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LAMPROPHYRES FROM NEAR RADIUM HILL

M G FARRAND

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Lamprophyres from near Radium Hill

M G FARRAND

Lamprophyres collected in 1971 from the vicinity of Radium Hill and dated as Ordovician are very similar petrographically to the alkaline and lamproitic rocks of Ordovician age in the area between Truro and Frankton. A specimen described as of intermediate composition appears petrographically to be a variant within the lamprophyric suite. The province of lamproitic lamprophyres may be of boomerang shape with a N-S limb along the eastern edge of the Mount Lofty Ranges and a NE-SW limb along the G7 lineament. In New South Wales the G7 is called the Darling Lineament and is also the locus of alkaline possibly diamondiferous intrusives.

INTRODUCTION

Specimens of lamprophyric and intermediate rocks were collected by Graham Pitt in 1971 and dated by Alan Webb of Amdel as 431, 451 and 272 Ma. Lamproites from the Truro-Frankton area were collected by Brian Morris in 1990 and were dated as 458, 478 and 480 Ma. Petrographic evidence of similarity would support the possibility of a continuous lamproitic province controlled by structures along the eastern side of the Adelaide Fold Belt and along the projection into South Australia of the Darling Lineament of New South Wales.

PETROGRAPHY

Specimen 7033 RS 32, P247/71, TS 26750

Rock name — Lamprophyre

Locality — South Hill, 4 km SSE of Radium Hill

Hard specimen

Abundant phlogopite macrocysts are contained within a weakly nodular pinkish grey groundmass. The macrocysts are often distorted to the extent of cupping nodules of groundmass but despite this exhibit a recognisable preferred orientation. Groundmass nodules consist of aggregates of fine grained minerals.

Adequate material for chemical analysis is available but the degree of alteration is too high for ideal analysis.

Thin Section

Phlogopite and occasional muscovite macrocysts are held in a groundmass of fine grained and closely interlocking potash feldspar, plagioclase and quartz with fine flakes of phlogopite and ragged patches of pale biotite and sericitic muscovite. Accessory minerals include opaques, rare sphene, rutile and apatite. Chlorite is a pseudomorphous alteration product after phlogopite. Nodular clusters of felsic minerals are distinguishable after careful search but are not as apparent in thin section as in hand specimen. Frequent isotropic patches are probably glassy. Much of the devitrification of groundmass minerals is imperfect and optical properties are too poorly defined to permit mineral identification.

Phlogopite macrocysts are thin flakes up to 1.5 mm across. Marginal resorption is strongly marked in

some of the coarser grained crystals but is not pronounced in flakes of finer grain size. Many flakes are zoned with an almost colourless central core and dark brown, biotitic margins. In cross section some flakes are seen to contain dark, biotitic bands within the crystal as well as along the margins. It is not uncommon to encounter reverse zoning in which the dark, biotitic phase forms the core and main part of the flake while pale to colourless phlogopite occurs only as a thin rim.

Muscovite is not abundant and may be primary or a production of alteration when occurring as macrocysts. It occurs independently and also as zones in flakes which are otherwise biotitic. Very rarely muscovite occurs within dominantly phlogopitic grains but in this situation appears to be of replacement origin.

The groundmass contains fine flakes of phlogopite of both dark and light type and muscovite but consists mainly of a closely interlocked mosaic of anhedral orthoclase, quartz and minor plagioclase which appears to be oligoclase. Much of the groundmass is poorly crystalline, possibly the product of devitrification, and hence is of indeterminate mineralogy.

Opaque accessory minerals are cubic, prismatic and anhedral. No reflected light mineralogy has been carried out. Sphene occurs as fine, very irregular grains. Rutile occurs as fine, prismatic to anhedral grains. Apatite, zircon and garnet are too fine grained for definitive identification.

Sericitic alteration occurs in patches which are often marked by a concentration of opaque minerals. This probably indicates the replacement of an unstable ferromagnesium mineral. Chlorite alteration is usually marginal to phlogopite flakes.

Comment

This lamprophyre from the vicinity of Radium Hill is similar to the ferromagnesium-poor alkali lamproites of the Truro area. It is not identical since the mica is of Frankton II type but the apatite content is very low. When devitrification of the groundmass is advanced the abundance of plagioclase is seen to be substantial.

Specimen 7033 RS 33, P248/71, TS 26751

Rock name Lamprophyre

Locality South Hill, 4 km SSE of Radium Hill

Hand specimen

The rock appears to be schistose but this is due to strong weathering which has obscured the groundmass with limonitic alteration. The flow-induced preferred orientation of coarse grained phlogopite is accentuated in the absence of groundmass. Coarse grained pseudomorphs of limonite after euhedral pyrite are present. The material is abundant enough but not suitable for chemical analysis because of weathering.

Thin section

The section shows none of the heavy weathering seen in hand specimen but does contain an abundance of coarse grained, preferentially aligned phlogopite and occasional muscovite macrocysts. The groundmass is dominantly felsic with untwinned feldspar and quartz predominant over multiply twinned plagioclase. The micaceous component of the groundmass includes phlogopite and abundant muscovite, possibly of replacement origin. Accessory minerals include opaques, minor sphene and rutile with rare apatite. Chloritic alteration of phlogopite is rare. The same minerals are present as in specimen 7033 RS 32 but grain sizes and the relative abundance of individual minerals vary slightly.

Phlogopite macrocysts are less frequent than in RS 32 and are mainly of pale colour but biotitic variants are present. Both normal and reversed zoning occur. Flakes of over 2 min across are present. Muscovite flakes are rare.

Groundmass phlogopite is also mainly of pale type. Most of the groundmass consists of a closely-interlocked anhedral mosaic of quartz, potash feldspar and rare plagioclase. Poorly crystalline indeterminate phases are common.

Opaque accessory minerals are abundant and sphene is more common than in RS 32. Rutile is pale in colour and forms fine acicular crystals. Apatite occurs sparsely as poorly shaped fine grains.

Sericitic alteration, with abundant opaque minerals, occurs in larger and more frequent patches than in RS 32.

Comment

The rock is a minor variant of the same type of lamproitic lamprophyre as comprises specimen 7033 RS 32.

Specimen 7033 RS 34, P 249/71, TS 26752

Rock name Lamprophyre

Locality South Hill, 4 km SSE of Radium Hill

Hand specimen

In hand specimen the rock is much less weathered than RS 33 and exhibits a much weaker preferred orientation. Phlogopite macrocysts are fewer and of finer grain size. The ground mass is pink and of visibly coarser grain size. A cut surface of the specimen has been treated with sodium cobaltinitrite and has been stained an almost uniform yellow, indicating dominance of potash feldspar. An orbicular texture is marked with some evidence of mica macrocysts cupping or being wrapped around spherical aggregates of groundmass minerals. The material is sufficient for chemical analysis and is fresh enough but may not be entirely representative because of a lower than average mica content.

Thin section

Despite the lack of alteration noted in hand specimen, weathered patches of limonitic replacement are present in the thin section. As far as pre-weathering alteration is concerned, micaceous and chloritic replacement are common. The thin section may not coincide exactly with the hand specimen. As with specimen 7033 RS 32, the orbicular structure evident in hand specimen is not as prominent in thin section. Weakly radial and concentric textures are sometimes apparent and the bending of phlogopite macrocysts around a spheroidal nucleus of groundmass minerals is occasionally evident.

Phlogopite macrocysts are up to 1.5 mm across but are on average of finer grain size than in the two specimens described above. They are often strongly resorbed with groundmass penetration of cleavage planes. Pale phlogopite predominates but biotitic types are common, with both normal and reverse zoning apparent. Alteration products are muscovite, sericite, chlorite and a pale brown to colourless mica with very weak pleochroism.

Groundmass minerals are relatively coarse in grain size but still of poorly developed crystal structures, marked by patchy and undulose extinction, and with poorly defined optical properties and transitional grain boundaries. Advanced devitrification has produced coarser grain size but not well developed crystal structures. On the evidence of sodium cobaltinitrite staining, if the hand specimen is at all representative, the predominant feldspar is orthoclase but plagioclase grains are certainly present as evident from multiple twinning. Quartz is also present.

Opaque minerals are the most common accessories as fine, euhedral to subhedral grains. Sphene is present as fine to medium grains of irregular shape. Rutile and apatite are very rare.

Comment

The specimen is a variant of the lamprophyres but chemical analysis is required for a precise classification.

Specimen 7033 RS 35, P 250/71, TS 26753

Rock name Lamprophyre

Locality South Hill, 4 km SSE of Radium Hill.

Hand Specimen

The specimen consists of two pieces. One is a large but highly weathered rock, brown red in colour and crumbly with many cavities in texture. Scattered relict phlogopite flakes are visible. The sample is not suitable for analysis. The second is a small rock, grey in colour and pitted in texture. It is possibly suitable for analysis and has been used to cut the thin section.

Thin Section

The rock contains a few relict phlogopite macrocrysts in a moderately fine grained groundmass. Alteration products are abundant.

What remains of the phlogopite macrocrysts is sufficient to identify the mica as including both the pale and the biotitic types. Alteration is mainly to muscovite, both as in situ replacement by individual mica flakes and as patches of fine grained sericite. Some flakes are replaced by opaque limonite and others by sericite and translucent limonite.

Groundmass grains are poorly defined, more because of alteration than of fine grain size or incomplete devitrification. Patches of coarse grained muscovite and fine grained sericite are up to several millimetres across. Less extensive mica flakes and patches are distributed throughout the groundmass. Limonitic alteration is also widespread.

Fine, opaque accessory grains are independent of introduced limonite. Anhedral sphene is rare and apatite is very rare.

Comment

The rock is a phlogopite poor variant of the lamprophyres of South Hill. The prevalence of micaceous and limonitic alteration prevents definitive conclusions as to the original abundance of phlogopite macrocysts but it is possible that this was not high even before the alteration. Sericitic alteration is regional near Radium Hill and is not confined to the lamprophyres.

Specimen 7033 RS 36, P 251/71, TS 26754

Rock Name — Lamprophyre

Locality — Figgins (Figgans) Dam, 4 km NE of Radium Hill.

Hand Specimen

The specimen comprises two pieces. One of these is purple in colour with many pits due to weathering. Decomposed mica is moderately abundant and displays preferred orientation. The rock is unsuitable for chemical analysis. The second piece is small but much less weathered and has been used for the thin section. The rock is grey with pink crystals in the groundmass. It appears to be less micaeous than the weathered piece but would be suitable for analysis.

Thin Section

The rock is of similar type to those of South Hill with frequent phlogopite macrocysts in a quartzo - felspathic groundmass.

Phlogopite macrocrysts are abundant relative to most of the South Hill specimens and show a strong tendency towards preferential orientation, probably due to flow alignment. They are mainly of the pale type with marginal and internal zones of the dark, biotitic type. Reverse zoning is present but rare. Most flakes show some evidence of resorption and distortion.

In the groundmass phlogopite flakes are of biotitic as well as pale type. A more common type of groundmass mica is more biotitic than phlogopitic but with a very faint colour and very weak pleochroism and birefringence. It consists of poorly defined, fine flakes of probably poor crystallinity and is more likely to be an alteration product than a primary phase. It appears to take the place of the sericite which typified the alteration of South Hill.

Most of the groundmass consists of a closely interlocked mosaic of poorly crystalline grains which include quartz, potash feldspar and minor plagioclase.

Opaque material consists of anhedral to subhedral primary accessory minerals and of coarse grains and patches of anhedral to pseudomorphous replacement products. Some replacement is clearly of phlogopite but some consists of scattered patches of opaque material contained in rare patches of sericite. In places the opaque materials forms a rim to the sericite patch.

Chlorite is a relatively rare alteration product and appears to be transitional from the weakly biotitic mica. The latter may be a transitional phase itself and both appear to be products of a progressive alteration of phlogopite.

Small, sub-circular domains contain a platy to fibrous mineral with a radial habit giving concentric bands of polarisation colours. The mineral may be talc and the domains may be vesicular cavities. Alternatively the process may be one of replacement.

Comment

Apart from minor differences in alteration the rock is similar to, or within the range of variation of the specimens from South Hill.

Specimen 7033 RS 67 P 256/71, TS 26657

Rock Name Lamprophyre

Locality Near Figgins (Figgans) Dam, 4 km NE of Radium Hill

Hand Specimens

The rock has been mapped as of intermediate composition and in hand specimen appears to be different from the lamprophyres. It consists of a fine grained black groundmass enveloping flakes of black mica which appear finer grained and more biotitic than in specimens described as lamprophyres. The specimen consists of two small pieces, probably sufficient material for chemical analysis.

Thin Section

The impression of fine grain size is confirmed in thin section. The groundmass is weakly devitrified and is crowded with fine flakes of the very pale biotite encountered in lamprophyric specimens. Macrocrysts are less abundant than in rocks already described here, tend to be of finer grain size and contain a higher proportion of biotitic types. Phlogopitic mica is abundant, however, and all variations encountered are within the range of those encountered in the lamprophyres. Opaque minerals are dominant among the accessories but rare sphene is included.

Macrocysts are up to 1.5 mm across but on the average are considerably less than this. Resorption is common. Zoning is often present, though generally weak. Many flakes exhibit a preferred orientation. Muscovite macrocrysts are rare.

The groundmass consists of a closely interlocked mosaic of irregular and poorly defined grains of untwinned feldspar, pale mica and quartz. Plagioclase may be present but twinning is not developed, possibly because of poor crystallinity due to weak devitrification. Some quartz crystals are relatively coarse grained and may be filling vesicles. Mica occurs both within and between felsic grains.

Opaque accessories vary from very fine, euhedral to subhedral grains to patches of irregular to skeletal shape. The former are probably primary and the latter probably replacement products.

Comment

Like the specimens identified as lamprophyres, this specimen, and possibly other dykes identified as intermediate on the Olary 1:250 000 Sheet, consist of phlogopitic macrocrysts in a groundmass of felsic minerals and fine grained mica. Variations between rocks identified as lamprophyres and as intermediate are of degree rather than kind, relating to the abundance and grain size of the same suite of minerals. It seems more likely that the two rock types are end members of a single magmatic suite rather than two quite distinct suites. Specimen 7033 RS 67 has been classified as a lamprophyre on petrographic evidence. Chemical analysis is necessary to confirm the identification.

DISCUSSION

Specimens described in 1971 as lamprophyres are very similar petrographically to the lamproites of the Truro-Frankton area and it is suggested here that at least one of the rocks described as of intermediate composition is a variant of the lamprophyric suite. Since the classification of lamprophyres depends partly on chemical criteria and since no analyses of the rocks described here are available, it is preferred to retain the broader category of lamprophyres for the specimens described, while emphasising the lamproitic affinity.

Some specimens from the Truro - Frankton area are more correctly described as alkaline than as lamproites, even as alkaline lamproites. Rocks have been mapped as nephelinites, probably on chemical criteria, by the Geological Survey of New South Wales in a zone which may be a continuation of that containing the lamprophyres of Radium Hill, Olary and Nackara. The New South Wales rocks are diatremic and are considered to be potential sources of diamonds.

It appears possible that lamproites and related rocks of Ordovician age may occupy a boomerang - shaped province extending along the eastern edge

of the Adelaide Fold Belt in a N-S direction and following the Darling Lineament in a north easterly direction into New South Wales. It is possible that this arm of the province may extend beyond the Nackara area in a south westerly direction and that a third branch may follow the line of the Peak and Denison Ranges to include the diamond occurrences of the Mount Norwest and Mount Kingston (Algebuckina) areas.