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THE GEOLOGY OF PERMIAN SEDIMENTS AND ERRATICS, TROUBRIDGE BASIN, SOUTH AUSTRALIA

by

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"An interesting field of enquiry is awaiting workers in the petrographical description of the erratics in relation to their origin, and particularly such as occur on the immediate seaboard which it may be expected, would give interesting evidence bearing on the nature of the rocks that are submerged to the southward." Walter Howchin, 1926

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ABSTRACT

The Troubridge Basin lacks obvious tectonic control. It probably was a broad topographic depression, which had an irregular topography of 700-100m. relief. Sub-glacial till occurs only in isolated patches. Sedimentation was initiated by glacial retreat, possibly influenced by isostatic or eustatic movements. Massive sands, claystones and shales of lacustrine, fluviatile and brackish facies predominate. Glacial outwash and aeolian deposits may also occur. Most diamictites are density flows or ice-rafting deposits. Original tills were probably reworked by meltwater and post-glacial erosion. A sediment thickness of at least 700m. accumulated.

There are two erratic assemblages, a local and an exotic one. The local assemblage occurs in till and slumped till and is not common. It is not known whether exotics occur in the local assemblage. The exotic assemblage is ubiquitous, and occurs in outwash and in ice-rafted facies.

The source area had a metamorphic basement, cut by younger intrusives, which were in turn overlain by a thick volcanic sequence. It has been impossible to unambiguously relate the erratics to areas of known outcrop.

CONTENTS

ERRATA

p.5. Line 3 should read "and silts are exposed"

p.6. Line 8 "moves" should read "moved"

p.10 Line 3 should read "allow an estimate to be made of"

REFERENCES 3, MAUD, R. R. "M.Sc." should read "MS"

REFERENCES 4, WARD, L. K. "cove" should read "bore"

In folder at back: "STRATAGRAPHIC" should read "STRATIGRAPHIC"

Hallett Cove, sections: "bellow beach" should read "below beach"

INTRODUCTION

Exotic erratics have long been known in Permian sediments exposed on Fleurieu Peninsula.

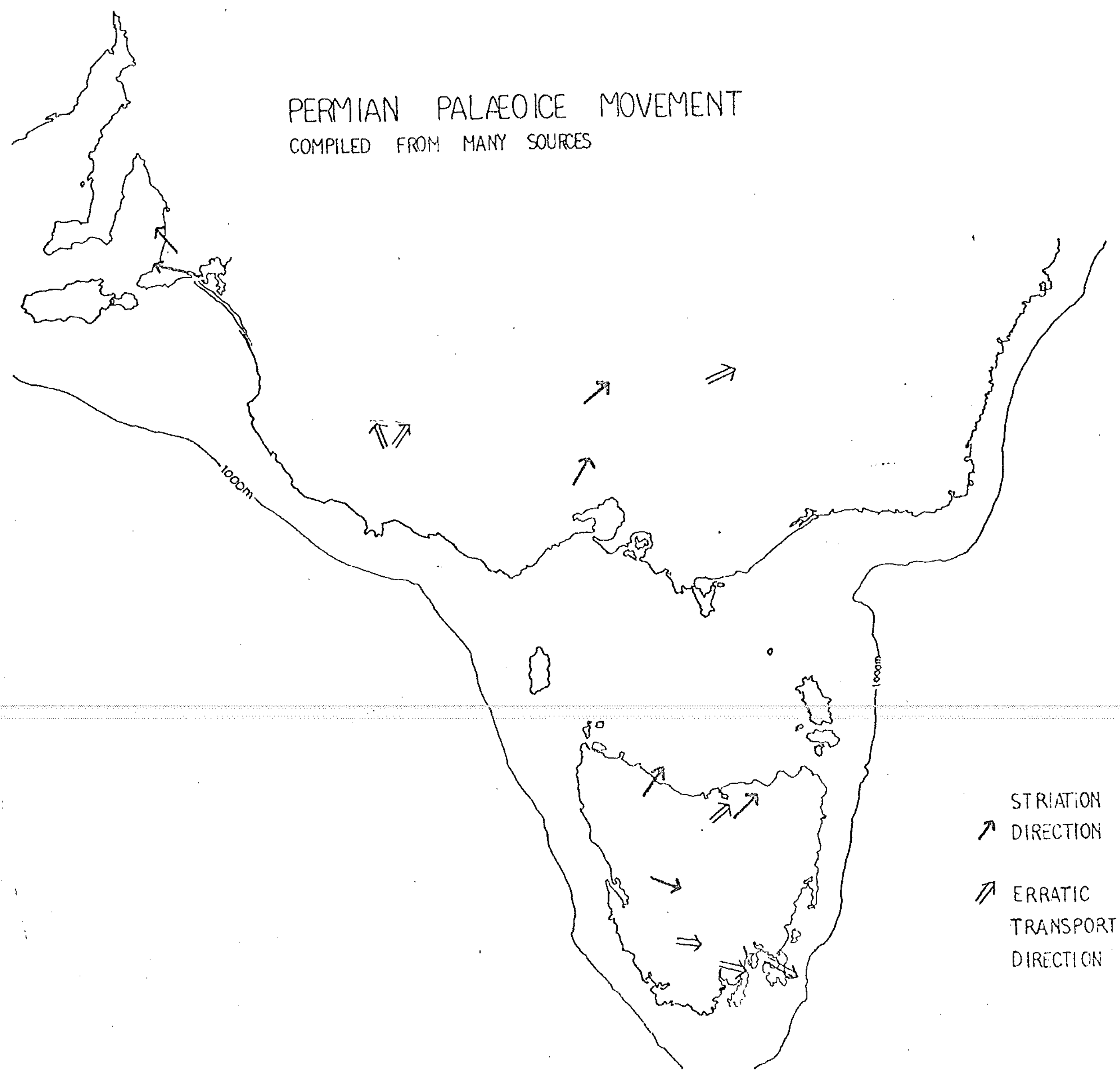


FIGURE 1

The erratics would be derived from all areas over which the ice sheet travelled. Abrasion and crushing during transport would tend to eliminate softer lithologies. 90% of the erratics seen in Pleistocene tills had travelled less than 15 Km., but transport distances of up to 1,200 Km. have been recorded. The erratics in an ice sheet usually form a narrow boulder train, although this is affected by the distribution of rock type and by the movement of the ice sheet, which, is usually radial. Erratic assemblages vary in tills of different stratigraphic horizons, tills higher in the sequence usually contain more exotic erratics.

Because of this it is necessary to study the mode of occurrence of the erratics and stratigraphic as well as geographic distribution. The writer therefore re-examined the Permian sediments which had largely been described by the classic work of Howchin.

CHAPTER 1

HALLETT COVE

Hallett Cove is the most outstanding locality for Permian glacial pavements and sediments in South Australia. Despite work by Tate, Howchin, Mawson, Sprigg and others, the area is largely undescribed with only one published detailed section (Tate, Howchin & David, 1896). No map differentiated Permian outcrop from sub-crop. The writer prepared an outcrop map and has restudied the sediments. To related scattered outcrops and to measure sections, the eye height method was used with a clinometer.

Three stratigraphic names are used herein for the Permian, the Waterfall Creek beds, Amphitheatre beds and the Sugarloaf Sand.

The Waterfall Creek beds are best exposed on the south side of Waterfall Creek where they are 11m. thick, and rest directly on bedrock. This is designated as the type locality. The unit consists of alternating grey green and red shale beds 20-80cm. thick and thin beds of fontainbleau sandstone (sandstone cemented by calcite crystals) 10-20cm. thick. It is 5m. thick at the National Trust Monument, and is absent 200m. north of Black Cliff where the overlying Amphitheatre beds rest directly on bedrock. This unit has not been recognized south of Black Cliff but equivalents of it may occur at low water level on the beach and 200m. south of the mouth of Hallett Creek.

The Amphitheatre beds extend from the National Trust Monument to 100m. south of the Sugarloaf. The main lithologies are purple shale and yellow sand. The type section is along the creek which drains the northern slopes of the Sugarloaf, and is 42m. thick. This unit contains varves (turbidites).

The Sugarloaf Sand rests with abrupt irregular, possibly erosional contact on the Amphitheatre beds at the Sugarloaf. This is a massive, coarse yellow sand, up to 13m. thick. It is unconformably overlain by Pliocene limestone. Near the base rare elongate fragments of shale occur.

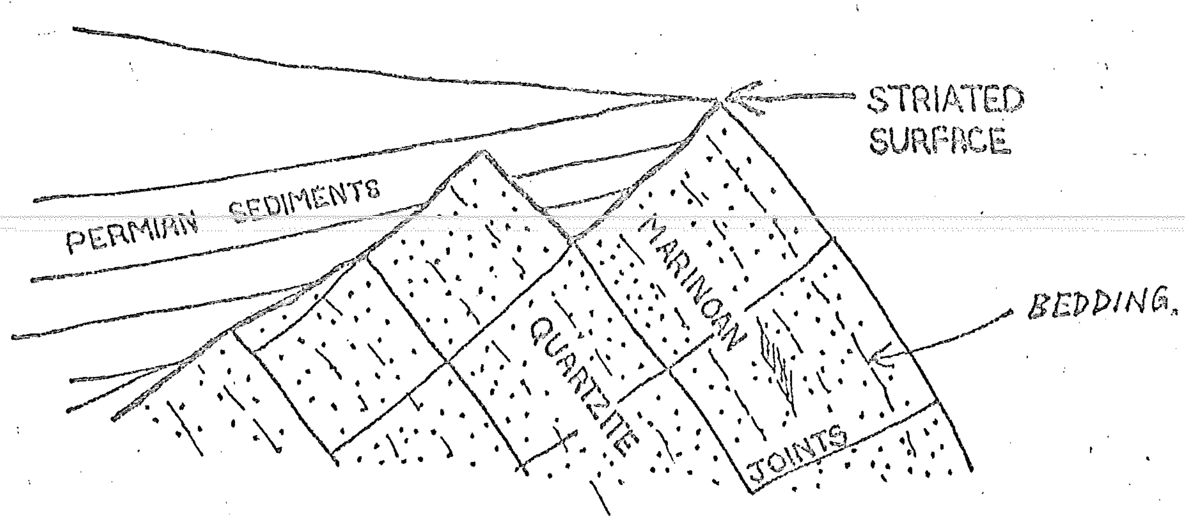
Lithologically this sand resembles those seen in the Finniss River district which have been assigned a Permian age. On the basis of this evidence, the writer believes the sand to be of Permian age, but it could also be younger, possibly Tertiary. Howchin (1923) considered this sand to be of Permian age.

North of Sandison Reserve

A few scattered outcrops of till and shale occur, but more commonly only striated quartzite surfaces. The most northerly exposure of pavement is 400m. north of the National Trust Monument. The till is compact (density 2.5), with a sandy matrix and lacks large clasts. It occurs as isolated patches on bedrock, at one point is 1m. thick.

The National Trust Monument

The Waterfall Creek beds are 7m. thick and are overlain by 10m. of Amphitheatre beds. A dark red shale band occurs at the top of the Amphitheatre beds; a similar bed can be seen at Waterfall Creek. The Permian is overlain by sandy Pliocene limestone which has reworked erratics at its base.



IRREGULAR SURFACE PRODUCED BY QUARRYING OF JOINT BLOCKS, HALLETS COVE

FIGURE 2

The lower surface of the Permian is irregular, with asymmetric troughs up to 5m. deep, where joint blocks of quartzite have been plucked out by the glaciers. Local glacial movement has been deflected by the troughs so formed from 330° to 350°.

Waterfall Creek

On the southern bank of Waterfall Creek is the type section of the Waterfall Creek beds. It is 11m. thick, consisting of red and green shales with interbedded thin fontainbleau sandstones. The tops of the fontainbleau sandstone beds are often ripple marked, showing a north-easterly current direction. Scattered small patches of till occur near the base of the unit, erratics are common towards the base of this unit. This is overlain by 12m. of Amphitheatre beds, which have a prominent brick red shale band 20cm. thick 1m. above the base of this unit, which can be used as a marker band.

From the northern bank of the creek the sediments can be seen wedging out against the rising bedrock surface. Dips steepen to the west, from 5° to 15°. Near Tate's Rock the Waterfall Creek beds are 5m. thick, and the Amphitheatre beds are 8m. thick.

Black Cliff

On top of Black Cliff the Waterfall Creek beds are about 1m. thick. Two hundred metres north, the Amphitheatre beds rest directly on bedrock and are 14m. thick. 15m. north of this point a sand bed 2m. from bedrock contains abundant barite sand crystals (Mawson, 1907). 200m. north of Black Cliff, a turbidite can be seen truncating a shale band, which becomes detached to form isolated, contorted stringers in the overlying bed. The slumping direction is to the south.

Sugarloaf Creek

Along this creek just north of the Sugarloaf (called here Sugarloaf Creek) an almost complete section of the Amphitheatre beds occurs. This is designated the type section for the Amphitheatre beds and is 42m. thick. The lowest unit exposed is 5m. of alternating sand, shale and mudstone. A trace fossil was found in a shale unit .7m. from the base. Large dropstones occur 3m. from the base. The tops of sand beds are ripple marked by westerly currents. This bed is on the same level as the varved outcrops close to the road 130m. south. This is overlain by 2.8m. thick bed of grey turbidites from 30 to 60cm. thick. Slump folds of isolated shale and angular shale clasts occur. Sand pillows 70cm. long occur near the top of this band. The next 35m. consist of alternating purple sand and shale with some turbidites. Sand becomes more abundant towards the top, forming beds up to 6m. thick. Below the Sugarloaf is a prominent varved purple shale band 4m. thick noted by Mawson (1926). This contains dropstones up to a metre long. Some of the beds in this outcrop are convexly curved, lying on top of planar beds. This may be due to the formation of miniature turbidite fans. Kuenen (1951) has shown that varves are turbidites, being formed by annual meltwater turbidity flows along the bottom of lakes. 60m. north of the Sugarloaf the underlying sands and clayey sands continue for another 8m. They contain isolated dropstones and several faults of about 1m. displacement which were probably formed by compaction.

Prominent outcrop near road and trace fossil locality

This outcrop has been discussed by Harris (1961) who noted the sedimentary structures, and suggested that turbidity currents had been active. As noted above (Kuenen, op. cit.), varves are probably turbidites. The turbidites at this locality have iron stained coarse sand basal layers, often with irregular lower contact, grade up to a fine sand or silt containing fragments of torn up shale layers and then pass up into purple laminated shale or mudstone. Dropstones have penetrated the sediment and folded adjoining layers by a wedging action. Some beds contain iron oxide spheres 1-3mm. in diameter after pyrite. Till pellets similar to those described by Ovenshine (1970) occur in these beds. Trace fossils have been found in these beds (see Appendix 4), and are mainly simple bilobate trails 2-3mm. wide. Possibly they were made by Arthropods.

450m. north of the mouth of Hallett Creek

Along the track there is an 1.3m. thick bed of slumped till containing large contorted blocks of fontainbleau sandstone, megaclasts and exotic erratics.

Beds here are grey to yellow silty clays with prominent slumps, boulder beds.

Below beach

At low tide, about 1m. of laminated shales and silts are exposed. It is 9.5-10m. below the lowest exposure of the Amphitheatre beds. In some exposures there is a dip of 15° to the east. In other exposures bedding is not discernible or intensely contorted. Slump rolls occur. In places the beds contain abundant shale clasts indicating disruption of nearby shale beds. In places 'nests' of boulders resembling the base of small scour channels occur.

South of the (Field River) Hallett Creek

300m. south of the mouth of Hallett Creek there are Permian sediments exposed which differ lithologically from those exposed further north. The sequence consists of two units, a lower one of grey silty clays and shales 5-10m. thick overlain by upper unit of conglomerate, fontainbleau sandstone 16-18m. thick. Three small patches of striated pavement were found by the writer. Small patches of till occur; one on the wavecut platform had a sandy matrix and showed a well developed till fabric. The other patch was argillaceous and interbedded with massive claystone. A thin silty limestone band occurs in the lower unit. The upper unit may either be an alluvial fan or braided stream deposit.

Direction of glacial movement

Sprigg (1942) recorded all known pavements north of Black Cliff. Three small patches of pavement were found south of Hallett Creek and these gave directions of 330° and 345°. Crowell and Frakes (1971) suggested that two trends in striation direction on top of Black Cliff was due to two periods of glaciation, 320° ± 10° and 350° ± 10°. The writer sees no basis for this suggestion. The direction of glacial movement within an ice sheet is variable, and the difference between the two sets is minor. However, there tend to be two modes for striae, 330° and 350°. The more northerly pavements tend to show the 350° trend, whilst those 300m. south of the National Trust Monument show the 330° trend, but both may occur in close proximity. The difference appears to be due to the influence of topography. The 330° trend is seen on the leading face (stoss) of the Black Cliff ridge and the 350° trend is seen on the tail (lee) face of the ridge, but may be joint controlled (quarrying of joint blocks would only occur on the lee side).

<u>Depositional environment</u>

The writer agrees with Sprigg (op. cit.) that the depression in which the Permian sediments lie was a pre-existing NNE valley which the glacier moves obliquely across.

Kuenen (op. cit.) has argued that varves could not form in seawater because the clay would flocculate and settle out with the silt fraction. Therefore the varved Amphitheatre beds must be lacustrine. The Sugarloaf sand may have been a sand bar or a small stream delta. The coarse boulder beds south of Hallett Creek may be glacial outwash as they contain striated erratics.

The presence of large dropstones 1-2m. across and the presence of till pellets suggest that iceberg rafting may have occurred. Ovenshine (op. cit.) suggests that dropped clasts of till indicate iceberg rafting because a glacier reaching sea level is the only likely source of the till. If, however, till existed at the shoreline winter freezing could result in floes rafting clasts of till.

<u>Erratics</u>

Howchin (1924) recorded the presence of Victor Harbour Granite, Felspar porphyry, Aldgate Sandstone, Sturt Tillite, Tapley Hill Shale, Mitcham Quartzite and Marinoan Shales. Large erratics of Howchin's "earthy and siliceous limestones" occur near the mouth of Hallett Creek. They were derived from the upper calcareous part of the Tapley Hill Shale (Sprigg's (op. cit.) Unit 12). Exotic erratics include gneisses, arkoses, quartz arenites, volcanics and granites.

CHAPTER 2

DESCRIPTION OF LOCALITIES

King's Point

This locality was first described by Howchin (1910a) and has been commented on by Ludbrook (1967) and Crowell and Frakes (1971). The Permian sediments occur in a strike valley 30-40m. deep, oriented at 045° in Kanmantoo Group metasediments. The basal beds are not exposed, the lowest beds seen are thinly bedded alternating sands and shales, which are varved in places with prominent dropstones up to 40cm. long. Thicker beds of sand and clay several metres thick occur higher in sequence. Most of the erratics were collected from a 3m. thick yellow clayey sand bed at the top of the sequence with dispersed erratics, and from an earlier lag deposit on top of this bed. The Permian is overlain by Recent or Pleistocene beach sands. The lag deposit of erratics apparently accumulated during this former high sea level. Large erratics of local granite and smaller erratics of Kanmantoo lithologies occur. Exotics are abundant, mainly gneisses, rhyolites and tuffs, quartz arenites, arkoses.

Cape Jervis

A detailed description of this locality is given in Ludbrook (1967). Her 'tills' of units 1 and 2 are slumped, they show sharp contacts at the base of boulder bearing beds with similar non-boulder bearing claystones (Plate 4), and the slumped beds contain contorted lenses of fontainbleau sandstone (sandstone cemented with calcite crystals). These slumped beds contain exotic erratics. Ludbrook's limestones are fontainbleau sandstones, which are pebbly in places. Erratics were collected in situ, and on the surface of the beds, where they had weathered out. These erratics were mainly derived from units 2 to 7. Exotic erratics include granites, gneisses, rhyolites, dacites, tuffs, arkoses and quartz arenites. Large boulders of Victor Harbour Granite occur.

Road cutting, Ashbourne district

Locality, 3 miles east of Ashbourne, Milang 826424. The exposure is 1.5-2.0m. thick and 40m. long. A 30cm. thick diamictite bed occurs interbedded with sands and grey shales. This outcrop is covered by a weathered mantle of clay which makes it difficult to follow beds. Horwitz (1960) considered this diamictite to be a true till, but it could have other origins. It does not show a till fabric, and does not have a compacted matrix. It could be a slump deposit or a subaqueous till. Erratics of Kanmantoo gneiss, rhyolitic porphyries, arkoses and quartz arenites. Clasts range up to 60cm. long.

Carrickalinga Creek

Yankalilla 312228. This locality was noted by Mawson (1926) who recorded varves. In a gully near the mouth of Carrickalinga Creek 40m. of Permian sandstones and conglomerates are exposed. The conglomerates occur as the basal boulder bed in channels 20-60m. wide and 5-15m. deep. The boulder beds carry abundant exotic erratics, including many striated erratics and granite boulders up to 2m. in diameter. Erratics of Kanmantoo metasediments, volcanics, arkoses, quartzites and gneiss also occur. These erratics have been reworked by Permian streams, but were probably derived from tills. Some of the channels may be oriented east-west but the clasts show no obvious imbrication. These sediments lap on to a bedrock high of Cambrian limestone to the east.

The sandstones are fine grained and well laminated, with some associated porcellanite (white siliceous claystone). They show no cross-bedding or ripple marks but show some parting lineation. This suggests that they may have formed in the upper flow regime. Mawson considered some of the alternating sandstone-porcellanite laminae to be varves.

Tookayerta Quarry

In the quarry (Milang 771280) channel conglomerates of erratics are exposed. These deposits are 50m. long and 5-10m. thick. They are iron cemented and carry abundant exotic and striated clasts. They pass up into yellow sands of variable sorting, and some laminated sandstone and siltstone occurs. They abut a striated and fluted wall (Maud, 1964).

These sediments may be postglacial, but they resemble typical glacial outwash deposits, which are usually formed by braided streams. Erratics would rapidly lose their striae during transport, so they must have been derived from a nearby source. In either case the deposits are ordinary fluviatile sediments, and differ only in the context in which they are placed.

Tooperang Quarry

Milang 753327, half a mile east of Mt. Observation. 5-8m. of laminated sandstone, porcellanite and siltstone are exposed in a roadside quarry. The porcellanite is white, fine grained and resembles museum rocks 7304, 7305 from the Finniss River which in thin section are entirely composed of silica ovules .01-.001mm. long, aligned parallel to bedding. Ripple marks and cross stratification appear to be absent, as are erratics. A channel 10m. wide, 2-3m. deep, oriented east-west occurs with clasts of shale and porcellanite at its base. Slump structures are common, with associated microfaults and load-casts. These sediments are either fluviatile or lacustrine.

At other localities, sediments occur which are transitional between the types exposed at Tookayerta and Tooperang quarries.

Kuipto Forest

The occurrence of glacial sediments in the area was first noted by Mawson (1923) and has recently been mapped by the Geological Survey (Thomson & Amtanis, 1971). Erratics were collected at Echunga 687545, along a forest track where they are weathering out of a yellow silty sand. Quartzite of the A345/428 type occurs abundantly here. Other exotics are common and include a hypersthene dacite, rhyolites, granites and a chert breccia. Locally derived erratics include metamorphics from the nearby

"Archaean" inlier and Adelaide Supergroup sediments including Aldgate Sandstone.

The locally derived erratics allow an estimate to be made of the direction of glacial transport. This indicates that the direction was not more easterly than towards 320°, which agrees with striation directions at Hallett Cove which are never more easterly than 330°. Permian sediments may have been reworked in Tertiary time, but it is difficult to determine the extent of this because of the poor exposure.

Glacier Rock

Apart from the pavement this locality is notable for a 4m. granite erratic sitting in a well sorted yellow slightly clayey sand, of which the grain surfaces show fluvial modification of original glacial features (Hamilton & Krinsley, 1967). Hamilton (op. cit.) suggests this was a kame deposit. Exotic rhyolitic rocks and arkoses occur in the same unit. These erratic bearing aqueous sediments are a sedimentological problem. The granite erratic was either ice rafted or has moved down slope from nearby tills that were being reworked by streams. The writer favours the ice rafting hypothesis.

York Farm, Kangaroo Island

Kingscote 331401. A granite erratic of Victor Harbour type occurs in an outlier of Permian sediment on the edge of the Cygnet Scarp. The erratic is half buried in soil and is 5m. long. A striated erratic of milky quartz was found nearby.

Christmas Cove, Penneshaw, K.I.

Penneshaw 654431. Howchin (1903) first described the sediments in this locality, and Ward (1922) recorded the striated wall in the cove. The cove is a circular basin of brown Permian shales dipping south-west at 30°. The northern wall of the cove is striated, and shows a prominent boss with large grooves running across it. Three metres from the base of the shales, calcareous concretions up to 40cm. across with cone-in-cone margins occur concentrated in one horizon. Slump structures and dropped boulders occur. Granite erratics are abundant, and had been used to build a breakwater. Exotics include arkoses, quartz arenites, gneisses, tuffs, rhyolites and many other rock types.

Kingscote, K.I.

Howchin described the sequences exposed in the cliffs north of Beare Point in 1899. A thickness of up to 20m. is exposed in the cliffs. A bore at beach level reached bedrock at 323m. (1,052ft.). At Reeves Point, 11m. of laminated green and grey shales with some red brown shales and dropped boulders are seen. Five hundred metres south at the old basalt quarry, 10m. of sandstone conformably overlies shale, which is in turn overlain by basalt. The sandstones appear to be a point bar deposit, with planar cross-stratified beds overlying trough cross-stratified beds, and a decrease in grain size upward. Current directions vary from north to north-west. At the Bluff 2m. of sand overlie 25m. of grey shales with interbedded sands. The upper sand bed shows planar cross stratification, and is probably the equivalent of the thicker sand at the old basalt quarry. Some of the clay beds at beach level contain abundant shale clasts. Dropped exotic boulders of augen gneiss and quartzite occur.

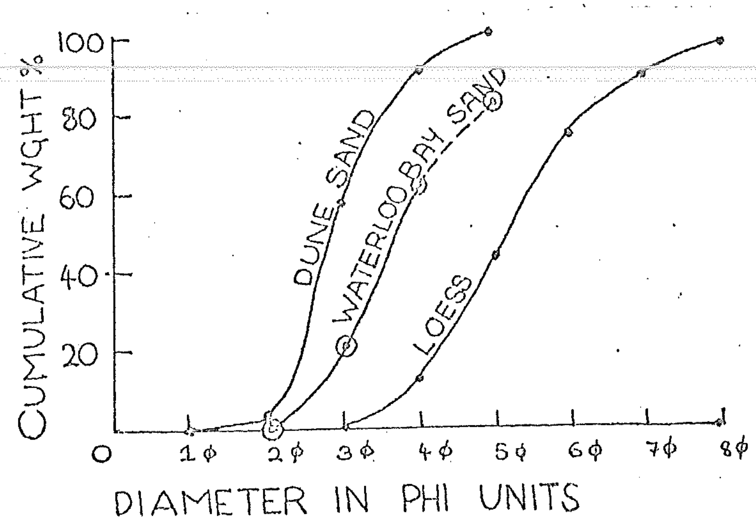
Smith Bay, K.I.

This locality, Cassini 219579, was noted by Howchin in 1899. Permian clays form a low cliff, but are poorly exposed. 5m. of section is exposed of till, with aligned clasts and shales and thin sand beds. The till matrix is a sandy clay. Kanmantoo metasediments are the most common erratics in the till. Abundant exotic erratics have weathered out of the sediments, including arkoses, quartzites, many varieties of gneisses and porphyritic igneous rocks.

Waterloo Bay, Yorke Peninsula

This locality was visited by Howchin in 1900. Permian claystones occur along the shore of Waterloo Bay, but are generally covered by cliff falls of Quaternary and Tertiary sediments. The best exposure seen was at Edithburgh 610599, where 5-7m. of brown, massive claystone, with rare erratics occurs. Where it is fresh the claystone is black and carbonaceous, but on weathering turns brown and blue. This sediment yielded a Lower Permian microflora which has been assigned to Evan's Stage 2, acritarchs, the arenaceous foraminifera Hemidiscus balmei and reworked Upper to Middle Devonian spores (Harris & McGowran, 1971, unpub.). The preservation of the palynomorphs is suggestive of non marine conditions, but the presence of arenaceous foraminifera may indicate marine influence. What this marine influence was is difficult to determine. The mono-specific assemblage and the "excessively agglutinated nature of the tests implies that the environment was undersaturated in calcium carbonate, i.e. that salinity and/or temperature were low" (Harris & McGowran, op. cit.).

The claystone is overlain by a lens of yellow silty very fine sand, 7-10m. thick and 100m. wide. Normally the contact between the two is abrupt, but at one place the upper part of the claystone contains a boulder bearing bed 15cm. thick. The sand is massive, with a large concentric concretion near the top. It is well sorted and may be aeolian, being intermediate between dune sand and loess (see Fig. 3).



WATERLOO BAY SAND

FIGURE 3 *after Krumbein & Sloss Fig 4.4*

Point Turton, Y.P.

This locality was also visited by Howchin (1900). A massive blue to brown claystone with dispersed erratics occurs beneath Tertiary limestone at the old limestone quarry. The claystone is similar to that at Waterloo Bay, but contains more erratics. The erratics are coated with secondary iron oxides. The claystone contains Hemidiscus balmei (Harris & McGowran, 1971). The erratics are Kanmantoo metasediments, porphyritic igneous rocks, including dacite, gneisses and quartz arenites.

NATURE OF GLACIATION

All the previous workers, Howchin, David and Bourman (1969) believe that the Permian glaciation was of the continental ice sheet, except Campana and Wilson (1955) and Horwitz (1960) who believed the glaciation to have been of Alpine type glaciation. Campana and Wilson believed the glaciation to have been Alpine because glacial over-deepening of several hundred feet had occurred. Bourman (op. cit.) refuted this, pointing out that the Antarctic ice sheet produces over-deepening. Horwitz (op. cit.) claimed that he could recognize three different valley systems by their erratic content. He recognized the Inman Valley by the presence of erratics of Victor Harbour granite, the Finniss Valley by the presence of exotic porphyries and quartzites, and the Hindmarsh Valley by the presence of local erratics. The sediments in the Hindmarsh region are poorly exposed and cannot be differentiated from the other regions without the presence of exotics. The exotic erratics occur in the Inman Valley as well as the Finniss. The only valid part of Horwitz's scheme is the boulder train of the Victor Harbour granite.

Striation directions indicate that the glacier overrode the topography, ice movement was not deflected by obstacles such as Strangway Hill.

Erratics of identical lithologies can be found at Blinman, Waterloo Bay and King's Point. This evidence suggests that a large ice sheet was responsible for the glacial erosion.

Sedimentary History

The sediments, with the exception of patches of till at Hallett Cove and Smith Bay, appear to be all water laid. The absence of till is surprising and even the majority of sediments are predominantly shales or sands.

This suggests that the till deposited by the ice was reworked by meltwater streams during glacial retreat and redeposited as fluvioglacial sediments.

A sediment thickness of 487m. (1,600 ft.) was encountered in Donna No. 1, and 446m. (1,359 ft.) in Edithburgh No. 1. This is a large sediment thickness and suggests that the area may have received sediment from outside, and that it was therefore a basin of deposition. This has been called the Trou-bridge Infrabasin by Sprigg (Sprigg & Stackler, 1965). At Hallett Cove lacustrine sediments lap on to a basement ridge, on which isolated patches of till occur. The basin fill appears to be a mixture of fluviatile and lacustrine deposits with some aeolian sands. Brackish water seems to be indicated by the presence of arenaceous foraminifera which have been recorded from Yorke Peninsula, Cape Jervis and in Donna No. 1 (Ludbrook, 1967). Apparently complex facies relationships combined with poor exposure makes it difficult to recognize meaningful stratigraphic relationships for these sediments.

Erratic Transport

At most localities erratics were collected out of water-laid sediments; striated and faceted clasts indicate that they were originally derived from tills.

The outcrop of true till is so limited that it has been impossible to determine whether exotic erratics occur in them. Exotic erratics occur as dropstones, in slumped tills and in stream deposits. Slumping and stream action would destroy local dispersal patterns, but would probably not destroy regional dispersal patterns although both slumps and streams can transport clasts over long distances. The writer believes that most of the erratics in stream deposits probably were not transported over more than a few kilometres. The distance over which ice rafting occurred would be limited only by the extent of the water body in the infrabasin and there is no means of recognizing the length of transport which occurred.

Age

The microflora from Waterloo Bay is the first reliable basis for dating the sequence. The arenaceous foraminifera are facies controlled and long ranging.

The microflora has been assigned to Evans' Stage 2 which Evans places in the lowermost Permian (Evans, 1969). The Waterloo Bay claystone would correlate with the upper 43m. of soft grey clays of a 446m. thick predominantly sandy section in Edithburgh No. 1, five kilometres north. On this basis a tentative Sakmarian age is assigned to the Troughbridge Basin sequence.

CHAPTER 3

EXOTIC ERRATICS

The erratics have been studied qualitatively by petrographic examination of representative exotic lithologies. Quantitative techniques were not used because of the lack of suitable till horizons, the great diversity in erratic lithologies, and a bias in sampling. Despite the great number of exotic rock types, they fall into a number of recognizable groups, suggesting that the sedimentary rocks may have been derived from one series and that the igneous rocks may have come from a small number of suites.

It has not been possible to locate a definite source for most lithologies. It would be difficult to recognize similarities on descriptions alone; a direct comparison of material would be more reliable.

Igneous Rocks

The existence of exotic igneous erratics in local Permian sediments was first noted by Howchin (1910a), who recorded exotic granites and porphyries at King's Point. Sprigg (1942) suggested that the porphyries were similar to outcrops in the South East and Horwitz (1962) supported this suggestion. These porphyries range from andesites to rhyolites and welded tuff, so specific rock names should be used to refer to these rocks wherever possible.

The only locally derived igneous erratics are of Victor Harbour Granite, which was transported W.N.W. from outcrops at Victor Harbour and Cape Willoughby. Such erratics occur at York Farm, Waterloo Bay, Lake Fowler, Port Vincent, Hallett Cove, Cape Jervis and Inman Valley.

No basalt erratics have been found by the author, but in the collection of the Geology Department there are two specimens, 12467 from the floor of Lake Fowler, and 8135, a tholeiitic basalt from Hallett Cove. The author found one erratic of andesite at Petrel Cove, A345/44.

Dacites are common and occur at most localities. A345/498 from Kuitpo Forest is a hypersthene-hornblende-biotite dacite. Most of the other dacites are biotite dacites, often with skeletal remnants of earlier mafic minerals which have altered to chlorite and opaque minerals. In appearance most of the dacites are a dark blue colour and porphyritic.

Rhyodacites are common and widespread. They include some rocks which megascopically resemble trachytes, have prominent aligned sanidine phenocrysts and with no obvious quartz phenocrysts. The rhyodacites have simple mineralogy, usually being biotite rhyodacites, but are variable in appearance and texture. Most are porphyritic, some may have recrystallized groundmasses.

Rhyolites are also common and widely distributed. The rhyolites are variable in appearance and show a range of devitrification textures. The rhyolites are apparently simple in composition. Some porphyritic, flow banded rhyolites occur.

Welded tuffs are common; most are highly devitrified, which makes recognition difficult in many cases. A345/510 contains pumice fragments and shows eutaxitic texture. A345/519 is a devitrified eutaxitic tuff showing a high degree of welding. Many of these tuffs contain a high proportion of crystals, which are usually angular and irregularly distributed throughout the rock.

This assemblage of rock types is reminiscent of the igneous association found in the Victorian Upper Devonian ring complexes (Hills, 1959) which show an igneous succession from basalts and andesites to biotite rhyodacites, hypersthene dacites, biotite dacites and have associated welded tuffs. It would need a study of chemical trends in these igneous erratics to see if they could represent one suite of igneous rocks.

Exotic granites, microgranites and associated porphyries occur but have not been studied in sufficient detail. One only exotic granite, A345/506, was examined, and it cannot be matched to any granite outcrop in the southern part of the state. This granite has undergone cataclasis. The sampling of granites proved difficult. The micrograrites studied lacked distinctive mineralogies or textures.

The writer cannot match any of these erratics to known outcrops in the Naracoorte 1:250,000 sheet area. Some of the microgranite erratics resemble those in the South East, but this similarity may not be significant since these lithologies show no distinctive features. Fluorite is an accessory mineral in many of the acidic erratics. Locally fluorite is characteristic of the Murray Bridge Granite suite, which occurs between Murray Bridge and Western Victoria. However, fluorite is a common accessory mineral in igneous rocks, so its presence may not be significant in determining the source of the igneous erratics.

A345/10 bears a striking resemblance in thin section to a slide (171-328) of quartz-felspar porphyry from near Hamilton, Western Victoria. Both these rocks have a simple fragmental texture, and simple composition, and accessory fluorite. 171-328 also shows spherulitic devitrification similar to A345/70 and A345/425, but is probably not a significant feature.

The igneous erratics have been given the name of extrusive rock type of appropriate composition. It is possible that some of these rocks may be intrusives, but it would be impossible to differentiate them when field relationships are unknown.

Metamorphic Rocks

Gneissic metamorphic rocks are some of the more common exotic erratics, consisting mainly of mechanically resistant lithologies. The most common rock types are granite gneisses, augen gneisses, with less common mylonites and related rock types. Exotic schists may also occur, but have not been recognized because of the difficulty in distinguishing them from locally derived Kanmantoo Group metasediments. Most of these rocks have a simple mineralogical composition, usually quartz-felspar-biotite. This gives no indication of metamorphic grade, since biotite can range from biotite to granulite facies. Gneisses are most common in the amphibolite facies, but are not restricted to it. Some rocks - e.g. A345/469, A345/441 - contain perthitic felspar, which in metamorphic rocks occurs only in the upper amphibolite and granulite facies. However, perthite may also form by exsolution. If so, it may not have any significance in determining metamorphic grade. Most of the erratics do not contain perthite. The blue colour of quartz in A345/306 and A345/308 is probably due to the presence of minute inclusions, and although such blue quartz is common in granulite facies rocks, the colour has no significance. A345/209 and A345/441 show chlorite replacing biotite. This suggests that these rocks may have undergone retrograde metamorphism.

Many of these rocks show strain textures or recrystallized strain textures - e.g. A345/274, A345/294. Rocks such as the mylonite, A345/504 and augen gneisses, A345/503, indicate extreme deformation. Cataclastically deformed granites such as A345/506 show that the source area had a complex deformational history, probably of several episodes. Rocks such as A345/274 and A345/517 may have been igneous rocks. The graphic texture in A345/274 may be a eutectic texture. If it is, then this may indicate high temperature metamorphism.

Some of these rocks are very distinctive in the hand specimen - e.g. A345/503 - which has bright red potassium felspar porphyroblasts. Such rocks cannot be matched to any known area of outcrop. It is unlikely that many of these rocks were derived from the Lower Proterozoic metamorphic inliers in the Mt. Lofty Ranges.

Sedimentary Rocks

I. Clastic Rocks

Arenites form an important part of exotic erratic assemblages. They occur ubiquitously, and mechanically resistant types predominate. The majority of these rocks may be assigned to one suite or series. They are characterized by reddish colours and by the presence of blue quartz grains and volcanic rock fragments and other labiles. They show a wide range of textural and compositional variation, forming a sequence ranging from arkoses and volcarenite to mature quartz arenites. The extreme members of this series are A345/428 and A345/240. A345/428 is a well sorted, mature rock, mainly quartz but containing rare devitrified volcanic rock fragments. The grain surfaces are coated with haematite. A345/240 shows intermediate rounding and sorting and is dominated by labiles, mainly potash felspar and volcanic rock fragments. In hand specimen some of these rocks show a fining up from grit layers containing more labiles to well sorted quartzite layers. These rapid changes in sorting may indicate a non-marine encironment such asalluvial fan, fluviatile or deltaic environment; however, there is insufficient information for a reliable interpretation.

The labile grains vary from sub-angular to subrounded, probably indicating moderate transport. The volcanic rock fragments and felspars are not likely to have been reworked. Fresh plagioclase fèlspar occurs in rock of almost silt size. The abundance of labiles suggests little chemical weathering occurred during erosion and transport. Possibly these sediments were formed in an arid or semi-arid environment, as many of these rocks are 'red beds', with haematite coated grains.

These rocks contain grains of metaquartzite, vein quartz, blue opalescent quartz, microcline, orthoclase and perthitic microcline and orthoclase, eutaxitic welded tuff and vitroclastic tuff. Clasts of chert and chalcedonic silica also occur but are not common. Reworked sedimentary quartz may have made a contribution to these rocks, but grains with earlier quartz overgrowths have been seen in only one rock, A345/17. The blue quartz is common in gneissic and porphyritic igneous erratics. Erratics of eutaxitic welded tuff - e.g. A345/420 - and metaquartzite - e.g. A345/470 - have also been found. This suggests that the area from which the metamorphic and igneous erratics were derived also formed the source area for these sedimentary erratics.

Although there are superficial similarities to local lithologies such as the Marino Group, the presence of volcanic rock fragments argues against this origin. No known source can be assigned to distinctive lithologies such as A345/428. There are some similarities to rocks such as the Jukes breccia in Tasmania and the Upper Devonian sediments of western New South Wales, but this may be due to similarity in depositional environment and tectonic setting rather than indicating likely sources for these erratics.

Several rock types show considerable pressure solution and all rock types show some pressure solution. This indicates high confining pressures and suggests that these rocks were part of a thick sequence. Undulose extinction in some rocks indicates mild deformation, possibly gentle folding. Rocks such as A345/430 which show preferred alignment and growth of sericite may have undergone low grade metamorphism (chlorite or zeolite facies).

The age of sedimentary erratics is unknown, but is possibly lower or middle Palaeozoic. Reworked Middle or Upper Devonian spores were found in Lower Permian claystone at Waterloo Bay (Harris & McGowran, 1971). These spores have undergone little transport and were apparently derived from unlithified sediments, and so may have had a different source to that of the sedimentary erratics. If it is assumed that the sedimentary lithologies are post orogenic, then an Ordivician or Upper Devonian age is most probable. Lower Ordivician orogeny affected the Adelaide Geosyncline and uplift occurred in western Tasmania - 'Tyennan movements'. The 'Tabberaberan' orogeny affected much of south-eastern Australia, including western Victoria and New South Wales, producing thick non marine sequences in grabens and half-grabens. This orogeny appears to have affected the Renmark trough where seismic data suggest the existence of sediments underneath Permian sediments.

II. Chemical Rocks

Cherts and other varieties of chalcedonic silica are a rare but persistent part of the exotic erratic assemblages. They occur at most localities. At least one silicified limestone was found, A345/497. This is a silicified intraclastic packstone. It may have been derived from nearby Torrens Group sediments. Some of the chert breccias - e.g. A345/520 - may be replaced carbonates or a silicified residual capping similar to the Pinjan chert breccia of the Pilbara district. Some such as A345/296 and A345/431 appear to be primary cherts. Small erratics of red and yellow jasper occur less frequently.

Some of these rocks may have been associated with acid volcanics, where cherts are formed by silica rich waters. Possibly A345/522, which shows concentric growth layers, may have had this origin. The jaspers may be residual from earlier erosion cycles or were derived from veins in other rock types.

It has been shown that many of the erratics are distinctive but cannot be assigned to known sources. These erratics, however, reveal something of the geological history of the area from which they were derived. In summary, this geological history shows three major episodes: metamorphism and deformation of what may be 'basement' in the source area, intrusion and eruption of a volcanic sequence, followed by deposition of a clastic sequence derived from the basement and the volcanic sequence.

CHAPTER 4

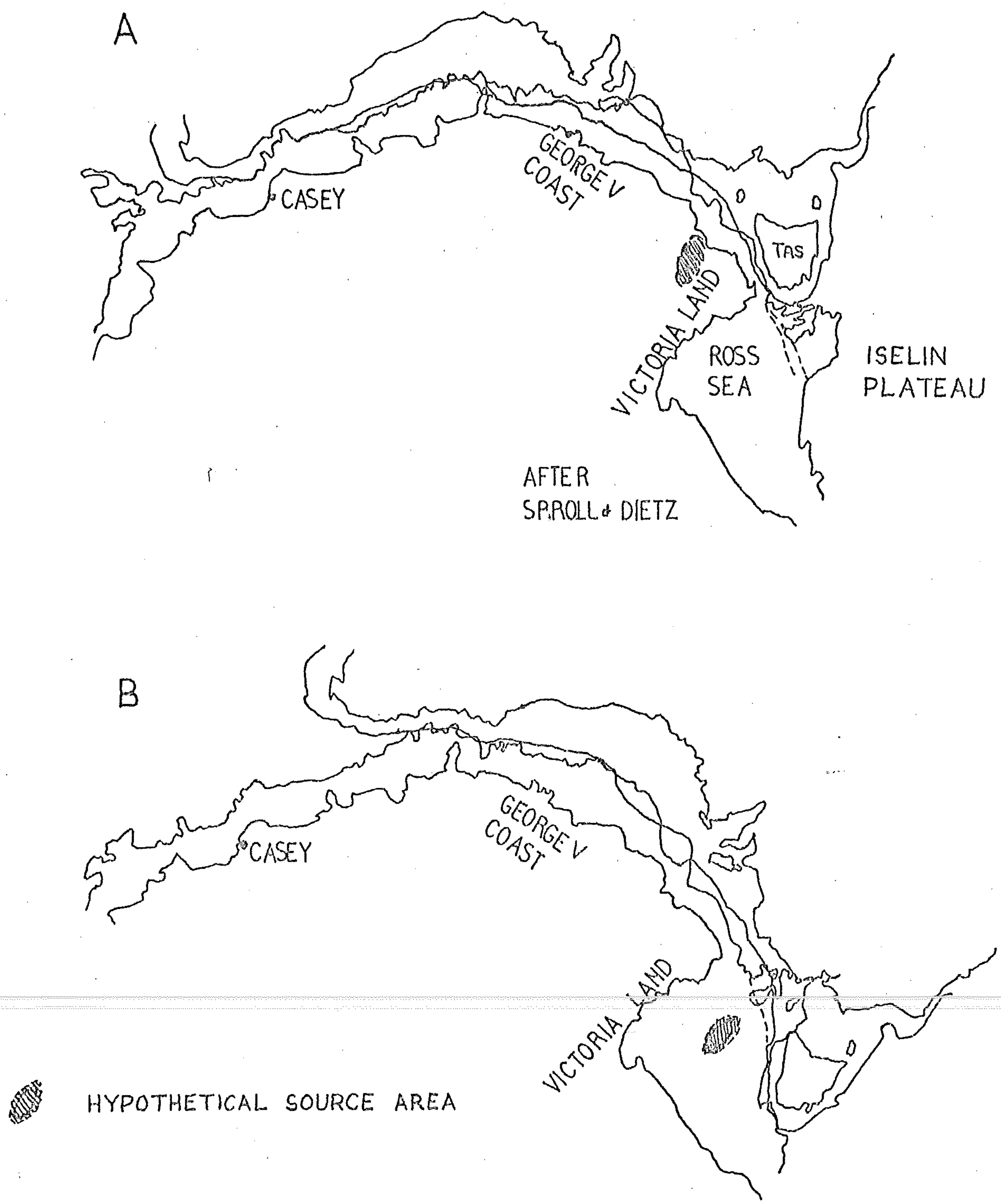
SOURCE AREAS

The ice movement data for the Permian suggests the existence of an ice sheet centred south of Portland, Victoria, and west of Queenstown, Tasmania, off the present Australian continental shelf edge. This has suggested the existence of a former land mass in this area (Officer, Balfour & Hogg, 1896; Howchin, 1926; David & Browne, 1950). Earlier workers have either postulated mountains raised from the sea floor (Howchin, 1926) or the presence of an extension of Antarctica (Officer et al., 1896). The theory of continental drift would suggest that Antarctica and Australia were joined in Palaeozoic times.

If the ice sheet had such a centre, it should be possible to locate this source area using pre-drift reconstructions of these continents. The reconstruction of Sproll and Dietz (1969) would place the inferred centre close to the Oates Coast. Other possibilities are shown in Figure 4.

In South Australia, the data would suggest that the ice flowed over the area now overlain by the sediments of the Murray and Otway Basins. Therefore it would seem likely that exotic erratics found on Fleurieu Peninsula had been derived from the basement underlying the Murray and Otway Basins, areas now lying on continental shelves and the source area of the ice sheet. It might also be expected that if erratics were derived from the ice sheet centre that they would be found in Victoria and Tasmania as well as South Australia.

In Victoria Scott (1937) has recorded the presence of Garnet Granites, tourmaline and topaz bearing greissen, quartz and felspar porphyries, rhyolites including resilicified aegirine rhyolite, andalusite garnet tourmaline rock, gneiss, schist and hornfels. He was unable to assign sources to many of these although some were distinctive because of Mesozoic and Tertiary cover south-west of Bacchus Marsh.



AUSTRALIA - ANTARCTIC RECONSTRUCTIONS

B made assuming Iselin plateau to be post drift.

FIGURE 4

In Tasmania most of the erratics resemble the older rocks of western Tasmania except for some high grade metamorphics and garnet bearing schists (D. Leamon, pers. comm. 1968; in Crowell & Frakes, 1971). No garnet bearing erratics have been found in this study, but Dr. N. H. Ludbrook records that pink garnets are common in local Permian sediments (in Coats, 1964).

Murray and Otway Basins

Sprigg (1942) and Horwitz have suggested the outcropping igneous rocks on the Padthaway Ridge as the source for some of the erratics. The igneous rocks have been described by Mawson et al. (1943, 1944, 1945) and more recently by Henstridge (1970). The rocks belong to the Murray Bridge Granite suite except for the adamellites which may belong to the Victor Harbour suite, and consist of granites, adamellites, microgranites, quartz felspar porphyries and rhyolites. They contain apatite, fluorite, epidote as accessory minerals. The Papineau Rocks rhyolite may be a welded tuff (see Appendix III). These rocks appear to intrude low grade metasediments, which have been compared to the Kanmantoo Group. They consist of meta-sandstones and meta-greywackes, phyllites and schists with rare calcareous bands. In Kalangadoo No. 1 bedrock consisted of practically unmetamorphosed red siltstone which passed down to a phyllite at depth.

Mt. Monster porphyry or any other South-Eastern extrusive rock was not found amongst the erratics. Possibly this may be due to the direction of movement of the ice which eroded these areas. If the direction of movement had been more northerly than that seen in the southern Mt. Lofty Ranges, then the Mt. Monster porphyry would have been carried north outside the present outcropping area of Permian sediments (see Figure 1).

Apart from a hypersthene bearing dacite in Robertson No. 1, no basic or intermediate extrusive rocks are known in this area.

The known geology of the area does not account for the quartz arenite, arkosic erratics, gneisses, nor all of the extrusive rocks. It may be argued that later cover obscures gneissic rocks and all but a few types of igneous rocks and the erratics were derived from these unknown basement lithologies. A sedimentary sequence similar to that seen in the erratics may have been formed if the area was uplifted in Ordivician or Devonian times, with volcanic rock fragments derived from the rhyolites etc.

WESTERN VICTORIA

This region has a geological history of several orogenic episodes, but because of lack of outcrop is rather poorly known. The oldest rocks in the region form the Glenelg River complex (Wells, 1956) of unknown (probably pre-Ordivician) age. These consist mainly of pelites and include some andalusite, staurolite or almendine bearing rocks. They are intruded by the Dergholm Granite which appears to be related to the Murray Bridge Granite suite. Ordivician slates and possible Cambrian greenstones occur in a belt running through Mt. Stavely-Mt. Drummond. These are overlain by the Upper Devonian Rocklands Rhyolites, which include spherulitic rhyolites, tuffs, rhyodacites and rare trachyte. They are overlain by the Grampians Group arenites. Post-Grampians Group granodiorites and porphyries occur.

A quartz felspar porphyry outcropping near Hamilton, Victoria is similar to several erratics, A345/10 and A345/70. The extent of this porphyry is not known because of Tertiary cover. Possibly this area may have supplied some igneous and metamorphic erratics;

The sedimentary erratics do not resemble Grampians Group lithologies in the Departmental collection.

TASMANIA

In western Tasmania there is an older and younger Precambrian series of metaquartzites, schists and dolomites. The Cambrian consists of a sequence including the Mt. Read Volcanics and overlying siltstone, shale with some carbonate, chert including chert breccia. Overlying this disconformably are coarse breccias and conglomerates, including abundant volcanic rock fragments etc. These pass up to a thick clastic sequence with some prominent limestones.

Tasmania could have supplied the igneous and sedimentary erratics and some of the metamorphic erratics.

ANTARCTICA

The fits made between Australia and Antarctica indicate the source lay in northern Victoria Land or possibly on an unknown part of the Antarctic continental shelf. Parts of this coast are poorly known, being mainly ice covered. The main elements are a Precambrian metamorphic complex, the Wilson Group of garnet gneisses, migmatites, biotite schists. In the east is a great thickness of metagreywackes and phyllites, the Robertson Bay Group. A lower Palaeozoic (?) series of quartzites, conglomerate, shales, carbonates, tuffs and agglomerates called the Bowers Group occurs in a faulted slice.

The area is intruded by the Granite Harbour intrusives of Ordivician age and the Admiralty intrusives of Carboniferous to Devonian age, both being mainly biotite granites and granodiorites. The Gallipoli porphyries are an extrusive equivalent of the Admiralty intrusives, consisting of porphyritic rhyolites (Gair, Sturm, Carryer & Grindley, 1970).

It can be seen that this area could supply many of the erratics of all types.

Conclusion

It may be seen that these regions adjacent to the hypothetical source area could have supplied many of the erratics. With only the literature as a basis for comparison, it may not be possible to find a source for many of the exotic erratics. A study of the Tasmanian and Victorian exotic erratics seems to be the most promising approach. If the same lithologies found in South Australia can be found at these localities, this would support a central source concept for the exotic erratics. If these lithologies were not found elsewhere, then this would reduce the size of the probable source area.

A geochemical study of the igneous erratics may clarify their relationships as an igneous assemblage and may permit a better comparison with local igneous suites.

CONCLUSION

The sediment in the Troubridge Basin show complex facies relationships. Non-marine sandy beds predominate, but aeolian and brackish water facies occur. Further sedimentological studies could clarify the nature of some boulder bearing beds.

The ice travelled over part of the basement of the present Murray Basin, from which some of the exotics have been derived. Most boreholes reaching bedrock met either Kanmantoo-like schists or phyllites or granites. If metamorphism was not uniform and a gneissic terrain occurred or there were "Archaean" inliers, the metamorphic erratics could be accounted for. The igneous erratics might be explained as unexposed members of the igneous suite of the Padthaway Ridge, and the sedimentary erratics as coming from a sequence which formed in response to uplift of the area, possibly contemporaneous with movements in the Tasman Geosyncline. However, similar arguments can be made in support of Victoria, Tasmania, Antarctica and areas now lying on the continental shelves as source areas.

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B.P.N.L. Edithburgh No. 1
Alliance Kalangadoo No. 1
A.O.D.A.N.L. Robertson No. 1

PLATE 1

A View of Sugarloaf from the north showing irregular contact between Sugarloaf Sand and the Amphitheatre beds. Note small fault displacing prominent shale band.

B View of Upper varved shale band, Amphitheatre beds, showing dropstones and the angular relationships between beds.

C The Upper 12m. of the Amphitheatre beds, showing faulting. The Pliocene limestone forms the prominent ledge in the upper left corner of the photo.

D Detail of angular relationship of varved overlying beds in varved band below Sugarloaf. Possibly due to the formation of miniature turbidite (varve) fans.

PLATE I

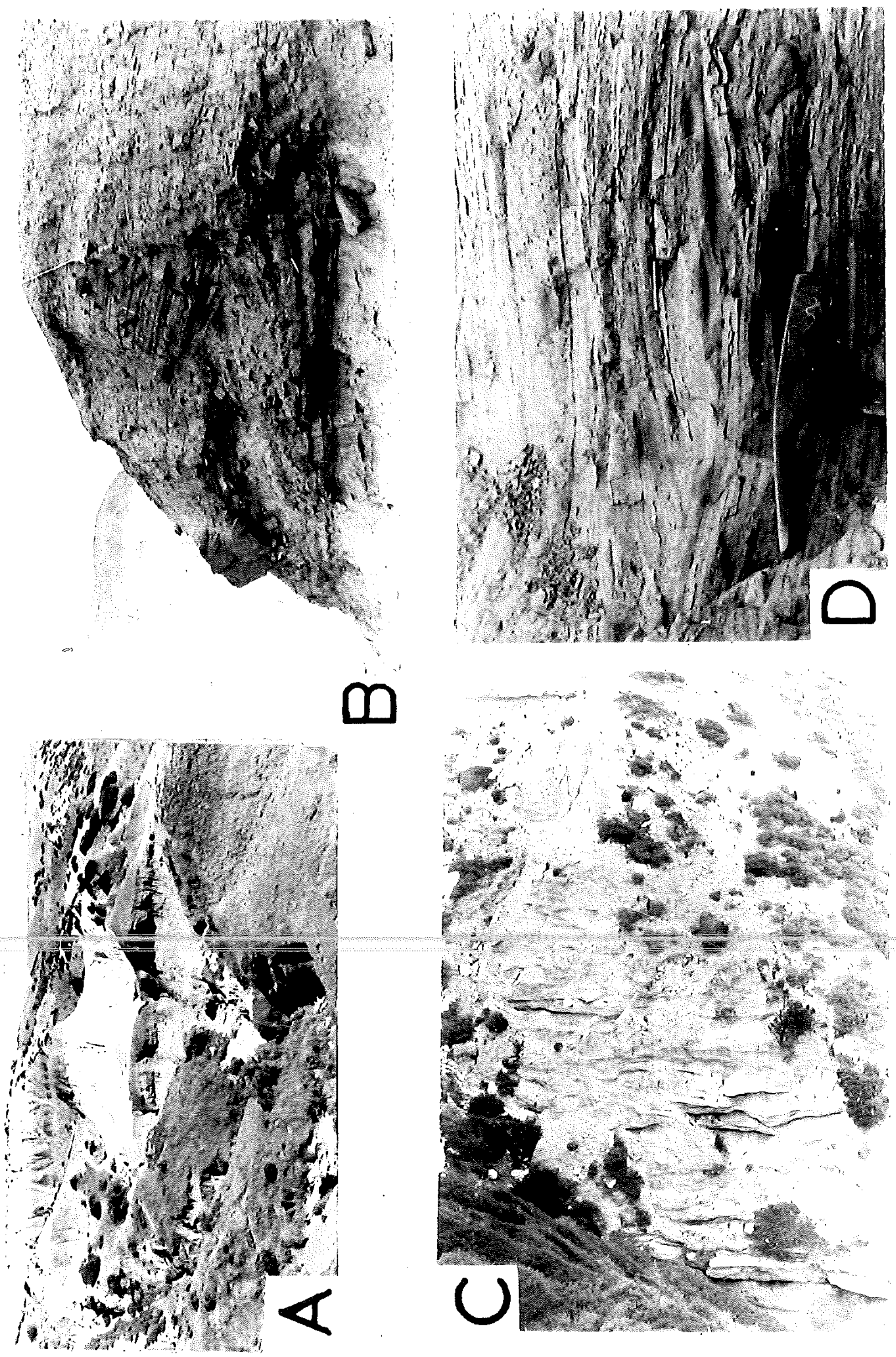


PLATE 2

A Ball and pillow structure, Sugarloaf Creek, 8m. from the base of the section, in a turbidite band, Amphitheatre beds.

B Dropped boulder, Amphitheatre beds, prominent outcrop near track. Note contortion of strata near hammer.

C Base of varve (turbidite) near hammer, iron stained coarse sand grading up to silt, containing slump rolls of shale. Prominent outcrop near track.

D Irregular contact at the base of a varve (turbidite).

PLATE 2

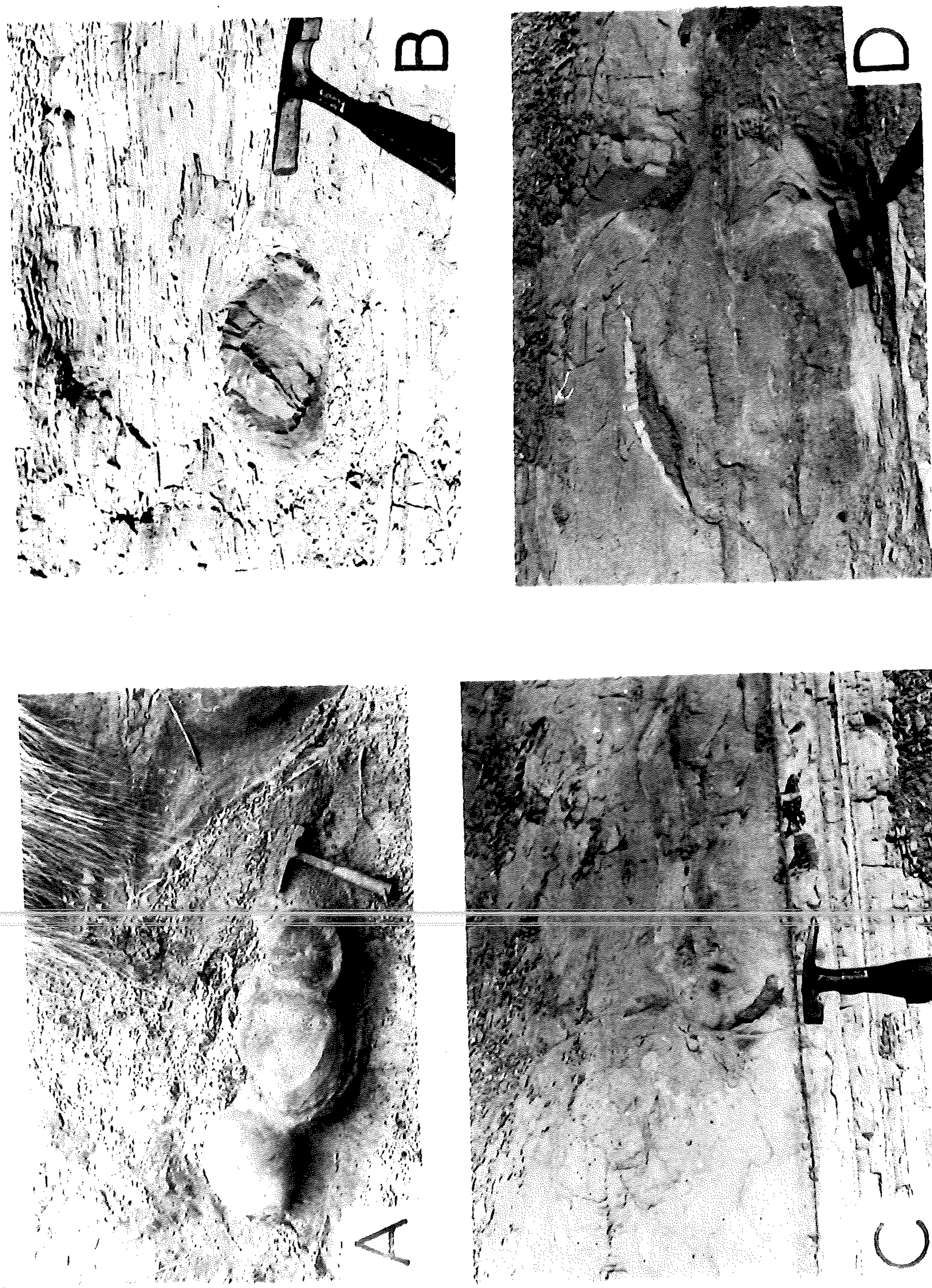


PLATE 3

A Coarse sand bed containing abundant shale fragments. Below beach, Hallett Cove.

B Base of scour channel, below beach, Hallett Cove.

C Interbedded sandy conglomerates and sands, braided stream or alluvial fan deposit. South of Hallett Creek.

D Sands and interbedded channel conglomerates, abutting Kanmantoo schists, Tookayerta quarry.

PLATE 3

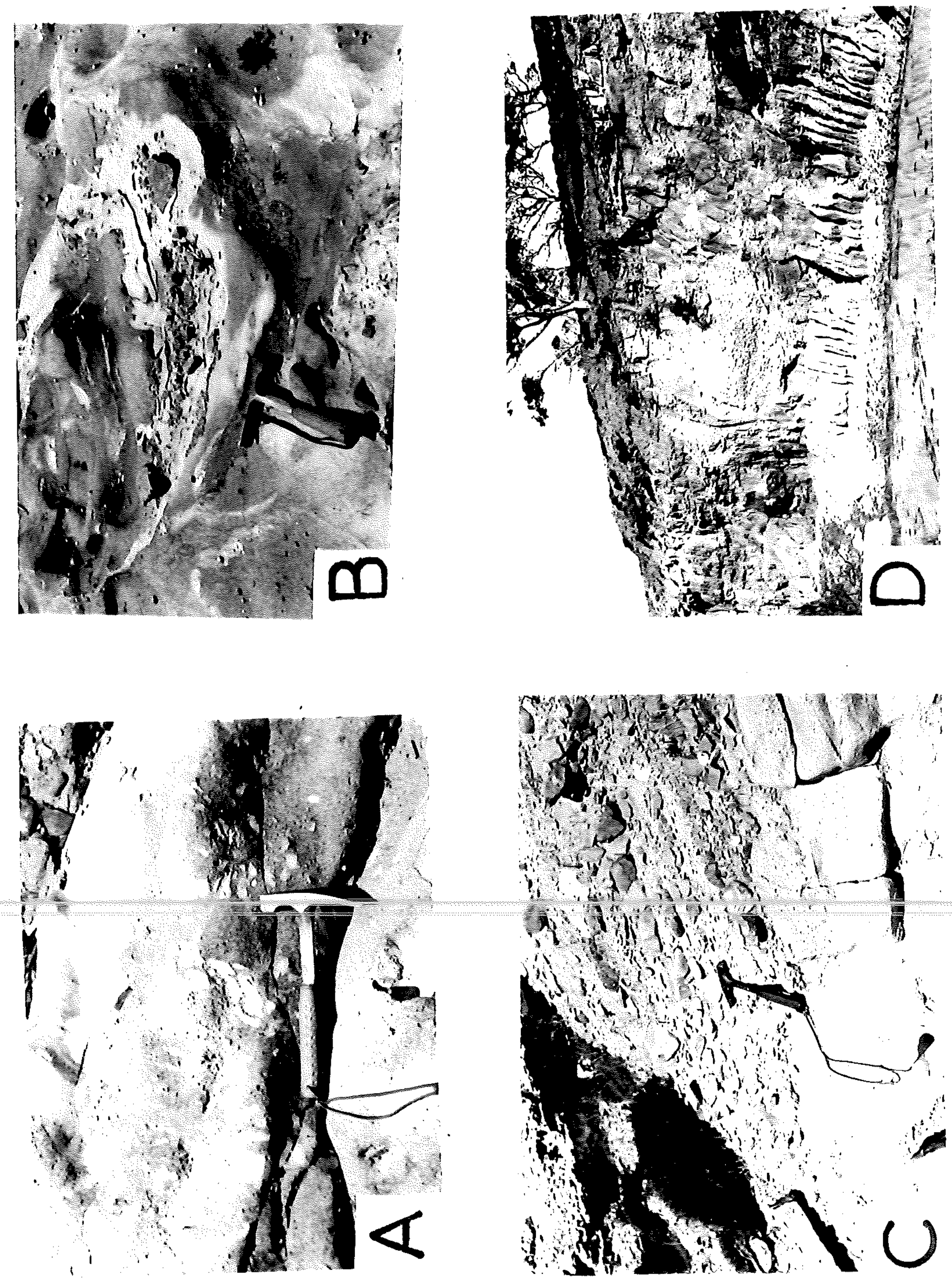


PLATE 4

A Diamictite with sharp lower contact overlying siltstone. Unit 2, Cape Jervis.

B Diamictite with sharp contact of boulder bearing layer overlying a similar claystone bed. Unit 2, Cape Jervis.

C Lower bed of shale casts at the base of a small channel. Tooperang quarry.

D Contorted and slumped sand and silt beds. Tooperang quarry.

PLATE 4

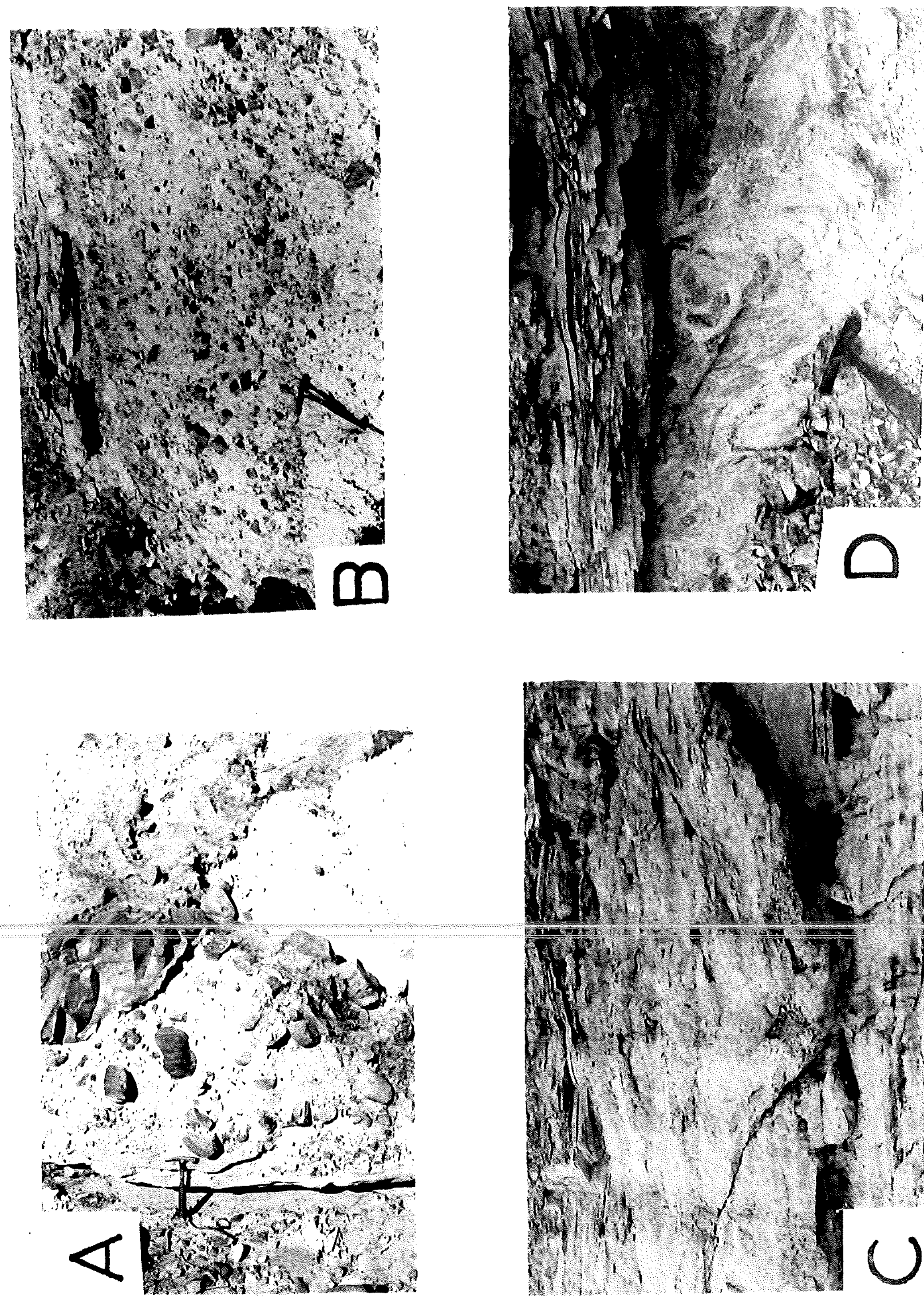


PLATE 5

A A345/504. Mylonite 10x showing ribbon texture.

B A345/283. Volcarenite 10x showing subangular grains of devitrified volcanic rock fragments.

C A345/498. Biotite hornblende hypersthene dacite 10x. Note corroded prism of hypersthene with prominent reaction rim.

D A345/175. Welded tuff 10x. Note fragmental texture of the rock.

PLATE 5

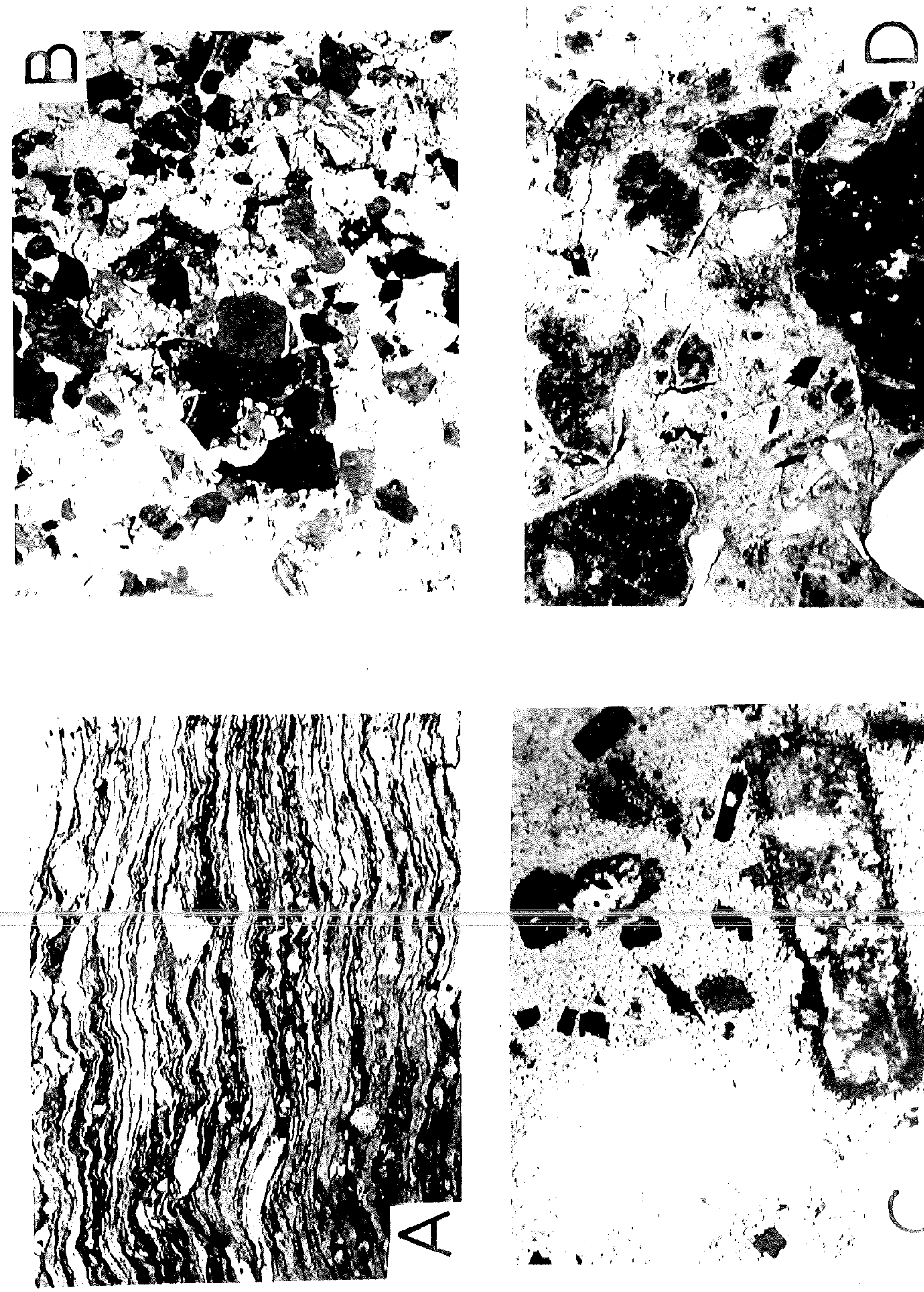


PLATE 6

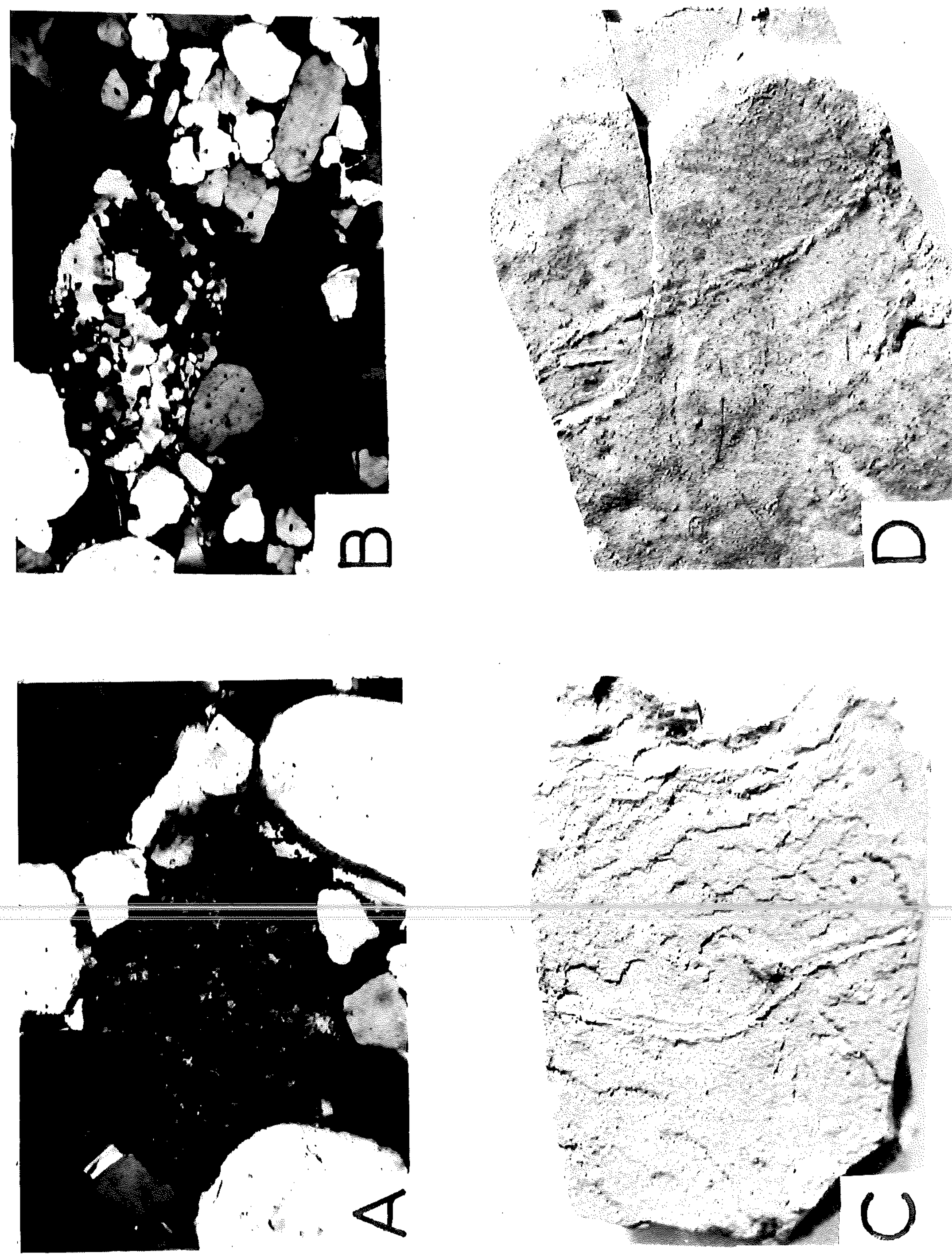
A A345/450. 60x. A devitrified volcanic rock fragment in a quartz arenite.

B A345/450. 60x. A metaquartzite grain in a quartz arenite.

C A345/Plb. 1.1x. Form B, *Gyrochorte*, impression on overlying bed.

D A345/P2. 1x. Form b, *Gyrochorte*, lower surface of bed, showing chevron marks, and the furrowed nature of the trace.

PLATE 6



APPENDIX 1

THIN SECTION DESCRIPTIONS

AND

HAND SPECIMEN DESCRIPTIONS

APPENDIX 1

IGNEOUS ROCKS

BASIC ROCKS

8135 THOLEIITIC BASALT

Locality: Hallett Cove

Micro: Porphyritic, phenocrysts of plagioclase and pyroxene in a groundmass of similar composition. Pilotaxitic.

Composition: Plagioclase: 40-50%, phenocrysts 3.0-.3mm. Also in groundmass ~ .05mm. 30-40% of groundmass. Subhedral-euhedral, rimmed grains. Albite, pericline twinning. An60.
Pyroxene: 45-55%. Rare phenocrysts, 2.0-.4mm. In groundmass ~ .05mm. Two varieties, augite, dark green, inclined extinction. Hypersthene (or enstatite), straight extinction.
Chlorite: $<$ 1%, light green, leafy flakes. Groundmass, 60-65%, ~ .05mm., hypidiomorphic, pilotaxitic.

A345/44 HORNBLENDE ANDESITE

Locality: Petrel Cove

Macro: Dark blue porphyry, with streaky plagioclase, biotite phenocrysts. Aphanitic groundmass. No obvious potash felspar.

Micro: Porphyritic, microcrystalline groundmass, containing no obvious quartz.

Composition: Plagioclase: 20-25% phenocrysts, 2.0-.5mm. Euhedral, zoned laths, corroded centres.
Biotite: 3-5%. Red-brown flakes and blades ~2.0-.5mm. long. Pleochroic haloes.
Hornblende: 2-3%, 1.2-.5mm. Euhedral, stubby prisms. Dark green, pleochroic. Two cleavages at 120°.
Chlorite: 1-2%. Green, ragged flakes in groundmass.
Groundmass: 70-80% microcrystalline, ~.05-.03mm. Contains sericite, chlorite, felspar, biotite.
Accessories: Opaques, sphene, apatite.

DACITES

A345/498 HYPERSTHENE HORNBLENDE DACITE

Locality: Kuitpo Forest

Macro: Dark blue porphyry, with aphanitic groundmass, phenocrysts of plagioclase, biotite. Staining with sodium cobaltinitrite shows rare potash felspar phenocrysts, rare quartz phenocrysts.

Micro: Porphyritic, microcrystalline. No quartz phenocrysts in slide, but quartz appears to be present in groundmass. Pilotaxitic.

Composition: Plagioclase: 25-35%, 10.0-.1mm. Phenocrysts. Euhedral-subhedral, albite, pericline twinning. An50-60. Zoned, with corroded centres. Occurs in groups. Cloudy alteration, iron stained. Also in groundmass.

Hornblende: 5-7%, 4.0-.4mm. Euhedral-subhedral. Dark green, pleochroic, $\gamma \wedge C = 15$, twinned. Two cleavages at 120°. Being replaced by biotite, chlorite.

Hypersthene: 5%, 5.0-.3mm. Euhedral-subhedral. Light green, with straight extinction. Surrounded by reaction coronas of pigeonite or chlorite. Commonly highly altered.

Biotite: 4-6%. Ragged, brown flakes, red-brown hexagons. Containing inclusions of plagioclase. Hexagons after hornblende?

Chlorite: 1%. Green, ragged leafy flakes. Occurs as an alteration product.

Groundmass: 55-65%. Microcrystalline, ~ .05mm. Quartz-plagioclase-mafics. Shows flow alignment.

A345/512 DACITE

Locality: Hallett Cove

Macro: Dark blue porphyritic rock, aphanitic groundmass, plagioclase, biotite phenocrysts. Rare pyroxene? phenocrysts.

Micro: Porphyritic, microcrystalline groundmass, ~ .01-.02mm.

Composition: Quartz: 15%. Rare phenocrysts. 25-30% of groundmass. .4-.1mm. Euhedral to anhedral. Composite grains with sutured boundaries. Undulose extinction.

Plagioclase: 20-30%. Abundant phenocrysts. 50% of groundmass. 3.0-.4mm. Euhedral to subhedral, laths, stubby prisms. Albite, pericline twinning. Zoned crystals, corroded cores. An55? Cloudy alteration, some sericitization.

Biotite: 3-5%. Ragged, light brown pleochroic flakes ~.4mm. long.
Remnants of pyroxene? Squarish prisms, chloritized. 2-3%.
Accessories: Apatite, sericite, chlorite.

A345/45 DACITE

Locality: Petrel Cove

Macro: Porphyry, dark blue aphanitic groundmass, plagioclase, biotite phenocrysts.

Micro: Porphyritic, feathery microcrystalline groundmass, slightly pilotaxitic. Devitrified groundmass?

Composition: Quartz: 5% phenocrysts .3-.1mm. Angular, subhedral, clear. Occurs in groups.
Plagioclase: 15-20% phenocrysts. Also large amount present in groundmass. Laths 3.0-.4mm. Zoned, corroded cores. Some occur in groups. Albite, pericline, carlsbad twinning.
Biotite: 5-7%, .3-1.0mm. blades. Light yellow, reddish brown. Pleochroic haloes.
Chlorite: 2-3%. Irregular ragged flakes in groundmass.
Groundmass: 60-70%
Accessories: Apatite, zircon, sericite.

Comments: Superficially similar to A345/44, but lacks hornblende and contains quartz.

A345/183 DACITE

Locality: Christmas Cove, Penneshaw, Kangaroo Island.

Macro: Dark red, aphanitic felspar mafic porphyry. Mottled weathering.

Micro: Porphyritic, devitrified groundmass. Phenocrysts occur in groups, almost glomeroporphyritic. Groundmass 65-70%.

Composition: Quartz: 5-7%, .3-.5mm. Anhedral, sutured boundaries, composite grains. Clear, with some undulose extinction.
Potash felspar: 3-5% phenocrysts, .4-.6mm. Cloudy, euhedral untwinned crystals.
Plagioclase: 17-22%, .5-4.0mm. Laths, euhedral to subhedral. Albite, pericline twinning, An50. Cloudy alteration.
Epidote: 3-5%, 1.0-.4mm. Euhedral to subhedral grains. Alteration product of an earlier mafic, associated with chlorite, included within felspar.
Chlorite: 3-5%, 2.0-.5mm. Dark green, pleochroic flakes. After hornblende?
Accessories: Opaques, apatite, haematite.

A345/382 DACITE

Locality: Smith Bay, Kangaroo Island

Macro: Melanocratic rock, porphyritic, blue quartz, brown felspar phenocrysts. Biotite? in groundmass.

Micro: Porphyritic, devitrified myrmekitic groundmass. A large amount of secondary alteration has occurred, possibly low grade metamorphism.

Composition: Quartz: 10-13%, 4.0-.1mm. Subhedral-anhedral, irregular, sutured boundaries. Embayed grains, with fine inclusion trains. Undulose extinction.
Potash felspar: 5-7%, .8-.4mm. Anhedral-subhedral, untwinned poikilitic grains. Also in groundmass as myrmekite.
Plagioclase: 20-22%, 4.0-.5mm. phenocrysts. Euhedral to subhedral, poikilitic grains. Albite, pericline and Carlsbad twinning. Cloudy alteration.
Epidote: 4-5%, .8-.3mm. Subhedral. Occurs in aggregates associated with chlorite. An alteration product.
Chlorite: 15-20%, .2-.6mm. Fibrous, brown, ragged pleochroic flakes. Replacing ? biotite.
Accessories: Sphene, biotite, zircon.

Comments: The epidote may be an alteration product of a calcic mafic mineral, but may also be due to low grade metamorphism.

A345/513 DACITE or RHYODACITE

Locality: Hallett Cove, southern area

Macro: Dark grey-blue aphanitic groundmass, scarce phenocrysts of quartz, felspar.

Micro: Porphyritic, microcrystalline devitrified groundmass, almost spherulitic in places. "Clouds" of chlorite needles surrounding some plagioclase phenocrysts. Relict earlier mafic mineral, with reaction rims, replaced by chlorite.

Composition: Quartz: 7-8%, 2.0-.4mm. Clear, rounded phenocrysts. Euhedral to subhedral.
Potash felspar: 5%, 2.0-1.0mm. Rounded, subhedral. Anorthoclase, cross hatched. Cloudy alteration.
Plagioclase: 10-15%, 2.0-.3mm. Euhedral to subhedral, laths, stubby prisms. Zoned crystals. Albite, pericline twinning. Some cloudy alteration, sericitization.

Biotite: 3%, 3.0-.5mm. Red brown, light yellow flakes, blades.
Chlorite: 3%. Brown, green flakes. Pleochroic haloes. After earlier mafic mineral.
Accessories: Apatite, epidote, fluorite.

RHYODACITES

A345/359 RHYODACITE

Locality: Smith Bay, Kangaroo Island

Macro: Coarse porphyritic rock, red-brown aphanitic groundmass, quartz, felspar phenocrysts.

Micro: Porphyritic, microcrystalline groundmass. Weak flow alignment.

Composition: Groundmass: 65-75%. Microcrystalline, ~.02mm. Equant, hypidiomorphic, quartz-felspar-chlorite etc.
Quartz: 10% phenocrysts. 5.0-.1mm. Clear subhedral, embayed grains, with fine inclusion trains. Fractured grains.
Orthoclase: 10-15% phenocrysts, 5.0-.3mm. Euhedral to subhedral. Carlsbad, baveno twinning. Cloudy alteration. Some graphic intergrowths with quartz.
Plagioclase: 10-15% phenocrysts, 5.0-.4mm. Euhedral to subhedral, zoned crystals, diffuse albite twinning. Some aggregates occur.
Biotite: 3-5%. Flakes $\lesssim$ 2mm. long. Pleochroic haloes.
Chlorite: 1-2%. Green, pleochroic, leafy flakes. Replacing earlier mafic mineral.
Accessories: Opaques, zircon (euhedral), fluorite.

A345/15 RHYODACITE

Locality: Petrel Cove

Macro: Grey porphyry, with coarse red felspar, quartz, biotite phenocrysts.

Micro: Porphyritic, microcrystalline groundmass.

Composition: Quartz: 10-12% phenocrysts, 4.0-.1mm. Euhedral to subhedral, embayed grains with fine inclusion trains. Undulose extinction.
Potash felspar: 10-15%, phenocrysts, 15.0-2.0mm. Euhedral to subhedral. ~~Albite, pericline~~ Carlsbad twinning, undulose extinction. Cloudy alteration.
Plagioclase: 20-27%, phenocrysts, 4.0-.2mm. Euhedral to subhedral. Albite, pericline twinning, zoned crystals with corroded cores. Occurs in groups, clumps. Cloudy alteration, sericitization.
Biotite: 5%. Ragged brown flakes. Corroded edges. Knots, after earlier mafic mineral? Replacing hornblende?
Accessories: Opaques, apatite, fluorite, chlorite, zircon.
Groundmass: ~55-65%, probably rhyodacitic in composition.

A345/28 RHYODACITE

Locality: Petrel Cove

Macro: Porphyritic rock, brown aphanitic groundmass, red and green felspar phenocrysts. Coarse, pink felspar phenocryst.

Micro: Porphyritic, cryptocrystalline, devitrified groundmass. Graphic intergrowths, myrmekitic.

Composition: Quartz: 7-10%, 1.0-.2m, rare phenocrysts, graphic intergrowths. Embayed grains. $\geqslant$ .01mm. in groundmass. Undulose extinction.
Potash felspar: 15-20%, 15.0-.4mm. Subhedral to euhedral. Turbid grains. Orthoclase.
Plagioclase: 10-15%, phenocrysts, 1.0-.5mm. Subhedral to euhedral. Albite twinning. Sericitized.
Chlorite: $<$1%. Green, leafy flakes. Present as alteration product.
Groundmass: 70-80%. Devitrified, myrmekitic.

A345/339 RHYODACITE

Locality: Smith Bay, Kangaroo Island

Macro: Porphyry, black aphanitic groundmass, with blue quartz, pink felspar phenocrysts. Phenocrysts of plagioclase, potash felspar.

Micro: Porphyritic, microcrystalline groundmass.

Composition: Quartz: 10%, phenocrysts, 4.0-.3mm. Euhedral to subhedral. Embayed, with fine inclusion trains.
Potash felspar: 12-17%, phenocrysts, 4.5-.4mm. Euhedral to subhedral. Carlsbad twinning. Slightly poikilitic, inclusions of chlorite, epidote. Turbid, sericitized grains.
Plagioclase: 10-12%, phenocrysts, 4.0-.3mm. Euhedral, some laths. Rimmed, zoned crystals, corroded cores. Albite, pericline twinning, An40.
Chlorite: 3-5%, .2-.05mm. Leafy flakes, in knots, after earlier mafic mineral?
Groundmass: 60-70%. Microcrystalline, equigranular $\sim$ .01mm. Subhedral mosaic of quartz, felspar, chlorite, sericite.
Accessories: Sphene, apatite, epidote.

A345/464 RHYODACITE

Locality: King's Point

Macro: Melanocratic porphyry, with aphanitic groundmass, blue quartz, felspar phenocrysts.

Micro: Porphyritic, holocrystalline, microcrystalline groundmass. Dark colour due to chlorite knots in groundmass.

Composition: Quartz: 15-20%, phenocrysts, 3.0-.01mm. Subhedral, rounded grains with fine inclusions. Undulose extinction.
Potash felspar: 12-18%, 1.0-.01mm. Subhedral to anhedral. Cloudy alteration, some sericitization.
Plagioclase: 18-22%, phenocrysts, 4.0-.3mm. Euhedral to subhedral. Albite, pericline twinning, zoned crystals. Highly sericitized.
Chlorite: 3-6%. Leafy ragged flakes in concentrations.
Accessories: Apatite, epidote, zircon.

Comments: Skeletal arrangements of chlorite, probably after an earlier mafic mineral.

A345/509 RHYODACITE

Locality: Hallett Cove

Macro: Porphyry, green aphanitic groundmass, phenocrysts of potash felspar (red), plagioclase, quartz.

Micro: Porphyritic, devitrified. Flow alignment of phenocrysts, groundmass. Groundmass 65-75% of rock.

Composition: Quartz: 15-18%, .3-.1mm. Subhedral to anhedral. Some myrmekitic intergrowths. In groundmass.
Potash felspar: 15-20%, phenocrysts, 6.0-3.0mm. Euhedral to subhedral. Carlsbad twinning. Orthoclase.
Plagioclase: 20-25%, 4.0-.5mm. Euhedral to subhedral. Laths, zoned crystals. Albite, pericline twinning. Cloudy alteration. Some occur in groups.
Biotite: 2-3%, red brown flakes, .5mm. long.
Hornblende: 3%, green pleochroic prisms, length fast, $\gamma \wedge c = 17^{\circ}$. Some replacement by chlorite.
Chlorite: 1-3%. Ragged flakes in groundmass, knots after hornblende or a pyroxene.
Accessories: Zircon, sericite, opaques.

A345/514 RHYODACITE

Locality: Hallett Cove, southern end

Macro: Dark brown quartz felspar biotite porphyry, aphanitic groundmass. Phenocrysts of potash felspar, plagioclase.

Micro: Porphyritic, microcrystalline groundmass, 65-70% of rock.

Composition: Quartz: 5-6%, phenocrysts, 4.0-.4mm. Composite grains, straight extinction. Euhedral to subhedral.
Potash felspar: 12-15%, 6.0-2.0mm. Euhedral to subhedral. Orthoclase. Carlsbad twinning. Slight cloudy alteration. Inclusions of quartz, plagioclase.
Plagioclase: 10-12%, 3.0-.5mm. Euhedral to subhedral. Laths, albite, pericline twinning, some zoned. Cloudy alteration.
Biotite: 3-4%. Brown, pleochroic flakes.
Chlorite: 2-3%. Green leafy flakes, replacing biotite.
Accessories: Opaques, apatite, zircon, fluorite.

A345/516 RHYODACITE or RHYOLITE

Locality: Hallett Cove

Macro: Light brown quartz-potash felspar-plagioclase-hornblende? porphyry. Aphanitic groundmass.

Micro: Porphyritic, devitrified, myrmekitic, microcrystalline groundmass.

Composition: Quartz: 15-18%, 3.0-.2mm. Euhedral to subhedral. Embayed phenocrysts, with fine inclusion trains. Plumose intergrowths in groundmass.
Potash felspar: 16-20%, 4.0-.3mm. Euhedral to subhedral. Carlsbad twinning. Turbid crystals.
Plagioclase: 10-13%, 3.0-.4mm. Euhedral to subhedral. Laths, albite, pericline twinning. Highly altered, turbid, sericitized crystals.
Biotite: 2%. Light yellow, ragged flakes.
Chlorite: 2-4%. Green, ragged, leafy flakes. After hornblende?
Accessories: Zircon, sphene, apatite.

RHYOLITES

A345/515 RHYOLITE

Locality: Hallett Cove

Macro: Brown, flow banded quartz felspar porphyry, aphanitic groundmass.

Micro: Porphyritic. Devitrified, microcrystalline groundmass. Flow layering defined by layers of replaced mafic mineral. Angular shard like phenocrysts. Possible welded? shards?

Composition: Quartz: 5-7%, .7-.1mm. Subhedral to euhedral. Clear, embayed, with strain shadows. Some graphic intergrowths.
Potash felspar: 10-13%, 3.0-.4mm. Subhedral to euhedral. Orthoclase, anorthoclase, cross hatched. Embayed, cloudy phenocrysts.
Plagioclase: 5-8%, 1.0-.5mm. Subhedral. Albite twinning. Turbid, slightly poikilitic phenocrysts.
Chlorite: 2-3%. Ragged flakes, ~ .1-.2mm. Altered.
Groundmass: 65-70%. Quartz-felspar mosaic. Devitrified, iron stained.
Accessories: Sphene, zircon, opaques, sericite.

A345/501 PORPHYRITIC RHYOLITE

Locality: Cape Jervis

Macro: Liver coloured, flow banded, vesicular porphyry.

Micro: Porphyritic, devitrified flow banded. Vesicles filled with chalcedony, calcite. Cut by later quartz veins.

Composition: Quartz: 15-20%, .8-.1mm. Vein filling, comb structure. Vesicle filling.
Potash felspar: 22-27%, 7.0-.8mm. phenocrysts, brick red. Euhedral, some angular, shard like. Cloudy, sericitized. Some orthoclase.
Groundmass: 65-75%. Felsitic, cryptocrystalline.
Accessories: Calcite, opaques, chlorite, sericite, zircon.

A345/474 RHYOLITE

Locality: King's Point

Macro: Schistose porphyry, red felspar phenocrysts.

Micro: Porphyritic, holocrystalline, fine grained groundmass. Preferred orientation of chlorites in groundmass. Layering bends around phenocrysts, strain shadows of quartz around phenocrysts. Quartz phenocrysts strung out into blebs, composite grains.

Composition: Quartz: 8-10%, 2.0-.01mm. phenocrysts. 25-30% in groundmass. Elongate grains. Subhedral to anhedral. Some undulose extinction.
Potash felspar: 10-15% phenocrysts, 30-35% in groundmass. 3.0-.05mm. Anorthoclase-cross hatched in strain shadows. Untwinned in groundmass. Phenocrysts cloudy.
Plagioclase: 5% phenocrysts. Cloudy, sericitized, poikilitic. Albite twinning.
Chlorite: 3-5%. Green needles in groundmass. Elongate knots along layering, after an earlier mafic mineral.
Accessories: Zircon, muscovite, apatite, opaques.

Comments: Possibly a deformed, recrystallized rhyolitic rock.

A345/368 RHYOLITE

Locality: Smith Bay, Kangaroo Island

Macro: Grey aphanitic, blue quartz felspar porphyry.

Micro: Devitrified, microcrystalline, myrmekitic. Relict flow layering. One patch of spherulitic devitrification. Porphyritic. Some strain shadows around phenocrysts.

Composition: Quartz: 20-22% phenocrysts 2.0-.2mm. Subhedral to euhedral. Embayed, fractured grains with many fine inclusion trains. Undulose extinction.
Potash felspar: 15-22%, phenocrysts 1.5-.4mm. Subhedral to euhedral, some angular. Carlsbad twinning. Orthoclase. Turbid.
Plagioclase: 5%, phenocrysts. Albite twinning, sericitized.
Groundmass: 65-75%.
Chlorite: 2%. Green leafy flakes, in groundmass.
Accessories: Opaques, muscovite, fluorite.

A345/362 RHYOLITE

Locality: Smith Bay, Kangaroo Island

Macro: Red brown aphanitic quartz felspar porphyry. Angular phenocrysts. Blue quartz phenocrysts.

Micro: Porphyritic. Devitrified, microcrystalline groundmass. Relict flow texture.

Composition: Quartz: 7%, phenocrysts, 3.0-.2mm. Euhedral to subhedral. Clear, embayed crystals. Some undulose extinction.
Plagioclase: 5-7%, phenocrysts, 2.5-.3mm. Euhedral to subhedral. Pericline twinning. Turbid, sericitized crystals.
Potash felspar: 17-20%, phenocrysts, 3.5-.4mm. Anorthoclase, cross-hatched, microperthitic. Embayed. Some orthoclase may be present.
Muscovite: 1%. Stumpy clear plates, mottled extinction. Rimmed by secondary iron oxides.
Chlorite: < 1%. Green leafy flakes.
Accessories: Fluorite, sphene, zircon, opaques.
Groundmass: 65-70% of rock.

Comments: The amount of anorthoclase suggests this rock may be a sodic rhyolite.

A345/70 SPHERULITIC RHYOLITE

Locality: Petrel Cove

Macro: Liver coloured, aphanitic quartz felspar porphyry. Has a wavy layering, flow banding?

Micro: Spherulitic, devitrified groundmass, with coarser laths that project into void like spaces. Spherulites are nucleated on phenocrysts, or on iron stained layers passing through rock.

Composition: Quartz: 8-10%, phenocrysts. Euhedral to subhedral. Embayed. Contains fine inclusion trains. Also in void fillings.
Potash felspar: 10-15%, phenocrysts. Orthoclase or sanidine. Carlsbad, Baveno twinning, 4.0-.6mm. Turbid.
Spherulites - sanidine + cristobalite: 65-75%, 1.5-.3mm. Haematite stained, in rows.
Accessories: Opaques, fluorite, sphene.

Comments: This devitrification texture only occurs in rhyolites and welded tuffs. This rock could be either.

A345/425 SPHERULITIC RHYOLITE or GRANOPHYRE

Locality: King's Point

Macro: Fine grained, spherulitic purple rock.

Micro: Spherulitic texture, consisting of quartz-felspar intergrowths, granophyric to myrmekitic. Rare phenocrysts of quartz and plagioclase.

Composition: Quartz: 5-7%, phenocrysts, .2-.05mm. Clear, subhedral grains.
Plagioclase: 5%, phenocrysts, .1-.2mm. Euhedral. Albite twinning, cloudy crystals.
Spherulites: 85-90%. Graphic, granophyric, plumose, vermicular intergrowths of quartz and orthoclase?
Accessories: Microcline, chlorite, opaques.

Comments: Probably a devitrification texture. It may have recrystallized. It may also be a quenched part of an acidic plutonic intrusion.

A345/43 DEVITRIFIED RHYOLITE

Locality: Petrel Cove

Macro: Grey aphanitic plagioclase biotite porphyry. Flow banded.

Micro: Porphyritic. Devitrified myrmekitic groundmass. Relict layering, flow banding? Extensively altered.

Composition: Quartz: 20-35%, phenocrysts, 5-7%, 1.5-.4mm. Myrmekitic intergrowths, 25-30%. Undulose extinction. Composite grains. Embayed phenocrysts.
Felspar: 15-20%, phenocrysts, 3.0-.5mm. Euhedral, elongate. Highly sericitized. Orthoclase?
Biotite: 7-10%. Dark brown, pleochroic flakes after earlier mafic mineral? 2.0-.3mm. Mottled extinction.
Chlorite: 5%. Dark brown, green leafy flakes.
Muscovite: 1-2%. Clear flakes, mottled extinction.
Accessories: Sphene, zircon, fluorite, opaques.
Groundmass: 65-70% of rock.

TUFFS AND WELDED TUFFS

A345/157 LITHIC TUFF

Locality: Wattle Flat, six miles south of Myponga

Macro: Olive grey, fragmental rock, angular fragments.

Micro: Tuff, trace of layering present. Shards, lapilli 40-45% of rock. Secondary tourmaline replacing some shards.

Composition: Quartz: 15-20%. Fragments, from subhedral grains to angular shards. .3-.01mm.
Lithic fragments: 20-30%, 6.0-.2mm. Fragments of volcanic rocks, tuffs.
Tourmaline: 7%. Needle-like prisms, spherulitic, zoned, pneumatolitic?
Groundmass: 50-60%. Microcrystalline. No sorting, chaotic arrangement of shards. Glass shards may have devitrified.

A345/510 WELDED TUFF

Locality: Hallett Cove, southern part

Macro: Dark green, porphyritic rock, eutaxitic layering, pumice fragments. Felspar phenocrysts.

Micro: Welded tuff, with compacted pumice fragments and abundant shards, phenocrysts of plagioclase, potash felspar. Texture varies with welding, compaction, from vitroclastic to eutaxitic to almost complete obliteration of shards. Devitrified. Angular phenocrysts.

Composition: Potash felspar: 8-12%, phenocrysts, 4.0-.4mm. Subhedral to euhedral. Carlsbad twinning. Cloudy alteration.
Plagioclase: 10-15%, phenocrysts, 4.5-.6mm. Albite, Carlsbad twinning. Cloudy alteration.
Pumice: 20%. Fibrous, patchy angular fragments up to 4cm. long.
Groundmass: 60-70%. Cryptocrystalline, devitrified. Shards often better preserved in the 'lee' of phenocrysts. Green colour. Shards .2-.1mm. long.
Chlorite: 3%. Green, leafy flakes.
Accessories: Opaques.

A345/519 EUTAXITIC WELDED TUFF

Locality: King's Point

Macro: Brick red rock with prominent eutaxitic (streaky) texture.

Micro: A compacted and highly welded tuff. Large streaked out glass shards (fiamme) up to 3cm. long. Large shards recrystallized into a coarse axiolitic texture, red at margins, clear in centres. Some with sericitized or chloritized cores, others have coarsely crystalline cores. Felspars are surrounded by corona like veins. Cryptocrystalline groundmass showing eutaxitic texture. Contains fragments of earlier welded tuffs, less welded than this rock showing vitroclastic texture.

Composition: Plagioclase: 5-10%, .8-.3mm. Euhedral crystals. Albite twinning, pericline twinning. Cloudy alteration, slight sericitization.
Quartz: 5-7%, .7-.2mm. Shards and in recrystallized cores of shards. Subhedral to anhedral.
Potash felspar: 5-10%, 1.0-.2mm. Euhedral to subhedral. Orthoclase? Cloudy alteration, some sericitization.
Chlorite: 3-5%, .6-.2mm. light yellow-green anhedral grains.
Tuff fragments: 3-5%, light red, welded, vitroclastic containing shards.
Groundmass (including welded shards): 80%.

Comments: The eutaxitic and axiolitic textures occur only in welded tuffs and hence are good criteria for the recognition of this rock type.

A345/420 CRYSTAL WELDED TUFF

Locality: King's Point

Macro: Streaky white layering, red and green felspar phenocrysts. Red aphanitic groundmass.

Micro: Eutaxitic (streaky texture). Porphyritic. Devitrified, cryptocrystalline groundmass. Traces of welded shards. Angular crystal shards. Chaotic arrangements of crystals, no sorting. Glass shards completely devitrified. Broken crystals.

Composition: Quartz: 20%, phenocrysts, shards. Euhedral-subhedral. 3.0-.1mm. Embayed, fractured grains. Clear. Some smaller shard shaped, angular crystals.
Potash felspar: 13-17%, phenocrysts, shards, 4.0-.2mm. Carlsbad, Baveno twinning. Cloudy and turbid crystals.
Plagioclase: 5%, crystals, 3.0-.4mm. Euhedral to subhedral. Albite twinning. An60? Highly altered, turbid crystals. More may be present but is made unrecognizable by the alteration.
Altered grains: 15-20%. Original texture obliterated by sericitization.
Mafic: 3-4%, 1.2-.5mm. Euhedral, prismatic. Altered to chlorite and opaques.
Accessories: Leucoxene, zircon, opaques.
Groundmass: 40-50%. Devitrified cryptocrystalline, quartz-felspar intergrowths.

Comments: This rock is considered a welded tuff because of the eutaxitic texture, the traces of shards, and the shard like shapes of the crystals.

A345/175 CRYSTAL TUFF

Locality: Christmas Cove, Penneshaw, Kangaroo Island

Macro: Porphyritic, quartz, felspar phenocrysts, in green aphanitic groundmass. Angular phenocrysts.

Micro: Porphyritic, devitrified cryptocrystalline groundmass, with spherulitic patches, often with chlorite cores. Phenocrysts are angular, with smaller shard shaped grains. Chaotic arrangements of crystals, no sorting.

Composition: Quartz: 20-25%. Crystals, shards. Angular-rounded. Fractured, clear grains with some fine inclusion trains. Some undulose formation.
Potash felspar: 18-22%, 4.0-.1mm. Subhedral-rounded. Embayed, turbid crystals, shards.
Plagioclase: 8-10%, 2.0-.3mm. Subhedral, subangular. Albite, pericline twinning, An50? Turbid altered crystals.
Chlorite: 3-5%. Light yellow-green, cloudy flakes.
Accessories: Sphene, apatite, opaques.

Comments: Considered a tuff because of the shard like crystals, chaotic, fragmental texture.

A345/78 CRYSTAL TUFF

Locality: Petrel Cove

Macro: Porphyritic, pink felspar, quartz phenocrysts. Brown aphanitic groundmass.

Micro: Porphyritic, cryptocrystalline, devitrified groundmass. An irregular, discontinuous streaky layering is present. May be due to welding. Shards present, broken phenocrysts.

Composition: Quartz: 15-20%, 5.0-.1mm., crystals, shards. Subhedral to anhedral. Embayed, fractured, with abundant inclusions.
Potash felspar: 10-15%, 4.0-.3mm. Crystals, shards. Subhedral to anhedral, angular. Embayed, perthitic. Turbid altered grains, some sericitization.
Devitrified shards?: 10-15%, 2.0-.4mm. Angular, turbid, highly altered, cloudy, dusty. Strings of quartz and felspar, form vague layering.
Altered mafic: 3-4%. Squarish prisms, altering to chlorite, opaques.
Groundmass: 60%±10%. Cryptocrystalline, devitrified. May have contained glass shards.

Comments: Considered a tuff because of presence of shards, broken crystals, and the lack of sorting.

A345/10 CRYSTAL TUFF

Locality: Petrel Cove

Macro: Liver coloured, quartz felspar porphyry. Angular phenocrysts.

Micro: Porphyritic, devitrified cryptocrystalline groundmass. Tuff, abundant shards. Angular phenocrysts, unsorted. Cut by quartz veins.

Composition: Quartz: 7-10%, 2.0-.2mm. Crystal shards. Subhedral to very angular. Embayed. Clear, with fine inclusion trains. Undulose extinction.
Plagioclase: 3-5%, 1.5-.4mm. Shards, turbid, altered. Resorbed?
Potash felspar: 18-22%, 2.0-.4mm. Crystal shards. Surrounded by clear rims. Cross-hatched - anorthoclase, microperthitic, embayed, Cloudy alteration.
Groundmass: 60-70% devitrified.
Accessories: Chlorite, fluorite, opaques, sericite.

Comments: Considered tuff because of presence of shards, lack of sorting.

MICROGRANITES

171-385 BIOTITE-HORNBLENDE MICROGRANITE or PORPHYRY

Locality: Petrel Cove

Macro: Pink felspar biotite mafic porphyry, fine grained groundmass.

Micro: Porphyritic, hypidiomorphic, granular groundmass. Graphic intergrowths in groundmass.

Composition: Quartz: 35-40%, .5-.1mm. Anhedral to subhedral. In groundmass. Clear grains, graphic intergrowth with felspar.
Potash felspar: 40-45%, 8.0-.1mm. phenocrysts, in groundmass. Orthoclase and microcline. Cloudy alteration, some sericitization.
Plagioclase: 5%, .8-.4mm., phenocrysts. Subhedral. Albite, pericline twinning. Sericitized.
Biotite: 1-3%, 2.0-.4mm. Light brown, striated flakes.
Hornblende: 1-2%. Ragged, resorbed green prisms.
Chlorite: 1-3%. Leafy ragged, green, pleochroic flakes.
Accessories: Zircon, sphene, apatite.

A345/381 MICROGRANITE

Locality: Smith Bay, Kangaroo Island

Macro: Porphyritic microgranite. Blue opalescent quartz phenocrysts, green plagioclase phenocrysts, brown fine grained groundmass.

Micro: Porphyritic, holocrystalline, allotriomorphic granular.

Composition: Quartz: 35-40%, 5.0-.05mm. Phenocrysts, subhedral to anhedral. In groundmass, mosaic of grains .1-.2mm. Inclusion trains in phenocrysts. Undulose extinction. Seriate boundaries.
Microcline: 25-30%, 2.0-.1mm. Anhedral, seriate boundaries. Cross-hatched, rare perthite. Cloudy alteration.
Plagioclase: 7-12%, 4.0-.2mm. Anhedral to subhedral. Albite twinning, some untwinned. Sericitized.
Biotite: 5%, ~ .5-.2mm. long. Ragged brown flakes, pleochroic haloes.
Accessories: Zircon, apatite, opaques.

Comments: May have undergone some strain, undulose extinction, elongation of grains.

A345/54 PORPHYRITIC MICROGRANITE

Locality: Petrel Cove

Macro: Grey quartz felspar porphyry, with granular groundmass.

Micro: Porphyritic, hypidiomorphic. Holocrystalline.

Composition: Quartz: 30-40%, 5.0-.05mm. Coarse phenocrysts, 50% of groundmass. Subhedral to anhedral. Clear, with fine inclusion trains. Embayed.
Potash felspar: 33-37%, 4.0-.05mm. Phenocrysts, in groundmass. Euhedral to subhedral. Carlsbad twinning. Cloudy alteration. Rare perthite.
Plagioclase: 5-7%, 2.5-.4mm., phenocrysts. Subhedral. Albite twinning. Turbid, highly altered grains.
Biotite: 2-3%. Brown ragged flakes.
Accessories: Zircon, opaques, apatite.

A345/19 GRAPHIC MICROGRANITE

Locality: Petrel Cove

Macro: Red quartz, potash felspar, plagioclase porphyry. Abundant graphic intergrowths.

Micro: Holocrystalline, coarse, hypidiomorphic. Common graphic intergrowths. Granophyric in places.

Composition: Quartz: 30-35%, 2.0-.6mm. Subhedral. Clear, graphic, granophyric intergrowths.
Potash felspar: 35-40%, 2.0-.4mm. Subhedral. Red, iron stained. Orthoclase, scarce flame perthite. Some sericitization.
Plagioclase: 8-12%, 4.0-.3mm. Subhedral. Albite, pericline twinning. Thoroughly sericitized.
Accessories: $\succ$ 1% spherulitic muscovite, chlorite, opaques.

CATACLASTIC IGNEOUS ROCKS

A345/506 CATACLASTIC GRANITE

Locality: Hallett Cove

Macro: Plum coloured, porphyritic granite, aphanitic groundmass, phenocrysts up to 8cm. across.

Micro: This rock has a cataclastic texture. Quartz is streaked out into a ribbon texture, giving a fine grained elongate mosaic of quartz and felspar as groundmass. Individual grains have seriate boundaries. There is a large range in grain size. Blastoporphyritic. Felspars are less deformed than quartz. Matrix ~50%.

Composition: Quartz: 25-35%, 3.0-.001mm. Anhedral grains with seriate to sutured grain boundaries. Straight extinction. Elongation approximately 5:1.
Orthoclase: 25-35%, 800.0-.01mm. Anhedral to subhedral, seriate to sutured grain boundaries. Deformed Carlsbad twinning. Undulose extinction.
Plagioclase: 25-30%, 200.0-.01mm. Subhedral. Seriate to sutured grain boundaries. Fractured grains. Albite twinning, sericitized.
Biotite: 3-5%. Occurs in knots up to 3cm. in diam. Ragged, bent flakes, with pleochroic haloes, undulose extinction.
Accessories: Spinel - altering from biotite? - muscovite, zircon

A345/48 FOLIATED GRANITE

Locality: Petrel Cove

Macro: Grey, porphyroblastic, foliated quartz felspar biotite rock.

Micro: Cataclastic texture, blastoporphyritic crystals sitting in a fine grained, sheared matrix, given an augen, mylonitic texture. Elongate grain aggregates, flaser like 'platen'. Matrix 30-45%. Prominent biotite layers, forming gneissosity. Ribbon texture.

Composition: Quartz: 30-40%, 2.0-.01mm. Clear subhedral to anhedral grains, with interlobate to seriate boundaries. Undulose extinction.
Potash felspar: 30-40%, 3.0-.01mm. Mainly microcline, some slightly perthitic. Subhedral grains with ragged, seriate boundaries. Cloudy alteration, sericitization.
Plagioclase: 5-10%, 2.0-.2mm. Subhedral grains, seriate boundaries. Albite twinning. Highly sericitized.
Biotite: 3-5%, ~.3mm. Ragged brown flakes (fibrous).
Accessories: Chlorite, sericite, zircon

Comments: This rock is a highly deformed granite. The division between deformed igneous rocks and metamorphic rocks is an arbitrary one. A345/503 which resembles this rock may also be a deformed granitic rock. A345/274 and A345/517 may also be meta-igneous rocks.

METAMORPHIC ROCKS

METAQUARTZITES

A345/470 METAQUARTZITE

Locality: King's Point

Macro: Light grey, foliated cherty metaquartzite

Micro: Metaquartzite. Undulose, elongate flaser like grains, semi-composite, recrystallising to a finer granoblastic, interlobate mosaic of grains. Rounded felspars occur, retaining original shape. Elongate micas also occur.

Composition: Quartz: 95-98%, 4.0-.05mm. Undulose, elongate, flame shaped grains. Finer polygonal grains with straight extinction. Clear grains.
Potash felspar: 3%, 1.5-.5mm. Rounded-subrounded grains, mainly orthoclase, some microcline. Altering to muscovite at margins.
Muscovite: 1%. Stretched, clear flakes, up to 5mm. long.
Accessory - biotite.

A345/40 HAEMATITE METAQUARTZITE

Locality: Petrel Cove

Macro: Massive gneissic, white. Veined with haematite.

Micro: A granoblastic metaquartzite, with elongate patches of haematite and irregular patches of sericite ½-1cm. long. Quartz with straight boundaries. Polygonal grains.

Composition: Quartz: 50-60%, .5-.05mm., av. .2mm. Granoblastic, equigranular, polygonal grains. Triple point intersections, straight or slightly curved grain boundaries, some slightly sutured.
Sericite, muscovite: 10-15%. Sericite in segregations 5-10mm. long, after some earlier mineral? Very fine grained ~.05-.01mm. Muscovite - flakes, interstitial.
Haematite: 25-30%. Stringers, xenoblastic, poikiloblastic. Irregular ragged grains, elongate, defining a gneissic layering? Blood red where translucent.
Comments: This rock has recrystallised at some late stage of diagenesis? metamorphism?

A345/418 GNEISS

Locality: Smith Bay, Kangaroo Island

Macro: Buff coloured, fine grained, with heavy mineral layering. Deformed cross bedding? Layering defines lozenge shaped structures. Deformed quartz vein.

Micro: Granoblastic, equigranular, interlobate grain boundaries. Grains elongate parallel to layering. Average grain size ~.2-.3mm. Deformed quartz vein showing comb structure.

Composition: Quartz: 50-60%, .8-.1mm., av. .2-.3mm. interlobate grains, subhedral-anhedral. Interpenetrating, clear grains. Straight extinction.
Potash felspar: 40-45%, .4-.05mm., av. .2mm. Mainly untwinned, but some microcline present. Cloudy alteration.
Muscovite: 3-5%. Clear irregular leafy flakes.
Accessories: Opaques 1-2%, chlorite ~ 1%, fluorite ~ 1%, sphene, zircon, tourmaline.
Comments: Possibly a deformed sediment?

STREAKY GNEISSES

A345/274 STREAKY GRANITE GNEISS

Locality: Emu Bay, Kangaroo Island

Macro: Brown foliated (minerals stretched) rock, blue quartz, felspars porphyroblasts in fine grained matrix.

Micro: Show several textures, dominated by graphic intergrowths between quartz and felspar. Some areas show granoblastic polygonal texture. In places the rock shows strain textures, elongate grains with undulose extinction, typical ribbon texture. Mortar texture? - small unstrained grains replacing larger strained grains.

Composition: Quartz: 30-40%, 4.0-.1mm. Shape variable from polygonal equant grains with straight extinction to stretched, undulose grains. Vermicular intergrowths with felspar.

Potash felspar: 40-50%, 3.0-.1mm. Most untwinned, 1/3-1/4 microcline. Subhedral-anhedral, undulose extinction. Blastoporphyritic? Turbid alteration, some sericitized.

Plagioclase: 5-10%, 2.0-.3mm. porphyroblasts. Albite twinning. Highly sericitized.

Biotite: 1-3%. Ragged brown pleochroic flakes.

Chlorite: 1-3%. Light green leafy flakes.

Accessories: Muscovite, fluorite, spinel, sphene.

Comments: Probably a sheared acid igneous rock. Recrystallising, possibly at high temperature, giving rise to quartz-felspar intergrowths.

A345/517 STREAKY GRANITE GNEISS

Locality: Hallett Cove

Macro: Dark brown foliated porphyroblastic rock. Metaigneous?

Micro: Gneissic, granoblastic, inequigranular, interlobate grain boundaries. Some tendency in certain grains toward polygonal shape. Augen structures. Recrystallised cataclastic texture?, with strained grains replaced by finer grained unstrained grains. Possibly a fully recrystallised equivalent of A345/274.

Composition: Quartz: 30-35%, .4-.01mm. Subhedral. Clear elongate grains with straight extinction. In fine grained matrix, also in porphyroblastic knots.

Potash felspar: 40-50%, .5-.01mm. Subhedral-anhedral. Elongate grains. Blastoporphyritic? Turbid alteration, sericitized grains. Some cross hatched - microcline.

Chlorite: 1-3%. Green leafy pleochroic flakes.
Biotite: 1-3%. Green mottled ragged flakes.
Accessories: Fluorite, sphene, zircon.

A345/294 STREAKY GRANITE GNEISS

Locality: Smith Bay, Kangaroo Island

Macro: Red gneissic rock, flaser texture?

Micro: Granoblastic, seriate to interlobate, slightly sutured grain boundaries. Some suggestion of flaser texture in ordinary light but not with crossed polars. Strained rock, elongate grains. Possibly a recrystallised deformation texture.

Composition: Quartz: 50-60%, 2.0-.05mm. Clear, elongate, anhedral grains with undulose extinction. Grains in long, composite streaks, 25-10mm. long.
Potash felspar: 30-40%, 2.0-.1mm. Turbid anhedral grains. Some iron staining. Elongate grains.
Plagioclase: 5-7%, 2.0-.4mm. Albite twinning, An50-60. Cloudy alteration. Some sericitization.
Opaques: 2-3%, .4-.1mm. Euhedral-anhedral. Contain rare inclusions.
Muscovite: 1%, clear flakes, interstitial.
Accessories: Sphene, zircon, apatite.

AUGEN GNEISSES AND MYLONITES

A345/300 AUGEN GNEISS

Locality: Smith Bay, Kangaroo Island.

Macro: Grey-brown, blastoporphyritic, quartz felspar biotite gneiss. Fine grained groundmass.

Micro: Granoblastic, inequigranular. Sutured to interlobate grain boundaries. Cataclastic texture, augen structures. Quartz porphyroblasts occur as elongate, composite lenticular masses, up to 10mm. long. Fine grained cataclastic patches form layers parallel to the gneissosity and resemble micro-shears.

Composition: Quartz: 25-30%, 2.0-.02mm. Subhedral-anhedral. Clear, elongate grains, with inclusions. Some grains show undulose extinction.
Potash felspar: 30-40%, 3.0-.02mm. Subhedral-anhedral. Cross-hatched, microcline, non-perthitic. Some grains almost poikiloblastic. Cloudy alteration, some sericitization.
Plagioclase: 5-10%, 7.0-.8mm. Relict igneous phenocrysts? Euhedral-subhedral. Sericitized and corroded grains.
Biotite: 3-5%, ~ 5mm. Ragged brown pleochroic flakes.
Muscovite: 1%. Euhedral-subhedral, clear flakes.
Accessories: Zircon, apatite, fluorite.

Comments: Possibly a deformed igneous rock.

A345/475 AUGEN GNEISS

Locality: King's Point

Macro: Augen K-spar, plagioclase, quartz, biotite gneiss. Bright red K-spar.

Micro: Granoblastic, inequigranular augen structure. Seriate to interlobate grain boundaries. Gneissosity defined by biotite. Finer grained patches ~ .01mm. due to shearing? Quartz appears to have recrystallised into granoblastic aggregates.

Composition: Quartz: 30-35%, 2.0-.01mm. Occurs in flaser like stringers, composite. Anhedral to euhedral grains. Undulose extinction in some grains. Most show straight extinction.
Potash felspar: 40-45%, 2.0-.2mm. Anhedral-subhedral. Microcline, orthoclase. Occurs as augen in knots. Cloudy alteration, some sericitization.
Plagioclase: 10-15%, 1.5-.4mm. Albite twinning, An55-60. Euhedral-anhedral. Cloudy alteration, sericitization.

Biotite: 5%, ~ .8-.3mm. long. Ragged green mottled flakes, partly replaced by chlorite.
Accessories: ~ 1-2%. Chlorite, opaques, zircon.

A345/505 AUGEN GNEISS

Locality: Inman Valley, near Welch's washout.

Macro: Grey augen, quartz felspar, biotite gneiss.

Micro: Porphyroblastic, potash felspar augen in a fine grained granoblastic groundmass. Quartz occurs in composite flaser like porphyroblasts with individual grains showing undulose extinction. Seriate to interlobate grain boundaries. Highly deformed, with some later recrystallisation.

Composition: Quartz: 30-40%, 3.0-.1mm. Clear anhedral-subhedral grains. Undulose extinction. Occurs in elongate stringers and in matrix.
Potash felspar: 30-40%, 5.0-.3mm. Augen porphyroblasts, disrupted fractured crystals. Carlsbad twinning, cross-hatched, microcline. Cloudy alteration.
Biotite: 3%. Ragged brown flakes. Defines gneissosity.
Accessories: Fluorite, chlorite, zircon, sphene.

Comments: Highly deformed rock.

A345/503 MYLONITIC AUGEN GNEISS

Locality: Cape Jervis

Macro: Augen quartz-potash felspar-plagioclase-biotite gneiss. Bright red potash felspar phenocrysts, streaked out quartz, plagioclase.

Micro: A highly deformed rock, with fractured augen felspars, fine grained cataclastic matrix. Quartz and plagioclase are streaked out into elongate, composite flaser like aggregates, in which individual grains have sutured boundaries and undulose extinction. The rock is cut by veins perpendicular to gneissosity, containing fine grained cataclastic material and quartz vein filling. The rock has a fine grained well developed layering, almost showing ribbon texture.

Composition: Quartz: 20-25%, .8-.01mm. Elongate, sutured grains, more equant fine grains in cataclastic matrix, with straight extinction. Fine grains developed along sutured grain boundaries - recrystallised or cataclastic.
Potash felspar: 30-35%, 15.0-.3mm. Orthoclase, microcline. Some flame perthite present. Shattered grains. Anhedral-subhedral, equant grains, slight cloudy alteration.

Plagioclase: 13-18%, 4.0-.05mm. Porphyroblasts, albite twinning. Turbid grains, some sericitization. An60. Anhedral-subhedral.
Chlorite: 3-4%. Green, ragged flakes, leafy, streaked out, associated with opaques. Altered from biotite or other mafics.
Accessories: Fluorite, muscovite, apatite, magnetite - opaque cubes.

Matrix: 20-30% cataclastic, .1-.01mm. quartz and felspar, granoblastic interlobate.

A345/504 MYLONITE

Locality: Inman Valley, near Welch's washout.

Macro: Light grey, foliated rock, crenulated. Staining with sodium cobaltinitrite shows potassium felspar present, 20-25% streak out plagioclase.

Micro: Fine grained, microcrystalline matrix. Very pronounced layering, mylonitic, ribbon texture. Elongate porphyroclasts, with grain boundaries perpendicular to long axis. Porphyroclasts up to 1.5mm. diam. Elongate porphyroclasts 5mm. long, .3mm. wide.

Composition: Plagioclase: ~ 20-25%. Untwinned, indistinguishable from quartz in slide.
Quartz + plagioclase: ~ 75-80%. Porphyroclasts and stringers 15-20%, matrix 65-70%. Matrix microcrystalline, granoblastic, equant polygonal grains ~ .01-.005mm.
Biotite: 7-10%. Elongate ribbons, ~ 3mm. long, pleochroic, high birefringence, brown colour.
Opaques: 3-5%. Dusty anhedral grains, up to .05mm.
Accessories: 1-3% muscovite, fluorite.

Comments: Originally quartz-plagioclase-biotite gneiss or tonalitic igneous rock.

A345/426 MYLONITIC METAQUARTZITE

Locality: King's Point

Macro: Fine grained, dark red, rodding lineation.

Micro: Mosaic texture, quartz grains elongate, define lineation. Interlocking grains.

Composition: Quartz: 97-99%, .4-.05mm., av. .1-.2mm. Equigranular, granoblastic, interlobate grains. Some semi-composite grains.

<u>Haematite</u>: 1-2%. Opaque needles ~.1mm. long, parallel to lineation.
<u>Chlorite</u>: 1-2%, .1-.05mm. long, green, brown needles. Inclusions in quartz grains.

Comments: A highly deformed rock.

GRANITE GNEISSES

A345/467 GRANITE GNEISS

Locality: King's Point

Macro: Grey, fine grained streaky, porphyroblastic felspar biotite gneiss. Augen?

Micro: Porphyroblastic-granoblastic inequigranular. Polygonal to interlobate grains. Typical gneiss.

Composition: Quartz: 18-25%, 1.0-.2mm. interlobate to polygonal. Clear grains, containing inclusions.
Microcline: 55-65%, 4.0-.2mm. Porphyroblasts, and in matrix. Cross-hatched, rarely perthitic. Cloudy alteration. Undulose extinction.
Biotite: 4-5%. Brown, pleochroic flakes .6-.2mm. long.
Accessories: Zircon, xenotime, fluorite.

A345/493 GRANITE GNEISS

Locality: King's Point

Macro: Leucocratic quartz felspar gneiss. Potash felspar 30-35%, plagioclase 15%.

Micro: Granoblastic equigranular. Interlobate to sutured grain boundaries. Typical gneiss.

Composition: Quartz: 30-35%, 2.0-.1mm. Anhedral-subhedral. Clear grains with scarce inclusions. Slightly undulose extinction.
Potash felspar: 35-40%, 3.0-.1mm. Anhedral-subhedral. Mainly microcline - cross-hatched. Some cloudy alteration. Undulose extinction.
Plagioclase: 5-10%, 2.0-.4mm. Albite twinning, An60. Subhedral.
Biotite: 3-5%. Ragged brown pleochroic flakes 2.0-.5mm. long.
Accessories: Zircon, apatite, sphene, tourmaline.

A345/468 GRANITIC GNEISS

Locality: King's Point

Macro: Buff coloured quartz felspar gneiss. Potash felspar 30%, plagioclase 30%, quartz 30%.

Micro: Granoblastic, inequigranular. Sutured (amoeboid) grain boundaries. Elongation of grains defines layering.

Composition: Quartz: 25-30%, 3.0-.1mm. Clear, elongate anhedral grains with sutured boundaries. Some coarse grains contain fine inclusion trains. Undulose extinction.
Potash felspar: 25-30%, 3.0-.1mm. Anhedral-subhedral grains, containing scarce inclusions. Cloudy alteration, sericitized. Microcline.
Plagioclase: 25-30%, 3.0-.1mm. Anhedral-subhedral grains. Albite twinning. Cloudy alteration, sericitized. An60?
Muscovite: 2-3%, clear flakes.
Biotite: 1-2%, brown flakes.
Accessories: Apatite, zircon, chlorite.

Comments: Could be a strained microgranite.

A345/518 GRANITE GNEISS OR MICROGRANITE

Locality: Hallett Cove

Macro: Leucocratic quartz felspar rock. K-spar 30%, plagioclase 20%, quartz 30%.

Micro: Granoblastic, inequigranular. Sutured grain boundaries. Deformed microgranite?

Composition: Quartz: 30-35%, 3.0-.1mm. Sutured anhedral grains. Occurs in interpenetrating grain aggregates. Undulose extinction.
Potash felspar: 35-40%, 4.0-.2mm. Anhedral-subhedral. Microcline, some perthitic, some orthoclase? Cloudy alteration, sericitized.
Plagioclase: 20-25%, 3.0-.3mm. Anhedral-subhedral. Highly altered, turbid, sericitized grains, with scarce inclusions.
Biotite & muscovite: 1-3%, ragged flakes.
Accessories: Sphene, apatite, fluorite.

A345/306 GRANITE GNEISS

Locality: Smith Bay, Kangaroo Island

Macro: Grey quartz-felspar-biotite gneiss. Blue opalescent quartz.

Micro: Granoblastic, inequigranular. Interlobate grains. Vague augen structures. Possibly a recrystallised originally cataclastic texture.

Composition: Quartz: 30-35%, .6-.1mm. Elongate clear, euhedral to subhedral grains. Undulose extinction. Occurs in elongate aggregates, platen texture. Euhedral fine grained grains recrystallised from earlier strained quartz grains.

Potash felspar: 40-50%, 1.0-.05mm. Euhedral-subhedral. Cloudy alteration, sericitized.
Plagioclase: 10-15%, 1.5-.2mm. Albite twinning. Highly sericitized, corroded cores.
Biotite: 3-5%, ragged brown flakes, pleochroic haloes.
Accessories: Apatite, zircon, sercite, chlorite.

A345/209 GRANITE GNEISS

Locality: Christmas Cove, Penneshaw, Kangaroo Island.

Macro: Dark pink felspar-biotite gneiss, massive.

Micro: Granoblastic equigranular. Interlobate, with some sutured grain boundaries.

Composition: Quartz: 5-10%, .4-.2mm. Occurs mainly as inclusions. Undulose extinction.
Potash felspar: 35-40%, 2.0-.4mm. Mainly orthoclase, with flame perthite. Scarce microcline occurs. Contains rounded inclusions. Cloudy alteration.
Plagioclase: 20%, 2.0-.5mm. Subhedral. Albite twinning, some untwinned grains may be present. Undulose extinction. An60-70?
Biotite: 3-5%, ragged brown flakes, concentrated into layers.
Chlorite: 2-3%, green pleochroic flakes, with straight extinction. Replacing biotite.
Accessories: Apatite, zircon, sphene.

Comments: Some very fine grained grain aggregates occur along grain boundaries, due to shearing. May have undergone retrogression.

A345/440 GRANITE GNEISS

Locality: King's Point.

Macro: Light yellow massive felspar biotite rock.

Micro: Granoblastic, inequigranular. Seriate to sutured grain boundaries. Fine grained layers run through the rock resembling microshears.

Composition: Quartz: 25-35%, 5.0-.1mm. Seriate anhedral-subhedral clear grains. Undulose, strained grains are recrystallising to a mosaic of equant, seriate grains with straight extinction.

Potash felspar: 30-35%, 5.0-.4mm. Subhedral-anhedral. Mainly untwinned. Orthoclase?, but some cross-hatched microcline occurs. Perthitic, flame and bead perthites. Cloudy alteration, sericitization. Undulose extinction. Carlsbad twinning.
Plagioclase: 20-30%, 3.0-.3mm. Anhedral-subhedral. Albite twinning. Bead like inclusions of quartz, muscovite. An60. Cut by microshears.
Chlorite: 2%, green, ragged leafy pleochroic flakes.
Accessories: Zircon, muscovite.

A345/441 GRANITE GNEISS

Locality: King's Point.

Macro: Medium grained, equigranular, bright pink quartz-felspar-biotite rock.

Micro: Granoblastic, inequigranular. Interlobate and sutured grain boundaries.

Composition: Quartz: 30-35%, 2.0-.2mm. Anhedral-subhedral grains. Clear, undulose grains. Also occurs as small, round inclusions in felspar.
Microcline: 35-40%, 4.0-.4mm. Anhedral-euhedral. Cross-hatched, perthitic, flame perthite. Cloudy alteration. Undulose extinction.
Plagioclase: 10-15%, 2.0-.1mm. Subhedral. Albite twinning. Cloudy alteration.
Biotite: 3-5%, green biotite, ragged flakes, being partially replaced by chlorite.
Accessories: Chlorite, apatite, zircon.

A345/502 GRANITIC GNEISS

Locality: Cape Jervis.

Macro: Quartz-felspar-biotite gneiss, with radial arrangement of biotites.

Micro: Granoblastic, inequigranular. Seriate to sutured grain boundaries. Felspar and quartz occur as inclusions in one another.

Composition: Quartz: 30-35%, 3.0-.1mm. Occurs in aggregates. Clear anhedral grains with sutured to seriate boundaries. Undulose extinction.
Microcline: 45-55%, 4.0-.5mm. Subhedral, cross-hatched, flame perthite. Cloudy alteration, some sericitization.
Biotite: 5%, brown elongate flakes.
Accessories: Chlorite, muscovite, calcite, apatite.

A345/469 GRANITIC GNEISS

Locality: King's Point.

Macro: Gneissic rock with red, rounded felspars and some biotite.

Micro: Granoblastic equigranular to inequigranular. Interlobate to sutured grain boundaries.

Composition: Quartz: 8-12%, 2.0-.2mm. Subhedral to anhedral. Occurs in aggregates, recrystallised crystals? Some with undulose extinction.
Microcline: 70-75%, 5.0-.4mm. Cross-hatched, flame perthite, subhedral to anhedral. Cloudy alteration.
Orthoclase: 10-12%, 4.0-.5mm. Subhedral to anhedral. Flame perthite. Common rounded quartz inclusions. Cloudy alteration.
Biotite: 2-4%, ragged brown pleochroic flakes.
Accessories: Apatite, zircon, opaques.

Comments: Fine grained patches occur along the boundary of quartz and microcline grains. They could be due either to cataclasis or to recrystallisation.

SEDIMENTARY ROCKS

QUARTZ ARENITES

A345/428 RED QUARTZ ARENITE (ORTHOQUARTZITE)

Locality: King's Point

Macro: Massive bright red quartzite, pigment in quartz matrix.

Micro: Texturally mature, well sorted, size range .8-.1mm. av. mean .3-.4mm. Some pressure solution, some straightening of grain boundaries, but most grains are in tangential contact. Oriented quartz overgrowths. Grains coated with haematite, giving the rock its intense colour.

Composition: Quartz: 98-99%. Common quartz, clear grains with straight extinction. 2-3% metaquartzite and composite grains - sutured boundaries, undulose extinction. 2-3% containing inclusions, accessory minerals - zircon etc. 2-3% undulose extinction.
Rock fragments: 1% fine grained, dusty-devitrified volc. R.F?
Kaolinite: < 1% in interstices, small vermiform crystals.

A345/450 RED QUARTZ ARENITE (ORTHOQUARTZITE)

Locality: King's Point

Macro: Massive red quartzite, with a coarser grained trough cross-laminated bed.

Micro: Mature rock, with variable sorting. In the finer bed size range .1-.4mm., av. mean .2mm. In the crossbedded bed, range .8-.1mm., av. ~ .4-.5mm. Grains rounded-subrounded, generally in tangential contact. A stylolite occurs, with interpenetration of grains, iron oxide concentrated along it. Grain surfaces coated with haematite.

Composition: Common Quartz: 90-93%. Some contain inclusion trains, gen. clear, straight extinction.
Metamorphic Quartz: 5-7%. More common in crossbedded bed, composite grains, sutured, elongate, fine grained schistose quartz.
Rock fragments: 3-6 grains per thin-section. Dusty-devitrified volc. R.F?

Comments: An undeformed, but compacted rock with stylolite. Same lithology as A345/428. Could be Hor witz's "quartzite rose"

A345/17 QUARTZ ARENITE (ORTHOQUARTZITE)

Locality: Petrel Cove

Macro: Pink massive quartzite - quartz cement.

Micro: A mature rock, quartz arenite. Well sorted, well rounded-subrounded grains. Tangential grain contacts. Slight undulose extinction developed in situ. Secondary quartz overgrowths, some reworked. Interstitial sericite.

Composition: Quartz: 97-99%, av. .3mm., range .5-.1mm. Mainly common quartz (95%), some reworked sedimentary quartz, with overgrowths. Some sutured metaquartzite grains.
Accessories: 1-2% sericite, opaques, rock fragments?

A345/18 QUARTZ ARENITE (ORTHOQUARTZITE)

Locality: Petrel Cove

Macro: Pink massive quartzite with coarse grains, blue quartz, rock fragments?

Micro: Moderately well sorted, size range 2.0-.1mm., av. .3mm. Rounded-subrounded straight grain contacts, with some interpenetration, secondary quartz overgrowths. Weak undulose extinction (developed in situ).

Composition: Quartz: 95-98%. Mainly common quartz (98%), 2-3% metaquartzite.
Rock fragments: 2% - dusty, granular, diffuse extinction could be devitrified volc. R.F? or phyllite.
Sericite: 1-2%. Interstitial, replacing rock fragments.
Accessories: < 1%, muscovite (bent by compaction), opaques.

A345/452 QUARTZ ARENITE (ORTHOQUARTZITE)

Locality: King's Point

Macro: Light purple banded quartzite, with some clots of pigment.

Micro: Quartz arenite. Well sorted. Grains rounded-subrounded. Secondary quartz overgrowths. Pressolved, some interpenetration of grains and some slight suturing of grain boundaries. Undulose extinction developed in situ. Sericite laths in interstices, replacing grain boundaries, shows preferred alignment.

Composition: Quartz: 98-99%, av. size .3mm., range .6-.1mm. Mainly common quartz ~95-96%. Metaquartzite, schistose quartz 3-5%. Vein quartz 2-3%. Common quartz mainly clear, ~ 5% contain fine inclusion trains, accessory minerals.
Sericite: ~ 1%, ~ .01mm. laths. In interstices, replacing grain boundaries.
Rock fragments: < 1%, ~.3mm. Schist, phyllite, one probable volcanic rock fragment.

Comments: The undulose extinction and growth of sericite indicates mild deformation and possibly low-grade metamorphism.

A345/499 PURPLE QUARTZ ARENITE

Locality: Cape Jervis

Macro: Massive purple quartzite, containing blue quartz grains, 2mm. diam.

Micro: Mineralogically mature. Moderate sorting, grain size range 2.0-.3mm., av. ~ .4-.5mm. Some pressure solution, most grain contacts straight or tangential, oriented quartz overgrowths. Undulose extinction in quartz overgrowths. Some preferred alignment of sericite.

Composition: Quartz: 93-95%. Subangular-subrounded. (96-98%) common quartz, elongate grains, undulose extinction. (1-2%) metamorphic quartz.
Rock fragments: 1-2%, not common, dusty, sericitized.
Sericite: 5-7%. Finely crystallized patches in the interstices, up to .4mm. across, radiating, squeezed out between grains.
Opaques: ~ ½%. Needles, ragged grains up to .3mm. Haematite pigment.

Comments: A slightly deformed rock, much less than A345/430.

A345/451 QUARTZ ARENITE

Locality: King's Point

Macro: Black massive quartzite with rare grit size blue quartz grains.

Micro: Poor sorting, but some of the finer quartz may be due to deformation. Preferred alignment of quartz and sericite. Some suturing of grain boundaries.

Composition: Quartz: 98-99%, size range 1.0-.05mm., av. .3-.4mm., grains rounded-subangular. (96-98%) common quartz - clear. (2-3%) vein quartz.
Rock fragments: < 1%, metamorphic-phyllitic.
Accessories: < 1% muscovite, chlorite, sericite.

Comments: Mildly deformed - folded?

A345/430 GREY QUARTZ ARENITE

Locality: King's Point

Macro: Grey quartzite with blue quartz grit 2-3mm. in diam.

Micro: This is a deformed quartz arenite. Deformation is shown by undulose extinction, sutured grain boundaries, preferred alignment of sericite, and deformed muscovite. Mineralogically mature, but poorly sorted.

Composition: Quartz: 97-98%, size range 2.0-.2mm., av. ~ .3-.4mm. Clear, some grains contain inclusions (rare). Some secondary quartz overgrowths. Suturing of boundaries and interpenetration of grains. Mosaic of fine grains .1-.05mm., developed at grain boundaries. Majority show undulose extinction, (3-5%) composite and semi-composite grains.
Rock fragments: 2-3%, dusty, phyllitic, sericitized.
Sericite: 2-3%, fine needles ~.05mm. long, concentrated at grain boundaries, replacing quartz. Show preferred alignment, contains some chlorite.
Stretched muscovite: < 1%, strung out to 5-6mm. long, bent around grains.

Comments: Mildly deformed, could range up to chlorite grade.

A345/460 QUARTZ ARENITE

Locality: King's Point

Macro: Grey cherty rock, cut by red brown veins.

Micro: Poorly sorted quartz arenite, large range of grain size, 5.0-.001mm. Microcrystalline silica cement, cut by fine grained, shear zones, running through rock. Sheared grains. Moderate pressure solution, shown by interlocking, slightly sutured grain boundaries.

Composition: Quartz: 95%, 5.0-.001mm. Well rounded to subangular. Mainly common quartz. (5%) composite grains.
Potash felspar: 5%, 1.0-.4mm. Rounded to subrounded, cloudy (vacuolized) grains. Mainly orthoclase, some microcline.
Accessories: opaques.

Comments: Matrix 40%, may be in part cataclastic.

FINE QUARTZ ARENITES

A345/246 SILTY QUARTZ ARENITE

Locality: Christmas Cove, Penneshaw, Kangaroo Island

Macro: Light red brown massive siltstone, mudflakes, not well sorted.

Micro: Sorting poor but variable, coarser grains concentrate in some beds, some tendency toward graded bedding. Grain size range 1.2-.01mm., with clay in matrix. Rounding is poor. Larger grains tend to be rounded but most are subrounded. Many angular and subangular grains occur. Haematite pigment mainly in matrix, but coats some grains. Some clay coated grains. Shows slightly undulose extinction. Some quartz overgrowths present.

Composition: Quartz: 90-93%, mainly common quartz, some semi-composite grains occur (3-5%). Size range 1.2-.005mm., av. .1-.07mm.
Matrix: 5% interstitial, phyllosilicates, sericitized in places (shale clasts).
Potash felspar: ½-1%, .4-.05,.02mm. Rounded-subangular. Microcline, orthoclase, fresh some with sericitized rims.
Accessories: ~½% tourmaline - rounded, plagioclase, zircon, staurolite, opaques.

A345/448 FINE QUARTZ ARENITE

Locality: King's Point

Macro: Chocolate brown siltstone, with mottling due to irregular distribution of pigment.

Micro: Well sorted, size range .4-.05mm., av. .1-.2mm. Grains subrounded-subangular. Secondary quartz overgrowths. Haematite coating grain surfaces. Majority of grains show straight extinction.

Composition: Quartz: 95-98%, mainly common quartz, (10-15%) metamorphic and igneous quartz. Some composite grains (~5%) show undulose extinction.
Rock fragments: 2-3% phyllitic, mainly metamorphic? Other types may be present.
Plagioclase: ½-1%, Albite twinning. Subrounded-subangular, .1-.025mm., fresh, some cloudy alteration.
Accessories: Muscovite, chlorite, potash felspar.

A40

A345/449 FINE QUARTZ ARENITE

Locality: King's Point

Macro: Dark pink coarse siltstone, massive, prominent black bedding laminae.

Micro: Sorting good, grain size varies between beds. Range .3-.05mm., av. .1-.2mm. Rounded-subrounded grains. Quartz overgrowths. Iron oxide coated grains.

Composition: Quartz: 95-98%. Mainly common quartz, with straight extinction (5-7%) with undulose extinction, (3-5%) semi-composite grains.
Haematite & opaques: 3-5%, .1-.2mm., ragged edges. Opaque with blood red edges.
Rock fragments: ~1%, .1-.2mm., rounded, granular, phyllitic M.R.F., V.R.F?
Accessories: Muscovite, zircon.

ARKOSES AND VOLCARENITE

A345/500 ARKOSE

Locality: Cape Jervis

Macro: Buff coloured arenite, felspathic, coarse grained, prominent opaques.

Micro: Numerous interlocking sutured grain boundaries indicating much pressure solution, and shows undulose extinction. Good sorting.

Composition: Quartz: 40-50%, 1.5-.2mm., clear, undulose extinction, anhedral sutured grains. Rare metaquartzite grains.
Potash felspar: 30-35%, 2.5-.3mm. Orthoclase 12-15%. Microcline 15-25%. Both felspar types show flame perthite, mainly fresh, some cloudy alteration.
Plagioclase: 15-18%, 1.2-.5mm., Albite twinning, An70, generally fresh, "drusy" alteration along edges, cleavages. Some sericitization.
Biotite: 1%, ~ .4mm., long flakes. could be iron stained muscovite.
Opaques: ~ 1%, 1.2-.4mm. anhedral, ragged, corroded - originally rounded.
Accessories: < 1% haematite, apatite, rutile, zircon.

Comments: Moderately deformed - folded?

A345/453 ARKOSE

Locality: King's Point

Macro: Coarse grey arenite, light pink with felspar and rock fragments.

Micro: Reasonably sorted 2.0-.3mm., av. ~ 1.0mm. grains rounded-subrounded. Moderate pressure solution, straightening of grain boundaries, oriented quartz overgrowths. Undulose extinction developed in situ. Growth of sericite at grain edges.

Composition: Quartz: 70-75%, 2.0-.2mm., well rounded-subrounded. Mainly common quartz (90%), metaquartzite (10%).
Potash felspar: 20%, 2.0-.3mm., rounded-subangular. Some nearly euhedral grains (70-80%) microcline, crosshatched. Cloudy alteration. Sericitization at edges, along cleavages and fractures.
Rock fragments: 5-7%, 1.0-.3mm. rounded-subrounded, phyllitic, igneous-myrmekitic quartz-felspar intergrowths - devitrified volc. R.F.
Plagioclase: 3-5%, 1.0-.4mm., subrounded. Albite twinning. Sericitized An60-An50?
Muscovite: 1-3%, .8-.2mm. Elongate clear flakes. Interstitial. Bent by compaction.
Accessories: Zircon, sphene.

Comments: The rounding and sorting are better than other comparable labile rich erratics - e.g. A345/240, A345/283.

A345/240 LITHIC ARKOSE

Locàlity: Christmas Cove, Penneshaw, Kangaroo Island

Macro: Coarse arenite, containing blue quartz, felspar and rock fragments.

Micro: Coarse arenite 3.0-.3mm. Moderate rounding and sorting. Highly compacted, pressolved, straightening of grain boundaries, oriented quartz overgrowths, kinked mica. Undulose extinction developed in situ.

Composition: Quartz: 22-27%, 2.0-.4mm., angular-subrounded. Iron oxide coated grains. Mainly common quartz (80%), but with large quartzite and metaquartzite grains.
Volcanic rock fragments: 23-28%, 4.0-.3mm., subangular-subrounded. Commonly brick red colour, devitrified. Includes eutaxitic welded tuff, rhyolite grains.
Potash felspar: 30-40%, 3.0-.3mm., angular-subrounded. Some nearly euhedral grains. Cloudy alteration, some grains turbid. Some sericitization. Microcline, perthitic microcline, orthoclase, perthitic orthoclase.
Plagioclase: 3-5%, .8-.2mm., subangular. Albite twinning. Highly altered, sericitized.
Muscovite: 1-3%, flakes, clear, iron stained. Kinked by compaction.
Accessories: Zircon, sphene.

Comments: Composition is probably a direct reflection of provenance. Requires an igneous and metamorphic source. Possibly very little chemical weathering during sedimentation.

A345/283 VOLCARENITE

Locality: Smith Bay, Kangaroo Island

Macro: Red brown arkosic rock containing blue quartz, rock fragments, felspar.

Micro: Coarse arenite, moderate sorting and rounding. Large size range, 5.0-.3mm., av. 2.0-1.5mm. Abundant volcanic rock fragments.

Composition: Quartz: 50-65%, 5.0-.5mm., av. 2.0mm. Subangular-rounded. Iron oxide coating grain surfaces. Pressure solution leading to straight contacts, oriented quartz overgrowths. Mainly common quartz (80-90%). Some composite grains - metaquartzite? (5-10%). Undulose extinction.
Volcanic rock fragments: 25-30%, 3.0-.3mm., av. 1.0-.7mm. Subangular-subrounded. Devitrified. Includes eutaxitic, vitroclastic welded tuff, rhyolite grains.
Potash felspar: 5-10%, 2.0-.5mm., av. 1.0-.8mm. Angular-subrounded. Orthoclase? Cloudy alteration (vacuolized, Falk, 1968)
Accessories: ~ 1-2% plagioclase, rutile, zircon, tourmaline, opaques, muscovite.

CHERT

A345/497 CHERT (SILICIFIED LIMESTONE)

Locality: Kuitpo Forest

Hand specimen: Grey rock with white, irregular pellet shaped inclusions. Cherty.

Thin section: A silicified limestone, with original carbonate texture completely replaced. Probably an intraclastic packstone, consisting of intraclasts? originally of carbonate mud and drusy calcite, with sparry calcite filling the interspaces. The intraclasts? are ovoid, irregular, subrounded, some are triangular or vaguely pentagonal, size 2-5mm., av. 3mm. They consist of mottled mud sized material with some large patches of drusy material. The material filling the interspaces was drusy and sparry carbonate, showing a comb structure with fine crystals at the margins and coarser, parallel crystals intermeshing and filling most of the interspace. The whole rock has been replaced by secondary silica, becoming a chert, and making it difficult to resolve the true nature of the intraclasts. Replaced calcite mud $\lesssim$ .05mm., 25-35%; replaced drusy calcite $\sim$.05-.2mm., 35-45%; replaced sparry calcite $\gtrsim$.2mm., subhedral, 25-30%.

Comments: This rock could be an exotic, but could also have been derived from the Torrens Group which occurs nearby. The latter contains cherts associated with the Montacute Dolomite equivalent.

HAND SPECIMEN DESCRIPTIONS

IGNEOUS ROCKS

A345/523 SANIDINE PORPHYRY

Locality: Hallett Cove

Macro: This rock was found on the wavecut platform 200 yds. south of the mouth of Hallett Creek.

This contains 80% coarse, tabular buff coloured crystals of sanidine, up to 5cm. long, and shows a well developed flow alignment. Groundmass occurs interstitially, is a dark green colour and contains a prominent black anhedral mafic mineral. The rock appears to be a trachyte, but the groundmass may contain some quartz.

SEDIMENTARY ROCKS

CLASTIC ROCKS

A345/508 QUARTZ ARENITE

Locality: Hallett Cove, southern area

Macro: This is grey, well sorted quartz arenite, containing a pebble of chert 4cm. long. The rest of the rock consists of well rounded quartz grains $\frac{1}{2}$-1$\frac{1}{2}$mm. in size, cemented by silica. It contains grains of bluish opalescent quartz.

A345/521 QUARTZ ARENITE or SUBARKOSE

Locality: Waterloo Bay, Yorke Peninsula

Macro: A light pink coarse arenite, similar to A345/453, containing rare quartz pebbles. Coarse grit bands occur at intervals of 1.5-2.0cm., with grains up to 4mm., containing blue quartz grains, red felspars and red-brown volcanic rock fragments. The coarser layers pass rapidly in medium grained quartz arenite, with no further changes in grain size. These coarse layers may have been concentrated by erosion and are 'lag' deposits rather than true graded bedding, which show a continuous change in grain size. Iron oxide layers cut bedding at an angle. This probably is a liesegang effect. The rock may be arkosic.

CHEMICAL ROCKS

A345/520 CHERT BRECCIA

Locality: Inman Valley

Macro: This rock is a massive chert breccia. Angular, squarish, grey chert fragments occur in a yellow, cherty matrix. Fragments range in size from 7cm. to .2mm. and are usually massive, but some are layered.

A345/496 LAYERED CHERT

Locality: King's Point

Macro: This rock is a light grey coloured cherty rock. It has several intersecting slate-grey layers running through it, resembling bedding, but this is probably a colour banding. The rock is cut by numerous, subparallel fractures.

A345/522 CHALCEDONIC CHERT

Locality: King's Point

Macro: This is a blue grey rock, a chalcedonic silica. It has a matrix of opaque, granular silica showing an irregular layer which is concentric in places. Included within the matrix are translucent white, tabular patches of chalcedony?, ranging in size from 0.1mm. to 6cm. long. The concentric layering suggests that this rock is a direct chemical precipitate.

APPENDIX 2

Blinman

A few outcrops of glacial sediments occur two miles south of Blinman (Coats, 1964). The main lithology is boulder bearing, yellow clayey sand similar to sediments in Inman Valley. Striated, faceted and polished clasts occur. The erratics are dominated by local sedimentary rock types, quartzites, siltstones, and shales. Exotics include gneisses, a weathered quartz felspar porphyry similar to the rhyolites and tuffs seen further south - e.g. A345/175 - and a red quartzite similar to A345/450. Mr. P. G. Haslett found a loose boulder of a silicified archaeocyathid coquina, which is unknown in outcrop in the Flinders Ranges. This indicates that a wider area of the Flinders Ranges was glaciated in Permian time, probably by a large continental ice sheet.

APPENDIX 3

WELDED TUFFS IN THE SOUTH EAST

An examination of thin sections cut by Mr. D. A. Henstridge (Honours thesis, 1970), 339/P of Papineau Rocks rhyolite contained pumice fragments and layers carrying abundant shards .1mm. to .01mm. long showing some compaction and some welding. The hand specimen is a large red fragment, which shows eutaxitic texture and contains pumice. The fragment seems to have been an earlier welded tuff, in a later less welded tuff. These features are characteristic of welded tuffs, so the writer feels that the rhyolite at Papineau Rocks is a welded tuff.

An examination of the sections examined by Mawson from this locality, but all except 5781 are altered and do not show remnants of shards. The rock may have undergone low grade metamorphism.

APPENDIX 4

TRACE FOSSILS FROM HALLETT COVE

The writer found trace fossils in a low outcrop of varved sediments 3m. thick, 100m. south of the boundary of the Area of Scientific Interest, near the track. Stratigraphically, this outcrop corresponds to the lowest beds exposed in the Waterfall Creek section. Similar occurrences have been noted in the Carboniferous varves at Seaham (Glaessner, 1957) and in Permian? varves in Natal (Savage, 1971). The varves contain dropstones and till pellets, indicating cold conditions in this lake deposit; Small spherical iron oxide concretions occur in some beds, possibly after pyrite. This may indicate reducing conditions in some beds, possibly due to the presence of organic matter. Three types of trace fossil occur, which will be designated as forms A, B and C. They usually occur within shale laminae, as solitary trails, but in some beds a large number of trails occur. The preservation is not as good as the Seaham material. This may be due to state of compaction of the sediment when the trace was made or to the water content of the sediment, yielding a diffuse impression.

Descriptions

Form A: This is a simple epichnial groove 1-2mm. wide. Arcuate, sinuous, with slight irregularities. In specimen A345/P13, the groove has been infilled by the base of the succeeding varve.
Material: A345/P5A & B, A345/P13A & B.

Form B: *Gyrochorte* sp. This is the most conspicuous ichnofossil in these beds. It is typical of the Zöpfe traces of the German literature. They usually occur as epichnial ridges 2-3mm. wide with prominent median furrows. Chevron marks can be seen in A345/P2 (best seen when specimen is moistened), A345/P10. Their absence in the majority of specimens is probably due to preservation. On some bedding planes (A345/P10) some ridges begin and terminate sharply, and individual traces vary in relief.

This suggests that the organism which produced the traces was a tunnelling animal. The organism tends to follow one layer, but will also deviate. Certain specimens, A345/P1, A345/P10, show the opposite relief - i.e. as epichnial grooves. There are two possible explanations for this; that the tunnel was infilled with a less compressible sediment and this has resulted in separation of the upper and lower surfaces, thus preventing the formation of a composite impression (and yielding a negative with the removal of the infilling); or that the organism was travelling through the sediment upside down. The traces occur in upper shale part of varve - e.g. A345/10 and in the lower fine sand layers - e.g. A345/P11, A345/P12.

The traces vary from straight to arcuate, most are gently sinuous. They cross, going around rather than pass through the other trace. Hallam (1970) has recently discussed the origin and the environment of Gyrochorte and notes that it occurs in non-marine and marginal marine deposits and may also occur in marine deposits.

Material: A345/P1A & B, A345/P2, A345/P10, A345/P11-P16.

Form C: Diplichnites

Location: Prominent bluff like outcrop near track and just south of the southern boundary of the Area of Scientific Interest.

A biserial trail 7mm. wide, with epichnial podial impressions 1-2mm. long inclined at 45^{o} to the trail. The trail curves slightly. The podial impressions appear to form single rows and there appear to be several types of impression, but this is not clear since the central portion of trail has been weathered. It was probably made by an Arthropod.

Material: S.A. Museum, P17166.

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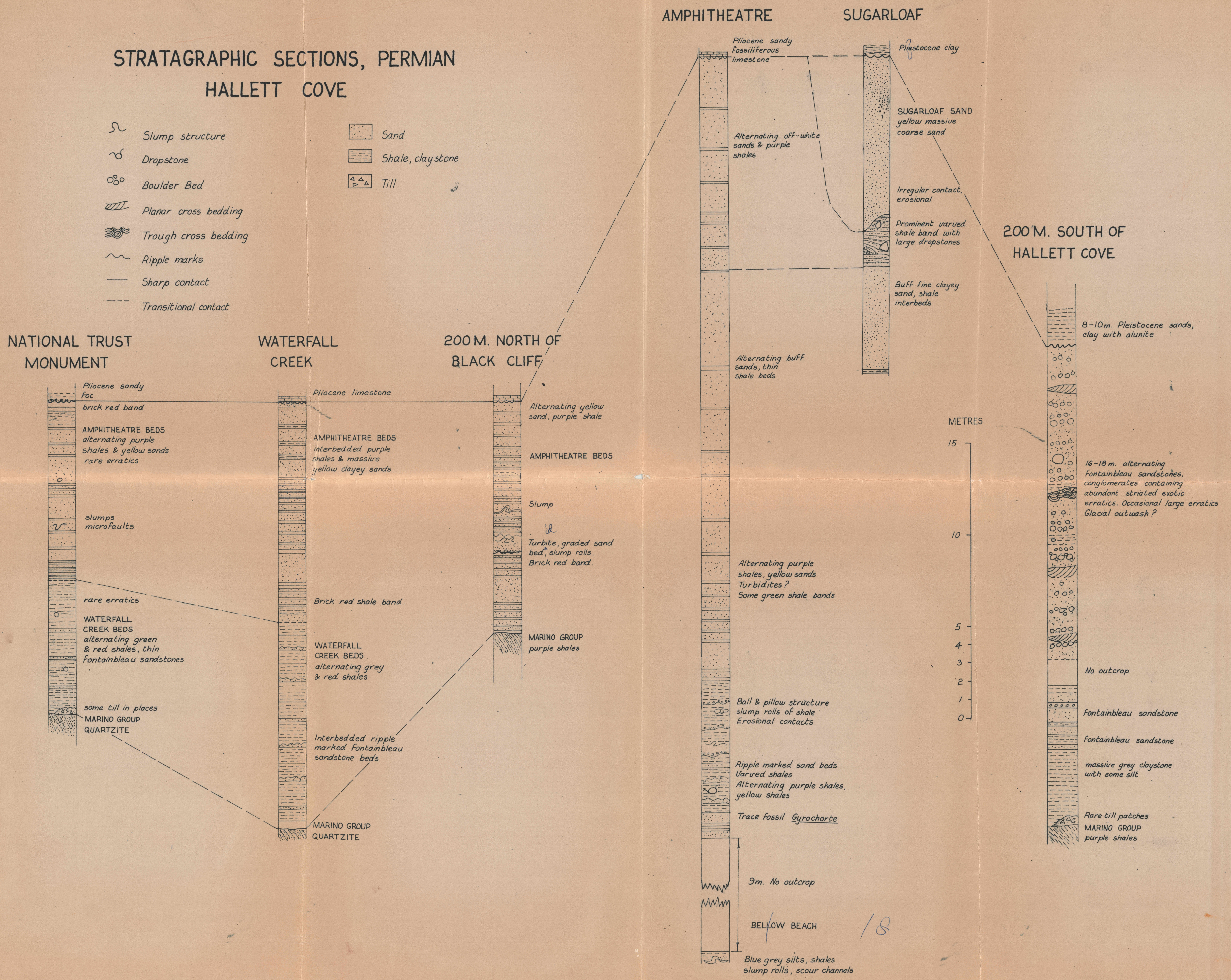

STRATAGRAPHIC SECTIONS, PERMIAN
HALLETT COVE
Slump structure
Dropstone
Boulder Bed
Planar cross bedding
Trough cross bedding
Ripple marks
Sharp contact
Transitional contact
Sand
Shale, claystone
Till
NATIONAL TRUST MONUMENT
Pliocene sandy foc
brick red band
AMPHITHEATRE BEDS alternating purple shales & yellow sands rare erratics
slumps microfaults
rare erratics
WATERFALL CREEK BEDS alternating green & red shales, thin Fontainbleau sandstones
some till in places
MARINO GROUP QUARTZITE
WATERFALL CREEK
Pliocene limestone
AMPHITHEATRE BEDS interbedded purple shales & massive yellow clayey sands
Brick red shale band.
WATERFALL CREEK BEDS alternating grey & red shales
Interbedded ripple marked Fontainbleau sandstone beds
MARINO GROUP QUARTZITE
200 M. NORTH OF BLACK CLIFF
Alternating yellow sand, purple shale
AMPHITHEATRE BEDS
Slump
Turbite, graded sand bed, slump rolls. Brick red band.
MARINO GROUP purple shales
AMPHITHEATRE
Pliocene sandy fossiliferous limestone
Alternating off-white sands & purple shales
Alternating buff sands, thin shale beds
Alternating purple shales, yellow sands Turbidites? Some green shale bands
Ball & pillow structure slump rolls of shale Erosional contacts
Ripple marked sand beds Varved shales Alternating purple shales, yellow shales
Trace fossil Gyrochorte
9m. No outcrop
BELLOW BEACH
Blue grey silts, shales slump rolls, scour channels
SUGARLOAF
Pleistocene clay
SUGARLOAF SAND yellow massive coarse sand
Irregular contact, erosional
Prominent varved shale band with large dropstones
Buff fine clayey sand, shale interbeds
METRES
15
10
5
4
3
2
1
0
200 M. SOUTH OF HALLETT COVE
8-10m. Pleistocene sands, clay with alunite
16-18 m. alternating fontainbleau sandstones, conglomerates containing abundant striated exotic erratics. Occasional large erratics Glacial outwash?
No outcrop
Fontainbleau sandstone
Fontainbleau sandstone
massive grey claystone with some silt
Rare till patches
MARINO GROUP purple shales


PERMIAN STRATA
TROUBRIDGE BASIN S.A.
KINGS POINT
course sand with erratics
alternating sands & shales
massive grey claystone
exposure poor 30%
alternating thin-bedded sands & shales
no outcrop but subcrop extends down to sea level
sea level
CAPE JERVIS
(AFTER LUDBROOK & WILSON)
UNIT 6
Poorly exposed, probably clay boulder at surface.
UNIT 5
Well laminated grey containing arenaceous foramenifera dispersed erratics.
UNIT 4
Prominent Fontainbleau sandstone - yellow, pebbly in places.
UNIT 3
UNIT 2
Slumped Till, slump rolls of sandstone
UNIT 1
Diamictite clay matrix, large erratics, sharp contacts of boulder beds.
Kanmantoo Group Meta Sediments
CARRICKALINGA CREEK
SM no outcrop
Weathered Granite boulders up to 2 m.
Mainly massive sand. some laminated
Striated erratics in boulder beds
Channel with basal boulder beds, up to 5 m. deep channel fill of massive & laminated sand.
Fine laminated sands, interbedded porcellanites
Coarse sand in white porcellanous matrix
Coarse mod - poorly sorted sands
No outcrop
KINGSCOTE
COMPOSITE SECTION
Columnular Basalt
White crossbedded claying sands
Shale bed
Sand bed
Dropstone, slump
Slump
pebble bed
dropstone
No outcrop
Sea level
Blueshales containing iron-oxide concretions
CHRISTMAS COVE
Brown shale
Brown shale with dispersed erratics
calcerous concretions
contorted beds
Kanmantoo Group Meta Sediments
Slump Structure
Dropstone
Boulder Bed
Planar cross bedding
Trough cross bedding
Sand
Shale, claystone
METRES
10
5
4
3
2
1
0