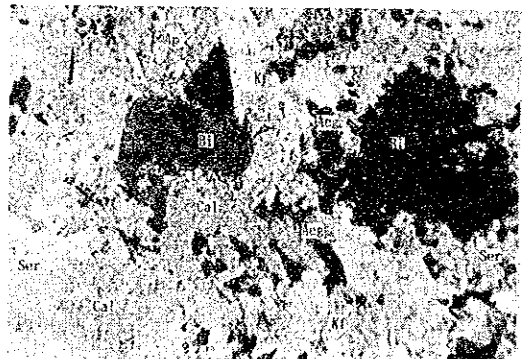
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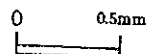
32

Sample No. : 7Y202
Sector : Tundulu Locality : Surface
Rock name : Porphyritic syenite

This is porphyritic syenite with phenocryst of orthoclase. It consists mainly of K-feldspar, plagioclase and aegirine. Aegirine is fine, elongated crystal with faint pleochloism, occurring commonly as an aggregate. Biotite, calcite and apatite are subordinate in amount. Sericite occurs replacing plagioclase. Metamict-state minerals are not uncommon, but is not identified.



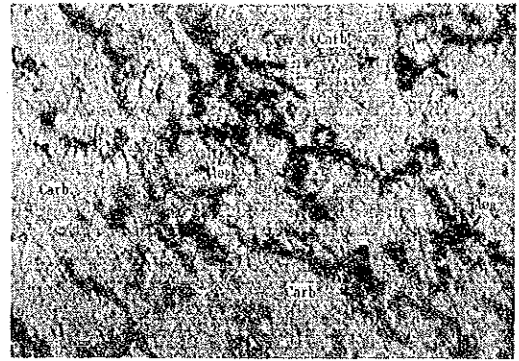
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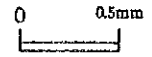
33

Sample No. : 7Y216
Sector : Tundulu Locality : Surface
Rock name : Carbonatite

This is light greenish carbonatite with mosaic texture. It consists mainly of calcite with subordinate amounts of dolomite and aegirine. Aegirine is fine acicular mineral, occurring at the grain boundaries among calcite grains. Apatite and opaque minerals are small in amount.



Plain polarized light



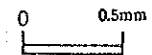
34

Sample No. : 7Y220
Sector : Tundulu Locality : Surface
Rock name : Dolerite

This rock is dolerite with ophitic texture and consists mainly of plagioclase and augite with a subordinate amount of opaque minerals. Sericite commonly replaces plagioclase. Chlorite and calcite are other secondary minerals.



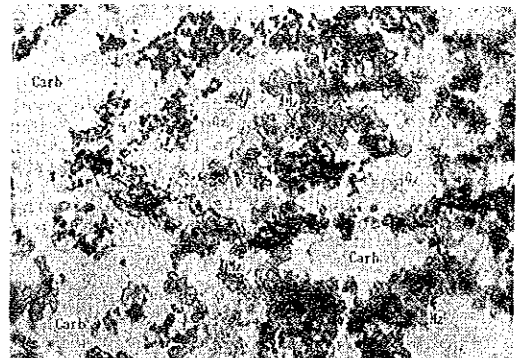
Crossed polarized light



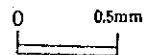
35

Sample No. : 7Y226
Sector : Kangankunde Locality : Surface
Rock name : Carbonatite

This rock is visibly composed of at least three parts with different colours; dark brown(carbonate-goethite), dark greenish(monazite-rich) and white parts(apatite-rich). It consists of dolomite, quartz, goethite and apatite with a subordinate amount of monazite. Monazite is mostly fine tabular mineral, occurring as an aggregate. Stronchianite is a rare mineral.



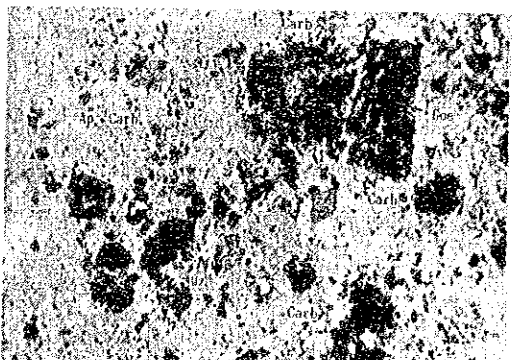
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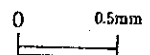
36

Sample No. : 7Y229
Sector : Kangankunde Locality : Surface
Rock name : Beforsite

This rock is composed of carbonate-rich and apatite-rich parts. It has mosaic to porphyritic texture and consists of dolomite, goethite and apatite with subordinate amounts of K-feldspar and quartz. Parisite is subhedral to anhedral grain, up to 0.4 mm in diameter, but is small in amount. Chloritization is not uncommon.



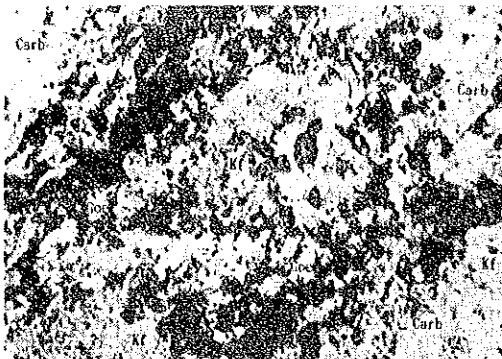
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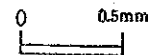
37

Sample No. : 7Y246
Sector : Kangankunde Locality : Surface
Rock name : Feldspathic rock

This rock is composed of laminated aggregate of goethite and dolomite. It has mosaic to porphyritic texture and consists of dolomite, goethite and K-feldspar with subordinate amounts of calcite and opaque minerals. K-feldspar, occurring like a phenocryst in carbonate matrix, is strongly altered by carbonate. Apatite sporadically occurs but is small in amount. Stronchianite is a rare mineral.



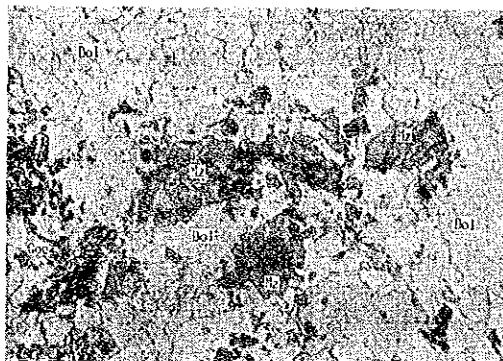
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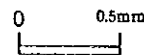
38

Sample No. : 7Y270
Sector : Kangankunde Locality : Surface
Rock name : Carbonatite

This is composed of goethite-rich and poor parts. It has mosaic texture and consists mostly of dolomite with subordinate amounts of goethite and parisite(or monazite). This sample contains many kind of rare metal-rich minerals such as stronchianite, bastaenesite, synchisite and pyrochlore, but each mineral is small or rare in amount. Barite is also present.



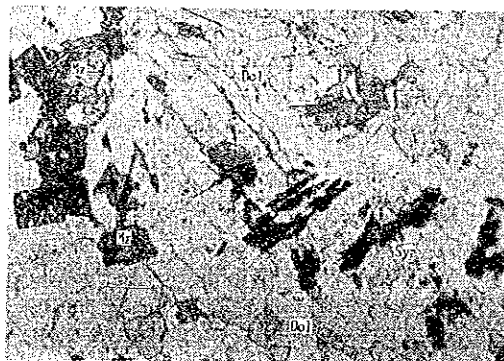
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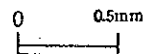
39

Sample No. : 7Y303
Sector : Kangankunde Locality : Surface
Rock name : Carbonatite

This rock is composed of carbonate-rich and carbonate-goethite-rich parts. It has mosaic texture and consists mainly of dolomite and goethite. K-feldspar, monazite and synchisite are small in amount. The latter two minerals occur only in a goethite-free part. Stronchianite and siderite are rare minerals. Siderite occurs mostly at the grain boundary between K-feldspar and carbonate.



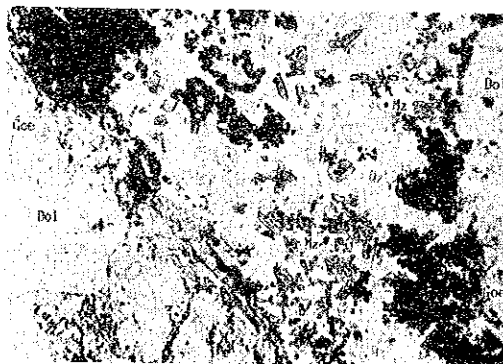
Plain polarized light



40

Sample No. : 7Y317
Sector : Kangankunde Locality : Surface
Rock name : Carbonatite

This is dark grey rock including white dolomite pools. It has mosaic texture and consists mainly of quartz, dolomite and goethite with subordinate amount of monazite. Monazite and goethite occur sporadically in quartz-rich parts. Pyrochlore is rare minerals, occurring with carbonate and opaque minerals in a quartz-rich part.



Plain polarized light

