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ROCKS FROM A POSSIBLE LAMPROITE DIATREME NEAR TRURO SOUTH AUSTRALIA

GEOLOGICAL SURVEY

by

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ROCKS FROM A POSSIBLE LAMPROITE DIATREME NEAR TRURO, SOUTH AUSTRALIA

ABSTRACT

Specimens collected from a circular geomorphological feature near Truro are interpreted as products of the alkali metasomatism of syenite, gabbro and dolerite. It is suggested that they may be xenoliths in a lamproitic diatreme.

INTRODUCTION

Five specimens of intrusive rocks from a road cutting 2.8 km north of Truro and adjacent to Sections 34 and 35, Hundred of Dutton, were examined as possible members of the alkaline - lamproitic suite described in Pet Rpt 2/90. The rocks had been described by Dr A C Purvis of Pontifex and Associates Pty Ltd (Mineralogical Report No. 5613 of 21/3/90). The rocks are of various lithologies but all come from within a sub-circular geomorphological feature about 50m across and may represent xenoliths in a lamproitic diatreme.

PETROGRAPHY

6729 RS 2599

Rock Name

Tourmaline - bearing syenite intruded by massive tourmaline.

Hand Specimen

A funnel-shaped body of massive, fine grained tourmaline intrudes a syenite containing tourmaline in bands and disseminated. Abundant potash feldspar in the syenite has been emphasised by sodium cobaltinitrite.

Thin Section

(a) **Transmitted Light**

The centre of the thin section consists of a closely packed aggregate of fine to medium grained tourmaline. Grains are equant and anhedral. Colour is patchy and pleochroism is pinkish brown, rusty brown and olive green. The mass of tourmaline is cut by thin veinlets of fine grained minerals with low birefingence and undulose extinction. The major part of the vein material appears to be untwinned plagioclase but optical properties are generally indeterminate and quartz of colloidal origin and zeolites are possibly present. This could be checked by non-optical methods.

Towards the margins of the massive body of tourmaline the grains are progressively coarser and better shaped. Patches of plagioclase, often with faintly displayed twinning, and other indeterminate minerals become more frequent until individual tourmaline grains are isolated within the felsic material and become subhedral to euhedral. An irregular zoning is often present. Felsic material is coarser in grain size and includes fine flakes of muscovite and pale brown mica. Some of the

felsic minerals form radiating aggregates of thin, prismatic crystals. Felsic material penetrates fractures in tourmaline and opaque minerals.

Bands of massive but coarse grained tourmaline extend outwards from the main body but in general the margins of the main mass are transitional to a coarse grained syenite with euhedral tourmaline. The syenite consists mainly of an unmixed feldspar in which the coarse grained patches of exsolved phase are almost as voluminous as the host mineral. Some grains appear to be perthitic with exsolved plagioclase in an orthoclase host while others seem antiperthitic with orthoclase exsolved from a plagioclase host. The plagioclase appears to be a pure albite. Both feldspars are very lightly altered to scattered fine flakes of sericitic mica.

Tourmaline inclusions in feldspar are up to 1mm across and consist of isolated, often perfectly euhedral, crystals and rare clusters of a few grains. Compositions tend to be patchy but a regular zoning between core and margin is often apparent, particularly in basal sections.

Tourmaline interstitial to feldspar is often strongly fractured into angular fragments and splinters. The fine grained felsic material forms a matrix for fragmented tourmaline and occasional feldspar with locally abundant, poorly crystalline mica which is probably an alteration product of feldspar.

The syenite contains rare grains of interstitial quartz. A poorly crystalline, pale brown, weakly pleochroic mica in fine grains is often associated with opaque material.

A few grains of zircon are present.

(b) **Reflected Light**

The main opaque mineral is nonmagnetic and highly reflective when polished. In plane polarised incident light it is grey white with very weak pleochroism and between crossed polarisers it is moderately bireflectant in shades of grey with yellow and purple tints. In euhedral form the cross section is hexagonal and the overall form prismatic. The margins of some grains are coated with an amorphous red brown layer. The mineral is probably haematite altering to goethite.

A few grains of haematite enclose fine grains and bands of ilmenite, possibly exsolved from the iron oxide.

Haematite is abundant in the syenite and includes coarse grains and clusters of grains. Individual grains are euhedral to subhedral but grains in clusters are anhedral. Large masses are often splintered into sharply angular fragments or divided by bands of limonitic alteration. The felsic vein material has penetrated many of the fractures in both opaque grains and tourmaline. Fine grains of opaque mineral are also present.

In the massive tourmaline facies opaque minerals are much less abundant and consist of fine to very fine grained inclusions in tourmaline grains.

Comment

Petrographic evidence suggests that the rock has had a complex history of stress and compositional change. The probable sequence of events is that an original syenite was greisenised and eventually invaded by fluid precipitating tourmaline. The fluid may have been generated as a late product of crystallisation of the syenite itself. After an indeterminate period of time an episode of stress was accompanied by the introduction

of fluid carrying felsic minerals in solution. Veinlets filled fine fractures in the mass of fine grained tourmaline. The coarser grained tourmaline and host syenite were more strongly fractured and the fluid surrounded shattered fragments of both.

Temperatures and containing pressures were relatively low in the latest episode of alteration but shock stresses were high. This is compatible with the emplacement of a diatreme.

The rock possibly represents a xenolith picked up at relatively shallow depth. The possibility that a greisenised syenite may outcrop or subcrop below superficial deposits is of economic interest as a potential source of tin, tungsten or molybdenum in the greisenising fluids or beryllium, niobium, tantalum or rare earths in the alkaline rock. In the absence of magma-generated mineralisation the intrusion may still have supplied the energy to drive convective mineralising fluids in contact metasediments.

6729 RS 2600

Rock Name

Altered gabbro.

Hand specimen

The rock consists of altered plagioclase, now a yellowish white, up to 15mm across in massive ferromagnesian minerals about 5mm across. The latter include black and dark green minerals. The rock does not respond to a hand magnet.

Thin Section

Relict fragments of very coarse plagioclase grains and less coarse grained relict pyroxene are surrounded and replaced by alteration products such as epidote, amphibole, chlorite, apatite, sphene and carbonate. Altered and poorly crystalline biotite in coarse flakes may be original or an alteration product. Fine grained sericite is certainly produced by the decomposition of feldspar.

Isolated, irregular fragments of plagioclase become extinct at the same angle of rotation over wide areas and are thus relics of coarse grains largely replaced. Twinning is not regular enough to determine the compositions of the fragments. A light alteration to flakes of sericite is present but the main replacement of plagioclase is by epidote, amphibole, chlorite, sphene, carbonate and apatite.

The original presence of pyroxene is indicated in highly altered crystals by retention of cleavage traces intersecting at high angles and rarely by the pyroxene cross section. Green, actinolitic amphibole and brown, strongly pleochroic hornblende are the most common alteration products, the former often replacing the latter, but a change towards biotite may be indicated by even stronger pleochroism and birefringence, straight or nearly straight extinction and a small optic axial angle. Some biotite may possibly be original, which may indicate affinity with the Black Hill noritic suite.

Further alteration, towards chlorite, is prevalent in both the amphiboles and the biotitic mineral. Amphibole is also altered to a carbonate which is probably dolomitic or ankeritic but may be high enough in magnesium to qualify as magnesite. Rare sphene and a fibrous mineral which may be talc are also alteration productions of the amphiboles.

Epidote replaces amphibole as well as plagioclase.

Opaque minerals are present but not abundant and occur as fine opaque grains and diffuse limonite patches and staining.

Comment

Intense alteration of an original gabbro is mainly towards more hydrous phases. If biotite is an alteration product the hydrous solutions also carried potash. A rejection of calcium and acquisition of sodium by plagioclase may be part of the same process. The calcium from both feldspar and original pyroxene was accommodated in epidote, sphene, apatite and carbonate. This alteration is compatible with, but not necessarily diagnostic of, occurrence as an inclusion in a diatreme.

6729 RS 2601

Rock Name

Altered dolerite.

Hand Specimen

The rock is medium grained with a grey to beige matrix speckled with brown and greenish grey grains and patches. The weathered surface is black and white. Without impregnation the rock is crumbly. The rock does not affect a hand magnet.

Thin Section

The original composition of the rock was highly feldspathic and may have anorthositic affinities. Microdiorite is also possible as the original composition. Abundant alteration products include epidote, acicular amphibole, chlorite and minor

carbonate. Leucoxenised and limonitic opaque minerals form frequent irregular patches. The status of frequent coarse flakes of phlogopitic mica is uncertain.

Plagioclase is partly obscured by alteration products but forms an almost continuous fabric of interlocking prismatic and tabular crystals between about 0.5mm and 1.5mm long. It is subhedral to anhedral in form. The present composition is oligoclase from symmetrical extinction of moderately well preserved multiple twinning.

Epidote is abundant and indicates considerable rejection of calcium from original plagioclase which may have been andesine or labradorite. Epidote occurs as fine to coarse grains as isolated crystals or patchy clusters.

Amphibole is strongly replaced by chlorite but a little remains as poorly crystalline, ragged acicular clusters, too altered for identification.

Chlorite is common as pseudomorphous replacement of acicular amphibole. A few small patches of carbonate, probably dolomite, are present.

Opaque to semi-translucent iron-titanium oxides are products of leucoxenisation and limonitic alteration of what was originally ilmenite. Grains are mainly coarse and anhedral with ragged, often skeletal form. They are widely distributed but tend to be concentrated locally in loose clusters.

Phlogopite occurs as coarse to fine flakes, isolated and in clusters of yellow brown, moderately pleochroic mica with small optic axial angles. Because of the similarity of form and distribution between epidote and phlogopite, it seems likely that the latter is also a replacement product. However, the

possibility that some or all of the mica is primary cannot be entirely excluded.

Comment

From petrographic evidence it is not clear whether this altered specimen is xenolithic or part of the host rock. If xenolithic it has received a substantial addition of potassium to form phlogopite. In either event the environment may be alkali-lamproitic. Other alteration is hydrous or due to the equilibration of early plagioclase to a lower temperature environment. This is not necessarily diagnostic of a lamproitic origin.

Chemical analysis is recommended to assist in the identification of the original rock before alteration.

6729 RS 2602

Rock Name

Greisenised ?dolerite with phlogopite.

Hand Specimen

A medium grained rock consists of white, brown and black crystals. It is crumbly with an open structure, possibly due in part to weathering. At one end of the specimen an open cavity contains coarse grained, blue white, tabular crystals growing from the walls.

Thin Section

Medium to coarse plates of feldspar enclose dark minerals, the most abundant of which is phlogopite. Particularly coarse grains of feldspar have grown into cavities some of which remain

open in the centre. These feldspars often enclose euhedral to skeletal crystals of tourmaline. Irregular grains and patches of opaque minerals are common. Two phases of alteration are represented with the introduction of phlogopite post-dating greisenisation.

Feldspars are essentially bimodal in grain size distribution although the two populations are not sharply distinct and do not correspond with the two compositions which are also present. The original rock may have been similar to specimen RS 2601 and some plagioclase grains are of similar grain size range of about 0.5mm - 1.5mm. The composition is now oligoclase. The second feldspar population consists of grains between about 2.5mm and 1cm long. These grains include both plagioclase and orthoclase. The plagioclase again appears to be oligoclase. Coarse grains tend to occur in clusters and represent in thin section the cavity lined with feldspar crystals seen in hand specimen. An open space is sometimes present in the centre of clusters of crystals seen in thin section. Coarse grained feldspars are also distinguished by subhedral to anhedral-skeletal crystals of tourmaline pleochroic from blue green to olive green to pale brownish pink.

Coarse grains of feldspar with tourmaline probably represent the same episode of greisenisation as is seen in RS 2599.
Opaque minerals are similar to those in RS 2601, anhedral leucoxenised ilmenite. Rare grains of apatite are present.

Phlogopite is in similar form but much greater abundance in RS 2602 than it is in RS 2601 and is distributed equally in areas of fine and of coarse grained feldspar and displays a cross-cutting relationship in some areas of coarse grained feldspar with tourmaline. The evidence suggests that phlogopite is an introduced phase and post-dates the episode of greisenisation. A few flakes are subject to weak alteration.

Comment

From petrographic evidence the history of the specimen began as a medium grained dolerite or microdiorite that was greisenised by the introduction of orthoclase, tourmaline and sodic plagioclase, having been initially corroded by the same pneumatolytic fluids. Later it was invaded by phlogopite and subsequently subjected to a very weak hydrothermal alteration.

The history is compatible with a xenolith from a greisenised mafic rock carried up in an alkali-rich lamproitic diatreme.

6729 RS 2603

Rock Name

Altered mafic rock.

Hand Specimen

The rock is crumbly, somewhat weathered and consists largely of fine to medium grained brownish mica.

Thin Section

The major part of the specimen is made up of phlogopite as coarse flakes and as large masses of fine flakes. Sodic amphibole and a little feldspar are present as relict fragments of coarse grains. Opaque grains and clusters of grains, irregular sphene, rare apatite and occasional patches of limonite staining are also present.

Two grain size populations of phlogopite flakes are distinct in mode of occurrence and possibly represent two separate generations. Fine grained phlogopite occurs as closely packed mosaics of anhedral flakes a few microns across in patches up to 2 mm or more across. Coarse grained phlogopite flakes are euhedral to subhedral, up to 1 mm across and occur alone or in clusters but rarely in close packed masses. A mottled birefringence suggests compositional inhomogeneity generally and systematic differences at the margins and along cleavage planes are apparent in plane polarised light. Brown patches and bands are similar in appearance to biotite but are poorly crystalline. A little chloritic alteration is apparent in some grains.

Amphibole occurs as ragged and irregular relict grains, fragments of which are in optical continuity over as much as 2 mm. The intervening phlogopite is assumed to have replaced originally continuous amphibole. Two compositional or structural types of amphibole are apparent from optical properties but differences are probably slight and both types are sodic varieties intermediate between riebeckite and glaucophane.

They are both pale with a pleochroism ranging from blue green through violet to slate grey or brownish grey. One type has a low birefringence in shades of grey with complete extinction and a large, negative 2V. This is possibly crossite. The other type has a strongly anomalous birefringence from bright blue to brown without an extinction position. It has a moderate, positive 2V of about 35° and is possibly a variety of arfvedsonite.

Both amphiboles are probably products of soda and possibly potash metasomatism, perhaps of original pyroxene.

Rare relict fragments of feldspar may be untwinned plagioclase or orthoclase.

Opaque minerals are probably original. Sphene is possibly a replacement product from calcium rejected by plagioclase or ferromagnesian silicate and titanium from ilmenite. Apatite may originate from the former process. Limonite is probably the product of weathering.

Comment

Abundant phlogopite appears from petrographic evidence to have been introduced, possibly in two episodes, at the expense of original coarse grained feldspar and ferromagnesian silicates. Soda-rich amphiboles are almost certainly the products of alkali metasomatism. Both processes are compatible with an original mafic rock immersed as a xenolith in a lamproitic magma with an alkali-rich volatile phase.

DISCUSSION

Two significant considerations arise from the specimens examined. One is that the petrographic evidence is compatible with an origin as inclusions in an alkali lamproite diatreme but not conclusively diagnostic of this genetic history. The other is that the inclusions constitute a sample of subcropping lithologies.

The presence of a lamprophyric diatreme is suggested by the combination of alkali and hydrous alteration and particularly by the abundance of phlogopite which appears on textural evidence to be a replacement product. Examination of the host rock or matrix of the inclusions may more conclusively demonstrate this and possibly some evidence could be obtained from even altered matrix material.

Evidence on the rocks sampled by the inclusions indicates the presence of a mafic and a felsic suite. Since mafic rocks appear to have been greisenised it appears that the felsic rocks probably postdate the mafic suite. It is assumed that greisenisation is the product of late fluids derived from felsic magmas. Silica does not appear to be involved and the magmas may be feldspathic rather than granitoid. However, a comparison with the Anabama and Bendigo granitoids is inevitable. Such intrusions may be of economic significance as direct sources of potential Sn, W, Mo, Bi, Nb, Ta, Li and Be. As heat sources for convective mineralising solutions, both mafic and felsic intrusions may promote the concentration of base metals such as lead and zinc ores. Geophysical evidence may indicate the presence of deep seated plutonic intrusions.