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PROGRESS REPORT ON UPPER PALAEOZOIC INTRUSIONS CONTROLLED BY RING FRACTURES, NEAR KIDSTON, NORTH QUEENSLAND.

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C.D. BRANCH

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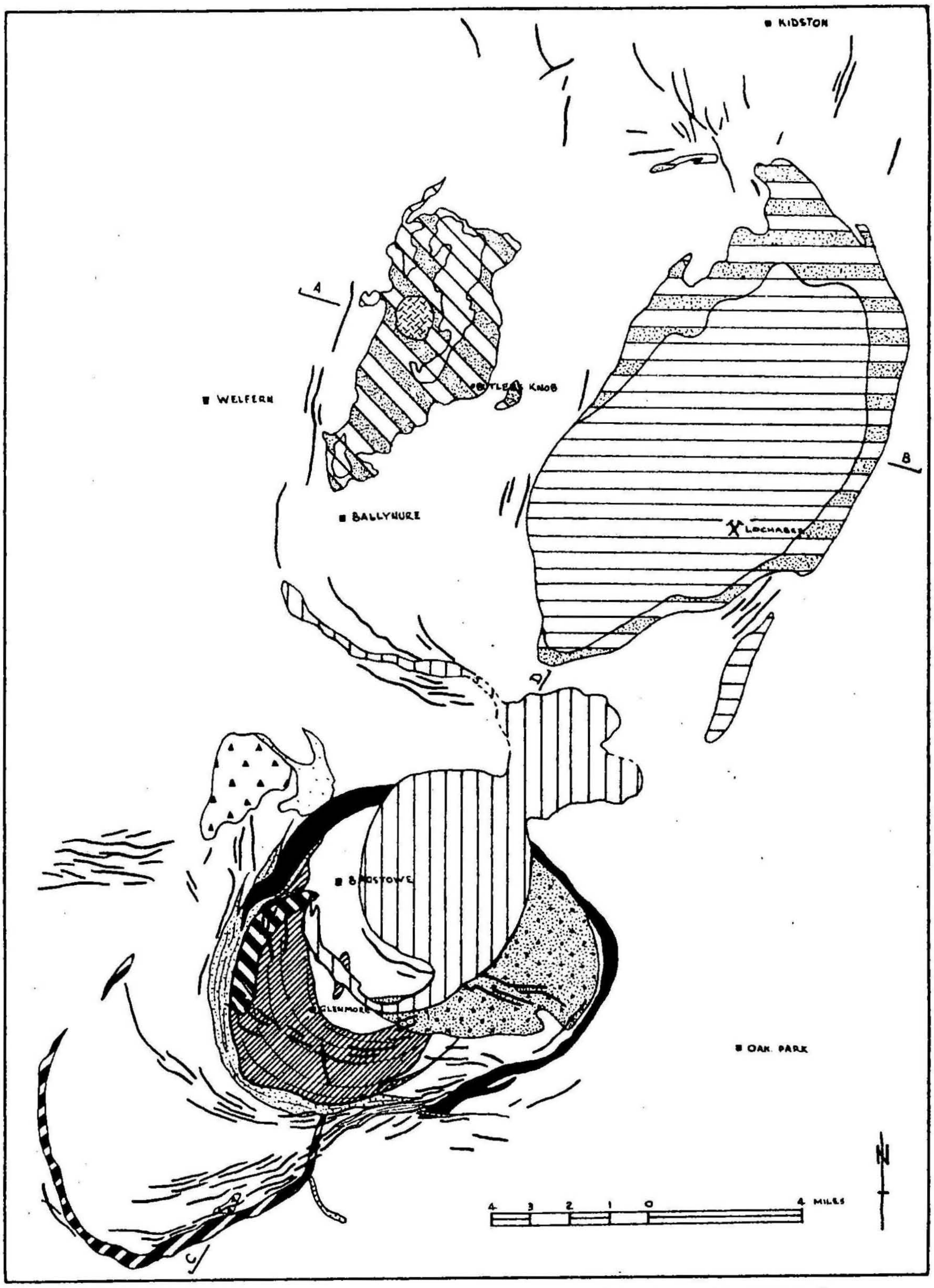
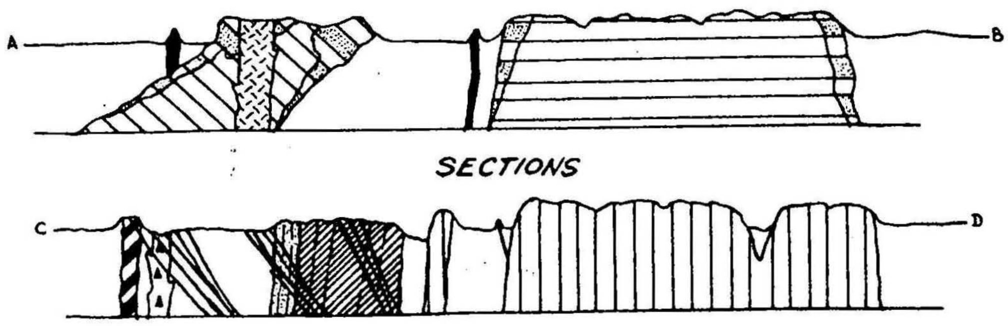


SIMPLIFIED GEOLOGICAL MAP OF RING STRUCTURES.



SECTIONS

BAGSTOWE RING DYKE COMPLEX.

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- Grey Rhyolite Porphyry Ring Dykes
- Augite Andesite Porphyry Dyke
- Micrograndiorite, near Four Mile Creek.
- Inner Pink Ring Dyke & Castle Hill Dyke
- Outer, Middle & Inner Cone Sheets & Radial Dykes
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- East & West Pink Granite Ring Dykes
- Granite Stock & Central Granite Ring Dyke.

LOCHABER GRANITE

- Granite
- Rhyolite Porphyry

BUTLERS IGNEOUS COMPLEX.

- Granite.
- Rhyolite Porphyry
- Trachyte.

FIGURE 1.

C.D.B./B.M.R. 4/59.

ABSTRACT

The geology, petrology and structure of three Upper Palaeozoic intrusions controlled by ring fractures near Kidston are described. These are the Bagstowe Ring Dyke Complex, the Lochaber Granite and Butlers Igneous Complex.

The Bagstowe Ring Dyke Complex has had the longest and most complex magmatic and structural history: rock types range from possible volcanic breccia in the earliest volcanic necks to augite andesite porphyry in the first dykes and leucocratic granite in the latest dykes. Contamination of uprising simatic magma in the roots of a granite batholith, and differentiation in the magma chamber, are thought to have lead to the gradual change in composition of the ring dykes: a possible outline of this history is given. After the ring intrusion of the last contaminated rock type - a microgranodiorite - three cone sheet swarms were injected, followed by ring dykes and a stock of leucocratic granite. Ring dykes range from nine to twenty miles in length and 400 yards to three miles in width. Overall, the complex crops out in an elliptical area 16 miles long and nine miles wide.

Synchronous with the granitic phase in the Bagstowe Complex, two other pink leucocratic granite masses were intruded: the Lochaber Granite and the Butlers Igneous Complex. Both these intrusions are hooded, i.e. on the roof and one or more sides the massive granite of the centre of the intrusion grades outwards through an intermediate zone of porphyritic microgranite to a flow banded rhyolite porphyry margin. The Lochaber Granite is stock-like intrusion with a maximum diameter of 13 miles, but the Butlers Igneous Complex seems to be an inclined granite sheet dipping west at 50° to 80°. A wolfram-molybdenum bearing quartz vein has been worked in the Lochaber Granite.

The report is accompanied by four black and white photographs and a geological map of the three intrusions at a scale of 1.37 inches equals one mile.

INTRODUCTION

The area described in this report covers about 320 square miles at the junction of the Clarke River (E55/13), Einasleigh (E55/9), and Gilberton (E54/16) Army Four Mile map areas. Three igneous intrusions controlled by ring fractures are exposed in the area between Oak Park Station, in the east; Welfern Station, in the west; Mount Rous, in the south; and Kidston, in the north. The following names have been proposed for the intrusions:

Bagstowe Ring Dyke Complex,

Lochaber Granite,

Butlers Igneous Complex.

R. Stevens, in White and Hughes, 1956, recorded the circular outcrop of possible ring dykes in the Bagstowe area and photo-interpreted the dykes. During the 1958 field season I re-examined the area and spent five weeks in mapping the Bagstowe Ring Dyke Complex at one mile to the inch, and the Lochaber Granite and Butlers Igneous Complex at four miles to one inch. Five samples for radioactive age determination have been collected.

A radial stream pattern aided the detailed mapping and a series of comprehensive creek traverses provided a good grid of data for later 'fill-in' traverses. Inaccessible country was examined during a one-hour flight over the area at the conclusion of the ground mapping. Plotting was done directly onto aerial photographs (at a scale of about one and one quarter inches to the mile) and then transferred onto a transparent planimetric base map supplied by the Department of the Army. Photographic reductions to four miles to the inch have been prepared.

PHYSIOGRAPHY

Country rock for the intrusions is an older granite which has weathered to a mature topography with an average relief of 75 feet and an elevation of 2000 feet a.s.l. This area has been described by Twidale (1956) as the Einasleigh-Copperfield Plain, a subdivision of the Einasleigh Uplands. Rising 300-500 feet above this level and forming local rugged divides (the Gilbert Range) are the rocks of the various younger intrusives.

Young radial streams, which only flow in the wet season, drain the Gilbert Range and flow into two major rivers: the north flowing Copperfield River in the east of the area, and the westerly flowing Gilbert River in the south-west. The rivers join before flowing into the Gulf of Carpentaria north of Normanton.

The older granite forms reasonably good cattle country, though water is scarce; the younger intrusions are fenced off as being too rough. Tree cover is light and is generally of ironbark or box. Ti-trees dominate nearly all creek beds. A distinctive silver-leafed ironbark is restricted to fine-grained acid rocks of the younger intrusives, but is not developed all over these rock types.

Rock exposures of the intrusives are excellent; creek sections expose 45% - 90% of fresh rock, and all hills are covered by fresh, untransported rubble. Correlation between topography and underlying geology is poor in the Bagstowe Ring Dyke Complex, but in the Butlers Igneous Complex and Lochaber Granite some geological boundaries can be photo-interpreted.

STRATIGRAPHY

ARCHAEAN

Migmatite and gneisse of the (?)Archaean Einasleigh Metamorphics crop out on the eastern and western margins of the area. General trends of the metamorphics are between north and north-east, with dips to east and west from 50 degrees to 90 degrees. In many exposures the metamorphics are roof pendants in a younger granite.

PROTEROZOIC

Unconformably overlying the Einasleigh Metamorphics in the west are the Etheridge and Bernecker Creek Formations, of probable Proterozoic age. The Bernecker Creek Formation consists of calcareous quartz sandstone and siltstone, impure argillaceous limestone and some lenses of limestone. It conformably underlies and interfingers with, black to grey quartz siltstone and shale of the Etheridge Formation. The beds strike north-east and dip east at 50 to 80 degrees.

Quartz-mica phyllite and quartzite of the Paddys Creek Formation of (?)Proterozoic age, are exposed in the nose of a south-westerly plunging syncline on the southern margin of the area. The phyllite is well foliated and lineated. A marked fine crenulation lineation, plunges to the south-west at 45 to 50 degrees (b lineation), on the foliation.

PROTEROZOIC OR LOWER PALAEOZOIC (Older Granites).

Intrusive into the northern third of the area is a grey, usually massive, porphyritic and biotite rich granite, known as the Forsayth Granite. Around the sharp contact of this large mass (it crops out over 2000 square miles to the north) the plagioclase phenocrysts are well lineated by flow in the magma during intrusion.

Of similar age, or slightly younger, is the Dumbano Granite, which crops out over most of the area examined. It is a medium grained, grey, biotite granite with pink porphyritic feldspars. The granite is strongly foliated in a wide zone around the younger Bagstowe Complex. The foliation parallels the margin of the complex and dips either vertically or inwards at angles greater than 60 degrees. A prominent feature of this granite is the development of myrmekite on albite where it is in contact with microcline.

A local variation of the Dumbano Granite is a pink-cream, semi-pegmatitic muscovite granite, which often appears as if it is older than the grey granite and has been partially resorbed by it.

The Forsayth and Dumbano Granites are considered to be Proterozoic, or more probably Lower Palaeozoic, in age. They have some contact metamorphic effect on the Proterozoic rocks but the result is often a retrogressive metamorphism of the Archaean rocks.

MIDDLE-UPPER PALAEOZOIC (Younger Granites)

These are described later under the heading: Geology, Petrology and Structure of the Intrusions controlled by Ring Fractures.

CRETACEOUS

Unconformably overlying parts of the area are horizontal conglomerate and sandstone beds of Cretaceous Age (possibly Blythesdale Group). In the Gilbert Range they average 50' in thickness and this gradually increases to the west. Few outcrops are found to the east of the area and the old shoreline of the Cretaceous basin must have been located near the eastern boundary of this area.

TERTIARY

Tertiary olivine basalts have flowed north from the Chudleigh Province down the valley of the Copperfield River, but were dammed in the gorge through the Lochaber Granite. Another outlier of Tertiary basalt near Kidstone is probably the southern end of a flow from the McBride Province to the north.

RECENT

Alluvium is exposed in the Upper valley of the Copperfield River and many of its tributaries, especially on the Dumbano Granite near Oak Park Homestead. Recent arkosic wash derived from the rugged hills on the granite stock and central ring dyke of the Glenmore Complex covers valleys to the south west of these structures.

GEOLOGY, PETROLOGY AND STRUCTURE OF THE INTRUSIONS CONTROLLED BY RING FRACTURES

The three comagmatic intrusive masses making up the Younger Granite exposed in the Kidston area are (i) Bagstowe Ring Dyke Complex (ii) Lochaber Granite, (iii) Butlers Igneous Complex. Preliminary examination of thin sections of these igneous rocks have been made; as further thin section and chemical analysis work is completed more data will become available but should not change the main conclusions of the report.

The rock nomenclature used is essentially that of Hatch, Wells and Wells (1949). The term rhyolite is used for all fine grained igneous rocks containing greater than 10% quartz and over two thirds of the feldspar is alkali feldspar. If the percentage of quartz is less than 10%, regardless of whether the ground mass is devitrified glass or microcrystalline, the rock is called a trachyte. When the rock is porphyritic and intrusive, the term 'porphyry' follows the rock name, e.g., rhyolite porphyry: if it is extrusive the rock is called a porphyritic rhyolite.

BAGSTOWE RING DYKE COMPLEX

Cropping out over an elliptical area, 16 miles north-east to south-west and 9 miles south-east to north-west, the various units of the complex form an off-centred pattern. The centre of the youngest intrusion, a granite stock, is located four miles from the northern end of the ellipse; the other elements of the complex are arranged crescentrically south of this granite stock (see figure I).

The various members of the complex are outlined below, starting with the oldest.

Possible Volcanic Necks

On the Gilbert River, a quarter of a mile below the Castle Hill Gully junction, is an irregular neck-like outcrop of volcanic agglomerate and tuff one square mile in area. The agglomerate contains rounded pebbles, 4-20 cm. in diameter, of grey, slightly porphyritic, rhyolite in a ground mass of devitrified glass, broken feldspar laths and quartz shards.

A micro-lineated, fine grained tuff, with few irregular quartz, muscovite and feldspar fragments, crops out on the northern edge of the agglomerate. Closely spaced joints in this tuff dip south at 30 degrees.

Another possible volcanic neck is exposed between Sawpit and Castle Hill Creeks, and centred two miles north of their junction. This volcanic neck occupies three square miles; it has a continuous outer zone, up to 200 yards wide, of fine grained, flow banded quartz trachyte porphyry (really a quartz-poor rhyolite): the lineated orthoclase and albite phenocrysts are slightly round and accompany chloritised biotite and occasional quartz fragments in a limonitic brown, devitrified glass. Inside this the rock is more massive, the phenocrysts are larger (averaging 1.5 mm. diameter) with a closer packing. Spherulites are present in the massive devitrified glass. In the north, coarse agglomeratic areas are found with fragments, up to 20 cm. in diameter, of a grey porphyritic rhyolite set in the quartz andesite groundmass.

Because of the roughly elliptical outcrop and the mixture of volcanic agglomerate with either tuff or quartz trachyte (with chilled border zone), it is thought that these two areas are old volcanic necks. They represent the first igneous phase of the Younger Granite.

Mount Rous Ring Dyke

This crescent-shaped ring dyke, with almost continuous outcrop from Pine Mountain through Mount Rous to the Castle Hill Creek - Ten Mile Creek junction, has a length of 16 miles and a maximum width of 900 yards. In the most northerly exposures along Castle Hill Creek the dyke is a typically felted quartz-hornblende trachy-andesite, with zoned plagioclase phenocrysts up to 2.5 mm long. Hornblende is present as subhedral, well twinned crystals, pleochroic from deep green to light brown. Disseminated pyrite is common in this dyke.

For the rest of the dyke, the rock type is essentially a porphyritic quartz microdiorite, though in places it is monzonitic. The groundmass is generally microcrystalline, but in specimens from the edges of the dyke the crystallinity may be due to a coarse devitrification of an original glassy base and the rock should be called an andesite.

Quartz phenocrysts are few, are typically embayed and are surrounded by reaction rims. In these rims minute isolated quartz grains, optically continuous with the central core, are mosaiced with strongly kaolinised feldspar grains. This proves the early stage of formation of the quartz and the fact that it was the feldspar which was the active member in the crystal lattice penetration and not an outward diffusion of quartz molecules.

Huge (2-5 mm. diameter), zoned, oligoclase-labradorite laths, often broken, are accompanied by smaller and more perfect laths of albite and orthoclase. Kaolinisation of the alkali feldspar is common, but the calcic plagioclase is always clear.

Hornblende (15%) is the main mafic mineral. Subhedral laths and end-sections, with twin seams, are abundant and range from 1.6-0.5 mm. in diameter. Pleochroism is from (X) yellow-green to (Z) medium to dark green. The hornblende is generally fresh, but four types of alteration have been noted.

a) Development of sieve texture.

b) Sections still retaining hornblende pleochrosim, etc., but crowded with magnetite granules along (usually) two direction inclined at 36 degrees to the cleavage (i.e. parallel to the slow ray) in lath sections. Small laths of highly birefringent brown biotite, with a more random orientation, accompany the magnetite.

c) Complete pseudomorphing by biotite or chlorite, with some epidote.

d) Core of magnetite surrounded by a small rim of biotite.

Primary biotite is rare (1-5%). That found is coloured brown when fresh, but is usually either surrounded by a rim of, or is completely pseudomorphed by, pennine. Xenoliths of a finer grained and more basic igneous rock (?dolerite) are common in the diorite. It is possible that these are part of an old chilled margin, now broken up and scattered through the magma. Butler (1920, quoted in Sharp, 1958) explains more basic xenoliths in a monzonite plug in Utah by a similar mechanism.

The contact of the quartz diorite and Dumbano Granite is always sharp, although not controlled by jointing in the granite. Metamorphic or metasomatic effects have not been observed and it can only be concluded that the diorite magma was injected into a ready made fissure in a zone of tension - i.e. a typical ring dyke.

<u>Grey Rhyolite Porphyry Ring Dykes,</u> nos. A to G

A crescent shaped series of six grey rhyolite porphyry ring dykes (A to F) crop out in the area around the centre of the elliptical complex, essentially south and north-west of Glenmore Homestead. One oval dyke (G) north-east of the homestead, while not closely structurally related, has the same mineralogical composition as dyke F.

These dykes average 9 miles in length and 700 yards in width. In part they are in contact with each other, while elsewhere they are separated by narrow screens, 20-100 yards wide, of Dumbano Granite. The dykes are generally similar in composition but small, diagnostic differences in composition are evident. It is hoped to clarify these differences by further thin section work and selected chemical analyses.

All the dykes are described as grey rhyolite porphyries and in dykes A to E the grey colour is very intense: many of the rocks are black. Thin sections have shown that this colour is due to the abundance of minute magnetite granules disseminated through the glassy base. Dyke F, however, is a very light grey in colour and contains practically no magnetite. Field evidence suggests that the boundary between dykes E and F is gradational, and that over a distance of 60 feet the magnetite percentage rapidly changes from 15% to less than 1% with no other alteration of mineralogical composition. Apart from a marked foliation produced during the intrusion of a younger granite ring dyke, the rhyolite in dyke G is identical to that in dyke F. In these two dykes the groundmass is a little coarser grained than in the darker grey dykes, and the rocks tend to be microgranitic.

Except for occasional quartz deficient segregation blebs, 1-10 feet in diameter, the rock in these dykes contains greater than 10% quartz. It is usual to find that the glassy groundmass, ranging from 45%-100% of the rock, has devitrified to a fine mosaic of clear quartz and kaolinised feldspar (50% each). In some glasses spherulites, composed of radiating blades of feldspar, are abundant.

Phenocrysts of quartz and feldspar are common, while those of biotite and hornblende are only present as accessories. Unbroken, unstrained quartz phenocrysts are usually found to be subhedral beta (high temperature) quartz. The phenocrysts, which vary from 2.8 mm. to 0.5 mm. in diameter, have numerous embayments and a dusty appearance. A second type of quartz phenocryst is an angular, fragmental variety which can generally be shown to have been derived from the break-up of granite xenoliths: they decrease in density of packing away from the xenolith margins. This and the fact that these brittle phenocrysts are frequently broken with the two matching fragments remaining close to each other, suggest autobrecciation during intrusion.

Alkali feldspars are the only feldspars found as lath-like phenocrysts. Six types are recognised but three of these are probably of secondary origin. Sanidine was the main feldspar to crystallise, but much of it has inverted to orthoclase during cooling. Half of the potassic feldspar is now strongly kaolinised (orthoclase) and the other 50% is clear (sanidine). Carlsbad twins are not common.

Microcline phenocrysts are rare, and are certainly derived fragments from granite xenoliths; often other minerals are found adhering to their margin.

Albite-oligoclase, with or without polysynthetic albite twins, is the other primary feldspar. These laths, averaging 0.7 mm. in diameter, are smaller and usually less common than the potassic feldspar. One example found of an albite lath with a calcite core may represent albitisation of a more anorthic plagioclase. Phenocrysts of perthite and antiperthite are of doubtful origin, but are probably derived from granite xenoliths, in which they are common.

Biotite flakes 0.6-1.0 mm. in length and pleochroic from light yellowish brown to very dark brown, are not common in these rhyolites. In some examples it is thought that the biotite is pseudomorphing earlier brown hornblende, which is very rare in its unaltered state. Magnetite and ilmenite granules, chlorite flakes and aggregates of clinozoisite crystals are the main accessories.

A prominent constituent of all these grey dykes is rounded igneous xenoliths. Xenoliths of grey-pink Dumbano Granite and microgranite are universally distributed through the seven dykes, with the greatest density in dykes B and C, then D, E, F, (G) and A. This is also the probable order of intrusion. These xenoliths range from one inch to 24 inches in diameter and make up to 75% of the rhyolite. Their density of packing increases towards the granite screens, especially on the convex (outer) side of the dyke.

In dyke B, east of the Castle Hill Creek - Ten Mile Creek junction, 'tuffaceous' xenoliths containing fragments of a fine-grained trachyte are found (plate 1). These have probably been derived from the Mt. Rous Ring Dyke which is cut by dyke B near here. Their 'tuffaceous' appearance may indicate that the rock is actually a fault breccia, produced when the fracture for ring dyke B commenced to move. The grey rhyolite has been chilled and is much finer grained in a 0.75 mm. wide contact zone against the tuffaceous xenoliths. The xenoliths have been recrystallised for 1.0 mm. in from the contact, and in this zone quartz grains have badly corroded margins.

Numerous xenoliths show that the rhyolite magma had to stope its way along a tight ring fracture. The autobrecciation of crystals and abrasion of xenoliths to produce a high roundness and sphericity suggest that this magma was viscous for two reasons:

a) the magma was injected at high pressure into a cool, near-surface, level of the crust.

b) the magma was partially saturated with xenoliths.

Flow banding in dyke B dips north-east (inwards) at 80 degrees, but the banding in dyke C is anomalous and dips south-west (outwards) at 30-35 degrees. The probable explanation for these low dips is that the dyke is exposed near the roof of the cauldron chamber: this would also account for the greater width of dyke C, compared with the other grey dykes. (See figures 1 and 2). Although contacts of all the dykes are sharp, there is not enough topographical relief to be certain in which direction any of the contacts dip.

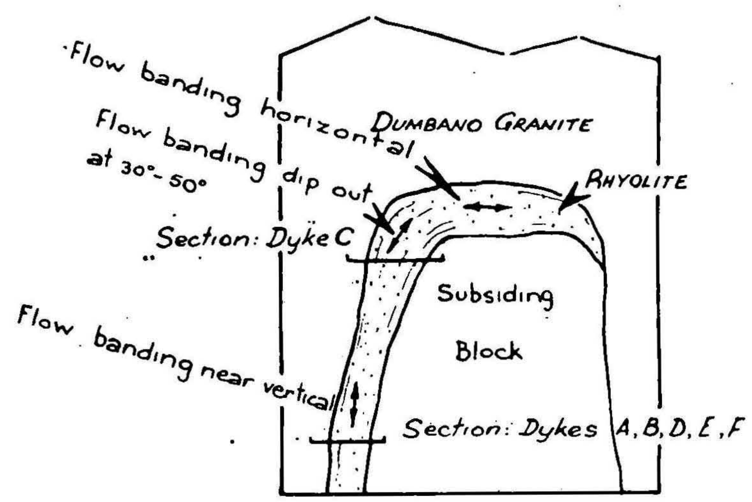

FIGURE 2
CROSS-SECTION OF GREY RING DYKE

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Augite Andesite Porphyry Ring Dykes

Two miles west of Glenmore Homestead a large augite andesite porphyry ring dyke crops out over a length of four miles and an average width of 900 yards. The rock is dark greenish-grey in colour with prominent white plagioclase phenocrysts. Flow banding is found in a zone 50 feet wide around the margin, but inside this the rock is massive.

The hyalopilitic groundmass contains minute laths, 0.02 mm. long, of andesine-labradorite, with grains of epidote, magnetite and chlorite in a devitrified glass. Phenocrysts are andesine, (Ab54), with polysynthetic twins and some zoning, and augite, found as sieve-textured, subhedral crystals. Aggregates of epidote granules and areas of mesh-textured pennine are probably of metasomatic origin.

This dyke cuts across dykes C, D, and E, and replaces the northern ends of dykes A and B, of the grey rhyolite porphyry group. Contacts are sharp, but dyke B is brecciated near the southern end of the andesite dyke. Two other dykes of andesite are exposed two miles west of Bagstowe Homestead. These parallel dykes, one mile and a half long and 50-100 yards wide, strike at an angle of 35 degrees to the circumference of the complex. Similarly, a third andesite dyke, five miles south-east of Glenmore Homestead on the track to Werrington, strikes at right angles to the margin of the complex. These probably represent tension fractures formed at the time of the andesite intrusion.

Microgranodiorite near Four Mile Creek

A semicircular intrusion of microgranodiorite, with a radius of three miles, crops out in the Four Mile Creek area on the eastern side of the complex. Hand specimens of this light pinkish-grey, slightly porphyritic rock are very similar to the micro quartz diorite of the Mount Rous Ring Dyke. However the percentage of quartz is a little higher and variations in the mafic minerals are evident.

In thin section the rock is holocrystalline with a granitic texture and an average grain size of 0.6 mm. Quartz (15-20%) definitely crystallised at a late stage and, especially in the outer (convex) side of the mass, it bears a poikilitic relationship to subhedral plagioclase laths. Graphic texture is common. The feldspar is mainly oligoclase, with a little albite and orthoclase. Zoned and polysynthetic twinned oligoclase laths, with a composition of Ab80, are found as phenocrysts.

Biotite, pleochroic from light yellow-brown to dark grey-brown, is the main mafic mineral. Euhedral laths of this mineral are most common in the outer zone of the mass where it averages 20%, and the percentage decreases to 2% on the north-western side. Paralleling this trend is the green hornblende percentage which drops from 3% at the outer contact to 0% two thirds of the way to the west. The scarcity of mafic minerals is very noticeable in a zone 200 yards wide on the inner margin. Magnetite granules are the only accessories.

Xenoliths of porphyritic hornblende trachy-andesite are numerous and average 12 inches in diameter. Near the headwaters of Four Mile Creek one large xenolith measured 100 yards. As in the Mount Rous Ring Dyke, it is possible that this more basic magma was injected into a narrow ring fissure, where it quickly crystallised. The rock was then broken up and dispersed by a reopening of the fissure allowing the uprising of the granodiorite magma.

Stoping was probably important as a mechanism of intrusion of this wide dyke: the protruding tongue of Dumbano Granite south of Four Mile Creek represents a partially unstoped block. No granite xenoliths have been recognised in the granodiorite but it is thought that these would be rapidly assimilated. The addition of so much quartz to the magma means it would crystallise as a granodiorite rather than a diorite.

Jointing is in two main directions: one striking 360 degrees and dipping west at 80 degrees, and the other striking 260-280 degrees and dipping north at 85 degrees. A swarm of younger dykes in the Four Mile Creek area follows this second joint direction.

Contacts with the country rock are always sharp and seem to have been controlled by circular fractures rather than pre-existing jointing. The microgranodiorite cuts across the eastern ends of the grey rhyolite porphyry dykes D and F.

Inner Pink Ring Dykes and Castle Hill Dyke.

Outside the grey rhyolite porphyry dyke A and the hornblende andesite porphyry ring dyke are exposed two major, and two minor, pink rhyolite porphyry dykes. The major dykes have a length of 12 miles and an average width of 400 yards: the minor ones are four miles long and 150 yards wide.

The dykes are generally separated from each other by granite screens, and in the Castle Hill Creek area there is a 200 yard wide screen between the pink rhyolite and grey dyke A. To the north of here the pink rhyolite is in intimate contact with the grey rhyolite and andesite; the contact between them is sharp and there is no metamorphism.

No thin sections of the pink rhyolite have been examined, but in hand specimen the rock has a granular texture, indicative of a hypocrystalline groundmass. Phenocrysts of quartz and pink (?)orthoclase-sanidine are abundant and in part the rock approximates a porphyritic microgranite. Flow banding is only found in the outer selvages of the dykes.

Castle Hill Dyke, between the headwaters of Castle Hill Creek and Gully, is a similar rock type, but here the border zone is a pink microgranite, which grades into a normal granite 25 feet in from the contact.

These pink rhyolite dykes are tentatively called ring dykes, because they conform in shape and size to proven ring dykes. However the dykes are only a minor part of the pink rhyolite phase and all later members are definitely cone sheets (see next section). These dykes were the last members of an extensive ring dyke succession. Following their intrusion, the underlying magma commenced to push towards the surface.

Outer Cone Sheet Swarm

As a result of an upward magmatic pressure, a linear swarm of pink rhyolite cone sheets was intruded into, and parallel to the south-eastern edge of the complex. This swarm measures ten miles in length and varies in width from 200 yards at the eastern end, to 2000 yards at the western extremity.

Where the cone sheet swarm crosses the Glenmore-Werrington track it is shown on the map as a cephalopod-shaped structure. It is only west of Castle Hill Creek that individual sheets can be distinguished. While they continue as separate sheets to the east of here, they are packed so closely that there are no screens between them and they appear to be single dyke.

The sheet intensity decreases where the swarm crosses the eastern limb of the Mount Rous Ring Dyke, probably because of the added competence this structure gives the Dumbano Granite. Maximum intensity of the swarm is reached between Black Cap and the Gilbert River; to the west it divides into two parallel arms separated by 900 yards of granite. Remnants of the swarm recross the Mount Rous Ring Dyke and crop out between Mount Rous and South Knob.

In the Gilbert River area the cone sheets have a slightly sinuous strike, within the limits 060-075 degrees, and dip to the north-west at 45-50 degrees. The individual sheets vary from 5-70 feet in thickness and from 10 feet to two miles in length.

Anastomosing sheets are rare: each sheet in the swarm is usually distinct and is separated from other sheets by a granite screen six inches to 100 yards wide. Low rubble mounds indicate the outcrop of the sheets, but their regional distribution can only be appreciated by examining aerial photographs, on which they show as faint white lines.

The narrower sheets are completely vitreous and flow banded throughout. Wider sheets have flow banded margins and grade into massive pink rhyolite porphyry at their centre. (No thin sections have been examined). The quartz percentage seems variable and some sheets are quartz free, but no definite pattern of distribution has been recognised.

The slightly irregular strike, the variability of width and length, and the inward dip of the sheets all indicate that these structures are cone sheets. As with the ring complexes described from Nigeria (Jacobson, Black and Macleod, 1958), the cone sheet swarms were intruded after a major, slightly basic, ring dyke phase and precede a granitic ring dyke sequence. This is certainly true in the Bagstowe area, where the cone sheets have followed diorite-andesite, (rhyolite), and granodiorite ring dykes and are succeeded by a completely granitic succession of dykes to be described later.

In the eastern and central sections of the swarm, certain age relations are proved:

a) The sheets cut across the Mount Rous Ring Dyke.

b) The sheets displace a pink rhyolite porphyry ring dyke where they have cut across its trend.

c) The eastern end of the swarm has been metamorphosed by a younger granite ring dyke. Here the glassy groundmass of the sheets has been completely recrystallised to a fine, equigranular mosaic of quartz and feldspar, in which are corroded quartz and orthoclase laths.

Middle Cone Sheet Swarm

Just outside the pink rhyolite porphyry ring dykes, but within the outer cone sheet swarm, is the middle cone sheet swarm. The swarm crops out over the seven miles between Pine Mountain and Castle Hill Creek, with the greatest intensity of sheets between the headwaters of Yard Gully and the north flowing Gilbert River. In this latter area the swarm has a width of 1000 yards, and of this width over 65% is occupied by pink rhyolite porphyry cone sheets: the remainder is Dumbano Granite screens.

In all mineralogical and structural aspects this middle swarm is identical to the outer cone sheet swarm. They differ only in trend. The middle cone sheets conform more closely to the trend of the grey rhyolite porphyry ring dykes, but even so they diverge by 15 degrees towards the north-west. The swarms have a common area of origin, but here the age relationship is uncertain. Probably the swarms are synchronous although the middle cone sheets may be younger than the granite ring dyke which metamorphoses the eastern end of the outer swarm.

Some Other Pink Rhyolite Porphyry Structures

Another possible cone sheet swarm crops out between Christmas Hill Creek and North Knob over an area of four and one half square miles. The sheets of pink rhyolite porphyry strike east-west and some dip to the south at 20 degrees. A north-south fault probably terminates the western edge of the swarm. The structural position of this swarm in the complex is unknown for the dykes are outside the complex and strike at 30 degrees to its circumference.

Centred three miles north of Bagstowe Homestead on the track to Kidston is a roughly circular outcrop, one mile in diameter, of massive, pink, rhyolite porphyry. Two arms project north from this mass and in them flow banding dips west at 60 degrees. No origin for this structure is known, but it may pre-date the pink porphyry ring dykes.

East and West Pink Granite Ring Dykes

Pink granite ring dykes crop out on the north-eastern and western sections of the circumference of the complex. The western dyke, centred one mile north-west of Bagstowe Homestead, has a maximum width of 950 yards and crops out over a length of five miles. At its southern end the dyke tapers out amongst the pink rhyolite ring dykes; to the north it passes under alluvium before being cut off by a younger granite stock.

Cropping out from the headwaters of Dairy Creek to near the junction of Ten Mile Creek and Ironwood Branch, is the eastern dyke. It measures nine miles in length and averages 300 yards in width. The southern end of the dyke abruptly tapers off; the northern end narrows slightly but appears to continue under alluvium.

It is thought that these two dykes were originally one large ring dyke continuous around the northern end of the complex. This reconstructed dyke had a length of 20 miles and was the longest and most complete of all the ring dykes in the complex. During the intrusion of a younger granite stock the central northern portion of this dyke was obliterated.

Only handspecimen descriptions of this rock are available at present. The rock is holocrystalline, pink and porphyritic in feldspar. This feldspar is white (? albite) and gives the rock a distinctive mottled appearance. Quartz percentage is greater than 10% and the rock is a porphyritic microgranite (or fine granite). No flow banding or marked variation in grain size has been found.

The western dyke cuts across pink rhyolite ring dykes and the eastern one metamorphoses the same rhyolite only here it is in cone sheets. Elsewhere the dykes are surrounded by Dumbano Granite. A narrow offshoot of the eastern dyke near its southern end is suggestive of incomplete stoping, which probably took place during the intrusion of the granite.

Inner Cone Sheet Swarm and Radial Dykes

At this stage of the evolution of the complex another swarm of pink rhyolite porphyry cone sheets was injected. Some of these are found intruding the eastern and western pink granite ring dykes; it is thought that the scattered sheets of pink rhyolite in the grey rhyolite porphyry ring dykes and andesite dyke are the same age.

The sheets in the Four Mile Creek area are spherulitic in texture: elsewhere the sheets are normal flow banded rhyolites. They average 25 feet in width and one mile in length. The sheets dip inwards at 55-60 degrees, i.e. they are steeper than those of the outer and middle cone sheet swarms.

Possibly synchronous with the cone sheets, a number of radial fractures formed and these were also filled by pink rhyolite porphyry. A distinct swarm of these dykes in the Four Mile Creek area are cut off at their western end by a granite stock. Near Ten Mile Creek similar radial dykes displace earlier cone sheets.

Although the cone sheets were intruded under conditions of upward pressure and the radial dykes under tension, no significant differences can be detected. Both these structures proceed the intrusion of the major, and final, granitic phase of the complex.

Granite Stock and Central Granite Ring Dyke

Dominating the northern end of the complex is a circular stock of granite four miles in diameter, with ring dyke attached to its southern margin. These structures are composed of a leucocratic, pink, fine to medium grained granite, of which no thin section have been examined yet. There is no appreciable decrease of grain size towards the margins of either the stock or the dyke, indicating that at the time of the intrusion the country rock was warmed up enough to allow the slow cooling of the intrusives.

Contacts of the granite stock against the older Dumbano Granite and the microgranodiorite near Four Mile Creek are sharp and regular. The granite continues irregularly for three miles to the north of the main Bagstowe Complex, but here it has been intruded into an intricate fracture zone between the complex to the south and the Lochaber Granite to the north.

Vertical jointing in the granite is in two directions at right angles; one north-west - south-east and the other north-east - south-west.

A pink granite dyke, six miles long, has been intruded into a ring fracture on the southern side of the stock. The irregular width of this dyke suggests that while the primary control for the dyke was a ring fracture, minor control was exercised by the jointing in the country rock. At its eastern end the dyke grades into the granite stock - the rock is identical in the two structures - and at its northern end the dyke bifurcates. An outcrop of andesite between the arms, 300 yards north of the track to Bagstowe Homestead, is ramified by veinlets of pink aplite and microgranite.

LOCHABER GRANITE

Seventeen miles north-east of Glenmore Homestead, at the centre of the Bagstowe Complex, is centred another elliptical granite mass here named the Lochaber Granite (plate 3). The major north-east - south-west trending axis of the ellipse measures 13 miles, and the minor axis seven miles, in length.

The characteristic feature of the leucocratic granite stock is its hooded nature. On the northern, eastern and southern sides the massive granite of the centre grades outwards through an intermediate zone of porphyritic microgranite to a flow banded rhyolite porphyry margin (plate 4).

Kaolinised perthite (55%) is the dominant mineral in the granite. It is found as subhedral to anhedral laths up to 1.5 mm. wide. A little unaltered albite-oligoclase is also present. Quartz (40%) is anhedral with a large scale graphic texture developed. Less than 5% biotite is typical: numerous small flakes 0.15 mm. long are aggregated into clots 1.8 mm. across. Individual laths 0.5 mm. long are uncommon. The biotite is pleochroic from light yellow-brown to deep reddish-brown and is accompanied by magnetite granules. In hand specimen, this granite appears to be identical to the granite stock of the Bagstowe Complex.

On the western side of the Lochaber Granite this rock type is a little finer grained at the contact. Towards the other three sides the rock becomes micrographitic with anhedral phenocrysts of quartz and feldspar in a groundmass of quartz, feldspar and a little biotite. Perthite and myrmekite rims are common.

Within one mile of the contact the groundmass is a devitrified glass in which are set rounded and embayed beta quartz phenocrysts and subhedral laths of perthite and albite, 1-5 mm. in length. Some small biotite flakes, now mainly chlorite and magnetite, are present. Flow banding is prominent and dips either vertically or outwards at 70°.

Contacts with the country rock are very sharp and there are no xenoliths in the Lochaber Granite: at the northern end of the granite it seems that the magma was intruded into joints and ring fractures outside the circumference of the original ellipse. East of Pannikin Creek a large block of Forsayth Granite was partially stoped into the Lochaber Granite, but it does not seem as though this mechanism was an important factor in the intrusion of the granite.

Vertical jointing is in two directions; one minor set parallels the long axis of the intrusion and the major set is normal to this. When traced over distances of up to four miles, the trend of these joints is usually slightly convex to the south.

Accompanying the intrusion of the magma, a swarm of radiating fractures were opened at the northern end of the granite mass. These have been filled by the magma which solidified as a flow banded rhyolite porphyry. Two stages of fracturing and intrusion are evidenced by the faulting of some dykes by others. Two dyke swarms and some single dykes of pink rhyolite porphyry are scattered around the margin of the granite and may be either ring dykes or cone sheets.

A major dyke swarm strikes at 200° westward from between the Lochaber Granite and the Bagstowe Complex. The main dyke in the swarm is five miles long and averages 800 yards in width (plate 2). It is a pink microgranite throughout whereas the narrower dykes are rhyolite porphyry. The shape and location of the swarm seem to be structurally controlled by the three members of the Younger Granites. Especially noticeable is the marked trend swing towards the north around the Butlers Igneous Complex. Near the Bagstowe - Ballynure track, the microgranite dyke swells out and abruptly ends. The line of the dyke is followed by a shear zone in which the foliation of the Dumbano Granite dips west at 70°. Half a mile north of the track the shear is filled by a pink rhyolite porphyry dyke which continues to the north for two miles.

A wolfram-molybdenum bearing quartz reef trending 045° and dipping north-west at 65° is found in the south-eastern part of the Lochaber Granite. The now abandoned Lochaber Mine was open cut on this reef to a maximum depth of 35' and over a length of 200 yards. The reef, three feet wide, was zoned with nearly all the ore concentrated in the one foot wide central zone. Here clusters of wolfram crystals and veins and bunches of molybdenite granules are disseminated through subhedral milky quartz.

In the edge zone, one foot wide, on the reef the white quartz is completely absent and the rock is dark green. Topaz and biotite in this zone are associated with quartz and a few ore granules. The topaz is mainly related to sericite filled vughs, but is occasionally found filling small cracks in the quartz. Both biotite, pleochroic from light greenish-brown to deep green, and quartz grow as euhedral crystals into these vughs; elsewhere they are anhedral to subhedral.

There is a definite boundary between the green reef edge zone and the pink, plagioclase bearing, granite; the only effect on the granite has been the addition of some iron into the first 2 - 3 cm. in the contact zone and this has oxidised to yellow limonite on the kaolinised feldspars.

Some lode tin (cassiterite) has been reported from the western side of the granite but no definite location is known.

BUTLERS IGNEOUS COMPLEX

Centred five miles north of Ballynure Homestead and twelve miles south-west of Kidston, the Butlers Igneous Complex rises 300' above the surrounding hills as a steep sided plateau (plate 3). The mass measures seven miles from north to south and is three miles wide at the northern end, gradually tapering to a point in the south.

Structurally and petrologically the complex is similar to the Lochaber Granite but as yet no thin sections have been examined. Essentially the mass is a granite sheet striking north-south and dipping to the west at 50° to 80°. The sheet is mantled by a flow banded, pink rhyolite porphyry hood into which the granite has been intruded at a late stage of its emplacement.

Pink-purple rhyolite crops out with a sharp contact against the Forsayth Granite in a section along Ten Mile Creek on the eastern side of the complex. In the rhyolite, flow banding, which dips to the west at 25° - 30°, is exposed in a 500 yards wide contact zone, but inside this the rock becomes massive. One thousand yards in from the contact there is a sharp boundary between pink rhyolite and pink porphyritic microgranite; mineralogically the two appear to be similar and only the grain size is different. The contact between the two rocks is sharp and it can only be concluded that the contact is intrusive. No veins or xenoliths of one in the other are found and there is no visible evidence of recrystallisation of the rhyolite.

The same relationship exists at the western edge of the microgranite and massive rhyolite near the centre of the complex. From aerial photographs it seems that the other scattered outcrops of microgranite are also intrusive.

It is concluded that after the rhyolitic hood over the sheet of granitic magma had solidified, an insulated chamber was formed keeping the rest of the magma liquid. A renewal of pressure, forced the granite magma to intrude the hood where it solidified as a porphyritic microgranite. Any xenoliths of rhyolite produced as the granite stoped its way into the hood would be easily and rapidly absorbed.

Jointing follows a similar pattern to that in the Lochaber Granite with the main set trending north-west. A prominent fracture, partially filled by pink rhyolite porphyry, trends north-south parallel to, and one mile from, the western margin of the complex. This seems to be an offset continuation of a major dyke one mile to the west; a description of this has been given under the heading: Lochaber Granite.

A circular (?)trachyte plug, one mile in diameter, has been intruded at the centre of the complex. No explanation for this plug is offered.

STRUCTURAL AND MAGMATIC EVOLUTION OF THE YOUNGER GRANITES IN THIS AREA.

The intrusion of the simpler Butlers Igneous Complex and Lochaber Granite was synchronous with the final stage of evolution of the Bagstowe Complex. Hence the sequence of events in the Bagstowe Complex will be described and the other two masses mentioned at the appropriate time.

Structural Control

The three igneous masses described here are located twenty miles south-east of the southern end of the Newcastle Range. This range consists of a downfaulted block of Middle Palaeozoic acid extrusives and ejecta (White, Stewart, Branch, Green, Wyatt, 1959, in preparation); an episode which preceeded the more deep seated activity of the Bagstowe, Butler Complexes and Lochaber Granite. The margin of the western range is a huge ring fracture 170 miles long; the eastern range is a more complex arrangement of ring dykes and ring fractures.

Parallel to the western side of the Newcastle Range, and ten miles west of it, is a large fracture in part filled by rhyolite, quartz reefs and dolerite. This fracture, which probably swings around the northern end of the range, is evident a few miles south of Dagworth Station and passes through Ironhurst Station to Georgetown. South of here the trend of the fracture is followed by the Etheridge River for fifteen miles after which it is again filled by intrusive dykes. It is though the fracture may be controlled by the western margin of the Archaean continent in this area.

The Permo-Carboniferous Agate Creek Volcanics (White et al, 1959), are on this line. From here it is uncertain if the fracture continues round the southern end of the range but it swings north-east and follows the north-western margin of the Bagstowe Complex and Lochaber Granite. It continues along the general trend of the Copperfield River, and here the Forsayth Granite is well foliated in a north-south direction; further north it is incorporated in the ring fractures around the Eastern Newcastle Range.

Minor parallel fractures have been formed on either side of this fracture in the Glenmore-Kidston area. It is between, or along, these fractures that the various members of the Younger Granites described here have been intruded. The method of intrusion is by ring fracturing accompanied by subsidence. The mechanics of this method were first explained by members of the Geological Survey of Scotland in relation to certain Tertiary intrusives at Glen Coe, Mull etc., (1909 onwards) and amply substantiated by later geologists (see bibliography).

These ring dykes were situated in the Precambrian craton near its rim at the time of their intrusion. Twenty-five miles to the south-east is the westerly extremity of a Lower to

Middle Palaeozoic geosyncline. The edge of this geosyncline represents the transition from unstable conditions in the east to stable conditions in the west during the Palaeozoic Era. Hence the complexes were intruded in an area of intermittent epiorogenic uplift, to which they are related, since both relie on immense vertical pressures of deep-seated origin.

Magmatic Evolution

Because the igneous masses are dominantly acidic and have been intruded in an area of older granite, it is not unnatural to assume the two are related. It is considered that the bulk of the magma for the various complexes has come from the mobilisation of part of the Dumbano Granite and that early dioritic types are formed by contamination.

The stages of evolution are envisaged as follows:

1. Heating of simatic substratum and rise of basaltic magma into the roots of the Dumbano Granite. Heating and formation of acid magma in a parabolic chamber above basic magma.

2. Explosive outburst reaching surface - formation of acid plugs and probably extrusive flows (e.g. (?) Newcastle Range). Very little extrusion of basic material.

3. Mingling of magmas at depth. Turner and Verhoogen (1951, pp 121-122) state that diorites can be produced by the assimilation of gabbro or amphibolite in a biotite granite. It is presumed that the reverse reaction world apply and that an uprising basaltic magma, on being contaminated by absorption of a biotite granite, would give rise to a dioritic magma. The calcic plagioclase of the basalt would be converted to oligoclase while olivine and augite follow the reaction series olivine, pyroxene, hornblende, biotite. High lime content of the magma, a surplus resulting from the convertion of the plagioclase, would favour hornblende as an end product rather than biotite. There would also be variable amounts of introduced alkali feldspar and quartz from the granite.

4. Reduction of pressure in the magma chamber allowing the eccentric collapse of a circular block of Dumbano Granite above the chamber. Uprising of quartz diorite magma into the fracture - the Mount Rous Ring Dyke. Note in this rock the reaction rims on the few quartz crystals, the large labradorite laths and the presence of hornblende being altered to biotite; all of this is taken as evidence of mingling of acid and basic magmas. The magma was intruded into a cold, high level of the crust as shown by the hypocrystalline groundmass; the large phenocrysts would be carried up from depth by the uprising magma.

5. A further series of ring fractures inside the Mount Rous Ring Dyke and the upsurge of viscous, acidic magma from the top of the chamber, carrying small pods of basic magma with it - the grey rhyolite porphyry ring dykes. Gradual decrease of percentage of magnetite granules carried in the magma and of country rock xenoliths as the later fractures in the series become more open.

6. Intrusion of quartz free dioritic magma from near the base of the chamber during a sudden upsurge of magma into a large open fracture - quick solidification to give augite andesite ring dyke.

7. Continued rise of dioritic magma into another ring fracture, but now contaminated by assimilation of granite

xenoliths during stoping. Also general heating of country rock by earlier intrusions allowing slower cooling - the Four Mile Creek Microgranodiorite.

8. This marks the end of the contaminated magma sequence. By now the granite above the basaltic and diorite magma is completely mobile. Possibly the sima has resolidified and all the contaminated magma has been extruded from the chamber leaving an oblate spheroidal mass of granitic magma pushing its way to the surface.

9. Reduction of magma pressure allowing rise of granite magma unto ring fracture outside the grey rhyolite porphyry ring dykes - the inner pink ring dykes; also Castle Hill dyke.

10. Great increase in magma pressure and rise of magma as out and middle cone sheet swarms.

11. Another reduction of pressure and intrusion of granite into large northern ring dyke, now represented by the eastern and western pink granite ring dykes. Note increase of grain size through further heating of country rock, especially due to the uprising magma chamber.

12. Increase of pressure over magma chamber and intrusion of inner cone sheets - also formation of radial tension cracks filled by rhyolite.

13. Intrusion of granite stock and central granite ring dyke - no chilling of this granite because of the general heating of the surrounding country rock, yet without metamorphic effect.

14. Intrusion of Lochaber Granite and granite sheet of the Butlers Igneous Complex. These are co-magmatic with the Bagstowe Complex granite stock, but have been intruded into cooler country rock. Hence they have chilled hoods of rhyolite grading inwards to normal granite.

15. Intrusion of (?)trachyte plug in the Butlers Igneous Complex.

Age

In North Queensland other hooded Younger Granite batholiths (e.g. Elizabeth Creek Granite) are known to intrude Middle Palaeozoic sediments and volcanics. Their structural similarity to the Lochaber Granite supports an Upper Palaeozoic age for these structures as they are unconformably overlain by Cretaceous sediments.

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Plate I Xenoliths of Auto-brecciated Mt. Rous Ring Dyke trachyte and Dumbano Granite in the outer zone of grey rhyolite porphyry of ring dyke B, located two miles south-south-east of Glenmore Homestead.

Neg. MRG/1303

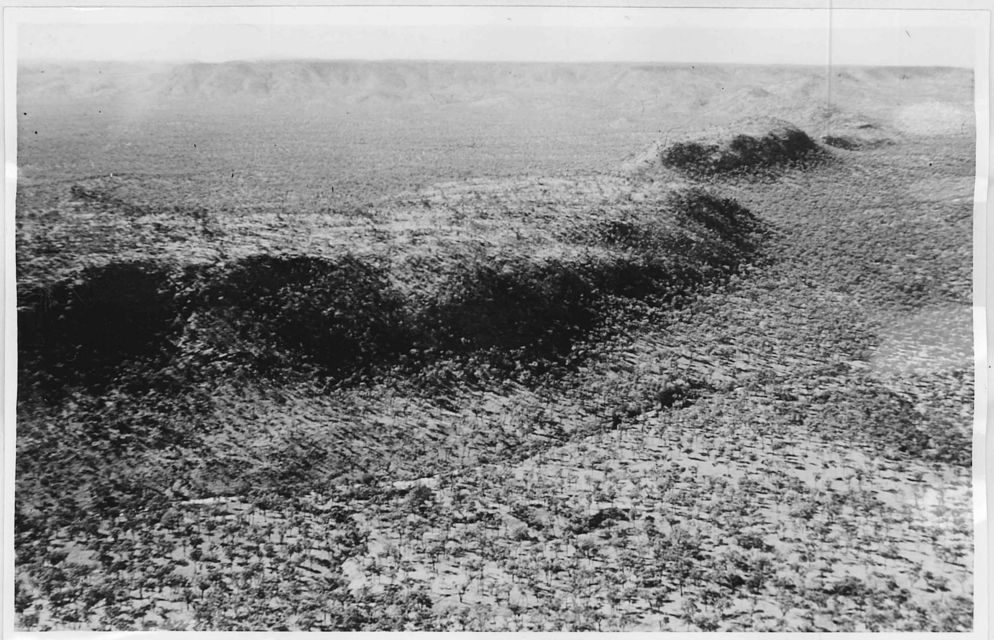

Plate 2 Pink microgranite ring dyke cutting Dumbano Granite two miles south of Ballynure Homestead - looking east towards the Gilbert Range. Photographed from an elevation of 500'.

Neg. MRG/1291

Plate 3 Looking north-west along the gorge of the Copperfield River in the Lochaber Granite, towards the Butlers Igneous Complex. Photographed from an elevation of 500'.

Neg. MRG/1300

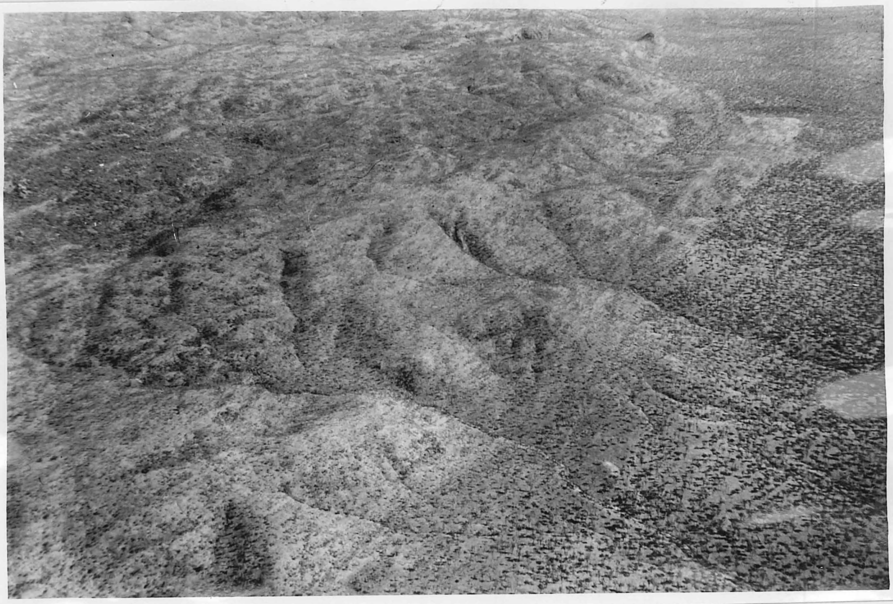

Plate 4 Northern end of the Lochaber Granite photographed from an elevation of 1000'. Massive granite in the upper left hand corner grades into flow banded rhyolite porphyry (centre) at the contact with the Forsayth Granite (lower right hand corner).

Neg. MRG/1292


GEOLOGICAL MAP OF
BAGSTOWE RING DYKE COMPLEX,
LOCHABER GRANITE &
BUTLERS IGNEOUS COMPLEX,
NORTH QUEENSLAND.
Reference
TERTIARY-RECENT
Qa Alluvium
Q-Tbc Chudleigh Basalt
CRETACEOUS
Klb Blythesdale Group
MIDDLE-UPPER PALAEOZOIC
in various 'ring structures'.
Trachyte
Pink Leucocratic granite
Fine pink granite
Cone sheets & narrow dykes
V Pink rhyolite porphyry
Augite andesite
Grey rhyolite porphyry
Quartz microdiorite & microgranodiorite
Possible volcanic necks
PRECAMBRIAN
PROTEROZOIC-LOWER PALAEOZOIC
Pgf Forsayth Granite
Pgu Dumbano Granite
PROTEROZOIC
Pb Bernecker Creek Formation
Pe Etheridge Formation
Pp Paddys Creek Formation
ARCHAEAN
Ae Einasleigh Metamorphics
Mine
Joint
Gneissosity
Lineation
Bedding
Flow banding
N
SCALE OF MILES
1 ½ 0 ½ 1 2
CAIRNS
MAREEBA
CHILLAGOE
MT GARNET
GEORGETOWN
EINASLEIGH
FORSAYTH
KIDSTON
INGHAM
Georgetown
Einasleigh
Burdekin R.
Bagstowe
Gilberton
Clarke River
CHARTERS TOWERS
HUGHENDEN
Road
Railway
50 0 50 100
SCALE OF MILES
LOCALITY MAP
WISES KNOB
Kidston
PADDYS KNOB
BUTLERS KNOB
Lochaber Mine
GILBERT RANGE
NEWCASTLE RA.
NORTH KNOB
PINE MT.
MIDDLE KNOB
SOUTH KNOB
MT ROUS
BLACK CAP
MT LOOKOUT
COPPERFIELD
GILBERT RIVER
Castle Hill Gully
FIELD SHEET ONLY