P5/75 → P24/75

MP 1/15/8/0

REPORT MP 2630/75

# EXAMINATION OF CLASTS FROM STURTIAN TILLITES, MT. GEE

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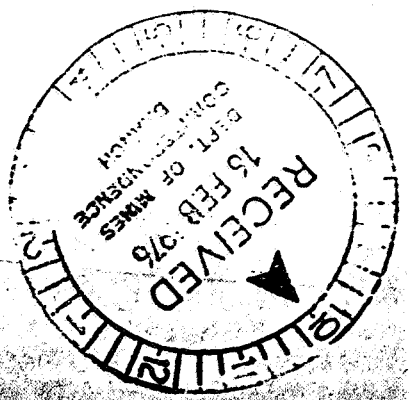
The Australian Mineral Development Laboratories,
Adelaide, South Australia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11th February, 1975

The Director,
Department of Mines,
Box 38, Rundle Street P.O.,
ADELAIDE, SA 5000

REPORT MP 2630/75

| | |
|---|---|
| YOUR REFERENCE: | Application of 10-1-75 |
| MATERIAL: | 18 samples |
| LOCALITY: | Mt. Gee prospect |
| IDENTIFICATION: | P5/75-P24/75 |
| DATE RECEIVED: | 13/1/75 |
| WORK REQUIRED: | Petrography |

Investigation and Report by: Dr B.G. Steveson

Officer in Charge, Mineralogy/Petrology Section: Dr K.J. Henley

K.J. Henley

for F.R. Hartley
Director

mhb

# EXAMINATION OF CLASTS FROM STURTIAN TILLITES, MT. GEE

**Sample:** P5/75; TS33356

**Location:**
RBM28B/74 N.F.M. R17/090 9 SP Mt. Gee Prospect.

**Rock Name:**
Altered Granite.

**Hand Specimen:**
A massive and compact pink rock. The hand specimen contains large crystals of pink feldspar and subhedral crystals of a cream coloured mineral both of which are up to 1 cm in size.

**Thin Section:**
An optical estimate of the constituents gives the following:

| | % |
|---|---|
| Potassium feldspar | 50 |
| Quartz | 20-25 |
| Sericite | 15-20 |
| Biotite | 5-7 |
| Opaques | 3-5 |

The sample has a rather heterogeneous granular texture and consists largely of coarse grained felsic minerals derived from an original granitic rock and secondary material represented by patches of sericite and a considerable amount of opaques and biotite. There appears to be a close spatial association between the biotite and the opaques and it is likely that both minerals have been introduced into the rock.

Potassium feldspar is the most abundant mineral in the rock and is present as microcline which is obscured by abundant turbidity and a moderate amount of fine-grained, probably sericitic, material. Some patches of microcline are up to about 8 mm in size and they contain small patches of ?sericitized albitic material probably derived from a perthite. Patches of quartz are common in the margins of potassium feldspar crystals and quartz crystals adjacent to the large microcline crystals commonly have embayed and rather bulbous outlines (such as are characteristic of acid igneous rocks) within which there has been some reaction between quartz and potassium feldspar. Most of the quartz crystals in the rock have undulose extinction, extremely

irregular outlines and inclusions of partially reacted potassium feldspar. The thin section contains no plagioclase but there are large patches of sericite some of which are of the order of about 2 mm in size. It is possible that these represent altered plagioclase crystals. The nature and texture of the felsic minerals in the rock are indicative of a plutonic acid igneous rock and therefore the rock has been described as a granite; there is no evidence to suggest that the rock is of volcanic origin.

Opaques and a rather pale, partly degraded biotite tend to occur together in numerous small patches throughout the rock. The flakes of biotite are commonly <0.2 mm in length and they are closely intergrown and commonly surround rather fine-grained and granular opaques. It is probable that both the opaques and the biotite have been introduced into the rock during a phase of mineralization. Small amounts of ?sphene and ?monazite are present in association with the biotite and the opaques.

In summary, therefore, the rock is a granite which contains some opaques and biotite which have probably been introduced during a phase of mineralization.

Sample: P6/75; TS33357

Location:
RBM28B/74 N.F.M. R/17090 9 SP Mt. Gee Prospect.

Rock Name:
Rhyolitic, porphyritic volcanic rock.

Hand Specimen:
The sample is a somewhat tabular rock which is clearly partly weathered and altered. Most of the rock consists of an aphanitic grey groundmass but there are numerous ?phenocrysts of a pale grey feldspar some of which are as much as 1.5 cm in length.

Thin Section:
An optical estimate of the constituents gives the following:

| | % |
|---|---|
| Potassium feldspar phenocrysts | 15 |
| Quartz phenocrysts | 5 |
| Quartz/feldspar groundmass | 65 |
| Biotite | 10 |
| Opaques | 5 |

This rock is an altered and partly recrystallized porphyritic volcanic rock which contains phenocrysts of potassium feldspar and quartz in a groundmass which has a rather distinctive texture and which consists also of quartz and potassium feldspar.

The phenocrysts of microcline are characteristically anhedral in shape and have deeply embayed and partially altered margins against the groundmass. In some cases the crystals of microcline are clearly only remnants of the original phenocrysts in the rock since they are surrounded by dense intergrowths of quartz and feldspar in which some of the feldspar is in optical continuity with the central remaining core of microcline. The largest microcline phenocryst in the thin section is approximately 1 cm in length and some of the relicts of phenocrysts are about 1-1.5 mm in size. One or two phenocrysts of feldspar have elongate rectangular shapes and contain a large amount of secondary opaque material; such crystals may be plagioclase feldspar but alteration has been too intense for a positive identification to be made. Quartz phenocrysts are much less abundant than those of potassium feldspar and most have distinctly irregular and embayed outlines. Most of the quartz phenocrysts are <1 mm in diameter.

The quartz and feldspar of the groundmass have a rather distinctive texture characterized by the close intergrowth of the two minerals. The average grain size of the groundmass is of the order of 0.05-0.1 mm but due to the presence of islands of one mineral in the other there is a wide variety of crystal sizes. Some of the intergrown quartz and feldspar crystals are characterized by extremely elongate shape probably due to reaction between the two minerals taking place preferentially in certain crystal directions. In some places in the thin section the intergrowths between the quartz and the feldspar are similar to micrographic intergrowths such as characterize granophyric rocks but in other places the intergrowth seems to be the result of replacement reactions between the two minerals rather than being of primary igneous origin. The feldspar in the groundmass is probably very largely (if not wholly) potassium feldspar and this mineral and quartz are approximately equally abundant. The great preponderance of potassium feldspar over sodic feldspar indicates that the rock is probably of rhyolitic composition.

The rock contains patches of biotite which are rather similar to those in sample P5/75. Characteristically these patches consist of flakes of biotite about 0.1 mm in length which have a decussate arrangement within the patch. Books of biotite are rimmed by opaque and semi-opaque limonitic material and the whole aspect of the biotite is not that of primary

igneous material but of a mineral introduced into the rock during a period of hydrothermal or deuteric alteration. Opaques are present partly in association with the biotite but also as extremely widely disseminated and fine-grained granular material distributed throughout the whole of the thin section.

The sample is a porphyritic volcanic rock consisting very largely of quartz and potassium feldspar. There has been extensive reaction between quartz and potassium feldspar and a significant introduction of biotite and opaques into the rock so that, overall, only a little of the original igneous texture remains.

Sample: P7/75; TS33358

Location:
RBM28B/74 N.F.M. R17/090 9 SP Mt. Gee Prospect.

Rock Name:
Medium-grained sandstone.

Hand Specimen:
A compact and massive rock which has a medium to fine-grained clastic texture. The sample has an overall rather dark grey to purple colour.

Thin Section:
An optical estimate of the constituents gives the following:

| | % |
|---|---|
| Quartz | 90-95 |
| Rock fragments | 2-5 |
| Matrix | <5 |
| Tourmaline | trace |
| Opaques | trace |

The sample is a sandstone which consists very largely of quartz fragments.

The grain size of the sample ranges from approximately 0.05-1.2 mm and the average grain size is probably about 0.2-0.3 mm. The quartz grains have round outlines and generally have a moderate to high sphericity. The most notable feature of the rock is the poor sorting of the quartz grains and the extent to which the quartz grains fit together to the exclusion of argillaceous matrix. Some of the quartz grains

have clearly been deformed or partly recrystallized during compaction in that they have rather irregular although still rounded shapes. Rock fragments consist largely of a brownish micaceous material and these fragments comprise about 3% of the rock's volume. Most of the fragments have well defined rounded outlines but some appear almost to degrade into the matrix material.

The matrix itself consists of small patches and intergranular seams of a micaceous or clayey mineral with a moderate birefringence but, as mentioned above, compaction of the rigid detrital grains as resulted in there being probably less than 5% of this matrix material in the rock as a whole.

A few grains of tourmaline and opaques are present as accessory heavy detrital minerals.

Sample: P8/75; TS33359

Location:
RBM28B/74 N.F.M.R17/090 9 SP Mt. Gee Prospect.

Rock Name:
Porphyritic ?rhyolite.

Hand Specimen:
A massive and compact rock which has an overall dark grey to pink colour. The sample consists largely of a siliceous groundmass with phenocrysts of glassy quartz. A thin vein of pink material is particularly prominent.

Thin Section:
An optical estimate of the constituents gives the following:

| | % |
|---|---|
| Quartz phenocrysts | 15-20 |
| Potassium feldspar phenocrysts | 3-7 |
| Quartz/feldspar groundmass | 75 |
| Opaques | 2-5 |
| Microcline vein | <1 |
| Carbonate | rare |

The sample is a porphyritic acid volcanic rock which consists largely of quartz phenocrysts in a groundmass which has a tridymitic snow-flake texture.

The quartz phenocrysts range in size up to about 8 mm and are equant anhedral crystals with characteristically rounded and in some cases bulbous outlines. Some of the crystals are fractured and some show a moderate amount of undulose extinction. One crystal particularly contains many fractures and in the wider ones there is a moderate amount of recrystallized fine-grained quartz. Potassium feldspar phenocrysts have distinctly irregular outlines and most are obscured by brown turbidity so that in some places it is not possible to delineate exactly the limits of the phenocrysts.

The groundmass of the rock has a characteristic snow-flake texture which is a result of the devitrification of the original quartz and feldspar groundmass. The individual snow-flakes which have common extinction positions are generally of the order of 0.05-0.1 mm in size. A few elongate quartz crystals are probably pseudomorphs after original tridymite crystals and hence the groundmass overall can be described as having a tridymitic snow-flake texture.

The thin section contains a thin veinlet which consists very largely of microcline which forms equant anhedral crystals generally about 0.2 mm in size. A little quartz and some opaque material is also present in this veinlet which appears to represent a phase of mineralization in which both opaques and potassium feldspar have been introduced into the rock. Apart from opaques in this veinlet fine-grained granular opaque material is very widely distributed throughout the groundmass of the rock and tends to form irregular and diffuse network textures.

This rock is a porphyritic dacite which has a tridymitic snow-flake texture similar to that of certain acid volcanic rocks from the Gawler Range Volcanics.

Sample: P9/75; TS33360

Location:
RBM28B/74 N.F.M. R17/090 9 SP Mt. Gee Prospect.

Rock Name:
Porphyritic ?rhyolite.

Hand Specimen:

The rock has an overall creamy grey colour and consists of an aphanitic groundmass and numerous phenocrysts some of which are quartz and some have a dull dark green colour and are of unknown composition.

Thin Section:

The sample is similar to P8/75 in most aspects of its mineralogy and texture, particularly in that it consists largely of quartz phenocrysts in a quartz/feldspar groundmass which has a tridymitic snow-flake texture. Some of the quartz phenocrysts in this rock have rims of intergrown quartz and feldspar in which the quartz is in optical continuity with the bulk of the phenocryst. The sample also contains some sericitic material which is widely and thinly distributed throughout the groundmass.

The dull grey-green phenocrysts observed in the hand specimen are in fact feldspar phenocrysts extensively altered to quartz and a clay mineral. These phenocrysts have irregular and even indefinite shapes but appear to consist either of single crystals or a few crystals of an untwinned potassium feldspar. These phenocrysts of feldspar are somewhat more abundant in this rock than in P8/75 but in both rocks the feldspars have a characteristically extremely altered and degraded appearance.

In brief, therefore, the rock is similar to P8/75 and is a partially devitrified porphyritic rhyolite.

Sample: P10/75; TS33361

Location:

RBM28B/74 N.F.M. R17/090 9 SP Mt. Gee Prospect.

Rock Name:

Porphyritic rhyolite.

Hand Specimen:

A distinctly pink coloured rock which contains phenocrysts of feldspar which are both pink and a pale green colour. The aphanitic groundmass has an homogeneous rather dull pink shade.

Thin Section:

An optical estimate of the constituents gives the following:

| | % |
|---|---|
| Potassium feldspar phenocrysts | 50 |
| ?Altered plagioclase phenocrysts | 15-20 |
| Quartz phenocrysts | <5 |
| Quartz/feldspar groundmass | 25 |
| Opaques | 2-3 |
| Muscovite | 1 |

The sample consists very largely of crystals of potassium feldspar in a groundmass which contains both quartz and feldspar. The potassium feldspar phenocrysts are commonly 5-12 mm in diameter and consist of equant anhedral crystals. The potassium feldspar is extensively altered and details of the structure of the feldspar cannot be seen in thin section. Commonly the feldspar is associated with patches of sericitic material and some of these patches form discrete phenocrysts. These patches may be partially altered plagioclase phenocrysts (as has been suggested in the list of minerals above) but it is also possible that they are partially altered patches of potassium feldspar. The quartz phenocrysts are generally <1 mm in size and form well defined round or bulbous crystals such as are characteristic of fine-grained porphyritic volcanic rocks.

The groundmass in which these phenocrysts occur has a characteristic texture which appears to be a combination of a micrographic intergrowth of quartz and feldspar and a tridymitic texture. The groundmass is relatively coarse grained and many patches of quartz and feldspar are as much as 0.2 mm in diameter. None of the feldspar in the groundmass is twinned and it is likely therefore that it consists entirely of a potassium feldspar rather than plagioclase. In some places in the groundmass quartz and feldspar adjacent to a quartz or feldspar phenocryst is in optical continuity with the phenocryst and hence there appears to have been some reaction between groundmass phases and the phenocrysts themselves.

The sample contains opaques widely distributed throughout the groundmass and also as rather larger aggregates which consists very largely of opaque material. In many cases the opaques are associated with fine-grained muscovite and these minerals have been introduced into the rock at a relatively late stage in its history.

This rock has a rather distinctive texture and it consists largely of large phenocrysts of potassium feldspar and subordinate smaller phenocrysts of quartz; these rest in a groundmass which has a relatively coarse grained micrographic and tridymitic texture.

Sample: P11/75; TS33362

Location:
RBM28C/74 N.F.M. R17/090 9 SP Mt. Gee Prospect.

Rock Name:
Altered and dioritic rock.

Hand Specimen:
A compact and massive igneous rock which appears to have an aphyric medium grained texture. The rock consists of white and green minerals.

Thin Section:
An optical estimate of the constituents gives the following:

| | % |
|---|---|
| Fine-grained quartz/clay | 60 |
| Sericite | 20 |
| Quartz | 10 |
| Opaques | 10 |
| Apatite | trace |

The origin of this rock is not entirely clear from thin section examination since the sample consists largely of secondary minerals; however, pseudomorphs of medium grained feldspar crystals can be detected in the fine-grained quartz and clay which constitutes the bulk of this rock and hence it appears likely that the rock was originally a medium grained feldspar-rich igneous rock probably a diorite or a similar lithology. Much of the opaque material in the rock and possibly a considerable proportion of the sericite is of secondary origin and the coarser grained quartz is also probably related to relatively late stage alteration of the rock.

Much of the thin section consists of a dense mosaic of quartz and clay partially obscured by a pervasive brown turbidity. At low magnifications, however, "ghosts" of lath-like feldspar

crystals can be detected in this aggregate and it is likely therefore that this material represents degraded and altered plagioclase which originally formed subhedral laths up to about 1 mm in length. Sericite is present both widely scattered throughout the rock and in more or less compact aggregates. Many of these groups of sericite crystals contain opaques and there is therefore some evidence that the opaques and sericite are genetically related to each other. It is possible that they are derived from the alteration of an original mafic mineral and in this interpretation it is possible to regard the rock as having been a gabbro which originally consisted of plagioclase laths (now altered quartz and clay) and pyroxene (now altered to sericitic material and opaques). An alternative hypothesis, however, is that the sericite and opaques were introduced into the rock during a mineralization period. The sericite in some places appear to show relicts of cleavage in a preexisting mineral and hence the former hypothesis seems to be preferable.

Quartz is present as medium to fine-grained granular material which has a crystal size of up to about 0.01 mm. It is likely that this material represents represents relatively low temperature quartz introduced into the rock after its crystallization but it is possible also that it is recrystallized quartz derived from the original rock; if this is the case then the original sample was probably an intermediate igneous rock but if the quartz is wholly or largely introduced then the original rock probably consisted almost entirely of plagioclase and a mafic mineral and hence was a gabbro or diorite.

As the above description suggests the origin of this sample is rather difficult to determine since the rock now consists entirely of secondary minerals; there are some relicts of original medium-grained minerals but is difficult to determine which components of the rock are derived from the original igneous rock and which were introduced at a later stage. The balance of the evidence suggests that the original rock was a medium-grained intermediate or possibly basic igneous rock related to a gabbro or a diorite.

Sample: P12/75; TS33363

Feldspar, Potassium granite dacite

Location:

RBM 28C/74 N.F.M. R17/090 9 SP Mt. Gee Prospect.

Hand Specimen:

A pink siliceous rock which clearly contains some large crystals

of both quartz and feldspar but consists predominantly of fine-grained material.

Thin Section:

The rock has a rather heterogeneous texture which consists principally of secondary minerals and large patches and elongate areas of vein quartz. Within the bulk of the material there are clearly relicts of original feldspar crystals which were of the order of 0.5-1.2 mm in size. These crystals appear to be equant anhedral potassium feldspars and they now consist of partly recrystallized material containing numerous patches of quartz. In some places relicts of microcline cross hatch twinning can be seen in this potassium feldspar. Apart from these crystals which comprise more than 50% of the non-vein part of the rock the sample consists of fine-grained granular quartz and potassium feldspar. The average grain size of this material is <0.05 mm and the crystals are present as equant anhedra in a dense interlocking granular texture. The potassium feldspar, which appears to be the most abundant of the minerals in this material, is microcline which shows well developed cross hatch twinning and it clear from the lack of turbidity and the well developed twinning in this feldspar that this and the interlocked quartz are of secondary origin. Whether this material was derived from coarse grained quartz and feldspar or from a fine-grained groundmass is not clear and hence it is difficult to determine whether the original rock was wholly coarse-grained and hence of granitic nature or whether it consisted of a porphyritic rock probably related to a dacite. The sample contains a small amount of sericitic material and brown clay minerals and a little biotite is present and is confined to a thin irregular veinlet.

The sample contains large patches of quartz up to about 1 cm across within which the quartz has a coarse-grained granular texture. Individual crystals are extremely irregular in shape and commonly show undulose extinction. The quartz is undoubtedly relatively low temperature vein quartz which has been introduced into the rock.

In brief, therefore, the sample now consists wholly of secondary minerals; the original rock contained large anhedral crystals of potassium feldspar but most of the potassium feldspar now present in the rock is finer grained recrystallized material. The sample has a highly potassic composition and was originally either a granite or a porphyritic dacite.

Sample: P13/75; TS33364

Location:
RBM28C/74 N.F.M. R17/0909 SP Mt. Gee Prospect.

Rock Name:
Highly altered ?granitic rock.

Hand Specimen:
A compact and massive rock which has an overall creamy pink colour. The surfaces of the sample have a brown crust and it is clear that the rock is partially weathered. The average grain size of the rock appears to be of the order of 1 mm and the sample consists of grey and altered brown mineral as well as opaques which can be distinctly seen particularly in the cut surface of the hand specimen.

Thin Section:
An optical estimate of the constituents gives the following:

| | % |
|---|---|
| Sericite | 25-30 |
| Quartz | 25 |
| Clay | 25 |
| Biotite | 10 |
| Opaques | 5-10 |

This sample is similar to several others in this collection which consist almost entirely of secondary minerals and contain a significant proportion of fine-grained clays and sericite. In this sample the clay is widely distributed throughout the rock and has an almost submicroscopic grain size; however, relicts of large feldspar crystals can be discerned within the clay material and, in fact, some of the clay in the rock could more probably be described as partially altered feldspar. The original feldspar crystals appear to have been subhedral to anhedral crystals generally about 1-1.5 mm in size. For the most part the rock consists of a fine-grained aggregate of clay and sericite with widely disseminated partially altered biotite and opaques. Quartz is present as well crystallized material which forms aggregates of equant anhedral crystals which have a granular to granoblastic texture. The average grain size of the quartz is about 0.1 mm and the quartz is a relatively low temperature form which has been deposited during the alteration of the rock rather than during the primary crystallization. Opaques are present both as widely disseminated fine-grained material commonly associated with the biotite and also as rather large irregular masses up to

about 1 mm in length. This material and also possibly the biotite in the rock has been introduced into the rock during a period of mineralization.

In summary therefore the thin section contains relicts of original large feldspar crystals which have probably been derived from an original granitic rock (but could also have been phenocrysts in a porphyritic volcanic rock); opaques and secondary quartz have been introduced into the rock and it is likely also that the biotite is derived from this source. Clay and sericite are abundant in the rock and both have been derived from original feldspars. The sample has similarities particularly with P11/75.

Sample: P14/75;TS33365

Location:
RBM28E/74 N.F.M. R17/090 9 SP Mt. Gee Prospect.

Rock Name:
Siltstone.

Hand Specimen:
A compact rock which has a somewhat platy habit and consists entirely of aphanitic grey material.

Thin Section:
An optical estimate of the constituents gives the following:

| | % |
|---|---|
| Clay/sericite | 70 |
| Quartz | 20 |
| Muscovite | 5 |
| Opaques | 5 |
| Feldspar | <2 |

This sample is a fine-grained sedimentary rock which consists very largely of argillaceous material with a minor amount of detrital quartz.

The quartz grains range in size up to about 0.08 mm but most are about 0.02-0.06 mm in size and hence belong to the silt grade. These grains are widely and randomly distributed throughout the argillaceous material and most are round to subround equant grains. Feldspar is present as a few relict crystals the largest of which is 0.1 mm in size. The relicts now have rather diffuse outlines but it is possible that the

original feldspar grains were rather angular in shape. Muscovite flakes are a third component of the detritus of this rock and the parallel alignment of these flakes defines a crude bedding within the sample. The largest muscovite flakes are of the order of 0.15 mm in length. Apart from these obviously detrital components the rock contains abundant fine-grained sericitic material which is present as a dense granular aggregate with moderate birefringence colours.

Within the rock there are diffuse masses which have a slightly deeper colour than the bulk of the sample although the overall mineralogy of these masses appears to be similar to that of the rest of the rock. These patches are generally equant in shape and commonly about 0.5 mm in size. Less abundant are smaller patches which consist of granular aggregates of felsic minerals in which both feldspar and quartz can be seen. The origin of these features cannot be determined unambiguously from the thin section examination but the granular aggregates of quartz and feldspar certainly do not appear to be part of the original sediment and probably represent material introduced into the rock during a post-depositional phase of mineralization.

At one edge of the thin section a thin bed of rather coarser silty material which contains approximately 70% of the quartz and feldspar increases in thickness so that there is a considerable mass of a slightly coarser silt which has a moderately sharp boundary against the predominant sericitic and clayey material.

In brief, therefore, the sample is a argillaceous silty sediment which contains some slightly coarser silty horizons and a few ?cavities which have been filled with quartz and feldspar.

Sample: P15/75; TS33366

Location:
RBM28E/74 N.F.M. R17/090 9 SP Mt. Gee Prospect.

Rock Name:
Siltstone.

Hand Specimen:
A massive and compact fine-grained rock which consists of aphanitic grey material with minute and rather indefinite spots. One part of the sample clearly consists of slightly

coarser material than the bulk of the grey material and this coarser material has a somewhat irregular distribution.

Thin Section:

The thin section contains a few different lithologies and hence proportions of the minerals have not been given above; however, the finer grained shaley rocks appear to consist almost entirely of sericite and clay whereas the rock also contains coarser grained silty horizons which consist of up to about 70% quartz with a moderate amount of argillaceous matrix. The largest quartz grains in the rock are approximately 0.4 mm in size and these are well rounded whereas some of the smaller quartz grains have rather more angular shapes. The main interest in the thin section lies in the relationships between the coarse and fine lithologies and some textural features of the finest grained rocks in the thin section.

In one part of the thin section there is a sharp straight contact between the finest grained argillaceous rock in the thin section and a moderately coarse grained silty sediment. This band of silty sediment appears to be graded in that it is coarsernext tosharp contact with the argillite and fines upwards until it grades into an argillite. The thickness of this bed is approximately 8 mm. In other parts of the section silty horizons have an extremely irregular distribution within the argillaceous material and there are swirling and irregular patches of the silt which form a continuous network isolating individual patches of the argillite. The texture is probably related to sedimentary features rather than to any folding as a result of tectonic activity.

The argillaceous material contains two features of interest; one is the presence of spherical structures which are generally about 0.4 mm in diameter and which consist of argillaceous material which is distinctly darker in colour than the bulk of the sericite and clay. These spherical structures have particularly dark rims under crossed nicols and it is likely that there is some chlorite at the margins of these structures. The other features of interest in the fine-grained rock are similar to the aggregates of quartz and feldspar described in sample P14/75. These are irregular patches of, in this case microcline which have a moderate grain size and are generally 0.4-1 mm in diameter. The origin of both the spherical structures and the irregular patches of feldspar is not known but it may be related to low grade metamorphic effects or diagenetic activity. Overall the sediments show no evidence of metamorphic recrystallization and it is a more likely general hypothesis that the textural features of the rock are related

to sedimentary and diagenetic effects (with possibly some much later mineralization) rather than due to metamorphism.

Sample: P16/75; TS33367

Location:
RBM28E/74 N.F.M. R17/090 9 SP Mt. Gee Prospect.

Rock Name:
Secondary quartz/clay rock.

Hand Specimen:
A compact and massive rock which has an overall brownish-grey colour. Some darker spots can be detected in the cut surface of the sample but for the most part the rock has an indefinite aphanitic texture.

Thin Section:
An optical estimate of the constituents gives the following:

| | % |
|---|---|
| Quartz | 50 |
| Feldspar | 15-20 |
| Sericite | 10-15 |
| Biotite | 20 |
| Opaques | <1 |
| Epidote | trace |

The sample consists largely of secondary mineral particularly coarse-grained quartz and finer grained granular sericitic material.

Quartz is present in the rock as irregular but equant crystals up to about 0.5 mm in diameter. Many of these crystals have serated and irregular margins against the finer-grained adjacent material and small patches of quartz commonly occur within the finer grained parts of the rock. For the most part, however, the quartz crystals are discrete and separate and only in a few places in the rock is there any aggregation of these crystals.

Much of the rock is occupied by material which is dark between crossed nicols but it appears to consist largely of partly altered feldspar. Sericitic material is widely distributed in irregular patches and individual flakes throughout this material and obscure the nature of the original feldspar.

In some places in the thin section some bulk extinction of the majority of the material indicates the relatively large grain size of the preexisting feldspars but for the most part the feldspar has been altered to such an extent that the original texture of this material cannot be seen.

Biotite and possibly opaques, appear to be secondary components of the rock probably introduced during a phase of mineralization. Biotite has notably pale colours and rather patchy distribution of both colour and small inclusions of opaques and semi-opaque mineral. The individual biotite flakes are generally 0.1-0.2 mm in length and in some parts of the rock biotite is sufficiently abundant to form an almost contiguous network around the larger quartz crystals and in places in the altered feldspar.

This rock was probably originally of granitic composition but it has been so extensively altered that no unambiguous identification of the original rock can be made.

Sample: P17/75; TS33368

Location:
RBM28E/74 N.F.M. R17/090 9 SP Mt. Gee Prospect.

Rock Name:
Pure quartz sandstone.

Hand Specimen:
A distinctly siliceous rock which has a medium to fine-grained texture. In the cut surface the sample shows a moderate number of small white spots but for the most part the rock appears to consist very largely of quartz which overall has a grey to pale purple colour.

Thin Section:
An optical estimate of the constituents gives the following:

| | % |
|---|---|
| Quartz | 98 |
| Clay | <2 |
| Tourmaline | trace |
| Opaques | trace |

The rock is a sandstone which consists almost entirely of detrital quartz grains. Compaction of these has resulted in

deformation and recrystallization of the quartz so that the grains now fit together and only a little argillaceous material has been retained in the rock.

The rock is well sorted and consists of rounded grains ranging in size mainly from 0.15-0.5 mm. The average grain size is about 0.2-0.25 mm. Many grains retain clear evidence of their original detrital shapes but in some parts of the rock compression and recrystallization have been such that the rock has a distinctly granular texture and consists of strained interlocking quartz crystals. In those parts of the rock in which the original grain outlines are preserved the grains have a characteristic rim of clays which has possibly retarded recrystallization of the quartz under stress. There are one or two patches of clayey material in the rock and these may be derived from the alteration of feldspar or from lithic fragments but overall clay probably constitutes <2% of the total volume of the rock. A few grains of tourmaline are present in the sample and these have distinctly irregular shapes probably as a result of fracturing and/or recrystallization under stress.

In brief, therefore, the rock is a well sorted, mature pure quartz sandstone which has undergone considerable compaction. Cementation is a result of the interlocking of the quartz grains and recrystallized quartz and argillaceous matrix material is virtually absent.

Sample: P18/75; TS33369

Location:
RBM 28E/74 N.F.M. R17/090 9 SP Mt. Gee Prospect.

Rock Name:
Metamorphosed Sandstone.

Hand Specimen:
A medium to fine-grained siliceous rock which has an overall grey colour. The weathered surface of the clast has a thin brown crust but the rock as a whole is unweathered.

Thin Section:
An optical estimate of the constituents gives the following:

| | % |
|---|---|
| Quartz | 90 |
| Muscovite | 5-7 |
| Opaques | 3-5 |
| Zircon | trace |
| Sphene | rare |

The rock consists almost entirely of a granular mosaic of quartz with intergranular patches of fine-grained muscovite.

Many of the quartz crystals in the rock are equant, anhedral and 0.2-0.4 mm in diameter. These crystals have irregular margins both against fine-grained quartz and muscovite. From the constancy of the grain size of this material it can be deduced that the sample was originally a sandstone and that these quartz crystals are recrystallized detrital grains. There is also a moderate amount of somewhat finer grained quartz which is associated particularly with the muscovite. The grain size of the mica is generally <0.05 mm and this mineral forms irregular intergranular patches and thin seams throughout the quartz and to a certain extent appears to have replaced original argillaceous material during the metamorphism of the rock. Apart from the distribution of quartz crystal sizes and, to a lesser extent, the arrangement of muscovite in the rock the sample shows no evidence of its original clastic texture.

The opaques, as can be seen from a microscopic examination of the thin section, are arranged in trains through the sandstone. These trains probably represent relicts of heavy mineral bands in the original sedimentary rock. Overall the opaques, which form irregular crystals up to about 0.2 mm in size, comprise approximately 3-5% of the rock and hence are unusually abundant for a mature sandy sediment.

The sample has a wholly recrystallized metamorphic texture but the grain size distribution of quartz, the arrangement of muscovite in the thin section and the overall chemistry of the rock suggests that the sample is derived from metamorphism of a relatively pure quartz sandstone.

Sample: P19/75; TS33370

Location:
RBM28E/74 N.F.M. R17/090 9 SP Mt. Gee Prospect.

Rock Name:
Very fine-grained argillaceous sandstone.

Hand Specimen:
A pale brown granular rock which contains a wide range of grain types some of which are white and some of which are black to dark green. The rock has a fine sandy granular texture.

Thin Section:

An optical estimate of the constituents gives the following:

| | % |
|---|---|
| Quartz grains | 60-65 |
| Quartz/sericite matrix | 35-40 |
| Opaques | 3-5 |

The rock consists essentially of quartz grains generally about 0.15 mm in size and a relatively abundant fine-grained matrix which consists of quartz and sericitic material.

Quartz grains comprise about two thirds of the volume of the rock and they occur as anhedral equant grains ranging in size up to about 0.2 mm. The grains have distinctly irregular shapes against the matrix material and few have well defined rounded detrital outlines. Recrystallization does not appear to have occurred to a great extent, however, and the rock has a clastic rather than a granular texture. In many parts of the thin section the quartz grains touch each other and hence form a framework and this effect is enhanced by the amount of rather finer grained quartz which occurs between the larger quartz crystals.

The matrix is rather dark between crossed nicols and appears to consist largely of fine-grained quartz and a birefringent phyllosilicate which is similar to sericite. A little of the phyllosilicate has pale brown colours and may be a partially degraded biotite. This material probably represents recrystallized argillaceous or rock fragment material derived from the original sedimentary rock.

The overall mineralogy and composition of this rock suggests that the original sediment was a rather impure and fine-grained sandstone which has now been slightly altered and possibly metamorphosed which has resulted in the development of a sericite/quartz matrix and the development of very small amounts of biotite. As in the case of the preceeding sample the rock contains a moderate amount of opaque material which could have been derived either from the original sediment or from the introduction of metals during a period of mineralization. The opaques appear to be confined to one half of the thin section and it appears that the sample in fact consists of two rocks with a slightly different mineralogy and texture and it is likely therefore that the opaques are derived from the immediately preexisting rocks rather than from the introduction of material

which would presumably have resulted in the distribution of opaques throughout the whole area of the thin section.

Sample: P20/75; TS33371

Location:
RBM28E/74 N.F.M. R17/090 9 SP Mt. Gee Prospect.

Rock Name:
Siltstone.

Hand Specimen:
A massive and compact rock which has an overall grey colour and an aphanitic texture. The cut surface of the sample contains several small intersecting veinlets filled with limonitic material.

Thin Section:
An optical estimate of the constituents gives the following:

| | % |
|---|---|
| Quartz | 60-80 |
| Sericite/clay | 20-30 |
| Opaques and semiopaques | 5-10 |

The rock has an homogeneous fine-grained texture and consists essentially of quartz and phyllosilicate minerals. The rock may have been slightly metamorphosed but the texture of the sample is essentially that of a lithified shaly sediment.

Some quartz grains in the rock are as much as 0.08 mm in diameter but for the most part the grain size of the quartz is about 0.03-0.05 mm. The grains are equant anhedral crystals with well defined margins against the adjacent phyllosilicate material. There is a small population of quartz grains smaller than 0.02 mm in size and these are intimately intergrown with the sericite/clay. The phyllosilicate itself is moderately birefringent and forms wispy elongate flakes up to about 0.1 mm in length but commonly much smaller than this. The irregular foliæ of this material show some parallel orientation and hence define a crude bedding direction in the rock.

Widely and randomly distributed throughout this material are subhedral and euhedral crystals of opaques. Commonly these are square, rectangular or rhombic crystals approximately 0.02-0.06 mm in size. These crystals show no evidence of rounding and hence

have probably developed in the sediment after its deposition. Ill defined brownish limonitic material has been introduced into the sample along a series of intersecting fractures so that the limonite is dispersed about these fractures within the quartz and sericitic material. Within the fractures themselves is relatively coarse-grained quartz and opaques which have a ill defined comb texture. The distribution of these veinlets can best be seen by microscopic examination of the cut surface of the hand specimen.

Summarizing, the rock is a argillaceous silty sediment which contains a moderate amount of euhedral opaque material and which has been invaded by limonitic material along a series of intersecting fractures. The sample has essentially a clastic texture but it is possible that it has undergone a little low grade metamorphism which has resulted in more efficient lithification of the rock.

Sample: P21/74; TS33372

Location:
RBM28E/74 N.F.M. R 117/090 9 SP Mt. Gee Prospect.

Rock Name:
Sandstone.

Hand Specimen:
An extremely siliceous massive and compact rock which has a dull purple colour. The sample has a medium to fine grain size and is clearly a pure quartz sandstone or quartzite.

Thin Section:
An optical estimate of the constituents gives the following:

| | % |
|---|---|
| Quartz | 85 |
| Clay/sericite | 15 |
| Biotite | trace |
| Opaques and semiopaques | trace |

This rock has a modified clastic texture and consists mainly of partially recrystallized quartz grains in a matrix which now consists very largely of clay/sericite.

The grains range in size up to 0.2 mm but most are approximately 0.1 mm in diameter. A few of the grains show original detrital outlines but instead most grains have been compressed together and partially recrystallized and altered by pressure solution phenomena. As a result of these processes some parts of the rock have a distinctly monomineralic granular texture whereas in others there are only small pools of matrix between the partially interlocking quartz grains. The matrix itself is composed very largely of a moderately birefringent phyllosilicate mineral which is present as small flakes and granular patches. In some parts of the rock this material is present as a thin film around these quartz grains but elsewhere there are discrete patches of matrix up to about 0.12 mm in diameter. There are a few small flakes of biotite in the rock and the presence of these is probably due to recrystallization of argillaceous matrix material since it is unlikely that biotite would be present in a rock where the bulk of the detrital material consists solely of quartz rather than more labile components. Opaque and semiopaque material is widely distributed throughout the rock and is generally present as rather fine grained granular and dusty material; however, there are a few patches of opaques which are as much as 0.2 mm in diameter and since these have somewhat irregular and embayed shapes it is likely that this material has been introduced into the rock rather than being part of the detrital component.

Sample: P22/75; TS33373

Location:
RBM28E/74 N.F.M. R17/090 9 SP Mt. Gee Prospect.

Rock Name:
Fine-grained pure quartz sandstone.

Hand Specimen:
A purple siliceous rock which is both compact and massive. The hand specimen contains a thin quartz veinlet about 5 mm in width.

Thin Section:
An optical estimate of the constituents gives the following:

| | % |
|---|---|
| Quartz | 85-90 |
| Sericite/clay | 10 |
| Muscovite | 2-3 |
| Opaques | <1 |

This rock has a granular texture which is clearly derived from the compaction and partial recrystallization of an original sandstone.

Most of the rock consists of equant anhedral quartz grains ranging in size from 0.05-0.2 mm. These crystals have well defined but irregular margins and there is considerable interlocking of adjacent crystals. Throughout most of the rock the phyllosilicate material is confined to small discrete intergranular spaces and thin seams of clay between adjacent quartz crystals. In some parts of the rock there are features which suggest stylolitic features such as result from pressure solution of sandstones. A few quartz grains have distinctly rounded outlines and hence further indicate the original clastic nature of the rock.

Muscovite has been used to describe discrete flakes of this mineral which appear to have been part of the original detrital component of the rock rather than the fine-grained muscovite/sericite/clay which comprises partially recrystallized matrix material. The detrital muscovite flakes are generally up to about 0.2 mm in length and some have distinctly bent shapes.

In brief, therefore, the rock is a sandstone which was medium-grained and mature; this rock has been compressed, either by metamorphic activity or simply by load compaction, and now the rock has a rather granular texture and most of the quartz grains have lost their detrital shape and have been at least partially recrystallized.

Sample: P23/75; TS33374

Location:
RBM28F/74 N.F.M. R17/090 9 SP Mt. Gee Prospect.

Rock Name:
Graywacke.

and Specimen:
The rock is massive and compact and has, overall, a dark /pink colour. Much of the rock consists of aphanitic material but there are also pebbles up to more than 1 cm in size.

hin Section:
An optical estimate of the constituents gives the following:

| | % |
|---|---|
| Quartz grains | 55-70 |
| Feldspar grains | <3 |
| Lithic grains | 10-25 |
| Matrix | 20 |

This is an immature sediment which contains sand grade quartz and feldspar grains and lithic grains which range in size up to more than 1 cm. The proportions of lithic grains in the thin section may not reflect the overall proportion in the rock due to sampling difficulties and the large size of many of these lithic fragments.

The quartz grains are poorly sorted and range in size from almost submicroscopic to about 0.7 mm. Most of the grains are subangular in outline and many of the smaller grains have rather low sphericities. Both large and small quartz grains are randomly distributed in the rock and throughout most of the sample they appear to form a framework. The feldspar grains are mainly microcline and are similar in size to the quartz grains and also have rather angular shapes. The feldspars are fresh and unaltered and most show well defined twinning, either Albite Law or cross hatch twinning of microcline.

The lithic fragments are an important component of this rock both in terms of their overall proportion in the sample and from the fact that many of the lithic grains are several millimetres in size. The largest clast intersected in the thin section consists wholly of more or less fine-grained granular quartz and hence has a somewhat cherty appearance and there are also a few smaller chert fragments throughout the thin section. Another large clast in the section consists of a compact and argillaceous sandstone rather similar to some of the other sandstones described in this collection. The quartz grains in this sandstone are about 0.2 mm in size and intercrystalline areas are occupied by fine-grained sericite/ clay. Volcanic rock fragments are represented most characteristically by one sample which shows a tridymitic texture. Several other

volcanic rock fragments in the thin section consists of quartz and intergranular limonitic material and the exact origin of many of these cannot be determined from the petrography of these small samples of the rock types. Overall, chert, sandstone and fine-grained volcanic rocks are abundant in the lithic clasts represented in the thin section.

The rock has a rather heterogeneous texture overall and is characterized by the presence of lithic clasts ranging in size up to more than 1 cm. The abundant quartz grains are generally <0.2 mm in size but these too have a wide size range extending from submicroscopic grains. As a result of this it is difficult to delineate exactly the distinction between very small detrital quartz grains and quartz included with argillaceous material in the matrix of the rock. The overall aspect of the rock is that of a immature graywacke-like sediment.

Sample: P24/75; TS33375

Location:
RBM28G/74 N.F.M. R 17/090 9 SP Mt. Gee Prospect.

Rock Name:
Altered and silicified granitic rock.

Hand Specimen:
A massive and compact buff coloured rock which consists largely of equant crystals 1 or 2 mm in diameter.

Thin Section:
An optical estimate of the constituents gives the following:

| | % |
|---|---|
| Quartz | 75 |
| Muscovite/sericite | 15 |
| Feldspar | 10 |

The sample has a rather heterogeneous granular texture and appears to consist only of quartz, feldspar and a colourless phyllosilicate phase. Much of this material is recrystallized and hence there is little evidence of the original texture of the rock.

Quartz occurs both as individual discrete crystals and also as monomineralic patches. The latter are commonly

1-2 mm in diameter and consist of equant anhedral crystals generally about 0.5 mm in size. The internal quartz/quartz crystal boundaries are well defined and irregular and it is clear that this quartz is recrystallized material. In some parts of the rock there is gradation from this material to patches of finer grained quartz which have a subgranoblastic texture. A considerable proportion of the rock consists of a fine-grained aggregate of quartz, feldspar and muscovite and within this material the average grain size of the felsic minerals is about 0.1 mm and the muscovite flakes are somewhat smaller. It is possible that the large patches of monomineralic quartz represent recrystallized granules from a sediment but the rock contains a considerable amount of coarse grained feldspar such as is unlikely to be derived from a sedimentary rock and hence it is more likely that the rock is a silicified and altered granite. These feldspar crystals are commonly 0.5-1.5 mm in length and most are microcline crystals which shows more or less well developed grid cross-hatch twinning. Other crystals of feldspar have rather indeterminate twinned patterns but appear to be potassium feldspar. In some places the potassium feldspar abuts against quartz crystals and has well defined irregular margins but in other parts of the rock the feldspar crystals have rather irregular boundaries against fine-grained muscovite.

This sample has a rather simple mineralogy which is probably the result of extensive recrystallization of the primary minerals of the rock. It is not possible to determine unambiguously from examination of the thin section whether the rock was derived from a coarse grained arkosic sediment or whether it represents a silicified and largely recrystallized granitic rock.