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MISCELLANEOUS SPECIMENS FROM THE TRURO-FRANKTON AREA

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by

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ABSTRACT

Specimens from the Truro-Frankton area include igneous and sedimentary rocks which have been altered to various extents by thermal and regional metamorphism and by metasomatic replacement. Igneous rocks have been divided into an alkaline suite of Early Palaeozoic age, a basalt-andesite suite of similar age, an albitite suite of indeterminate age and a member of a lamproite suite which is known elsewhere in South Australia to range from Ordovician to Jurassic age. The diversity of rock types and of metamorphic processes is ascribed to the intersection of three crustal sutures in the area.

INTRODUCTION

Twenty four specimens and thin sections were received for examination from Ted Dubowski of the Mineral Resources Branch. A report from Analabs on the same samples is numbered 1000-0-07-1270.

PETROGRAPHY

6729 RS 3260

Rock Name Metasandstone with ?metavolcanic clasts

Hand Specimen

The specimen is a poorly sorted, matrix supported, altered arenite with rounded clasts up to 2cm across. A thin veinlet is stained yellow, presumably by sodium cobaltinitrite. Carbonate clasts with dark coloured euhedral laths about 1mm long are possibly of volcanic origin.

Thin Section

The metasediment ranges in grain size from a few microns to 18mm without apparent bedding on other preferred orientation. Alteration to greenschist grade has resulted in a matrix containing fine grains of quartz and feldspar but consisting mainly of biotite with minor carbonate and chlorite and occasional muscovite flakes. The section contains part of the large, possibly volcanic clast noted in hand specimen and fine veinlets of chlorite and feldspar.

Quartz is the most abundant clast mineral and occurs up to about 1mm as single grains and somewhat over 1mm as multiple grains. Shapes range from almost perfectly spherical to elongated and angular. Some irregularity is due to embayment of the margins of quartz grains and filling of the corroded space by matrix minerals. Evidence of authigenic growth of extensions to a few quartz grains into the matrix is also apparent.

Microcline grains are similar in size and shape to quartz but less abundant. A few grains appear to be feldspathic but without twinning. These may be orthoclase or untwinned plagioclase. Occasional positive optical signs indicate the presence of albite.

Large but irregular flakes of chlorite with complex margins may be clasts with authigenic overgrowths or may possibly have grown in place. A third possibility, supported by the presence of flakes intermediate in optical properties between chlorite and biotite, is that biotite may alter to chlorite and may then be enlarged by authigenic overgrowth. Large chlorite flakes are most frequent in the vicinity of veins carrying chlorite.

Lithic fragments are less abundant than quartz and feldspar clasts but are generally larger. They include quartz metasandstone, quartz-muscovite sandstone, fine grained, quartz-biotite siltstones, rock composed almost entirely of sericite, polycrystalline quartz and chlorite-carbonate lithologies. The most prominent example of the latter, and at 18mm the largest clast in the metasandstone, consists of micritic, ferruginous carbonate forming a matrix to fine, equant grains of plagioclase and rare quartz with lath shaped grains of chlorite up to 1.5mm long. The latter are subhedral in overall outline but enclose plagioclase, carbonate and quartz. The chlorite laths may be partly the product of post-sedimentary recrystallisation but relatively good shape suggests that they may be pseudomorphously replacing earlier ferromagnesian minerals such as amphibole or pyroxene. This, and the presence of plagioclase, raises the possibility that the lithic fragment and less well-preserved examples of similar fragments in the rock, are altered volcanic rocks with groundmass or matrix largely replaced by carbonate and the phenocrysts by chlorite. An alternative is that the original rock was a tremolitic, feldspathic marble.

Minor clastic components include opaque grains and rare zircon and tourmaline.

Vein minerals include chlorite, carbonate, limonite and alkali feldspar. A thin, meandering veinlet cutting the whole specimen consists mainly of chlorite but includes a carbonate, probably siderite, which has exsolved so much iron that it is almost obscured by limonite. Veinlets now consisting of opaque limonite may have originated in this way. The veinlet seen in hand specimen to be stained by sodium cobaltinitrite also contains ferruginous carbonate. The main constituent is a fine grained mineral of low birefringence and no twinning which is presumably alkali feldspar.

Comment

The extent of alteration and uncertainty as to the history of the chlorite prevents a clear determination of the extent to which the metasediment can be considered volcanigenic. It is possible that both chloritic lithic clasts and individual crystals of chlorite in the sandstone may have a volcanic origin but neither can be conclusively identified as volcanigenic on the available evidence.

6729 RS 3261

Rock name ?Metatrachyte

Hand specimen

The rock is fine and even grained with black, pink and brown grains. A patchy development of yellow-stain suggests that potash feldspar is present in a locally varied concentration. The distribution of brown grains is similarly varied. Pyrite grains are disseminated throughout the rock.

Thin section

The rock consists essentially of a closely interlocking, decussate array of tabular feldspar, superimposed on which are large, irregular patches of a carbonate heavily impregnated with limonite. Less abundant constituents are opaque grains, quartz, chlorite, biotite and muscovite.

The feldspar consists of tabular grains with random orientation except where present in radiating clusters. Grains are up to 1mm long but average about 0.3mm. Plagioclase is dominant and appears from the symmetrical extinction of multiple twins to be oligoclase. From the evidence of sodium cobaltinitrite stains potash feldspar is also present. Many grains are not twinned and optical properties are often obscure due to alteration.

The main alteration product is a carbonate which was originally either siderite or a strongly iron-rich ankerite. It now forms irregular patches cutting across several grain boundaries and largely obscured itself by amorphous limonite. Patches are up to 6mm long but the intensity of this type of replacement varies in patches. In some places limonite occurs in small veinlets as well as in carbonate and the whole specimen is coloured brown.

Opaque grains include fresh pyrite but also include opaque limonite. These appear to be superimposed on the original rock.

Quartz occurs as fine, interstitial grains and as patches of mosaic grains, often with limonite between the subgrains. Some quartz may be introduced.

Chlorite occurs in lath shaped grains up to about 1mm across. It is interstitial to feldspar but cuts across carbonate. It is often associated with muscovite and appears to be part of an alteration assemblage, presumably earlier than the carbonate.

Biotite occurs as clusters of fine flakes. The clusters are superimposed on the feldspar over areas up to about 15mm across. Distribution overall is patchy.

Muscovite occurs as individual flakes up to about 0.5mm across associated with alteration assemblages of chlorite and biotite. The platy minerals appear to be independent of the introduction of ferruginous carbonate.

Comment

The rock has a complex history of alteration and the extent to which the present mineralogy represents the original mineralogy is uncertain. It appears to have been essentially feldspathic and is identified as trachyte on the assumption that potash feldspar is original. If it is the product of potash metasomatism, as probably are the muscovite and biotite, the original rock may have been dacitic or andesitic. The close packed mass of feldspar leaves little space for ferromagnesian constituents in the original rock and the extent that chlorite and ferruginous carbonate are metasomatic is not clear.

The rock may be intrusive but could equally be a volcanic which cooled relatively slowly.

6729 RS 3262

Rock name Porphyritic microsyenite

Hand specimen

The rock contains fine grained dark minerals but a mass of formless grey material rather than well defined grains of felsic minerals. A preferred orientation is marked by limonitic alteration.

Thin section

The rock is strongly feldspathic, porphyritic but with a medium grained groundmass and is alkaline in composition. It is probably intrusive rather than volcanic and exhibits no directional fabric in its original constituents. Alteration is strong.

The range of felsic constituents is quite broad. Phenocrysts are up to 4mm across and tabular in shape. Some are heavily sericitised and may have been potash feldspars. Others are plagioclase with multiple twinning but are too strongly altered to be identified.

Groundmass feldspar ranges in grain size between about 1mm and 0.1mm. Many of the coarser grained and better shaped groundmass feldspars are well twinned and, from symmetrical extinction angles, are within the oligoclase range of composition. Fine grained feldspars of poor shape and interstitial position are generally untwinned with rare examples of Carlsbad twinning. Many of these feldspars are optically positive and hence probably albite. Relatively fewer are negative with a small optic axial angle and are probably sanidine. A few grains display the complex multiple twinning of anorthoclase but this has not been confirmed optically. It is possible that a few grains of nepheline may be present since occasional off-centre figures in convergent light appeared to be uniaxial negative. No grains were found with the right orientation to confirm this optically and it is suggested that non-optical methods might be used. The abundance of these grains is relatively insignificant, however.

A few fine, interstitial grains of quartz are present.

The same range of platy minerals as was seen in RS 3261 are present in this specimen. Apart from sericite in feldspars and large patches where original feldspar is assumed, biotite, chlorite and muscovite are widely developed.

Carbonate with strong exsolution of limonite forms frequent irregular patches but is not as abundant as in RS 3261. In this rock the carbonate appears to be associated with opaque minerals which were probably pyrite before they were oxidised. It is principally these alteration products which produced the directional fabric noted in hand specimen. They appear to have been introduced along fine fractures now filled with translucent limonite which has diffused outwards to form a zone of iron staining.

Comment

The alkaline composition of the specimen is confirmed by determinations of 6.34% Na_2O and 2.35% K_2O in the assay. Alkaline magmas are not uncommon in the area and an inclusion of syenite was collected from a diatreme in the Truro-Frankton area. Identification as microsyenite rather than trachyte reflects the opinion that the rock forms a minor intrusion rather than a lava flow.

6729 RS 3263

Rock name Retrograde ?cordierite hornfels

Hand specimen

Not available

Thin section

The rock consists of fine grained quartz and biotite with a weak preferred orientation spotted with subcircular patches of fine grained clay, quartz and biotite.

The weakly oriented biotite and quartz are the metamorphosed equivalent of a fine grained sediment, siltstone or fine sandstone. The alteration is predominantly thermal but the preferred orientation may be the product of stress at the time of alteration as well as, or without a prior sedimentary fabric.

The subcircular domains are filled with decomposition products, probably of cordierite porphyroblasts, formed under a low temperature regime.

Comment

The occurrence of this rock indicates a stage of high heat flow, probably in the aureole of a plutonic intrusive. The effects of regional dynamic metamorphism may also be represented.

6729 RS 3264

Rock name Retrograde cordierite hornfels.

Hand specimen

A very fine grained black rock is spotted with pale brown, circular patches about 1mm across.

Thin section

Both the mineralogy and the texture of this specimen are virtually identical to those of specimen RS 3263.

Comment

The rock is probably part of the same hornfelsic aureole as RS 3263.

6729 RS 3265

Rock name Laminated phyllite.

Hand specimen

The rock is dark grey and very fine grained. It is marked by parallel laminations about 1mm thick of red brown material punctuated by open cavities. A second set of red brown banding intersects the first at about 40° in one corner of the specimen.

Thin section

Very fine grained quartz, muscovite and biotite with a strict preferred orientation create a phyllitic metamorphic fabric at about 40° to the bedding traces of the original shale. A faint lamination throughout the rock is accentuated by the more prominent laminations seen in hand specimen. These are formed by thin beds of coarser grained muscovite flakes and grains of quartz accentuated by heavy limonite staining and the deposition of red brown, translucent, amorphous limonite.

The metamorphic foliation is also accentuated in one corner of the thin section by deposition of amorphous limonite along the cleavage planes.

Comment

The rock is the product of regional metamorphism of an original shale.

6729 RS 3266

Rock name Epidote and quartz veins

Hand specimen

The rock is pale green and grey. It is coarse grained with a high density. A strip of coarse grained quartz adheres to one edge.

Thin section

Two lithologies are present and may represent two distinct veins in contact or two zones of the same vein. One lithology consists of quartz alone and cuts the second. This consists principally of epidote and quartz with opaque minerals and minor apatite, sphene, very minor plagioclase and possibly a trace of monazite.

Epidote is highly birefringent and pleochroic in patches from colourless to yellow green. It forms a loose to close-packed mass of prismatic to irregular crystals up to 4mm across. Local arrays with preferred orientation include radial clusters and en echelon fragments at the contact between epidote-quartz and monomineralic quartz lithologies. No regional preferred orientation is evident.

Quartz grains are up to 7mm across in the monomineralic vein and up to 2.5mm across where they are interstitial to epidote. In this epidote-quartz lithology some of the interstitial quartz consists of mosaics of fine grains and highly stressed arrays of incipient mosaic or partially annealed mosaic appears to penetrate the epidote bearing lithology from the contact with monomineralic quartz. At this contact arcuate fragments of epidote have been split from a cluster and dispersed in an en echelon array within the adjacent quartz.

This appears to indicate that the quartz lithology is later than the quartz-epidote lithology, possibly as a distinct vein, possibly as a central zone to an earlier marginal zone of one vein.

Fine, irregular grains of opaque minerals are dispersed within both the epidote and the quartz of the quartz-epidote lithology.

Apatite is relatively common as inclusions in quartz of the epidote-quartz lithology. It forms euhedral, broad prisms and subhedral prisms with a circular cross section. Very fine grained, acicular prisms are abundant in some quartz grains and may be apatite.

Sphene occurs as well-shaped prisms with acute angled terminations and as irregular aggregates of fine granules. As euhedral prisms it is preferentially included in or closely associated with epidote but as granules it occurs as inclusions in both epidote and quartz. The sphene is very pale in colour and with a neutral rather than brown tint. It displays a very low optic axial angle and some grains appear to be virtually uniaxial. With a phosphate content of 2.05% P_2O_5 it is possible that monazite may be present.

In some patches of mosaic quartz a few fine grains of plagioclase are present.

Comment

The thin section is slightly too thick. Both lithologies are those of hydrothermal veins, possibly of the same vein.

6729 RS 3267

Rock name Silty limestone

Hand specimen

The rock is fine grained and light grey. It effervesces vigorously with dilute HCl and exhibits a bedded fabric but no detectable metamorphic foliation.

Thin section

The rock consists mainly of fine grained calcitic carbonate. Minor quartz, opaque and translucent grains, chlorite, muscovite and biotite are also present.

Carbonate grains tend to be elongated in a direction assumed to be bedding. It is possible that some recrystallisation has taken place under load but unlikely that a regional metamorphic foliation has been imposed.

Granular opaque and weakly translucent brown material may be organic rather than limonitic in the rock but brown material in a thin, discordant fracture is probably limonite.

The platy minerals may also have recrystallised but apparently not under tectonic stress.

Comment

The rock appears to be a sediment, probably a calcareous mud, which has recrystallised during diagenesis, and possibly by burial metamorphism, but does not display a regional foliation. The designation of limestone appears more appropriate than marble.

6729 RS 3268

Rock name Porphyritic metabasalt

Hand specimen

A fine grained, grey groundmass encloses dark green, rounded and elongated phenocrysts. Irregular patches and elongated grains of pale green minerals are locally abundant. Elongated grains of both types are preferentially oriented.

Thin section

Both amphibole and epidote form phenocrysts up to 1.5mm across. Relict plagioclase phenocrysts are occasionally detectable in the groundmass but most of the latter consists of alteration products such as biotite, chlorite, epidote, carbonate and secondary amphibole. Fine laths of plagioclase may be of primary or secondary origin. Minerals of the groundmass exhibit a marked preferred orientation. A series of fine veins carrying epidote and quartz form an en echelon array conforming to the same orientation.

Dark and light green phenocrysts seen in hand specimen are respectively hornblende and epidote. The two minerals occur separately or together in clusters up to 3mm across. Clusters also contain chlorite. A few crystals contain both epidote and amphibole within the same outline but the evidence is ambiguous as to whether epidote is replacing amphibole or both were precipitated together. Individual phenocrysts do not conform to a preferred orientation but clusters of phenocrysts are elongated along the direction of the common fabric.

The groundmass consists of a felted mass of fine grained minerals most of which are alteration products. No evidence of replacement of individual grains is detectable and the original groundmass was probably as fine or finer grained than the

alteration products. Biotite and chlorite are the most abundant, epidote and a micritic carbonate are widely distributed. Secondary amphibole is patchy in distribution and may be an alteration product of phenocrysts.

Opaque grains are also patchy in distribution and are concentrated in the vicinity of phenocryst clusters.

Comment

Processes of alteration and replacement have been too severe and too complex to permit a clear identification of the original rock. High concentrations of iron (12.9% Fe_2O_3), magnesium (9.14% MgO) and calcium (9.77%% CaO) with silica of 43.8% SiO_2 indicates a basalt with andesite affinities. However, the present composition may not represent the original composition. The lime content appears to be particularly high. The directional fabric suggests flow banding or regional metamorphism.

6729 RS 3269

Rock name Metatrachyte

Hand specimen

Irregular patches of fine grained, light brown, platy minerals are superimposed on a light grey, coarser grained rock.

Thin section

Intense alteration conceals much of the rock. It is micaceous, in contrast with that affecting RS 3268. The original rock appears to have been composed mainly of plagioclase on the evidence of what remains free of alteration.

Rectilinear patches of dense sericite felt up to 5cm across possibly conceal porphyritic crystals of feldspar but the original composition of these is indeterminate. What feldspar is visible is all plagioclase and, from symmetrical extinction of multiple twins and optical sign, compositions range from albite to andesine. Grain size varies from 2mm to material of about 0.1mm which has been subjected to granulation, probably by recrystallisation.

The rock may originally have carried a ferromagnesian component but, if it did, only alteration products remain. These are mainly muscovite as sericite and as flakes up to 0.5mm long, limonite, biotite and epidote. Limonite occurs along grain boundaries and cleavages, in fractures and as a generalised brown stain. Biotite is pale and weakly pleochroic. It occurs in patches of fine to medium grained flakes. Epidote forms scattered, irregular, interstitial grains.

Opaque minerals are granular and similar to recognisable limonite in distribution. Limonite may occur as opaque material as well as in brown, translucent form.

Silica occurs as scattered interstitial quartz grains, as patches of mosaic quartz grains and as chalcedonic silica in a few open cavities. The cavities and deposition of amorphous silica are probably produced by weathering.

Comment

The rock has clear affinities with specimens RS 3261 and 3262 and is intermediate between them in grain size. The similarity is underlined by a soda content of 4.53% Na_2O and a potash content of 3.50% K_2O, now contained in the micas. There is no affinity with specimen RS 3268.

6729 RS 3270

Rock name ?Metatrachyandesite

Hand specimen

The rock is grey with light brown patches and scattered cavities with limonite coating the walls. Scattered patches of yellow stain indicate the presence of a potash feldspar.

Thin section

Alteration is heavier and richer in epidote with less mica and more quartz than in specimen RS 3269. However, what is visible of the plagioclase, and in particular the mode of radiating crystal growth, suggest similarity with the trachyte-microsyenite suite.

Relict plagioclase is fragmented but appears similar in habit to that of RS 3269. Compositions appear to be between andesine and oligoclase but albite may have been preferentially replaced. Potash feldspar is not identifiable optically.

A characteristic of the rock is the development of epidote in rounded, contiguous blebs, making up large masses of alteration.

Pale biotite closely interwoven with chlorite forms the next most abundant alteration product. Much of it is impregnated with limonite.

Fine grains of quartz are widely distributed as single grains and as patches of mosaic.

Opaque minerals are irregular and probably consist of limonite.

Comment

Because of heavy alteration the rock is not conclusively associated with any suite but similarity is greater with the alkaline suite than with the metadolerite.

6729 RS 3271

Rock name Metatrachyte

Hand specimen

The rock is fine grained and speckled dark brown and white. Fine grains of pyrite are disseminated throughout. Dense staining by sodium cobaltinitrite, and a potash content of 4.46% K_2O indicate a substantial concentration of alkali feldspar.

Thin Section

The rock consists essentially of plagioclase and biotite. A directional fabric is produced by a preferred orientation in the plagioclase and a mainly interstitial habit of the biotite. Individual biotite flakes are not consistently oriented. Muscovite flakes are disseminated. Opaque minerals are ubiquitous in the biotite.

The plagioclase includes oligoclase with well developed multiple twinning and albite without twinning. The soda content of the rock is 3.90% Na_2O. Potash feldspar is not identifiable.

Biotite is fine grained and mainly interstitial but appears to invade the feldspar. It has possibly replaced potash feldspar and may be responsible for most of the potassium content of the rock.

Muscovite occurs within clusters of biotite flakes and as inclusions in plagioclase. It is probably a replacement product.

Fine inclusions of opaque minerals occur throughout the biotite and are probably responsible for the 2.98% TiO_2 in the assay. The biotite may itself be titaniferous.

Comment

From the assay the rock is part of the alkaline suite. Preferred orientation in the feldspars appears to be a product of magma flow rather than metamorphic stress. On this basis the original rock was probably a trachyte lava. Mica appears to be a product of alteration. Metasomatic introduction of potassium is possible.

6729 RS 3273

Rock name Lamproite

Hand specimen

Not available. Analabs reports a positive staining test for potash feldspar.

Thin section

Ragged and poorly crystalline flakes of biotite up to 2mm long are oriented in random, subparallel and radiating arrays.

A groundmass composed of closely interlocked, poorly defined grains about 0.2mm across displays occasional spherulitic textures. Quartz is identifiable but other felsic grains are not. Limonite is present as an impregnation of the mica and as weakly translucent pseudomorphs after coarse grained opaque minerals. An inclusion about 15mm across at one end of the section consists of the same minerals but is even finer in grain size.

The biotite is a pale rusty brown and is weakly pleochroic. It appears to be corroded at the margins and patchy rather than zoned in optical properties. This is typical of one type of lamproite biotite but is not a true phlogopite. Subparallel orientation denotes local flow in the magma but random and radial orientation suggests that most of the rock cooled in a static state.

Poor grain definition and spherulitic textures in the groundmass are typical of devitrification of a glass. The full range of mineral components cannot be defined by optical methods. Soda and potash contents of 3.72% Na_2O and 3.43% K_2O respectively suggest the presence of albite and possibly nepheline and sanidine with possible leucite.

The fine grained inclusion is possibly a small lapillus or bomb erupted into the cooling magma.

Comment

The specimen is typical of one of at least two types of Mesozoic alkaline lamproite identified in the Truro-Frankton area. The exact identity is unclear but a general classification would be minette rather than kersantite. In common with the other lamproites of this area, the specimen belongs as much to an alkaline suite as to a lamproite suite.

6729 RS 3274

Rock name Metatrachyte

Hand specimen

The specimen consists of a fine grained, speckled white and pale pinkish brown lithology in contact with a more massive grey lithology. Both are weathered with oriented elongated patches of honeycomb cavities with limonite on the cavity walls. A patch of yellow staining indicates the presence of alkali feldspar in both rock types.

Thin section

The main constituent is plagioclase feldspar but the abundance of epidote, chlorite and micaceous alteration indicates a premetamorphic age. A preferred orientation in feldspar prisms at right angles to the length of the section contrasts with the elongation of the cavities at about 45° to that direction.

The speckled lithology consists of close packed clusters of plagioclase surrounded by biotite with chloritic alteration and minor epidote and muscovite. Trails of fine, opaque grains loop around feldspar clusters and patches of translucent limonite replace biotite and coarse grains of opaque minerals.

Large areas of translucent amorphous limonite appear to be precursors to elongated open cavities.

The massive lithology is similar but contains less biotite and more muscovite. It also contains bands of continuous sericite felt oriented parallel to the fabric of the feldspar.

Comment

The specimen is similar to other pre-metamorphic, feldspathic alkaline rocks examined in this series. Orientation of the feldspars is possibly by flow. Subsequent fabrics are metamorphic and lead to the formation of cavities after limonite replacement.

6729 RS 3275

Rock name Albitite

Hand specimen

The rock consists of white material without visible grain boundaries except where they are marked by limonite stains. Numerous cavities are lined with limonite and often outline individual crystals and crystal clusters. Pyrite grains are disseminated through the specimen.

Thin section

The rock is made up almost exclusively of plagioclase feldspar in closely interlocked arrays, often radial, of bladed crystals. Grain contacts are not sharply defined and one crystal is often distinguishable from adjacent crystals only by slight variations in the orientation of optical properties. Limonite, muscovite and rutile are very minor constituents.

Plagioclase includes twinned, optically negative crystals and untwinned, positive crystals. The lime content as determined analytically is only 0.55% CaO while Na_2O is 9.60%. This suggests that both twinned and untwinned plagioclase may be albite, the optically negative type possibly closer to the compositional boundary of oligoclase. Individual crystals are up to 1.5mm long. Shapes are subhedral to anhedral.

Limonite occurs as linings to cavities, as stains along grain boundaries and as pseudomorphous replacement of coarse grains, probably of pyrite.

Muscovite forms rare flakes and clusters of flakes with a random distribution and as scattered sericite flakes in plagioclase grains.

Rutile is widely distributed as fine to very fine prismatic crystals.

Comment

The rock is clearly part of an alkaline suite. The absence of any substantial alteration suggests that it is either Ordovician but later than any of the major plutonic intrusives or possibly part of the Mesozoic alkaline - lamproite suite.

6729 RS 3276

Rock name Greisenised metasandstone

Hand specimen

The rock is a weakly bedded sandstone with rounded quartz clasts up to 2mm across. It contains lenticular cavities filled with limonite up to 12mm long.

Thin section

The largest quartz clast in the section is 1mm across. A lenticular cavity 8mm long contains remnants of limonite. The largest of several lenticular siltstone clasts is also 8mm long.

These clasts may be of intraformational origin and the cavities may have been produced by weathering out of the clasts. The sediment is poorly sorted and matrix supported. The matrix contains limonite and rare muscovite but the most abundant constituent is tourmaline. A few coarse opaque grains are present.

Quartz grains are occasionally compound and a few quartzite lithic fragments are present.

Limonite appears to have replaced part of the matrix but in so doing has obscured any remnants of the mineral replaced.

Muscovite has also probably been introduced.

Tourmaline occurs as abundant, close packed, irregular grains interstitial to the clasts. It is pleochroic from deep green though pale olive green to pink. It has probably replaced an original clay mineral.

Comment

The specimen probably comes from the aureole of a granite from which pneumatolytic fluids rich in boron have invaded adjacent country rock. Matrix minerals were more reactive than the dominantly siliceous clasts and the rock was only partly greisenised.

6729 RS 3279

Rock name Albitite

Hand specimen

At one end of the specimen the rock is light grey and appears massive. At the other end a fine granularity is evident. Between these two facies is a coarser grained white and grey rock. Many irregular cavities are lined with limonite.

Thin section

All three lithologies are porphyritic, highly feldspathic igneous rocks of probable volcanic origin. The difference appears to be solely in grain size.

The major part of the section is made up of the finest grained rock in which phenocrysts are laths up to 1mm long. The groundmass consists of crystallites with poor definition but generally rod shaped. Areas of preferred orientation are consistent locally but not over the whole section. They are almost certainly the product of local flow in a viscous magma. Limonite and a few flakes of muscovite tend to be associated with cavities in the rock.

The intermediate grain size is restricted to a thin strip at the opposite end of the section. Phenocrysts are up to 1.5mm across and are more abundant than in the lithology of finest grain size. A strong and consistent preferred orientation covers the whole area. Groundmass minerals are developed with irregular shape and size.

Opaque grains are frequent and enhance the general preferred orientation. The composition of the rock appears to be more potassic and flakes of muscovite are abundant in the groundmass. Limonitic alteration is strong.

The third lithology is of considerably coarser grain size. It forms a band about 1cm wide between the two other lithologies. Phenocrysts are as much as 4mm long and the average grain size of the plagioclase laths of the groundmass is about 1mm. Occasional clusters of laths occur with a radial arrangement. Some plagioclase laths are bent. Interstitial flakes of muscovite are common. Preferred orientation is weak but persistent over the whole section. Opaque minerals and limonite are frequent.

Comment

The assay includes soda and potash determinations of 7.14% Na_2O and 2.21% K_2O respectively and indicate that this rock also is part of an alkaline suite. It lacks any phlogopite or even biotite phenocrysts so is possibly not part of the Mesozoic lamproite suite. On the other hand it lacks strong alteration so probably postdates the intrusion of major plutons in the Ordovician.

6729 RS 3280

Rock name Dolomitic metasiltstone

Hand specimen

A pale grey, fine grained sediment contains flaser structures related to grain size variation.

Thin section

The sediment is banded by variation in grain size and relative properties of muscovite, quartz and dolomite. These bands are not regular bedding structures but a form of flaser bedding. A metamorphic foliation is imprinted at about 35° to the general axis of flaser bedding.

The lithology with finest grain size is a phyllite consisting of muscovite, biotite and quartz with minor opaque minerals, very minor dolomite and chlorite and accessory zircon and tourmaline.

Siltstones of various grain sizes are adjacent to and intertonguing with the phyllites. Clasts of quartz, plagioclase and muscovite with rare opaques and tourmaline are contained in a matrix of biotite with chlorite and fine grained muscovite.

Dolomite grains have undergone minor recrystallisation but are comparable in grain size with the quartz and plagioclase clasts. It appears likely that they originated as clasts rather than as material introduced by dolomitisation.

Comment

The specimen is a normal sediment with a fine cross bedding of flaser type which has been subject to low grade dynamic metamorphism.

6729 RS 3281

Rock name Fine bedded phyllitic metasiltstone

Hand specimen

Much of the specimen consists of regular thin beds of siltstone and phyllite. Localised patches of irregular flaser bedding are marked by enlarged pockets of siltstone.

Thin section

The rock contains the same minerals as specimen RS 3280. In the finer grained lithologies sericitic muscovite displays a preferred orientation which corresponds with the bedding planes. Biotite and chlorite are minor constituents. Muscovite also occurs as clasts with quartz, plagioclase and opaque minerals.

The sandy lithologies consist of clasts of quartz, plagioclase and muscovite with traces of tourmaline and zircon in a matrix of muscovite, biotite and chlorite. Dolomite is concentrated in the coarser grained lithologies and forms individual coarse grains and clusters which are recrystallised and probably enlarged by overgrowth but which may have originated as clasts.

Comment

The metasediment is very similar to RS 3280

6729 RS 3282

Rock name Phyllite

Hand specimen

Most of the specimen consists of fine, sericitic muscovite with a strong preferred orientation. Quartz clasts are present and stringers of carbonate are aligned along the foliation.

A few small pods of coarser grained sediment consist of quartz, muscovite and dolomite. The carbonate forms elongated lenses along the foliation and appears to be more strongly recrystallised than in specimens RS 3280 and 3281.

Comment

The phyllite is similar to the other two metasediments RS 3280 and 3281 but has responded more strongly to the dynamic metamorphic stress.

6729 RS 3283

Rock name Porphyritic, amygdaloidal basaltic meta-andesite

Hand specimen

The groundmass of the rock is too fine grained for individual crystals to be visible. Phenocrysts are up to 3mm across but range down to about 0.5mm. Elongated amygdales filled with pale brown carbonate display a preferred orientation. The carbonate effervesces vigorously with dilute HCl.

Thin section

Plagioclase phenocrysts are contained in a groundmass of plagioclase, chlorite, opaque minerals, carbonate and a few muscovite flakes. Amygdales are filled with calcite. Both phenocrysts and groundmass display a preferred orientation.

Plagioclase phenocrysts are tabular to lath shaped. Many are bent. Compositions from symmetrical extinction angles of multiple twinning are in the oligoclase range. Untwinned grains of plagioclase with positive optic axial angles are probably albite.

The groundmass is a felted mass of crystals and crystallites, lath shaped to ribbon shaped respectively. Many of the ribbons are bent. Most display a preferred orientation which is consistent locally and approximate to a general consistent fabric. From the determinations of lime as 9.73% CaO and of soda as 5.93% Na_2O the composition appears to be somewhat basic. However, the carbonate of the abundant large amygdales is calcite and carbonate is present in the groundmass. It is possible that the plagioclase is in the andesine range, most likely towards the labradorite end. Only microprobe analysis would determine this satisfactorily.

Chlorite is widespread as an interstitial phase in the groundmass. It is presumably the alteration product of an original ferromagnesian mineral but no evidence remains as to the identity of the original mineral. Chlorite is also present, often associated with carbonate and muscovite, in fine fractures. In this situation all these minerals are probably metasomatic in origin.

Opaque grains and stringers are abundant and are subject to alteration to a limonite stained leucoxene. They are probably ilmenite and are responsible for the relatively high titania content (2.81% TiO_2).

Carbonate and muscovite in the groundmass are strictly oriented and probably fill fractures found along the prevailing fabric of flow orientation.

Carbonate in amygdales is oriented in so far as the amygdales themselves are flattened and elongated. There is no preferred orientation in the carbonate crystals themselves.

Comment

Directional fabric appears to be produced more by flow than by any regional dynamic stress and alteration appears to be limited to retrograde metamorphism of the original ferromagnesian mineral to chlorite. Some metasomatic changes have possibly occurred such as the introduction of chlorite, muscovite and carbonate along fine fractures parallel to the flow induced fabric. Chemically this rock appears to be most closely similar to the andesitic basalt RS 3268. However, the latter is quite strongly altered and is quite different in appearance from RS 3283. Because alteration may vary with proximity to major plutonic intrusives and associated heat flow the exact relationship of the specimen is somewhat uncertain. On balance there is perhaps greater affinity to the andesitic basalt than to the alkaline suite despite the presence of andesitic trachytes in that suite.

6729 RS 3284

Rock name Muscovite schist with quartz-limonite pods.

Hand specimen

A fine grained, strongly foliated rock is marked by numerous elongated cavities containing powdery amorphous limonite.

Thin section

Bands of perfectly oriented muscovite flakes are interrupted by lenticular pods of quartz, opaque grains and limonitic alteration products. Quartz grains are closely interlocked and often irregular in shape with poorly defined grain boundaries.

Comment

The rock was probably similar initially to the phyllite and siltstone lithologies encountered in other specimens of this collection. The grade of metamorphism which affected this specimen appears to have been higher than that affecting the phyllite-siltstone facies.

6729 RS 3285

Rock name Muscovite-chlorite-quartz-feldspar schist

Hand specimen

Not available.

Thin section

Bands of aligned muscovite and chlorite flakes extend from one end of the thin section to the other. These are very substantially interrupted by lenses of fine grained quartz and by individual crystals of both plagioclase and alkali feldspar. Other interruptions are by open cavities containing sporadic outgrowths of amorphous limonite and highly birefringent orange fingers of probable acicular jarosite. Limonite also forms pseudomorphs of cubic crystals, probably of pyrite. Carbonate coats the walls of some cavities. Corroded grains of tourmaline are also present.

The rock has clearly undergone a series of changes, both metamorphic and metasomatic. The plagioclase crystals resemble phenocrysts seen in some of the magmatic rocks of this series and the alkali feldspar may have been derived from plutonic rocks shattered in volcanic eruptions. However, the feldspars may alternatively have originated as porphyroblasts in thermally altered sediments.

Comment

A pyroclastic origin for some components of the rock is possible but not proven. Alteration is too complex and too far advanced for definitive identifications to be made.

6729 RS 3286

Rock name Schistose, volcanigenic metasandstone.

Hand specimen

A fine grained, light grey rock with a preferred orientation in the form of fine banding contains white crystals up to 3mm across. Yellow staining indicates the presence of disseminated alkali feldspars.

Thin section

The fine banding seen in hand specimen is produced by repeated but rather irregular and discontinuous layers of biotite with limonite and opaque minerals. Between these layers in which biotite is the dominant mineral, it occurs interstitially in layers of broken and corroded plagioclase with minor quartz.

The biotite is a pale and weakly pleochroic type except where stained by limonite. Since biotite is the only ferromagnesian mineral, the relatively high magnesia content of the sample (6.88% MgO) indicates a phlogopitic composition but there is no other evidence of a lamprophyric association. Most of the biotite is oriented along the plane of the layers but some orientation at high angles to this direction is due to diversion around plagioclase crystals, to random orientation in small lenticular modules and to possible recrystallisation after formation of the directional fabric. Biotite penetrates fractures in plagioclase grains.

Plagioclase grains are up to 5mm across but the average size is about 0.5mm. They tend to be somewhat altered, replaced at the margins, fractured and of less than perfect crystal structure. Few grains are well enough twinned to permit definitive compositional identification but from the available optical evidence compositions range from oligoclase to albite. The assay (3.46% Na_2O and 1.09% CaO) indicates a soda-rich plagioclase. As noted above, biotite has penetrated fractures in plagioclase and separates fragments of grains which have

broken apart but have not dispersed. Grain size is approximately bimodal and probably corresponds to phenocrystal and groundmass feldspar. While phenocrysts do not display any preferred orientation, probably because their dimensions are close to equant, the lath-shaped groundmass (or in this case matrix) feldspar shares the preferred orientation of the biotite.

It is the form and distribution of quartz which forms the basis for identification of the rock as a pyroclastic, slightly reworked, rather than a flow with severe alteration. Quartz is fine grained and scattered in lenticular patches through the rock as if deposited intermittently by streams eroding sediments rather than evenly disseminated as it would be in a lava or ash deposited directly.

Both limonite and opaque grains are associated as bands and patches with the biotite and their distribution is similar. High titania (2.43% TiO_2) indicates a probable ilmenite composition for the opaque grains.

Comment

The distribution of biotite and limonite is clearly controlled to a great extent by recrystallisation, part of which took place under directional stress but some of which was driven thermally without stress. As with several of the samples, the history of alteration is complex.

Shattering of plagioclase took place before recrystallisation of biotite although some wedging apart may be related to that recrystallisation. It seems probable that the plagioclase (and hence possibly the plagioclase in RS 3285) is of igneous origin. Early fracturing seems likely to have resulted from explosive eruption of an ash cloud. Slight resorting appears likely from the distribution of quartz. Preferred orientation in fine grained plagioclase may be the product of deposition of the ash cloud but that of biotite is

more likely to be tectonic in origin. A post-tectonic recrystallisation of the biotite may be related to heat flow in the vicinity of plutonic magmas.

The rock appears to be part of the alkali suite.

DISCUSSION

The samples were collected in a zone of intersection of three major crustal sutures. The G_2 suture in South Australia and the Darling Lineament which enters South Australia from New South Wales are broad bands of deep rooted tectonic disturbance trending NNW and NE respectively. The Kanmantoo Trough is a local N-S graben or half graben to the east of the Mount Lofty Ranges and is the site of numerous plutonic intrusions.

The combination of complex faulting, local high heat flow, plutonic intrusion with associated volatile fractions and regional stress during the Delamerian orogeny has produced a wide variety of thermal and dynamic metamorphic alteration and metasomatic reactions. Local variations in these conditions often prevent definitive identification of age relationships and the intensity of alteration often obscures the original composition of the rocks. In these circumstances data obtained from optical microscopy must be interpreted with care and in combination with spatial and structural relationships observed in the field.

On this basis the following relationships are suggested between the specimens examined.

A) Sediments

The fine and even grained limestone, RS 3267, appears to be virtually unaltered since diagenesis.

B) Thermal metamorphism

1. A relatively low level of thermal alteration without additional stress has affected metasandstone RS 3260 but the presence of veinlets of chlorite and ferruginous carbonate indicate the mobility of these minerals and hence metasomatic effects including the possible total replacement of volcanic clasts.

2. A higher degree of thermal alteration, although subsequently retrograded, is exemplified by specimens believed to be original cordierite hornfelses, RS 3263 and 3264.

C) Dynamic metamorphism

1. Relatively low levels of regional metamorphism are represented by phyllites RS 3265 and 3282, phyllitic siltstones RS 3280 and 3281 and sandstones with probable volcanigenic components RS 3285 and 3286.

2. Higher levels are exemplified by muscovite schist RS 3284.

D) Metasomatism

1. Pure hydrothermal mobility of silica and epidote is exemplified by RS 3266.

2. Higher temperature and pressure pneumatolytic alteration is exemplified by tourmaline replacement in greisen 3276.

3. Mobility of such minerals as chlorite, carbonate, epidote biotite, muscovite and limonite (or its precursors) is shown by many specimens.

E) Igneous Rocks

1. Alkaline suite

This is represented by the most numerous specimens collected and includes trachytes 3261, 3269, 3271 and 3274, a probably intrusive microsyenite 3262 and a slightly more calcic variant (according to plagioclase optical properties) trachyandesite 3270. Pyroclastic or partly pyroclastic members of this suite are probably 3285, 3286 and possibly 3260.

All members of the suite are altered but with wide variation in the intensity of replacement. A few display a preferred orientation of some constituents but this is ascribed to flow or to depositional alignment of volcaniclastic fragments. A consistent regional foliation is absent and the intensity of alteration may be related to proximity to local sources of heat or mobile fractions of plutonic magmas. The age of the suite may be post-Delamerian but before the end of major intrusive activity in the Ordovician. This suggestion should be assessed against field relationships.

2. Basalt-andesite association

Although a variation of the alkaline suite is towards an andesite, the presence of altered ferromagnesian phenocrysts in the andesitic basalt 3268 and a ferromagnesian groundmass in the basaltic andesite 3283 set these two rocks apart. The suggestion that the two are associated is tentative since they differ in appearance and in alteration. This may be a local rather than temporal effect.

Mafic compositions are possibly more compatible with the concept of Truro Volcanics than the alkaline suite but nomenclature for early Palaeozoic volcanics will be reviewed in the light of abundant volcanics in the basement of the adjacent Murray Basin. Either, neither or both the suites may be included as Truro Volcanics.

3. Albitites

Two specimens, 3275 and 3279, are members of an alkaline suite both from their mineralogy (dominantly albite) and from their soda content (9.60% and 7.14% Na_2O respectively). They differ from the alkaline suite described above in a very low level of alteration and an almost monomineralic paragenesis.

Another known alkaline suite in the Truro-Frankton area is the Palaeozoic-Mesozoic lamproite suite. The albitites differ from known members of this suite in the absence of porphyritic phlogopite but the full range of rock types may not be known.

If the low level of alteration is not due to locality, that is distance from a heat source, the suite might be dated as early as Ordovician after the last pluton was intruded. The earliest diamonds known in South Australia are in a Late Permian conglomerate. Possibly field relationships may permit identification of the affinity of these rocks.

4. Lamproite

One specimen, 3273, is readily ascribed to one of the two main suites of lamproite-alkaline rocks in the Truro-Frankton area. It contains phenocrysts of phlogopite with a biotitic appearance but with the typical corroded, patchy appearance of a porphyritic mineral out of equilibrium with its groundmass.