THE BROKEN HILL PROPRIETARY COMPANY LIMITED

GEOLOGICAL SECTION

MELBOURNE

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SPECIMENS OF ARKOSE FROM FINGAL NO. 1 BORE, TASMANIA AND FROM WELLINGTON PARK WELL, GIPPSLAND, VICTORIA

Sylvia Whitehead

Melbourne

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Five specimens of arkose from Fingal No. 1 Bore, Tasmania, and seven specimens from Wellington Park Well, Gippsland, were submitted for petrological examination and comparison.

Thin sections of these rocks and some heavy mineral assemblages have been examined. During the course of this work, problems have been encountered concerning the possible presence of zeolites in very fine grained material, and the identity of a colourless mineral, believed to be albite partly replacing felspar crystals in the Victorian specimens. So far, none of the specimens has been found to contain sufficiently large patches of these materials to make possible separation and identification by optical and X-ray investigation. As further investigations into the possible presence of zeolites and their significance will take considerable time, it has been decided not to delay this report further, but to issue a separate one later should useful information emerge from a more detailed study.

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FINGAL NO. 1 BORE, TASMANIA.

Specimen	Depth (Ft.)	Thin Section
"A"	220	M.572
"B"	262	M.573
"C"	285	M.574
"D"	307	M.575
"E"	668	M.576

Specimens "A", "C" and "E" are composed predominantly of relatively fresh, unweathered angular to slightly rounded fragments of very fine grained volcanic rock showing great variation in texture (micro-porphyritic, flow structure, trachytic texture, etc.). Most of these fragments appear to have been derived from an andesitic type of rock, and in this respect they are very similar to those present in specimens of arkose from Victoria.

Other clastic detritus includes felspar grains, (oligoclase, albite, orthoclase, rare microcline) quartz, flakes of biotite, chloritic fragments, shreds and fragments of carbonised plant remains, and minor heavy mineral grains mainly apatite, epidote, and zircon.

Specimens "B" and "D" have a similar composition but the detrital fragments show more evidence of rounding and predepositional weathering, and many are obscured by brown staining.

In general, the detrital grains are of relatively uniform size in the one specimen and are closely packed. No bedding planes were observed, but there is a tendency for elongated fragments and biotite flakes to lie with their long direction approximately horizontal.

Heavy minerals separated in bromoform from specimen "B" include:

brown biotite - common

chlorite - few flakes, some chloritic fragments, portions of schist, or altered ferro-magnesian minerals,

opaque iron oxides and leucoxene,

apatite - common, prismatic, some semi-rounded, few cloudy grains, grey to red brown, pleochroic,

epidote - generally angular and irregular grains,

zircon - small prismatic crystals, some with inclusions, no rounding of edges. Only rare rounded grains probably from a different source.

sphene - rare - angular to semi-rounded.

garnet - very rare grains

tourmaline - very rare (some well rounded)

Apatite prisms and more rarely small crystals of zircon are included within some grains of biotite indicating that these three minerals have come from the same source.

The cementing material in the Fingal specimens is now mainly clay, at least part of which is probably the result of alteration. Little was preserved in sections of specimens "A" and "C".

In specimen "B", and more particularly in "D", small flakes of a micaceous mineral with higher birefringence, possibly illite, "sericite", or some related hydro-mica, surround many of the detrital grains. This has almost certainly crystallised from a clay mineral. X-ray investigations would be necessary for identification but it has not yet been possible to separate this material.

In specimen "E" the cementing material is partly very fine grained green to yellowish chlorite and partly colourless micaceous clay.

Traces of calcite are preseht in some specimens both as cement and replacing some felspar grains.

SPECIMEN "A" Grain size of detrital fragments commonly 0.2 - 0.4 mm. Angular. Biotite is common in places.

SPECIMEN "B" Grain size commonly 0.05 - 0.15 mm. Grains rounded, weathered and stained. Chloritic particles are more abundant. This may represent a stage of slower sedimentation. Cementing material contains traces of a hydro-mica (?).

SPECIMEN "C" Grain size commonly 0.5 - 1 mm. Angular to semi-rounded. Predominantly volcanic rock, minor felspar, very little quartz.

SPECIMEN "D" Grain size commonly 0.3 - 0.5 mm. Carbonised plant remains common. Fragments of volcanic rock are rounded, weathered and stained. Minor hydro-mica (?) surrounds detrital grains and probably developed from cementing clay.

SPECIMEN "E" Grain size commonly 0.2 - 0.3 mm. Detrital quartz (angular) is more abundant but still subordinate to fragments of volcanic rock. Cemented by very fine grained chlorite and a micaceous clay. Minor calcite.

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WELLINGTON PARK WELL, GIPPSLAND.

Specimen	Depth (Ft.)	Thin Section	
Core 1	3,725	M.583 (heavy minerals)	Quartz grit
"F" Core 2	3,826	M.577	arkose
"G" Core 6	5,815	M.578	arkose
"H" Core 10	7,943	M.579	arkose
"I" Core 13	9,508	M.580	arkose
"J" Core 16	11,238	M.581	arkose
"K" Core 17	11,379	M.582	arkose

The specimen from core 1 (3,725 ft.) differs from all the others in that it is composed mainly of angular to semi-rounded quartz grains commonly 0.2 - 0.6 mm rarely to 3 mm in size. Flakes of muscovite are present, lesser biotite, very few fragments of volcanic rock and felspar. The rock is partly cemented by white clay.

The grain size varies in different bands and one finer grained band contains streaks of black carbonised plant debris.

The rock is too friable for satisfactory sectioning.

Heavy minerals separated in bromoform include:

Tourmaline - Abundant as angular and prismatic fragments to 0.4 mm. Mainly shades of brown, some blue. Probably derived from a local granitic rock.

Opaque iron oxides, ilmenite and leucoxene - common.

Zircon - Common. Prismatic crystals to 0.3 mm long but generally smaller. Many show zoning and inclusions, bubbles, etc. Some have brown to pinkish colouration. Generally little evidence of rounding. Few well rounded grains may be from a different source.

Garnet - Very rare - angular.

Apatite - Very rare (1 grain) strongly coloured reddish brown.

There are also rare grains of an unidentified colourless mineral (biaxial, moderate relief).

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The specimens "F" to "K" are all similar in that they are composed of detrital fragments of fine grained volcanic rock (andesitic) of very variable texture, grains of felspar (plagioclase, orthoclase and rare microcline), grains of quartz, scattered flakes of biotite and minor heavy mineral grains cemented mainly by a fine grained green chlorite (authigenic) and also containing very fine grained epidote, minor albite and/or a fine grained zeolite.

The detrital grains are well sorted (commonly 0.15 - 0.3 mm) but vary in grain size in different specimens, and occasionally in different bands in the one specimen (e.g. "H"). Bedding planes were not observed but elongated fragments, biotite flakes, and in "F" shreds of plant debris tend to lie in a horizontal position.

Heavy minerals, separated in bromoform from specimens "F" and "J" are as follows:

Angular fragments of microcrystalline green chlorite from interstices are abundant, particularly in "F". Many of these remained suspended in the bromoform (S.G. 2.85 - 2.9).

Other minerals of clastic sedimentary origin are:

brown biotite - common, partly bleached in "J"
chlorite flakes - "J" only
opaque iron oxides and leucoxene
pyrite - cubic crystals, authigenic "F" only
apatite - common in both as prismatic crystals. Some cloudy and pleochroic.
zircon - small prismatic crystals, generally showing no evidence of rounding.

epidote - common in "J" as irregular grains.
garnet - rare, generally angular.
rutile - very rare, "F" only.
sphene - very rare, "J" only.
tourmaline - very rare.

Some of the biotite grains contain prismatic crystals of apatite, and very rarely small crystals of zircon, indicating a similar origin for all three minerals.

Heavy minerals from these two specimens are very similar to those from specimens of arkose from other areas. The assemblage, however, differs markedly from the heavy mineral assemblage from the overlying quartz grit (3,725 ft.) in which angular tourmaline is the most abundant mineral and apatite only very rare.

Cementing Material:

In specimens "F" and "H", the detrital grains are not closely packed. Most of the interstices contain a very fine grained green chlorite of authigenic origin, much of which occurs as minute flakes or fibres orientated normal to the surface of the interstice. Some of this has a refractive index between 1.62 and 1.63 and remains suspended in bromoform suggesting an iron bearing chlorite. It is hoped that by additional separations in bromoform sufficient material will be obtained for identification by X-ray investigation.

In specimens "G" to "K" ("F" too friable for sectioning) very fine grained epidote has formed along the boundaries of many detrital fragments and grains, and where these are closely packed, this film of epidote is all that separates many. Where chlorite and epidote are both present in interstices, the epidote is commonly along the boundary, the chlorite further in towards the centre, but there are occasional scattered grains of epidote surrounded by chlorite.

Similar fine grained epidote is scattered through a number of detrital rock fragments, partly replacing them.

The grain size of the epidote varies slightly in different specimens, and on occasions in the one thin section. No progressive change with depth could be detected.

In some interstices only partly filled or lined by chlorite, the centre has been filled by a colourless mineral with low refractive index and commonly showing wavy extinction. This may be albite or a zeolite but so little is present that it is not possible to separate it for identification.

Alteration of Fragments:

In all specimens "F" to "K" many of the detrital plagioclase grains show a patchy replacement by a colourless mineral with lower refractive index (generally between 1.52 and 1.53). This is biaxial with large 2V, and from available evidence has been tentatively identified as albite, but the possibility of a zeolite mineral cannot be disregarded. This mineral occurs in very small grains and in thin films and it has not yet been possible to separate sufficient for identification by optical and X-ray methods.

In thin sections of specimens "G" to "K" there are scattered areas where the colourless mineral replacing felspar grains extends across grain boundaries, and, accompanied by chlorite, partly replaces some fragments of volcanic rock forming a more or less continuous mosaic of strained and inter-locking grains. The mottled appearance of "G" in hand specimen is almost certainly due to development of these patches of secondary albite or zeolite. In specimens "H", "I" and "J" these areas are rather more abundant but there is no very marked change. In "K" it is more extensive but there is still little change in the general appearance of the rock in thin section.

In some places where the secondary albite (?) is in contact with interstitial chlorite, a slightly brownish, very

fine grained fibrous zone has developed apparently by reaction, and in a few interstices chlorite has been almost completely replaced by the colourless mineral.

There is no very definite change in the chlorite from specimen "G" to "J", but in "K" it shows more brownish colouration along boundaries of former interstices where it is in contact with epidote and secondary albite and/or zeolite.

Although an irregular mosaic of albite (?) is more or less continuous in places in specimen "K", boundaries of the original detrital fragments are still clear and show no evidence of distortion. Many are marked by lines of very fine grained epidote or by films of chlorite.

Note: It should be mentioned here that in some surface specimens of arkose described in a previous report (thin section M.173 from Boolarra and more particularly section M.177 from Mt. Best) there is rather more secondary albite (?) present extending across many former grain boundaries and filling interstices. Chlorite in section M.177 shows similar brown staining to that in specimen "K".

These facts indicate two alternatives:

(a) The amount of secondary albite (?) replacing felspar and extending across former grain boundaries of detrital fragments and filling interstices is not an indication of the degree of metamorphism due to depth of burial, or

(b) If it is an indication of increased metamorphism, then arkose now exposed at the surface in places (e.g. Mt. Best) in Victoria was formerly buried to some considerable depth.

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COMPARISON OF TASMANIAN AND VICTORIAN SPECIMENS

The specimens from the Fingal bore, Tasmania, are similar to specimens of arkose from Victoria in the following particulars:

1. They are composed largely of angular to sub-angular, sand-sized fragments of fine grained volcanic rock, probably much of it of andesitic composition. The rock textures of these fragments are very variable in all specimens both from Tasmania and from Victoria, and it is unlikely that this will be of use for purposes of correlation. Many detrital fragments showing microporphyritic, trachytic, andesitic and flow textures in Fingal specimens are indistinguishable from detrital fragments in many Victorian rocks.

2. Detrital felspar grains, including oligoclase, albite, orthoclase and rare microcline are common in all specimens. Quartz grains (generally angular) occur in more variable amounts.

3. Detrital flakes of brown biotite are scattered through all specimens. Some have been crumpled, freyed and partly altered. They tend to lie in a direction roughly parallel to the bedding but many have been bent around adjacent rock or mineral fragments.

4. Assemblages of heavy mineral grains of detrital sedimentary origin are similar. Apart from the abundant brown biotite, opaque iron oxides and leucoxene, apatite is common, zircon slightly less common, and epidote common in places. Other generally very minor constituents are garnet, rare sphene and tourmaline. Amphiboles and pyroxene grains are present in some Victorian specimens but were not noted from the Wellington Park Well. Chloritic fragments in some Fingal rocks may be altered ferromagnesian minerals.

A number of the prismatic crystals of apatite from both the Fingal and Victorian specimens contain vertical lines of minute inclusion, or are cloudy grey to reddish brown and pleochroic. Inclusions of apatite, and more rarely of zircon are present in biotite grains.

5. Although grain size varies in different specimens, the detrital fragments and mineral grains are generally well sorted and there is no evidence of very fine grained clastic detritus. Definite bedding planes were not observed suggesting that sedimentation was continuous.

6. Carbonised plant remains are present in specimens from both areas.

7. Calcite, generally only a very minor constituent occurs in Fingal and in Victorian specimens partly replacing some felspar grains and partly as cement.

8. Detrital fragments in two specimens from Fingal bore show more evidence of rounding, weathering and staining than has been noted in Victorian specimens. However, these specimens may not be typical of the area as a whole.

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The specimens from the Fingal bore differ from Victorian specimens mainly in the nature of the cementing material and subsequent history:

1. In the Fingal specimens the cementing material is now mainly white clay, but how much of this is due to weathering and replaces an earlier cementing mineral is not known. In some specimens (those composed of more rounded and weathered grains) flakes of a hydro-mica ? showing higher double refraction than the interstitial clay have developed along grain boundaries of the detrital fragments. This is present in very thin films and it has not yet been possible to separate it for identification.

It probably crystallised from a clay mineral.

2. Chlorite, the most abundant cementing material in Victorian specimens is now present only in very small amounts in the five Fingal specimens. Too much significance should not be placed on this as it may have been present and been altered to clay, but textures typical of the cementing chlorite in Victorian specimens were not observed.

3. Very fine grained epidote common along grain boundaries in Victorian specimens was not observed in those from the Fingal bore.

4. Secondary albite and/or zeolite was not observed crossing grain boundaries and occupying interstices in the Fingal specimens.

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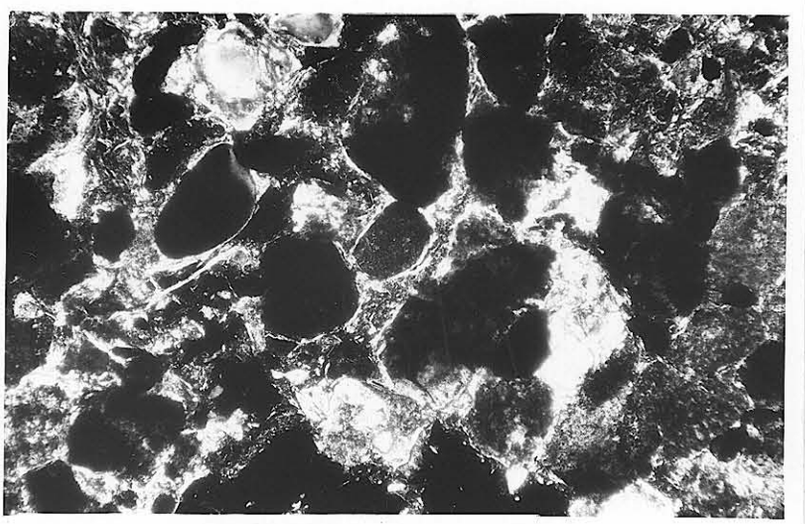
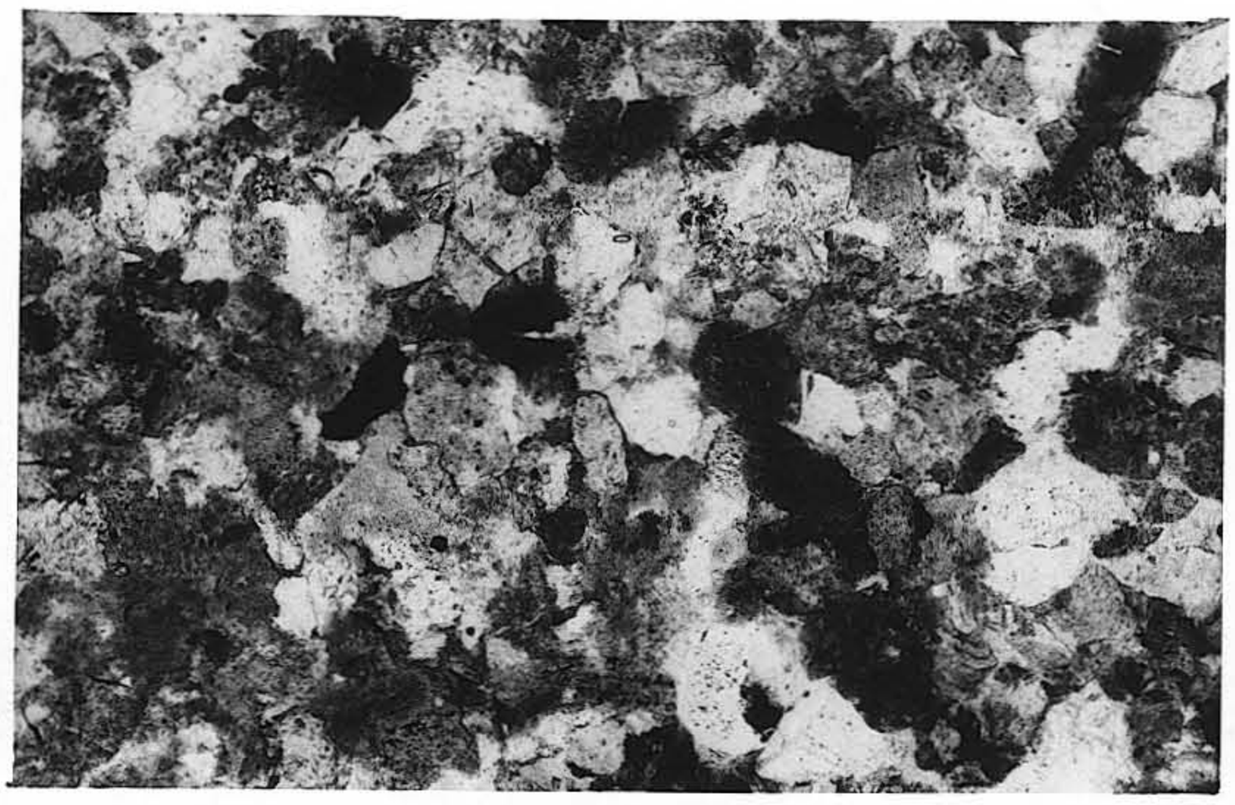
THIN SECTION M.575 - (X.40)

Specimen "D" Fingal Bore. Fragments of volcanic rock have been rounded, weathered and stained. Cementing material is fine grained clay with flakes of a hydro-mica (?) along grain boundaries of detrital fragments.



CROSSED NICOLS

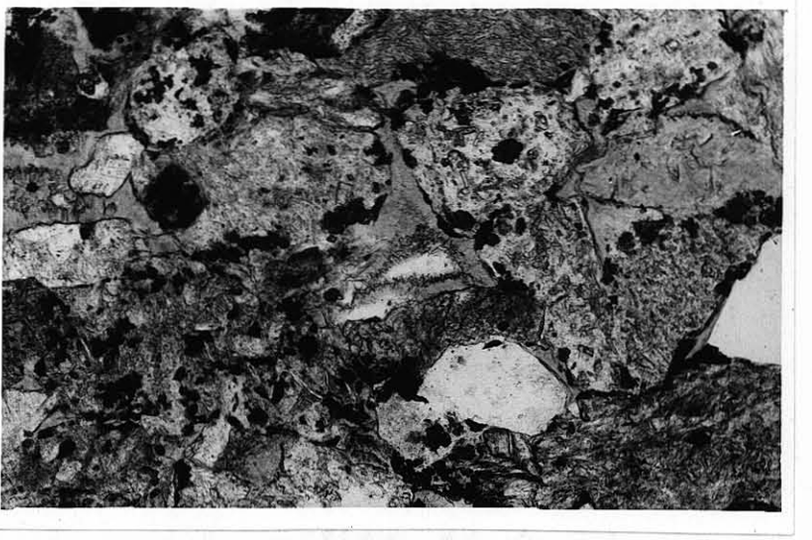


THIN SECTION M.576 (X.40)

Specimen "E" Fingal Bore. Composed of closely packed angular to partly rounded unweathered fragments of volcanic rock, quartz, and felspar grains cemented by fine grained clay, chlorite, and minor calcite.

THIN SECTION M.578 (X.40)

Specimen "G" Wellington Park Well. Closely packed fragments of volcanic rock, quartz, and felspar grains. Films of fine grained epidote or chlorite or both separate the fragments. Elongated fragments tend to be parallel to bedding.



THIN SECTION M.579 (X.120)

Specimen "H" Wellington Park Well. Fine grained epidote (dark) occurs along some grain boundaries and is scattered through fragments. Interstices are filled or lined by chlorite and some (centre) contain colourless albite (?). Calcite has replaced the elongated fragment immediately below the centre.

THIN SECTION M.580 (X.120)

Specimen "I" Wellington Park Well. Patchy replacement of felspar grains by a colourless mineral with lower R.I. (albite?). Interstices contain chlorite, epidote and some of the colourless mineral which tends to form a patchy mosaic across grain boundaries.

CROSSED NICOLS

THIN SECTION M.582 (X.40)

Specimen "K" Wellington Park Well, 11,379'. Although many felspars have been replaced and there is a more or less continuous patchy mosaic of secondary albite ? across grain boundaries, there is little change in the general appearance of the rock in thin section. Grain boundaries of original detrital fragments are still clearly defined. Fragments of volcanic rock have been partly replaced by albite (?), chlorite, fine grained epidote, and in places by fine grained, slightly orange or brown stained zeolite (?).