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EXCURSION GUIDES B1, B2, B3, B4, GEOLOGY OF THE ADELAIDE REGION

GEOLOGICAL SURVEY

edited by

R.L. OLIVER AND C.G. GATEHOUSE

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EXCURSION GUIDES B1, B2, B3, B4

GEOLOGY OF THE ADELAIDE REGION

EDITED BY

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INTRODUCTION - R.L. Oliver

Excursions B1, B2, B3, and B4 are designed to cover the Precambrian, Cambrian, and Permian geology of the Adelaide region. During the range of time covered by this geology it is believed that South Australia and Antarctic were in juxtaposition. Those excursionists familiar with the relevant parts of the geology of Antarctica may find interest in features possibly evidencing this former juxtaposition.

The younger geology of the Adelaide region represents the Tertiary Period, a span of time during which Australia and Antarctica were separated. This geology will not be covered by the B excursions.

GENERAL GEOLOGY

The pre-Tertiary rocks of the Adelaide area are predominently sedimentary rocks which were originally deposited as sediments in the Adelaide Geosyncline (Sprigg, 1942, 1946, Mawson and Sprigg, 1950; Glaessner and Parkin, 1958; Thomson, 1969) and now comprise the Adelaide Orogen.

Basement to the geosynclinal sedimentation are gneisses and schists occurring now at the surface in anticlinal or upfolded inliers as the results of compression and fracturing (Fig. Intro-1).

These rocks may be part of the extensive crystalline basement to the west (Glaessner and Parkin, 1958; Thomson 1969) but the greatest age so far recorded by radiometric analysis of basement gneisses is ca 900 Ma (Cooper and Compston, 1971). These particular gneisses compositionally are calc-silicates. Their origin is somewhat enigmatic. Schistose rocks with abundant sillimanite occur in places. Elsewhere micaceous quartz schists manifest extensive retrogradation.

The Precambrian sequence of the Adelaide Geosyncline, known as the Adelaide Supergroup (Daily, 1963) rests unconformably on the basement schists and gneisses. The lowermost unit in the Adelaide region, the Burra Group (see Fig. Intro-1), consists of sandstone, dolomite, shale, and quartzite representing shallow marine conditions of deposition.

A marked change in climatic conditions and the onset of glaciation is evidenced by the Sturt Tillite (Howchin, 1900; Sprigg, 1942; Coats, 1967; Link & Gostin, 1981) of the Umberatana Group of sediments. Overlying the Sturt Tillite are the well laminated Tapley Hill Formation siltstones and the Brighton Limestone, oolitic and dolomitic at the top and with rare stromatolites. Granule bearing mudstones and poorly sorted sandstones in the uppermost Umberatana Group are correlated with more obviously tillitic sequences in the northern Flinders Ranges and in the eastern Olary region (Thomson, 1966).

The Wilpena Group at the top of the Adelaide Super Group is noteworthy for the development of redbeds - sandstones, siltstones, and shales - reflecting shallow water oxidising conditions.

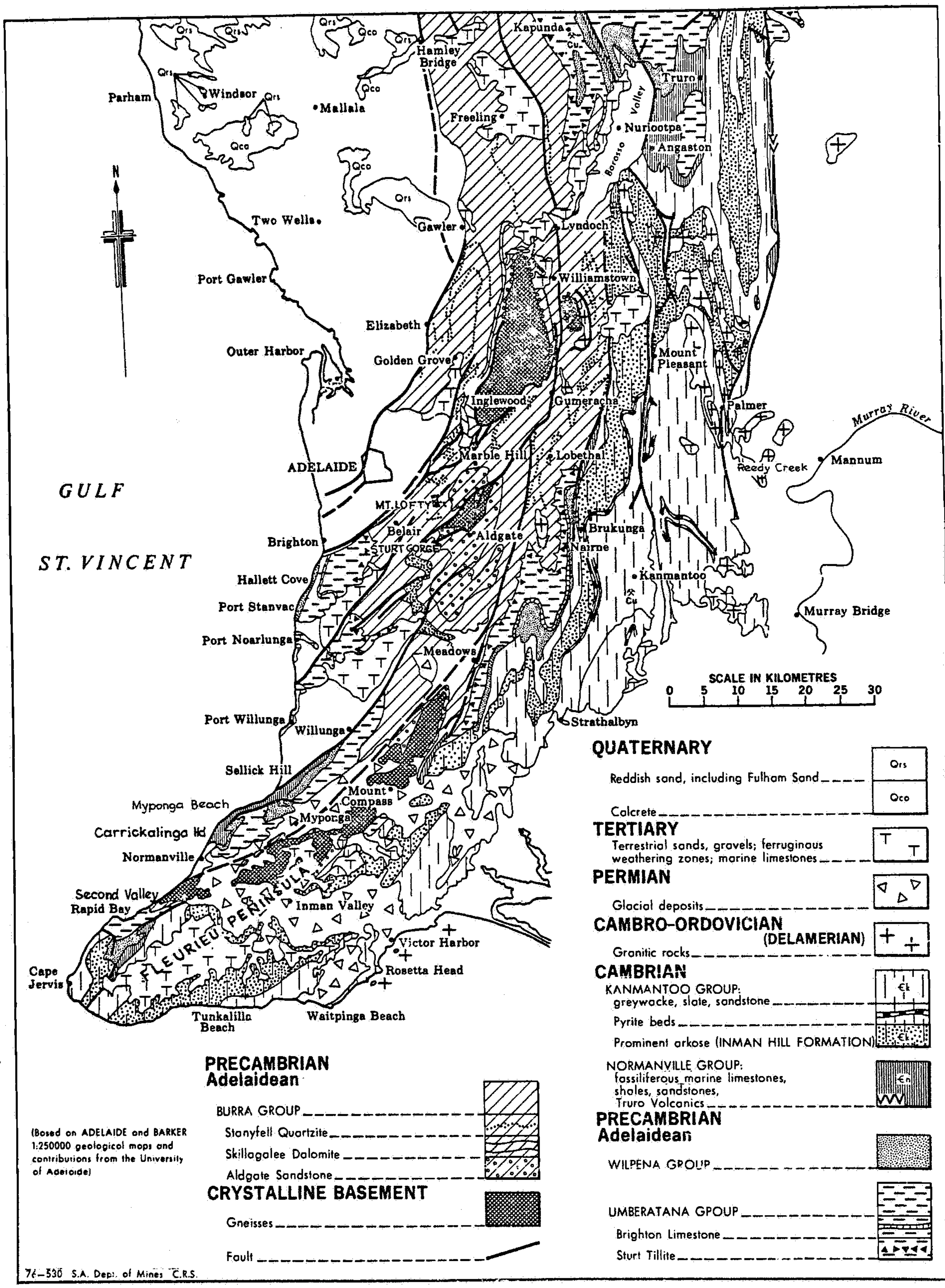

FIG. INTRO-1

FLEURIEU PENINSULA AND THE MOUNT LOFTY RANGES
(Modified from Daily et al., 1976)

The Adelaide Supergroup is probably 7,000 - 8,000 metres thick and ranges in age from 800 - 900 Ma to ca 570 Ma. It is separated from the overlying Cambrian by slight unconformity (Daily, Firman, Forbes and Lindsay, 1976).

Cambrian rocks in the Adelaide region comprise two conformable sedimentary sequences, viz. the older Normanville Group (Daily and Milnes, 1973) and the younger Kanmantoo Group (Sprigg and Campana, 1953).

The Normanville Group is largely calcareous. Near Truro, in the northernmost part of the Adelaide region shown in Fig. Intro-1, lavas interbedded with the sediments are the only record of volcanism in the Mt. Lofty Ranges. The Normanville Group crops out to a limited extent only (see Fig. Intro-1) and is best exposed on Sellick Hill and at Carrickalinga Head where it will be seen during the B3 excursion.

The overlying Kanmantoo Group is introduced by a new cycle of marine deposition in the form of sandstones, siltstones and shales of the Carrickalinga Head Formation. This forms the basal unit of the 9,000 m thick Kanmantoo Group which comprises the bulk of the Cambrian in the Adelaide region. Most of the original sediments of the Kanmantoo Group were impure sands, occasionally pebbly, separated by thin beds of silt and mud. There are several thin horizons of sedimentary sulphide.

Noteworthy is the fact that the Kanmantoo Group is metamorphosed to varying degrees, in places to as high as the upper amphibolite facies.

The metamorphism was associated with the intrusion of a number of granites now cropping out in the Victor Harbour area, east of Kanmantoo and near Palmer (see Fig. Intro-1). The age of these granites is ca 514 - 490 Ma (Milnes et al, 1977).

The emplacement of the granites in general accompanies the deformation manifesting the Early Palaeozoic Delamerian Orogeny though the first intrusions may have preceded the main phase of folding (Milnes et al., 1977). There is a progressive decrease in metamorphic grade of the Kanmantoo metasediments westward and northwestward away from the line joining the Victor Harbor, Kànmantoo and Palmer granitoids (Fig. Intro-1 and see, also, Offler and Fleming, 1968).

The similarity between the association of ca. 500 Ma granitoids and metamorphosed geosynclinal metasediments in the Adelaide region and in the Transantarctic Mountains is noteworthy.

No sediments are known in the Adelaide region covering the time interval between the end of the Delamerian Orogeny and the early Permian (see Fig. Intro-2). Erosion prevailed to the extent that in the vicinity of the granites, at least, a thickness of between 5 and 10 km of overlying metasediments was removed.

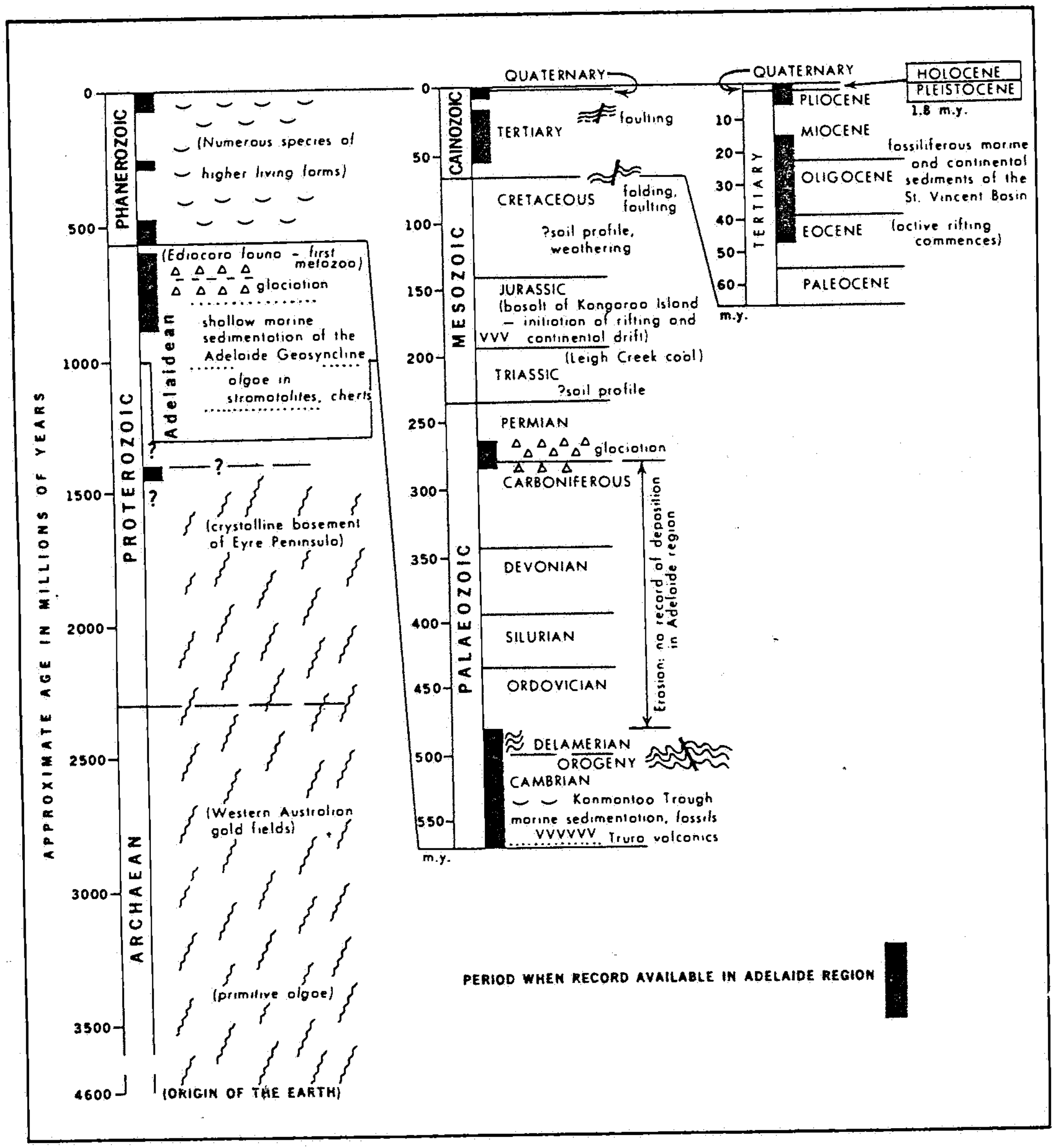

FIG. INTRO-2

GEOLOGICAL RECORD IN THE ADELAIDE REGION

(From Daily et al., 1976)

Unconformably lying on eroded Precambrian or Cambrian surfaces, at Hallett Cove and at several localities on Fleurieu Peninsula (Fig. Intro-1), are deposits of ill-sorted, poorly- to non-stratified pebble- and boulder-bearing sandy clays resembling glacial till.

There are also well bedded sediments which have been deposited subaqueously from meltwater streams or lakes during ice retreat.

Evidence for the earlier advance of glacial ice are the striated surfaces on which the glacial debris is resting, currently being exposed by erosion.

The glacial sediments in the Adelaide region are remarkably unconsolidated compared with Gondawanaland glacial deposits elswhere and, in fact, were originally assigned a Cenozoic age.

The subsequent Permian designation was based on correlation with similar (fossiliferous) deposits in Victoria, Australia, and further supported by the occurrence of arenaceous foraminifera on Fleurieu Peninsula (Ludbrook 1967) and achritarchs at Waterloo Bay on Yorke Peninsula (Foster, 1974). Cooper (1981), however, based on additional palynological evidence, suggests that these sediments may be Late Carboniferous rather than Permian in age.

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EXCURSION B1

RECORDS OF THE LATE PROTEROZOIC AND LATE PALAEOZOIC ICE AGES NEAR ADELAIDE

by V.A. Gostin

A. The Late Proterozoic Ice Age

About 800 million years ago a major ice age affected a large part of Australia. It is recorded in the Adelaide region as the Sturt (Tillite) Formation interbedded within the folded and variously metamorphosed Adelaide Fold Belt or Geosyncline. Sturt Gorge (Figs. Intro-1, B1-1) is the type area for this formation and its glacial origin was first recognised here by Howchin in 1900. Its southernmost outcrop in on Kangaroo Island (Daly and Milnes, 1971). Northward the formation has been traced through the Flinders Ranges to equivalents in the Amadeus Basin, central Australia, and to the Kimberleys in northwestern Australia. Possible equivalents occur also to the southeast in Tasmania (Jago, 1981). Excellent summaries by various authors are available in Hambrey and Harland (eds, 1981). As expressed in the South Australian summary by Coats (1981), the Sturtian Ice Age included several ice advances separated by major inter-glacials. Maximum thicknesses of the glacigene beds reach 2 500 m near Mt. Painter area in the northern Flinders Ranges (Bolla Bollana Formation) and 3 300 m in the Olary area 250 km northeast of Adelaide (Pualco Tillite) but are less than 300 m in most other places.

Sedimentological studies of the glacigene strata by Link and Gostin (1981) recognised five facies:

1. Massive diamictite facies deposited as subaqueous basal till beneath a dominantly grounded, but locally buoyant ice shelf.

2. Bedded diamictite and siltstone facies formed by abundant marine ice rafting and subaqueous mass movement.

3. Calcareous granule conglomerate facies of limited extent deposited by englacial or sub-glacial meltwater during glacial retreat.

4. Bedded sandstone facies deposited largely as turbidites with a minor ice-rafted component.

5. Ironstone facies of various iron-bearing lithologies deposited mainly in localised aqueous environments.

A glacial origin for the Sturt (Tillite) Formation is supported by the vast area over which the diamictites are developed. Individual tillite beds of uniform thickness have been traced for 20 km in the northwestern Flinders Ranges, faceted and striated erratics are present, as are dropstones, till clasts and till pellets (Link and Gostin, 1981). The absence of striated pavements below the massive diamictites, the presence of locally calcareous matrix and rare carbonate interbeds, and the low iron and manganese, and high boron contents of the diamictite matrix further suggest a marine glacigene environment, except in the probably lacustrine ironstone facies, (Sumartojo and Gostin, 1976). A representative

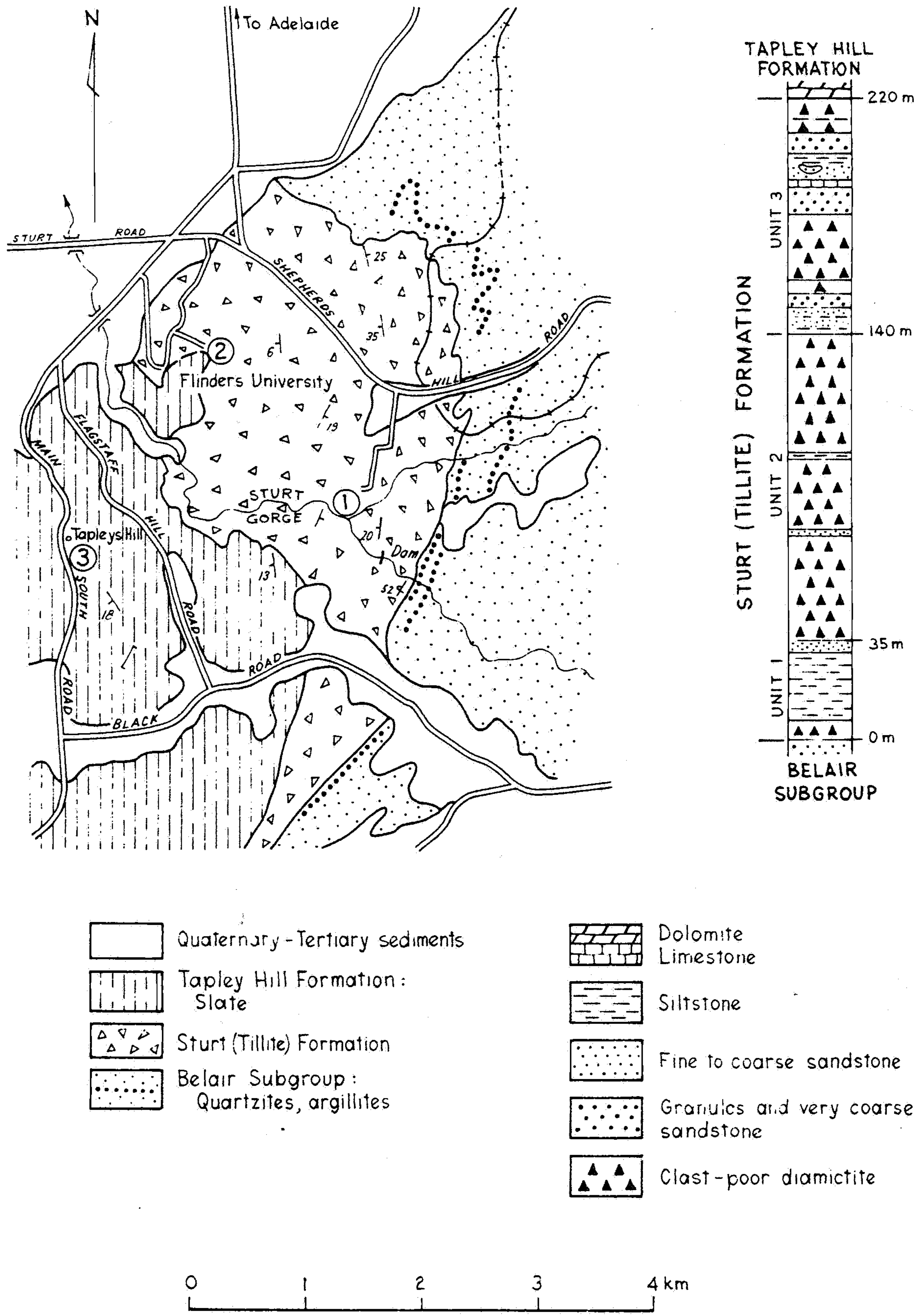


FIG. B1-1

GEOLOGY IN THE VICINITY OF STURT GORGE
Modified from S.A. Department of Mines and Energy
1:50,000 Noarlunga Sheet

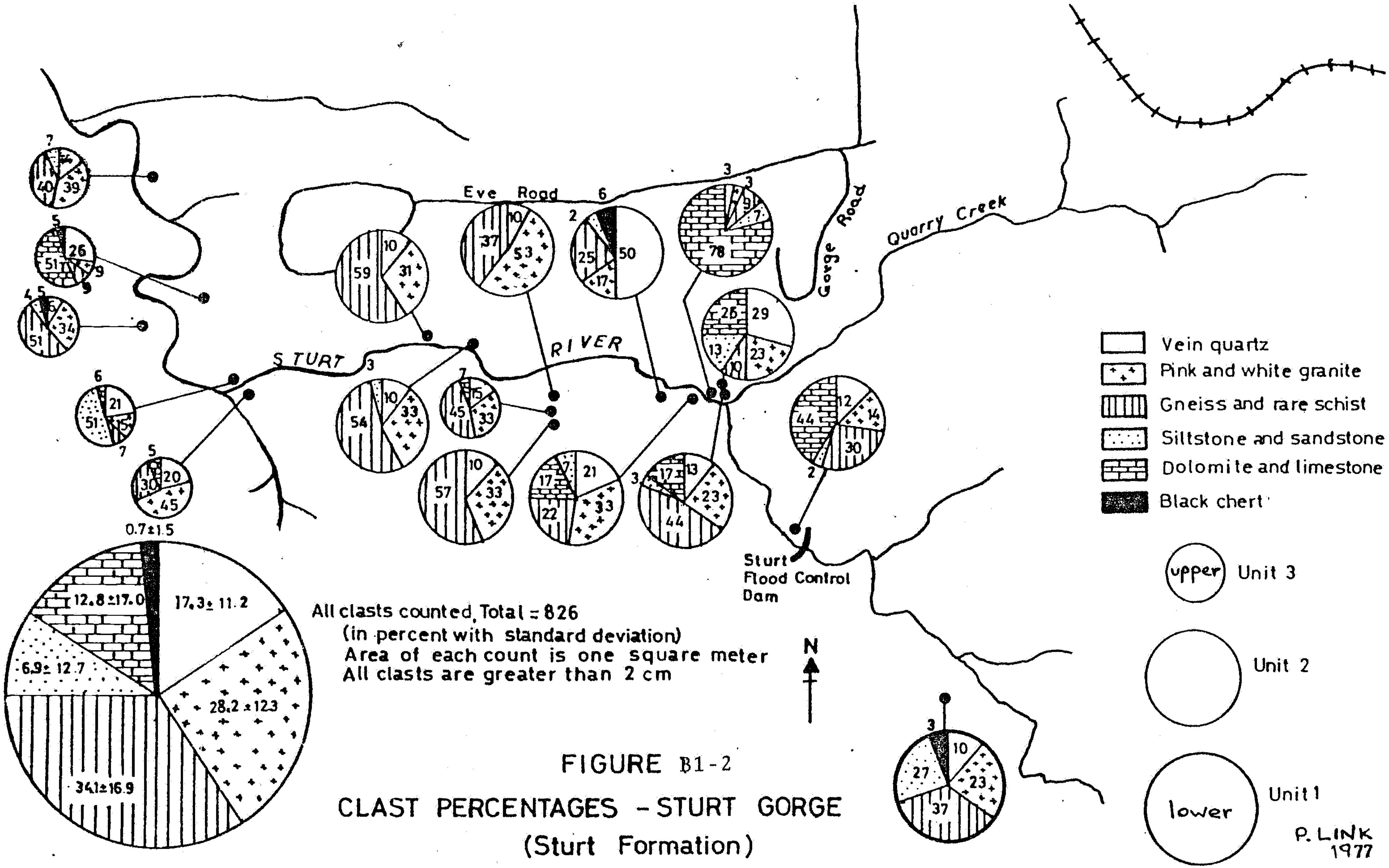


FIGURE B1-2

CLAST PERCENTAGES - STURT GORGE

(Sturt Formation)

From Link, 1977 (Univ. Adelaide, B.Sc. Hons. thesis) stratigraphic section from Sturt Gorge is illustrated in Fig. B1-1, and results of a detailed analysis of clast lithologies in Sturt Gorge in Fig. B1-2. The latter shows that crystalline basement rocks and some Adelaidean cover rocks made up the glacial debris. Zircon and tourmaline dominate the heavy mineral assemblage and, according to Gravenor and Gostin (1979), the absence of garnets as well as the less stable heavy minerals is due to weathering during the many interglacial periods, and to some extent to their removal by alkaline intrastratal solutions.

In Sturt Gorge the rocks have suffered mild metamorphism with an intense development of cleavage. This has fractured many of the dispersed clasts in the diamictites, resulting in prominent tension gashes oriented normal to the cleavage and filled with quartz and calcite.

Stop 1 - Sturt Gorge. Descend from Gorge Road to the junction of Sturt River and a tributary. Note the essentially flat-lying, thick and massive diamictite (tillite) layer with intense sub-vertical cleavage. At creek level observe some thin diamictite beds and laminated siltstones. Creek exposures of massive diamictite show complete lack of sorting with subangular to rounded erratics of gneisses, granites and sedimentary rocks.

Stop 2 - Flinders University. Outcrops of coarse grained arkosic sandstones and other terrigenous sediments at the top of the Sturt (Tillite) Formation are overlain by subhorizontal and thinly bedded to laminated dolomites and shales. These belong to the basal part of the very thick, postglacial, Tapley Hill Formation.

Stop 3 - Tapley Hill. Examine details of the dark grey, well laminated and strongly cleaved shales or slates of the Tapley Hill Formation, the most extensive and uniform formation of the Adelaide System. Deposited in relatively deep water, it contains graded (silt-clay) beds and occasional thin cross-laminated and climbing-rippled coarse siltstone layers.

B. The Late Palaeozoic Ice Age

This occurred at the end of the Carboniferous and during the earliest Permian, about 280 million years ago, and lasting 40 to 70 million years. Much of Australia was at various times covered by ice as shown by Brown et al (1968) and by Crowell and Frakes (1971), but the regions of maximum glaciation shifted with the many ice advances and retreats (Gravenor, 1979).

Glacial pavements and glacigene sediments outcrop extensively south of Adelaide, and are also found buried in several basins or troughs elsewhere in South Australia (Harris, 1981). The age of these south Australian glacigene sediments has been considered to be Permian palynological Stage 2 (Harris, 1981), but redefined as latest Carboniferous by Cooper (1981). These sediments are up to 400 m, and possibly to 900 m thick. Some were deposited close to sea level and contain arenaceous foraminifera (Ludbrook, 1967). The glacial pavements at Hallett Cove were recognized by Professor Ralph Tate of Adelaide University in 1877 (Tate, 1878); Howchin, (1895) showed the overlying sediments to be probably Permian.

HALLETT COVE AREA

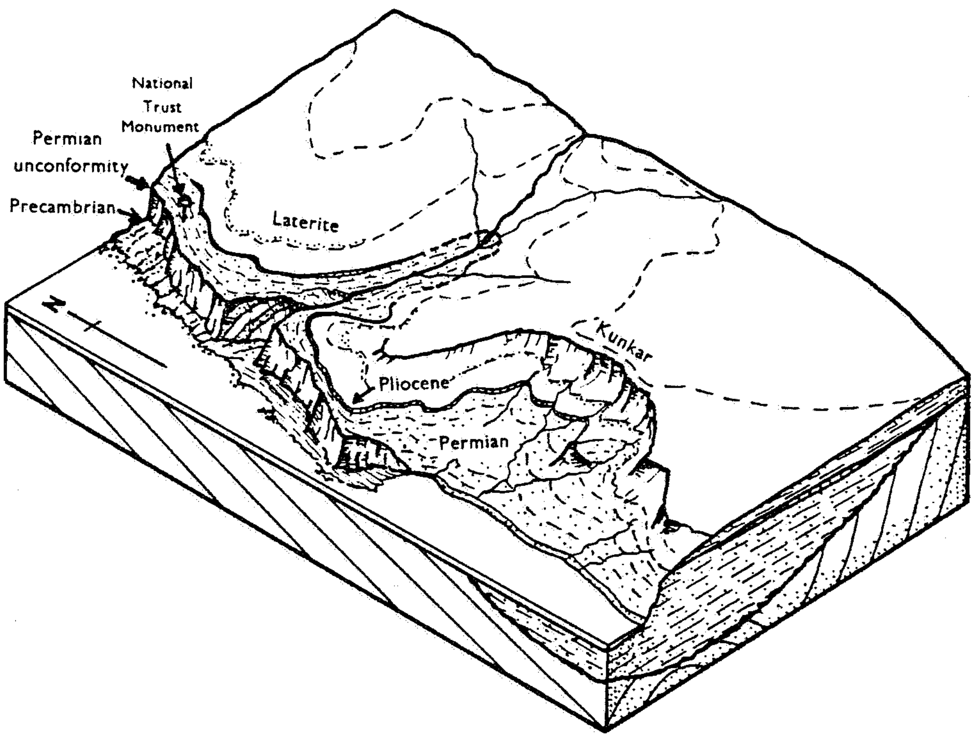


FIG. B1-3

BLOCK DIAGRAM OF THE HALLET COVE AREA

(From Talbot and Nesbitt, 1968)

The bedrock at Hallett Cove consists of folded and steeply dipping Late Proterozoic (Marinoan) sandstones (or quartzites), purple shales, and minor laminated dolomite. The glacial pavement occurs as an angular unconformity that truncates the folded bedrock, and forms part of a Permian valley (Fig. B1-3). Present day outcrops occur on the side of this valley exposed along the cliff edge. In detail, the glaciers differentially eroded the surface, which now displays excellent glacial polish, grooves, striations, chatter marks and crescentic gouges. These indicate a northward ice movement, and this may be contrasted with the westward ice movement in southern Fleurieu Peninsula (Bourman et al., 1976).

Sediments immediately overlying the glacial pavements are predominantly well bedded and surprisingly weakly consolidated. Ice-contact deposits of till occur only in isolated patches. Flow till and other gravity induced debris flows formed bedded diamictites (clast bearing sandy mudstones). Many sequences are predominantly varicoloured sands, claystones and shales deposited in proglacial lakes and lagoons. Some of the laminated shales are probably true varves. Pebble- to boulder-size erratics, often glacially faceted and striated occur as dropstones throughout the sequence, and indicate persistent ice-rafting. Some sandstones were produced by density flows (turbidites); they are graded and may include shale slump-rolls, and display water-escape structures. Other sandstone beds are better sorted, ripple marked, and cemented by a mozaic of large calcite crystals (fontainbleau sandstone).

Rock types forming the pebble to boulder erratics at Hallett

Cove include Victor Harbor Granite, Sturt Tillite, Tapley Hill Formation and rocks of unknown origin such as gneisses, granites, arkoses, quartz arenites, feldspar porphyry, basalt and various acid volcanics (Ron Harris, 1971).

Heavy minerals are dominated by garnets many of which are well rounded and display very delicate surface chattermark trails formed during glacial transport (Gravenor and Gostin, 1979).

Hallett Cove Conservation Park was established in 1976. Normal National Park rules now apply. All collecting is prohibited, and visitors are requested to cooperate in the maintenance of this outstanding scientific reserve. Only some of the numbered stations on the National Parks and Wildlife Service leaflet will be visited (see Fig. B1-4).

Stop 4 (Nat. Parks No. 10) Excellent glacial pavements on Proterozoic quartzites. Near the Park's northern boundary fence these Marinoan quartzites show water escape structures (small silica cemented channels and sand volcanoes). About 15 m of Permian shale and sand overlie the pavement, and are in turn overlain by a thin Pliocene marine sandy limestone.

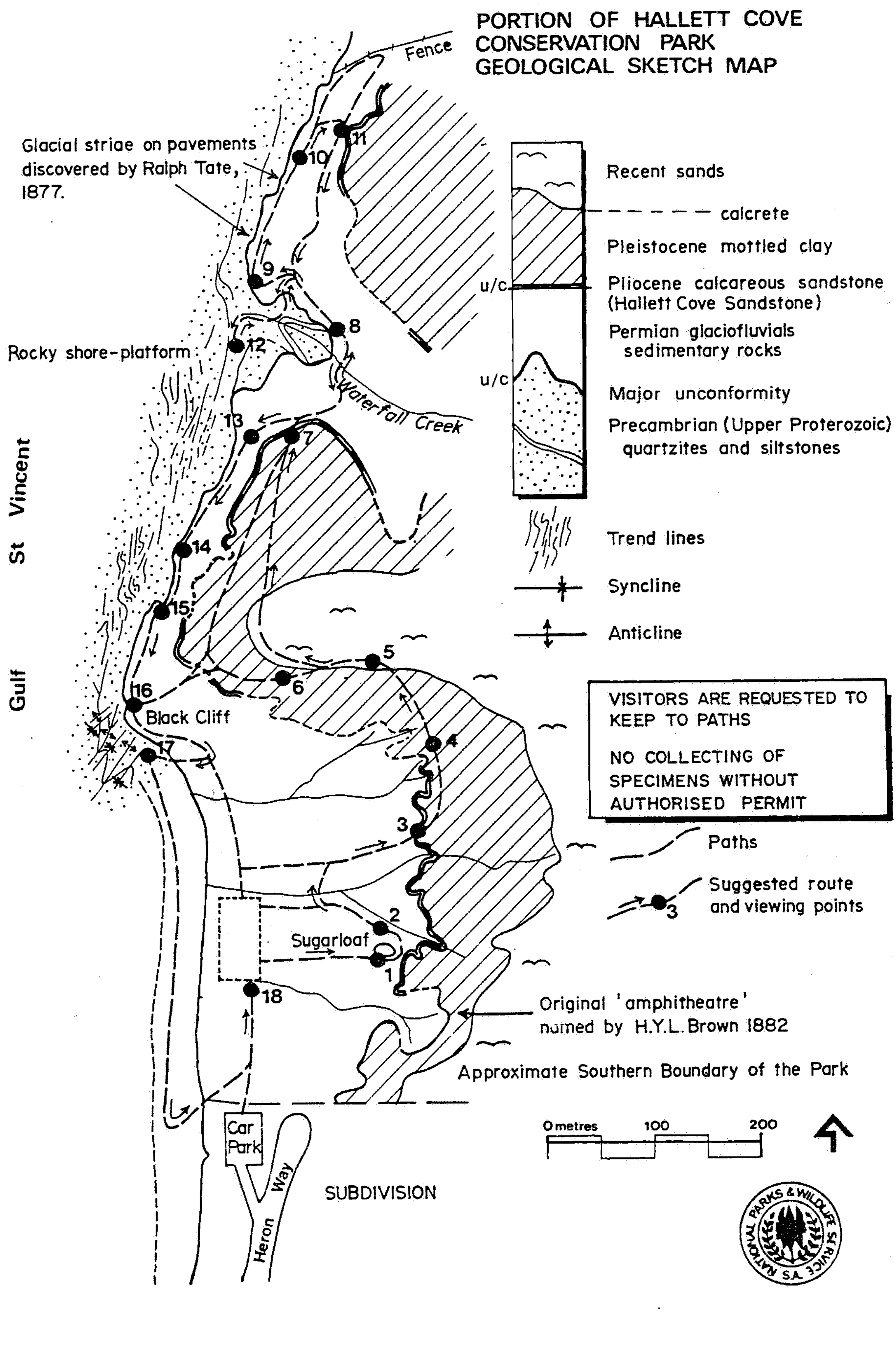
Stop 5 (Nat. Parks No. 8 and 9). Excellent views to the south showing an angular unconformity between the Proterozoic and the Permian. The latter has an eastward dip and is unconformably overlain by thin blocky Pliocene limestone, which is in turn overlain by Pleistocene clays with calcrete near the top. The shore platform and the cliff track southward display excellent boulder erratics. Some Permian sands are cemented by calcite or contain small barite sand crystals (sand roses).

Stop 6 (Nat. Parks No. 16). Black Cliff with excellent views to the south showing a distant fossil valley filled with glacial sediments. A large flat polished and glacially striated surface is present at your feet. Several erratics occur in the Permian sediments - a "Sturt Tillite" boulder among them.

Stop 7 (Nat. Parks No. 2). The Sugarloaf, showing bedded diamictites, partly slumped, and containing large ice-rafted dropstones.

Stop 8 (Nat. Parks No. 18). Possible varves with dropstones, and a thick graded bed containing deformed shale clasts and vertical water escape structures. Nearby to the south, Ron Harris (1971) records till pellets and simple bilobate trails 2-3 mm wide, possibly made by arthropods. The best tillite exposures were made, and later concealed, by land development south of the amphitheatre.

Fig. B1-4


PORTION OF HALLETT COVE
CONSERVATION PARK
GEOLOGICAL SKETCH MAP
Fence
Glacial striae on pavements discovered by Ralph Tate, 1877.
Rocky shore-platform
Waterfall Creek
Gulf St Vincent
Black Cliff
Sugarloaf
Car Park
Heron Way
SUBDIVISION
Original 'amphitheatre' named by H.Y.L. Brown 1882
Approximate Southern Boundary of the Park
Recent sands
calcrete
Pleistocene mottled clay
u/c
Pliocene calcareous sandstone (Hallett Cove Sandstone)
Permian glaciofluvials sedimentary rocks
u/c
Major unconformity
Precambrian (Upper Proterozoic) quartzites and siltstones
Trend lines
Syncline
Anticline
VISITORS ARE REQUESTED TO KEEP TO PATHS
NO COLLECTING OF SPECIMENS WITHOUT AUTHORISED PERMIT
Paths
Suggested route and viewing points
0 metres
100
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NATIONAL PARKS & WILDLIFE SERVICE S.A.

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THE ENCOUNTER BAY GRANITES AND THEIR RELATIONSHIP TO THE CAMBRIAN KANMANTOO GROUP

by

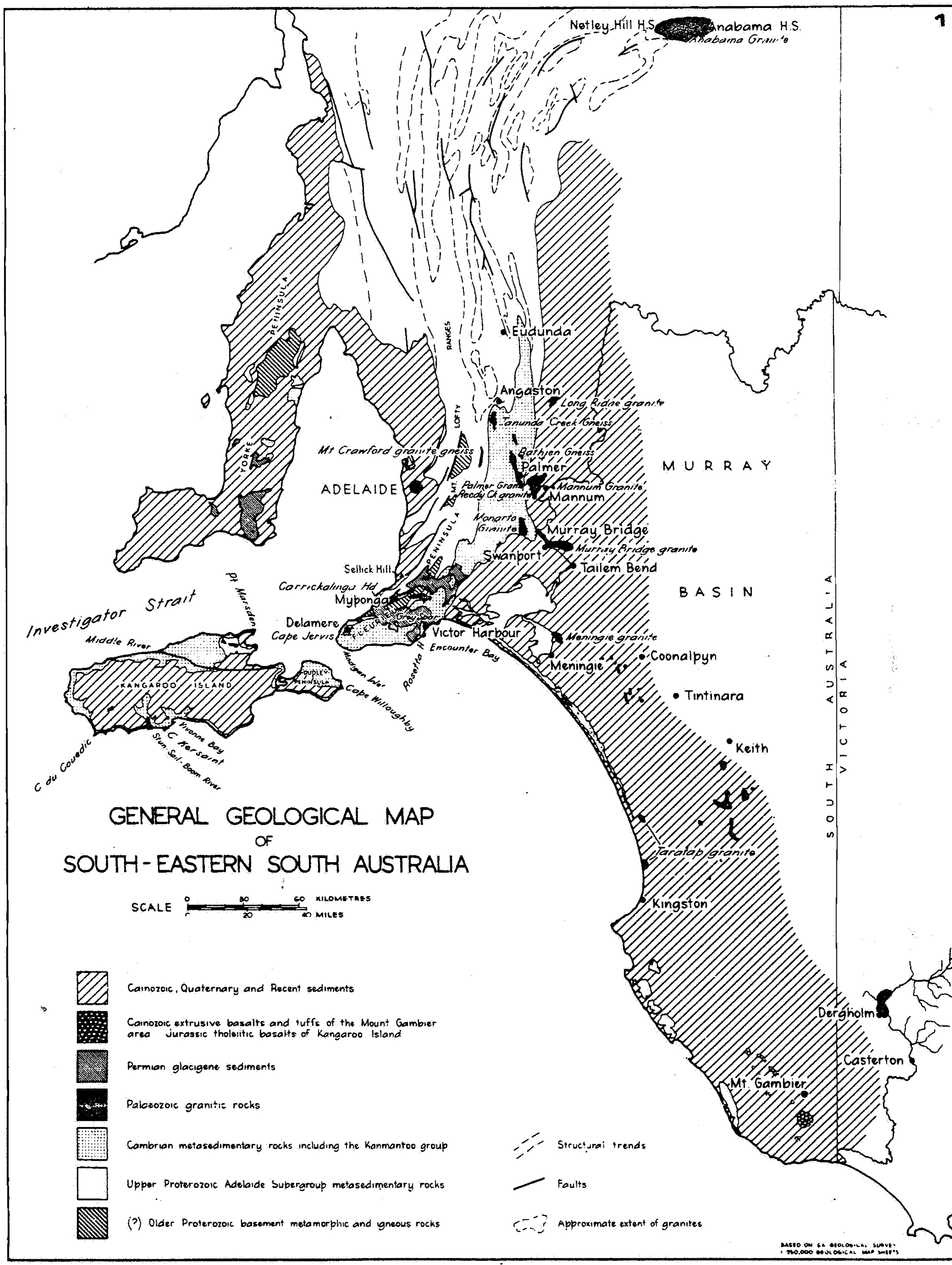
A.R. MILNES

INTRODUCTION

Granitic rocks in southeastern South Australia occur as discontinuous masses within Precambrian and Cambrian metasediments in the eastern part of the Adelaide Orogen, and also as relict islands within Cainozoic marine sediments in the Murray Basin (Fig. B2-1). They are both schistose and non-schistose in character, and where field relationships are exposed, are seen to be broadly concordant bodies within metasediments containing mineral assemblages of andalusite-staurolite and higher grades of regional metamorphism. Contact metamorphic aureoles are characteristically absent.

The Encounter Bay Granites crop out at Cape Willoughby and further west along the southern coast of Kangaroo Island, and on the southern coast of Fleurieu Peninsula in Encounter Bay (Fig. B2-1). They occur within metasediments of the Kanmantoo Group. The type section of the Kanmantoo Group in the coastal cliffs between Cape Jervis and Encounter Bay on Fleurieu Peninsula (Sprigg & Campana, 1953), and a subsidiary section around the coastline of Dudley Peninsula on Kangaroo Island, have been mapped in detail by Daily & Milnes (1971a, 1971b, 1972a, 1972b, 1973, In Daily et al., 1979). Late Palaeozoic (Carboniferous-Permian) glacigene sediments overlie grooved and striated rock surfaces of both Kanmantoo Group metasediments and Encounter Bay Granites (Howchin, 1899, 1903, 1910, 1926; Ludbrook, 1967; Milnes & Bourman, 1972).

Early research on the Encounter Bay Granites was mainly concerned with mineralogy and geochemistry, and included studies by Tilley (1919a, 1919b), Browne (1920), Kleeman (1937), and Bowes (1954, 1959). Although there was considerable uncertainty at this time about the age of the Kanmantoo Group (Mawson, 1926), the granites were usually regarded as Early Palaeozoic because they were clearly older than the Late Palaeozoic glaciation. Recent field, structural, petrological, and geochemical studies of the Encounter Bay Granites and the contiguous Kanmantoo Group metasediments, together with isotopic age determinations, provide a framework for interpreting the orogenic history of the region in relation to absolute ages of igneous emplacement, folding events and final cooling (Milnes, 1973; Daily & Milnes, 1973; Milnes et al. 1977). Exposures in the coastal cliffs of Encounter Bay and Kangaroo Island provide the opportunity for particularly close examination of field relationships, structures, textures, and other features that are important in the formulation of reasonable geological models. Several exposures in the Encounter Bay area will be visited during the excursion.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GENERAL GEOLOGICAL MAP
OF
SOUTH-EASTERN SOUTH AUSTRALIA
SCALE 0 30 60 KILOMETRES
0 20 40 MILES
Cainozoic, Quaternary and Recent sediments
Cainozoic extrusive basalts and tuffs of the Mount Gambier area Jurassic tholeiitic basalts of Kangaroo Island
Permian glacigene sediments
Palaeozoic granitic rocks
Cambrian metasedimentary rocks including the Kanmantoo group
Upper Proterozoic Adelaide Subergroup metasedimentary rocks
(?) Older Proterozoic basement metamorphic and igneous rocks
Structural trends
Faults
Approximate extent of granites
Netley Hill H.S.
Anabama H.S.
Anabama Granite
YORKE PENINSULA
MT. LOFTY RANGES
Eudunda
Angaston
Long Ridge granite
Tanunda Creek Gneiss
Mt Crawford granite gneiss
Rathjen Gneiss
Palmer
ADELAIDE
Palmer Granite
Reedy Ck granite
Mannum Granite
Mannum
Monarto Granite
Murray Bridge
Murray Bridge granite
Swanport
Tailem Bend
MURRAY
BASIN
Sellick Hill
Carrickalinga Hd
Myponga
Delamere
Cape Jervis
FLEURIEU PENINSULA
Victor Harbour
Encounter Bay
Investigator Strait
Pt Marsden
Middle River
KANGAROO ISLAND
DUDLEY PENINSULA
Hindmarsh Inlet
Rosetta H
Cape Willoughby
C du Couedic
C Kersaint
Vivonne Bay
Stun Sail Boom River
Meningie granite
Meningie
Coonalpyn
Tintinara
Keith
Taratap granite
Kingston
SOUTH AUSTRALIA
VICTORIA
Dergholm
Casterton
Mt. Gambier
BASED ON S.A. GEOLOGICAL SURVEY 1:250,000 GEOLOGICAL MAP SHEETS

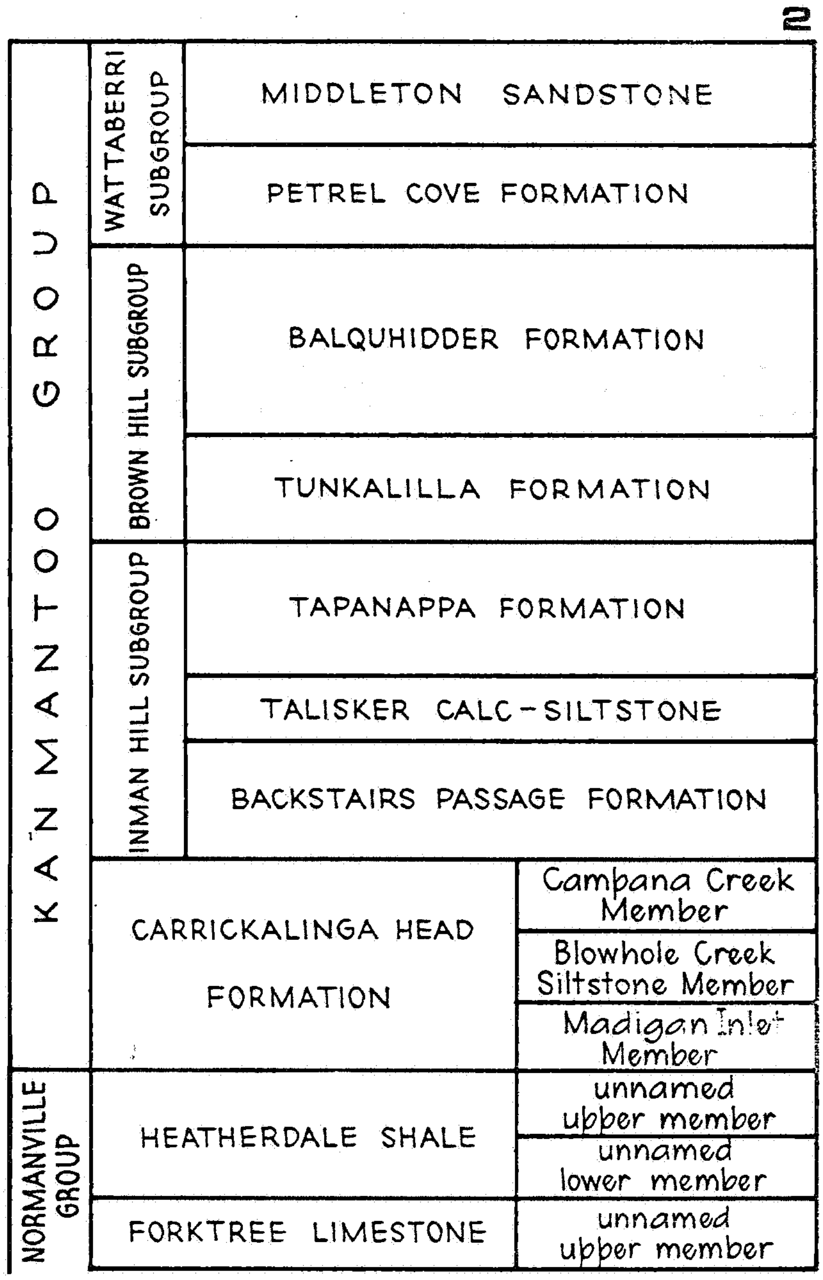
THE KANMANTOO GROUP IN ITS TYPE SECTION

Daily & Milnes (1971a, 1972b, 1973) demonstrated that the Kanmantoo Group in its type section east of Cape Jervis conformably overlies fossiliferous Lower Cambrian metasediments (Normanville Group) which form the core of a regional overturned anticline. The stratigraphic succession (Fig. B2-2) occurs on the normal easterly-dipping limb of the regional fold, and can be traced almost continuously eastwards into contact with the Encounter Bay Granites at Rosetta Head (Figs. B2-1, -3). The succession is straightforward despite the amphibolite facies metamorphism and the occurrence of parasitic folds.

The Kanmantoo Group is comprised predominantly of metaclastics of immature 'flysch-like' character. Daily & Milnes postulated very rapid deposition in an actively subsiding basin by currents flowing mainly southeastwards from nearby tectonic lands. Moderately shallow water marine environments of deposition were envisaged, partly because unmetamorphosed sediments of similar facies and known shallow-water origin occur on the north coast of Kangaroo Island (Daily & Milnes, 1973, In Daily et al., 1979).

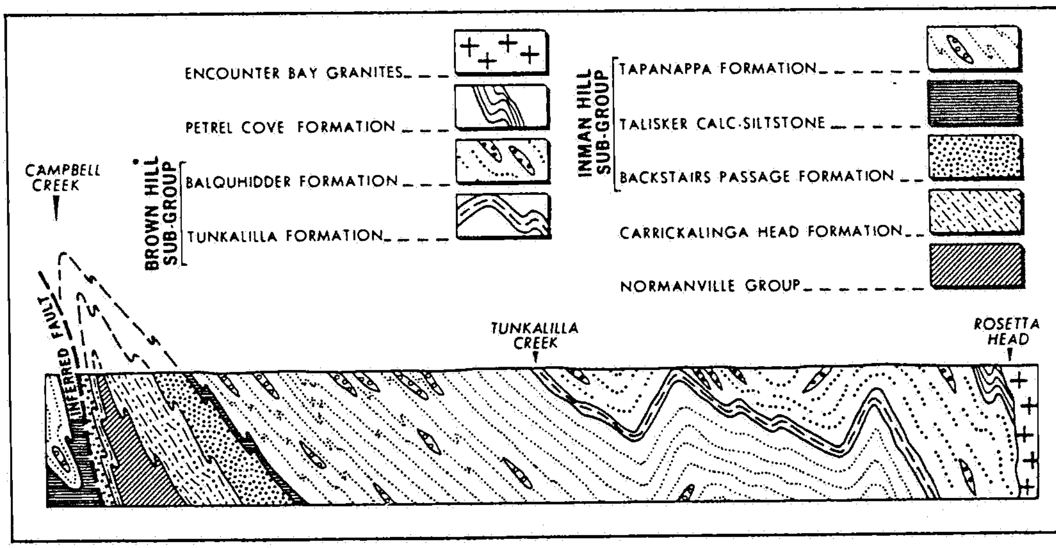
Metasandstone is by far the dominant lithology; parallel laminations are the common bedding structure, and lenticular conglomerates and pebble bands are conspicuous. The metasediments of the Carrickalinga Head Formation, the Tapanappa Formation and the Balquhidder Formation are generally similar and to a large degree repetitious. However, certain formations contain unique lithologies or lithological intervals which can be used successfully as marker beds (Daily & Milnes, 1972b). For example, the Backstairs Passage Formation comprises light-coloured, well-laminated metasandstones with prominent cross-bedding and slump-bedding. The Talisker Calc-siltstone is a formation of banded calcareous phyllites containing abundant iron sulphide in some areas. The base of the Tunkalilla Formation is marked by a distinctive blue-black carbonaceous phyllite containing a significant concentration of iron sulphide. Similar phyllites mark the top of the formation and occur sporadically through the overlying Balquhidder Formation. The Middleton Sandstone comprises well-laminated, cross-bedded, and slump-bedded metasandstones that contain abundant epidote-rich segregations as lenticular patches and nodules in bands parallel to bedding and record original carbonate concentrations.

Observations and measurements of structural elements in the Kanmantoo Group indicate two main phases of deformation (Daily & Milnes, 1973). First generation (D_1) structures are dominant, but second generation (D_2) structures become well developed in the eastern part of the type section in the Petrel Cove Formation and the Middleton Sandstone (Fig. B2-4). Cordierite appears to be restricted in its distribution to the vicinity of Rosetta Head, and on the basis of porphyroblast textures, crystallised both prior to and during the early stages of D_1. Andalusite has a regional distribution and porphyroblast textures suggest crystallisation during the later stages of D_1 and in the post-D_1 static phase. Other post-D_1 minerals including garnet, hornblende, biotite, chlorite, muscovite, scapolite, and epidote also have a regional distribution.



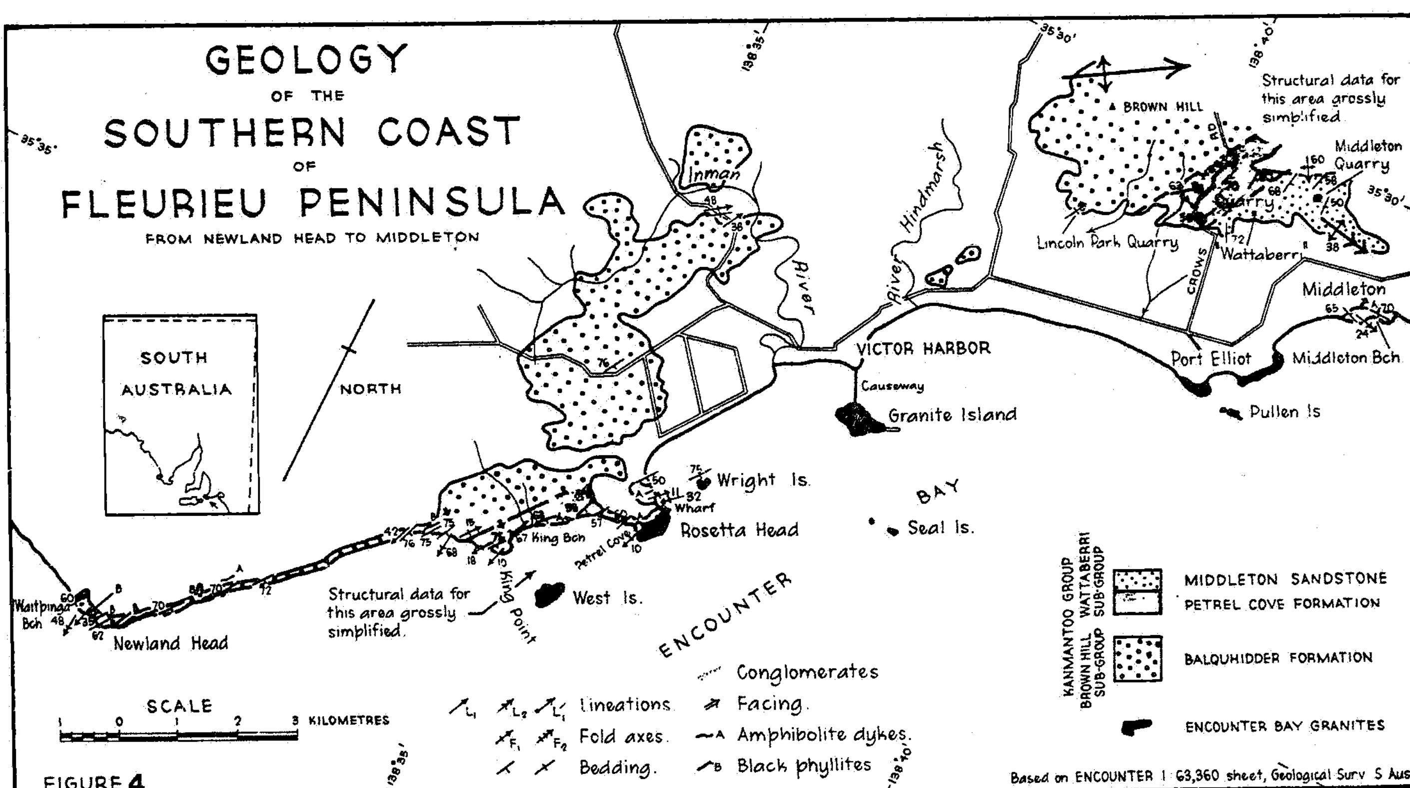
B2-2

STRATIGRAPHIC COLUMN FOR THE NORMANVILLE AND KANMANTOO GROUP



B2-3

STRATIGRAPHY AND STRUCTURE OF THE KANMANTOO GROUP TYPE SECTION. FROM DAILY AND MILNES, 1973.



B2-4

NATURE OF THE CONTACT BETWEEN THE GRANITES AND THE KANMANTOO GROUP

The contact between the Encounter Bay Granites and the Kanmantoo Group is exposed along the landward side of Rosetta Head and Wright Island (Fig. B2-4), where a coarse-grained granite containing megacrysts of potash feldspar, plagioclase, and opalescent blue quartz abuts well-laminated metasediments of the Petrel Cove Formation. The granite is broadly concordant, but in detail may transgress bedding. The contact has an approximate dip of 45-60° towards the east such that the granite actually overlies the Kanmantoo Group. The contact is not exposed elsewhere in Encounter Bay, but from the trend of the outcrops the granites appear to transgress the stratigraphic boundary between the Petrel Cove Formation and the Middleton Sandstone.

Concordant granite sheets up to 1 m thick were emplaced along bedding planes in Petrel Cove Formation metasediments adjacent to the contact, and are well exposed on Wright Island. In this respect, the granite sheets contrast with the many discordant dolerite dykes that intruded both granites and metasediments. The contacts are very sharp but extremely irregular due to the projection of feldspar and quartz crystals from the granites into the metasediments. There is little variation in grain size of either rock type near the contacts, although a thin biotite selvage occurs within the metasediments along the serrated boundary.

Metasediment xenoliths within the granites have a similar lithology to contiguous Kanmantoo Group metasediments. Many display fine sedimentary structures, but in general they do not contain a penetrative mica preferred orientation. Spectacular boudinage structures and a layered schistosity in granite sheets and parts of the main granite mass close to the contact have an orientation consistent with D_1 structures in the contiguous metasediments. These relationships suggest that the Encounter Bay Granites were emplaced and had crystallised prior to the culmination of D_1 in the region. At this time, it appears that bedding planes in Kanmantoo Group metasediments were preferentially available as planes of weakness to the intruding granites. In fact, the general concordant nature of the granites may reflect the control that bedding had on the emplacement of the pluton as a whole, with wedging apart of beds and active stoping being important emplacement mechanisms, at least on a small scale. The dominance of bedding as the structural inhomogeneity in Kanmantoo Group metasediments was lost after emplacement of the granites and the culmination of D_1, presumably because of metamorphic crystallisation and the formation of a penetrative schistosity (S_1). Indeed, post-D_1 dolerites and pegmatites are always discordant. On the other hand, the undeformed nature of the granites away from the contact suggests that the intrusion behaved essentially as a rigid body during the deformation.

GENERAL DESCRIPTION OF THE ENCOUNTER BAY GRANITES

Present exposures of the Encounter Bay Granites represent only a glimpse of the margins of a regional granitic terrain, and so any observations may be significantly biased. Nevertheless, the major granite variety is a coarse-grained, non-schistose, grey-blue granite containing large ovoid potash feldspar megacrysts (generally mantled by plagioclase), with plagioclase, distinctive opalescent blue quartz, and biotite. It contains a large variety of xenoliths, of which the most conspicuous and abundant are rock fragments similar in lithology to contiguous Kanmantoo Group metasediments. Hornfelses, hybrid granites, fine-grained granites, and granophyric rocks also occur as inclusions in the megacrystic granite. There are two variants of the granite: a border facies which occurs close to the contact with the Kanmantoo Group and contains abundant metasediment fragments and a fine granophyric groundmass indicating rapid crystallisation; and a slowly-cooled inner facies uncontaminated by metasediments, but characterised by abundant pegmatite clots usually containing tourmaline. The distinction between the two facies is also evident in the structural state of the potash feldspar megacrysts (triclinic in the inner facies variant but partly monoclinic in the border facies), and in total-rock chemistry. Other interesting features of the megacrystic granites are zones of accumulation of potash feldspar megacrysts and various types of layering. The border facies megacrystic granite occurs in all localities, but the inner facies variant occurs only at Port Elliot (Fig. B2-5) where the contact between the two is a fault. In this locality, fine- and medium-grained granites, a red leucogranite, and a miarolitic granophyre crop out, together with minor granite varieties including aplites and pegmatites.

Hybrid granites are well represented on Granite island (Fig. B2-6), and comprise fine-grained rocks with a biotite- or hornblende-rich matrix and coarse-grained megacrysts of blue quartz, potash feldspar and plagioclase mimicing those in the surrounding granite. Similar rock types are recorded in granites from many parts of the world, and are sometimes referred to as 'microgranites' or 'diorites'. On Granite island, hybrid granites occur as inclusions of varying size within the border facies megacrystic granite, but they themselves contain a heterogeneous collection of hornfels inclusions. Two facies of hybrid granite are recognised, and are thought to represent different stages of assimilation of sediments or metasediments incorporated into the megacrystic granite magma prior to crystallisation of potash feldspar.

Late stage albitisation affected the Encounter Bay Granites along a prominent joint set approximately normal to the contact between the granites and the Kanmantoo Group, and thus the albitised zones are dyke-like in form. The altered granites are texturally identical to the surrounding rocks but are composed of albite, quartz, and biotite; all pre-existing potash feldspar is replaced by albite. In places at Rosetta Head (Fig. B2-7), the border facies megacrystic granite displays a greater degree of albitisation, and the result is a rock composed of albite and chlorite although it retains the original granite texture. The albite-chlorite rock contains albitised metasediment xenoliths, and interfingers with the megacrystic granite. The contact

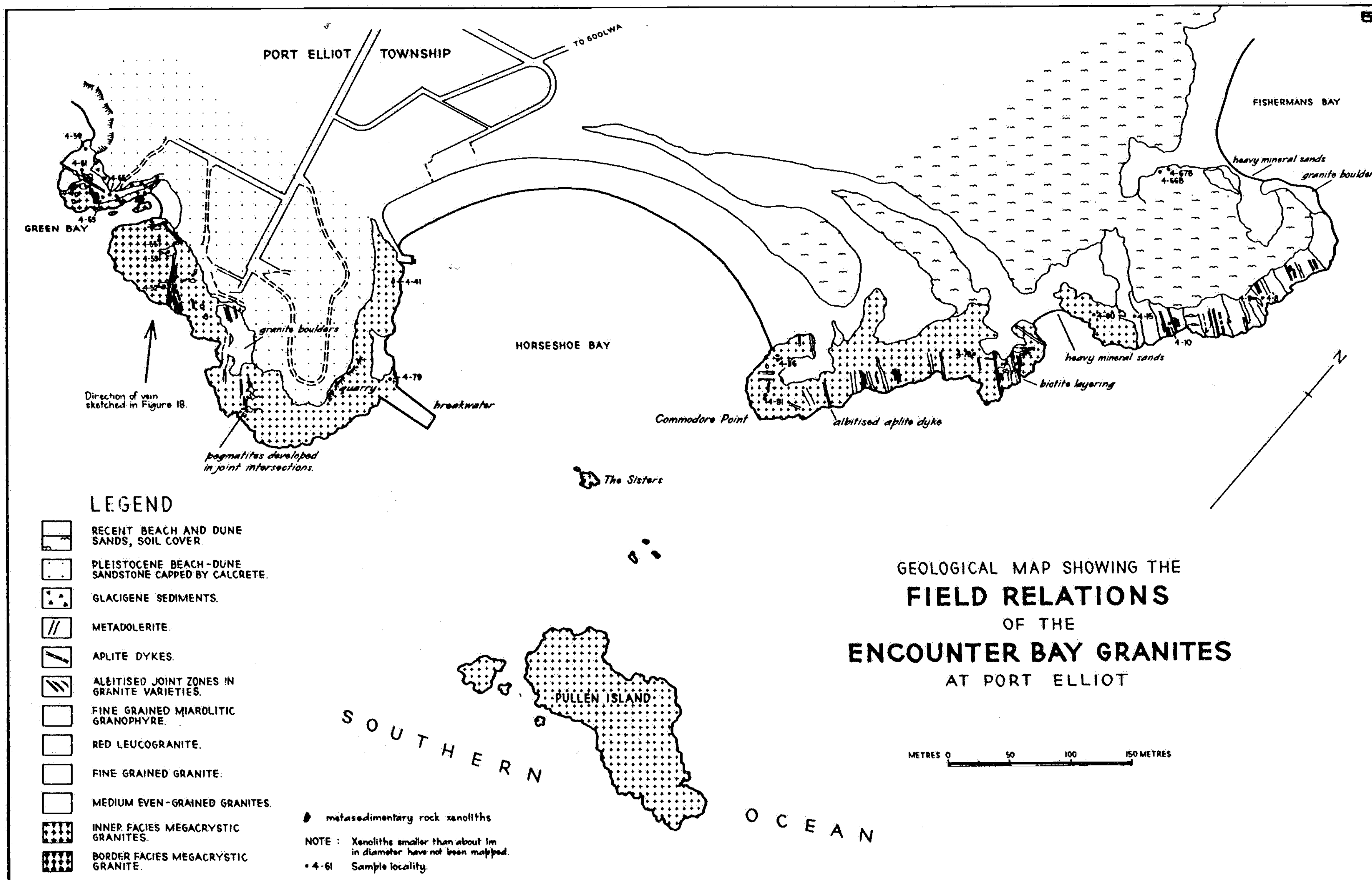

5
PORT ELLIOT TOWNSHIP
TO GOOLWA
FISHERMANS BAY
heavy mineral sands
granite boulders
GREEN BAY
granite boulders
quarry
breakwater
HORSESHOE BAY
Commodore Point
albitised aplite dyke
biotite layering
heavy mineral sands
Direction of vein sketched in Figure 18.
pegmatites developed in joint intersections.
The Sisters
PULLEN ISLAND
SOUTHERN OCEAN
N
LEGEND
RECENT BEACH AND DUNE SANDS, SOIL COVER.
PLEISTOCENE BEACH-DUNE SANDSTONE CAPPED BY CALCRETE.
GLACIGENE SEDIMENTS.
METADOLERITE.
APLITE DYKES.
ALBITISED JOINT ZONES IN GRANITE VARIETIES.
FINE GRAINED MIAROLITIC GRANOPHYRE.
RED LEUCOGRANITE.
FINE GRAINED GRANITE.
MEDIUM EVEN-GRAINED GRANITES.
INNER FACIES MEGACRYSTIC GRANITES.
BORDER FACIES MEGACRYSTIC GRANITE.
metasedimentary rock xenoliths
NOTE : Xenoliths smaller than about 1m in diameter have not been mapped.
• 4-61 Sample locality.
GEOLOGICAL MAP SHOWING THE
FIELD RELATIONS
OF THE
ENCOUNTER BAY GRANITES
AT PORT ELLIOT
METRES 0 50 100 150 METRES

FIG. B2-5

-23-

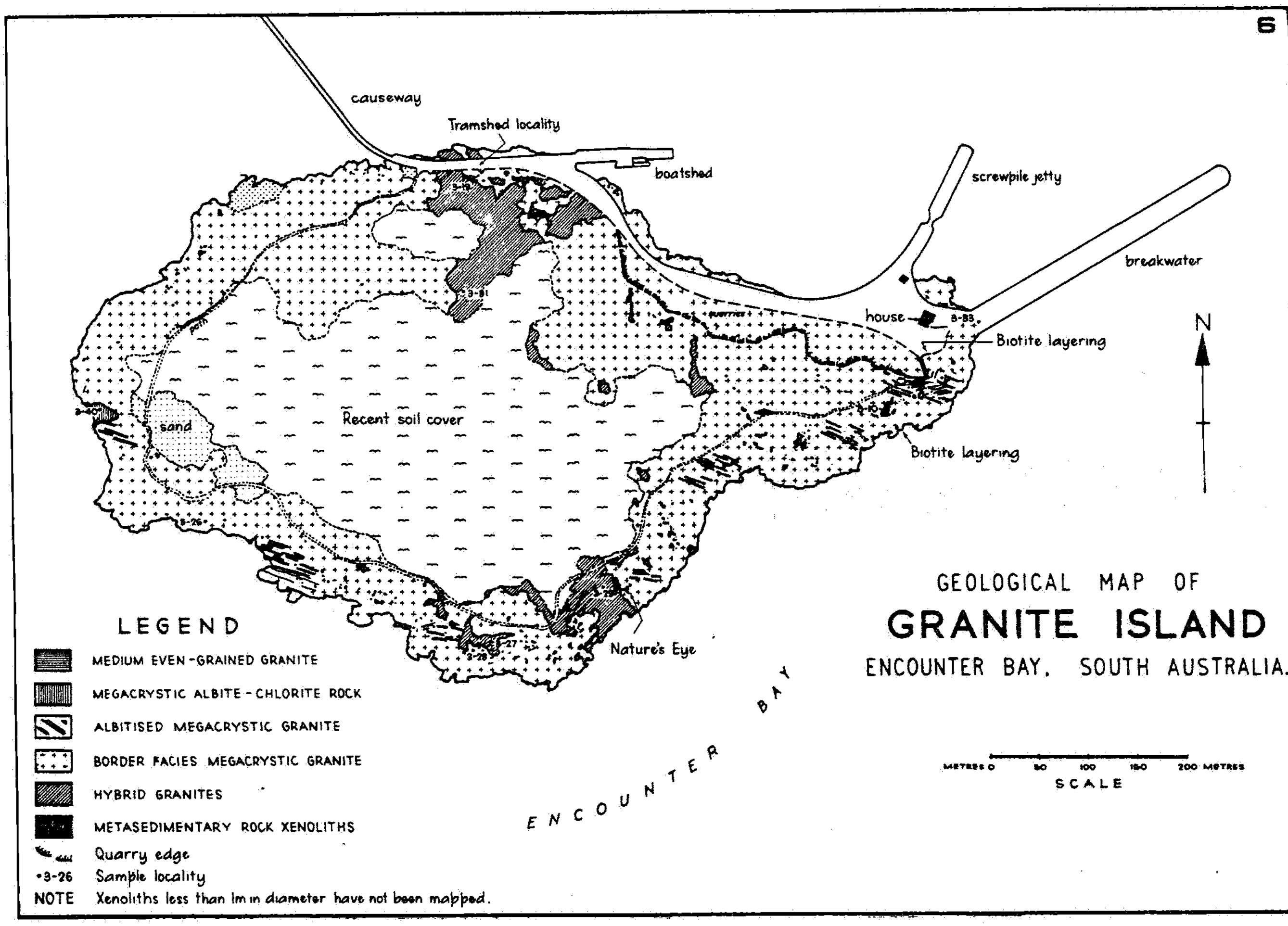

6
causeway
Tramshed locality
boatshed
screwpile jetty
breakwater
house
Biotite layering
Biotite layering
N
Recent soil cover
sand
path
Nature's Eye
ENCOUNTER BAY
GEOLOGICAL MAP OF
GRANITE ISLAND
ENCOUNTER BAY, SOUTH AUSTRALIA.
SCALE
LEGEND
MEDIUM EVEN-GRAINED GRANITE
MEGACRYSTIC ALBITE-CHLORITE ROCK
ALBITISED MEGACRYSTIC GRANITE
BORDER FACIES MEGACRYSTIC GRANITE
HYBRID GRANITES
METASEDIMENTARY ROCK XENOLITHS
Quarry edge
•3-26 Sample locality
NOTE Xenoliths less than 1m in diameter have not been mapped.

FIG. B2-6

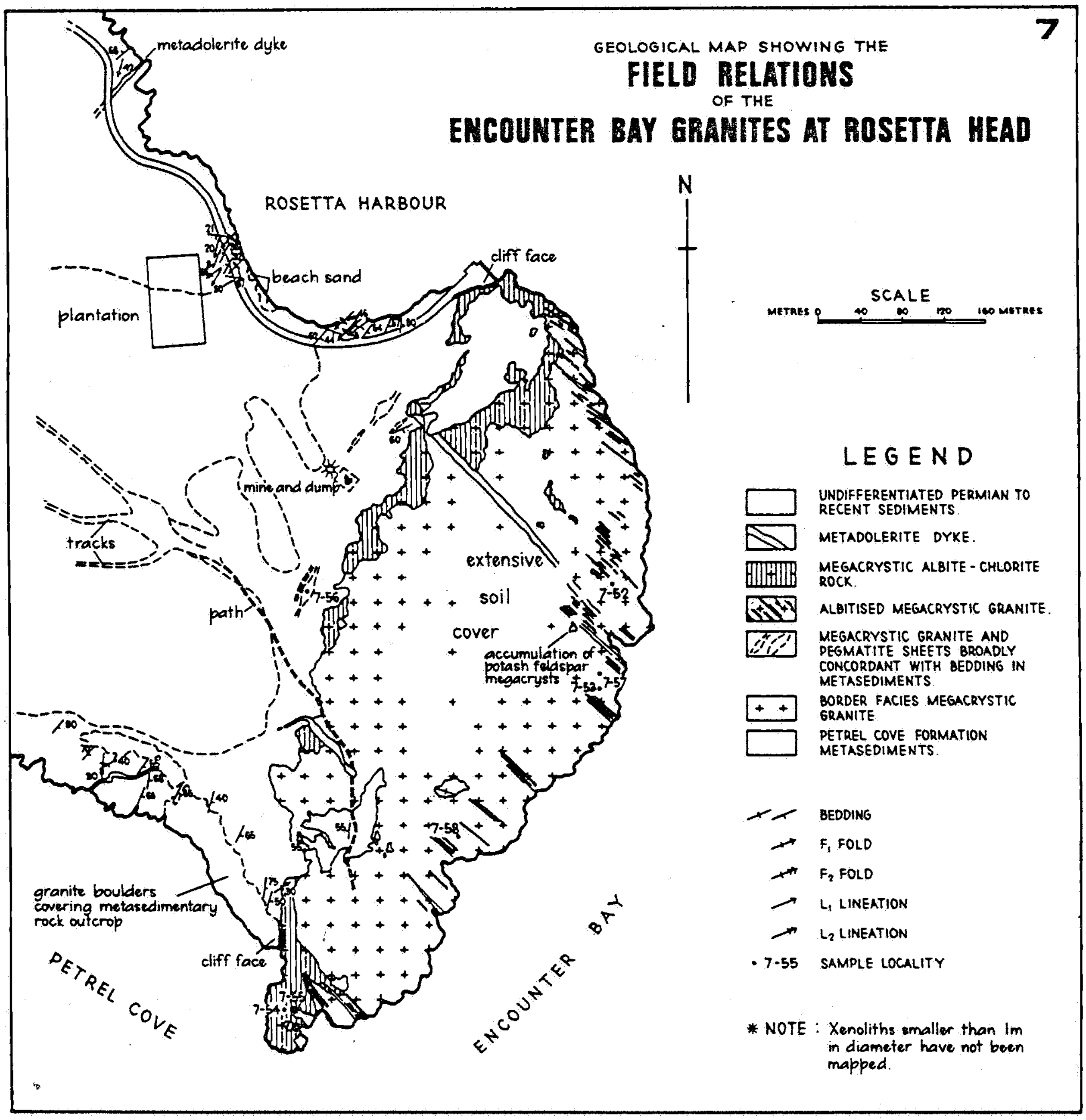

7
GEOLOGICAL MAP SHOWING THE
FIELD RELATIONS
OF THE
ENCOUNTER BAY GRANITES AT ROSETTA HEAD
N
SCALE
METRES 0 40 80 120 160 METRES
metadolerite dyke
ROSETTA HARBOUR
beach sand
plantation
cliff face
mine and dump
tracks
path
extensive
soil
cover
accumulation of potash feldspar megacrysts
granite boulders covering metasedimentary rock outcrop
cliff face
PETREL COVE
ENCOUNTER BAY
LEGEND
UNDIFFERENTIATED PERMIAN TO RECENT SEDIMENTS.
METADOLERITE DYKE.
MEGACRYSTIC ALBITE - CHLORITE ROCK.
ALBITISED MEGACRYSTIC GRANITE.
MEGACRYSTIC GRANITE AND PEGMATITE SHEETS BROADLY CONCORDANT WITH BEDDING IN METASEDIMENTS.
BORDER FACIES MEGACRYSTIC GRANITE
PETREL COVE FORMATION METASEDIMENTS.
BEDDING
F1 FOLD
F2 FOLD
L1 LINEATION
L2 LINEATION
• 7-55 SAMPLE LOCALITY
* NOTE : Xenoliths smaller than 1m in diameter have not been mapped.

FIG. B2-7

between the two is gradational over about 5 cm, and is marked by a progressive replacement of quartz by albite and the alteration of biotite to chlorite.

Total-rock geochemical data for the Encounter Bay Granites are summarised in the triangular composition diagram in Figure B2-8, and define a curvilinear trend extending from the total alkalis apex towards the Fe-Mg side of the diagram. The different granite varieties occupy fairly discrete composition fields. In particular, the border facies megacrystic granite occupies an elongate field that overlaps the inner facies megacrystic granite but extends towards the Fe-Mg side of the diagram into the field of Kanmantoo Group metasediments and xenoliths. The progressive displacement of these granites along this trend, away from the field of medium-grained granites which are presumed to have a composition close to that of the primary magma, is considered to reflect various degrees of contamination by incorporation of country rock. On the other hand, a composition trend due to enrichment of alkalis relative to the medium-grained granites is recorded in data for the red leucogranite, granophyres, and aplites, and is probably a differentation trend due to late-stage crystallisation of residual magma in favourable sites.

AGES OF GRANITE EMPLACEMENT AND METAMORPHISM

Rb-Sr isotope data for total-rock, feldspar, and muscovite samples of the granites indicate emplacement between 504-594Ma[1] ago in the Late Cambrian to Early Ordovician. Rb-Sr and K-Ar data for biotites record variable radiogenic strontium loss until about 459Ma ago and comparatively uniform radiogenic argon loss until about 483-468Ma[2] ago. On the other hand, Rb-Sr data for Kanmantoo Group metasediments and a metamorphic pegmatite containing coarse andalusite indicate crystallisation ages between 453-449Ma ago. Thus, the regional andalusite grade temperatures and pressures that appear responsible for the leakage of radiogenic strontium and argon from biotite in the granites and the redistribution of Rb and Sr in the metasediments seem to have persisted for some 50Ma after emplacement of the granites, until the Middle Ordovician. There is evidence for further leakage of radiogenic Sr and Ar from biotite in the deformed megacrystic granites from the margins of the intrusion in the Late Silurian or Early Devonian, possibly during D_2.

EXCURSION SITES

1. Rosetta Head (Fig. B2-7).
   Examine: a. Petrel Cove Formation lithologies and sedimentary structures, deformation features and metamorphism; discordant metadolerites.

   b. Features of the contact between the Petrel Cove Formation and the Encounter Bay Granites; border facies megacrystic granite; metasediment xenoliths; albitisation zones.

[1] Calculated for $Rb_{half-life} = 1.42 \times 10^{-11} yr^{-1}$
[2] Based on ^{40}K = 0.01167 atom percent; $\lambda_\beta = 4.963 \times 10^{-10} yr^{-1}$; $\lambda_\varepsilon = 0.5811 \times 10^{-10} yr^{-1}$

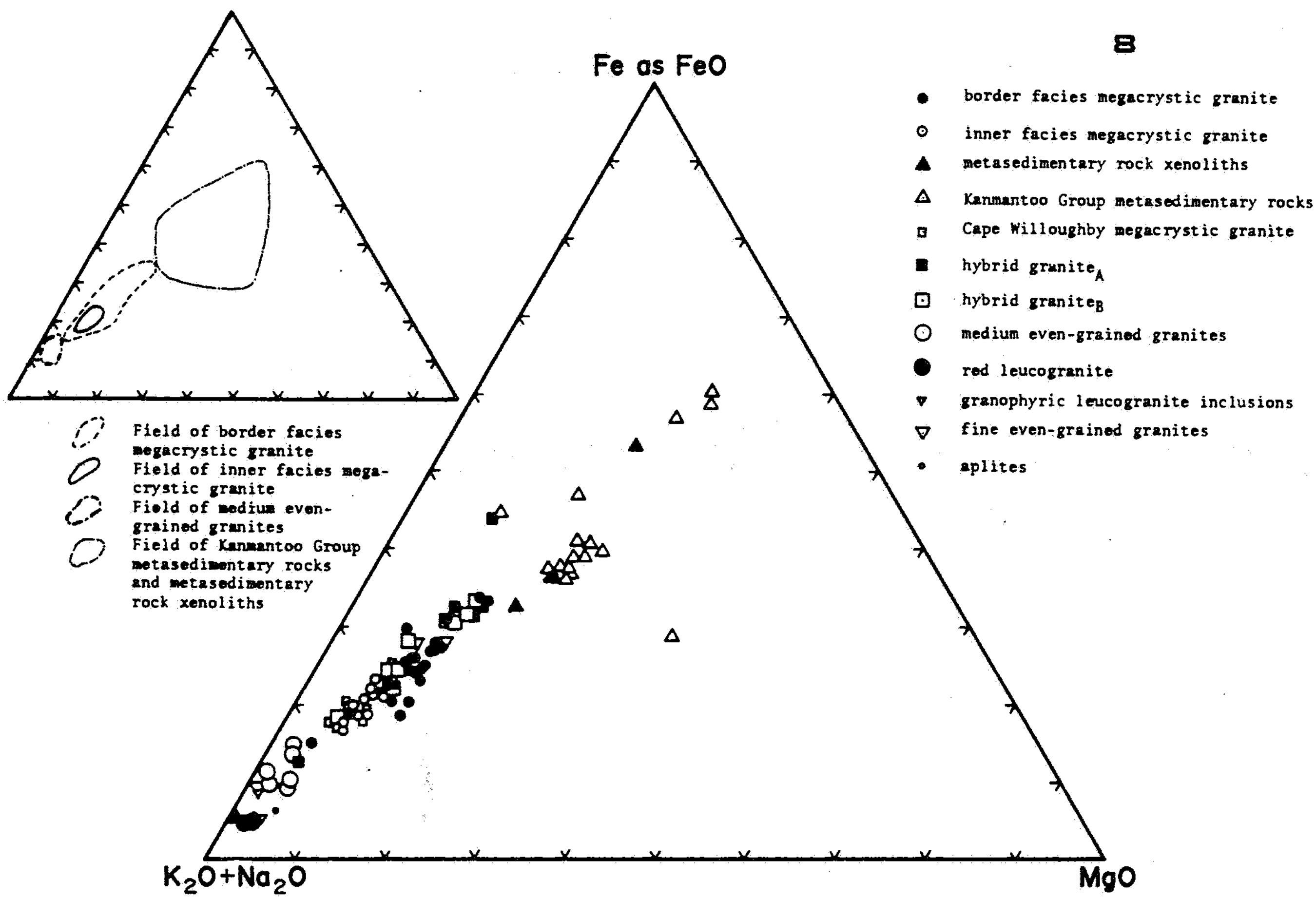


FIG. B2-8

TRIANGULAR COMPOSITION DIAGRAM: TOTAL-ROCK GEOCHEMICAL DATA FOR ENCOUNTER BAY GRANITES

2. Granite Island (Fig. B2-6).

Examine: Border facies megacrystic granite; hybrid granites; accumulations of potash feldspar megacrysts; layering; albitised joint zones.

3. Port Elliot (Fig. B2-5).

Examine: a. Border facies megacrystic granite; potash feldspar megacrysts; medium-grained granites; glaciated granite surface.

b. Inner facies megacrystic granite; red leucogranite; albitised joint zones.

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EXCURSION B3

LOWER CAMBRIAN SEDIMENTS, PRECAMBRIAN - CAMBRIAN BOUNDARY AND DELAMERIAN TECTONICS OF SOUTHERN FLEURIEU PENINSULA

by Daily, B., Jago, J.B., and James P.R.

South of Carrickalinga Head, the ancient rocks which form the backbone of the Fleurieu Peninsula intersect the coastline between the small town of Normanville and Rapid Bay (Fig. Intro-1). In an overturned to near recumbent major fold, which is a tight neutral (closing to the southwest) anticline, basement gneisses which include quartz-biotite and sillimanite-garnet gneisses, pegmatites, and aplites and intensely sheared and foliated mylonitic schists, occur in the nose of the southeast plunging Normanville inlier (Fig. B3-1).

On the southwest flanks of the structure, a simple shallowly southeast dipping angular unconformity separates the basement from a normal gently inclined sequence of Adelaidean strata. A coarse basal conglomerate with overlying slates and quartzite containing heavy mineral laminations (Aldgate(?) Sandstone equivalents) is superceded by typical Sturt (Tillite) Formation, on a thick sequence of black, finely laminated Tapley Hill Formation and finally the Brighton Limestone equivalent. This sequence is upfaulted against Kanmantoo Group greywacke along a major northeast - southwest trending fault which occupies the valley followed by the Normanville - Delamere road. Lithologies on this upper limb of the fold are very weakly metamorphosed to lower greenschist facies and rarely contain a discernable foliation. Minor folds and other tectonic structures are absent.

On the northwesterly overturned limb of the major anticline the Adelaidean sequence although apparently complete lies structurally beneath highly sheared and retrogressed equivalents of the basement gneisses. The whole sequence is thinned to a few tens of metres and shows evidence of intense ductile strain. The strain, which accompanied development of a low grade tectonothermal axial plane fabric, has an intense shallowly southeast dipping principal plane of flattening and also an intense southeast plunging elongation lineation. Values of shortening across the foliation of >70% and of elongation parallel to the down-dip lineation of >250% were recorded from minimum strain values from the deformed basal conglomerate by Anderson (1975). He further described a strain path progressing from early oblate upright flattening strains through to reclined plane to prolate strains which developed from the weakly deformed upper limbs to the intensely sheared and overturned lower limb of the major fold.

From a later study by Manktelow (1981) it has become clear that the area has developed as a local complex variation of the more typical Adelaidean folding of the Delamarian Orogeny. Its peculiar deformational history appears to be related to its position on both the inner core of the Fleurieu oroclinal bend and the western boundary between the Adelaide geosyncline against the Early Proterozoic Gawler Craton. This location appears to have deflected the characteristic east-west subhorizontal Delamarian D_1 principal stress leading to a northwest-southeast subhorizontal intensly localised simple shear strain. Upright

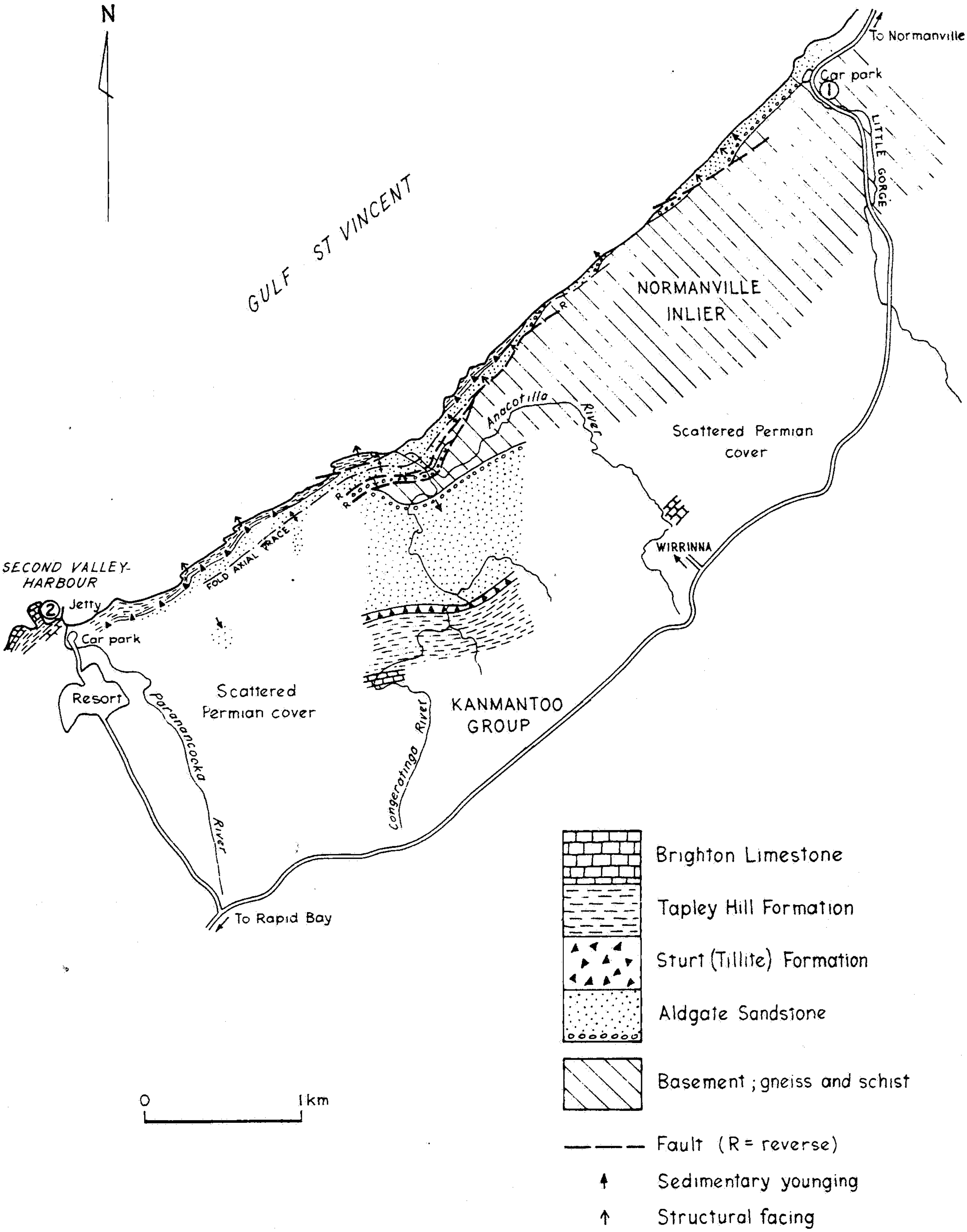

FIG. B3-1

GEOLOGICAL MAP OF THE AREA BETWEEN LITTLE GORGE AND SECOND VALLEY
(Modified from Anderson, 1975)

open to tight folds were overturned and 'thrust' onto the presumably shallow southeasterly inclined erosional surface of the gneisses of the rigid Gawler Craton. The simple shear strain concentrated on the lower limbs of overturned folds and rotated fold axial planes and axes to southeast dips and plunges respectively. Traversing to the southeast across strike and away from the Gawler Craton the gradual decrease in strain intensity and return of fold geometry and orientation to more-typical D_1 Delamarian style is detailed by Manktelow (1981)

In the Mount Lofty Ranges and Fleurieu Peninsula, Cambrian sediments disconformably overlie Adelaidean (Late Proterozoic) sediments. The Cambrian sediments comprise two main depositional cycles, the older Normanville Group (Daily and Milnes, 1973) and the younger Kanmantoo Group (Sprigg and Campana, 1953).

The Normanville Group (figs. Intro-1,B3-2,B3-3) is best exposed in the Sellick Hill area where there are two marine cycles of shallow shelf sedimentation separated by an erosional break between the Wangkonda and the Sellick Hill Formations.

The oldest unit of the Normanville Group is the Mount Terrible Formation of Daily (1963) which in the type area near Sellick Hill comprises three members. The lowest member is a 12 m thick feldspathic sandstone and arkose which at the base fills small erosional hollows cut into the underlying Adelaidean rocks. The middle member is a 60 m thick grey siltstone which is phospatic in places; the top member is a 13 m thick cavernous weathered sandstone which is conformably overlain by the Wangkonda Formation.

Daily (1976) considers the Mount Terrible Formation to be of early Tommotian (earliest Cambrian) age, although other workers suggest a slightly younger age. Daily (1976, pp. 48-49) and subsequent work indicates that the upper part of the basal member is bioturbated, with the lowest shelly fossils occurring towards the base of the middle member. In this member the fossils include hyolithids, the rostroconch *Heraultipegma*, the problematical fossil cf. *Sachites*, conodonts (?*Onetodus*), sabelliditids, and problematica. The top member includes various species of hyolithids, *Chancelloria* spicules, helcionellid gastropods (including *Bemella*). pelagiellids, *Saarina* and other sabelliditids, and problematica.

The conformably overlying Wangkonda Formation consists of two shallowing-upward cycles of carbonate-rich rocks (Daily *et al.*, 1976). Each cycle commences with calcareous sandstones and siltstones which are overlain by dark grey mottled limestones and are capped by unfossiliferous pale grey limestones deposited in intertidal to supratidal environments. Features indicating such deposition include oolitic and fragmental limestones, intraclastic limestones and limestones with a fenestral or "birdseye" structure. The only fossils known from the Wangkonda Formation come from near its base, where a fauna similar to that from the upper part of the Mount Terrible Formation is found.

The Sellick Hill Formation disconformably overlies the Wangkonda Formation with cut and fill structures clearly visible in road cuttings near Sellick Hill (Daily 1963). The sandy, and in places pebbly, basal parts of the unit fill hollows eroded in the top of the Wangkonda Formation. The Sellick Hill Formation shows quite a variable lithology (Daily, 1969) with the lower

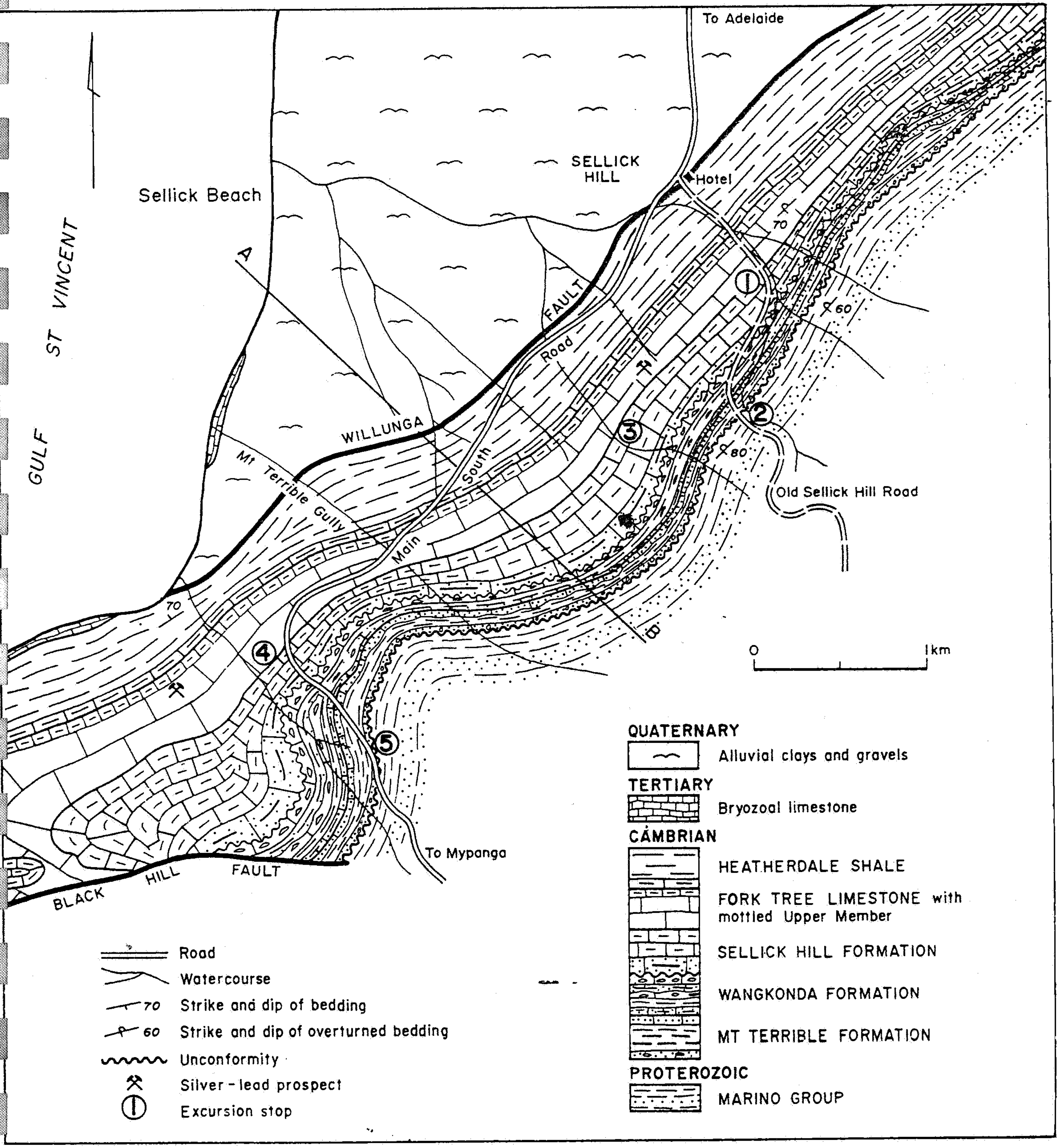

FIG. B3-2

GEOLOGY OF THE SELLICK HILL AREA

(Modified from Abele and McGowran, 1959) part comprising mainly highly bioturbated calcareous quartz sandstone and siltstone. The upper part comprises scantily fossiliferous dark grey mottled and banded silty limestone and calcareous shales distinctive of much of the formation (Daily _et. al._, 1976). Hyolithids and rare gastropods (including _Helcionella_ and _Tanuella_ near the base) are scattered throughout the formation; in places they occur as current-concentrated thin bands. Daily _et. al._, (1976) consider that the majority of the Sellick Hill Formation was deposited in a marginal basin with stagnant bottom conditions although the presence of small domed mounds and limestone bands with archaeocyatha near the top of the formation (Daily, 1969) suggest better water circulation.

The Fork Tree Limestone (Abele and McGowran, 1959) conformably overlies the Sellick Hill Formation. It comprises a clean archaeocyathid-rich lower member deposited in shallow clear water and a sparsely fossiliferous, massive mottled upper member probably deposited in a deeper, more reducing environment. The archaeocyathids of the lower member are very abundant, but poorly preserved. Gravestock (pers comm.) has identified the following archaeocyathids from the lower member: _Erugatocyathus sellicksi_, _Dokidocyathus_, and _Picnoidocyathus_, but notes that because all are long ranging forms, an exact age within the Early Cambrian cannot be determined. The upper member contains sparse archaeocyathids and tommotiids (Daily _et al._, 1976).

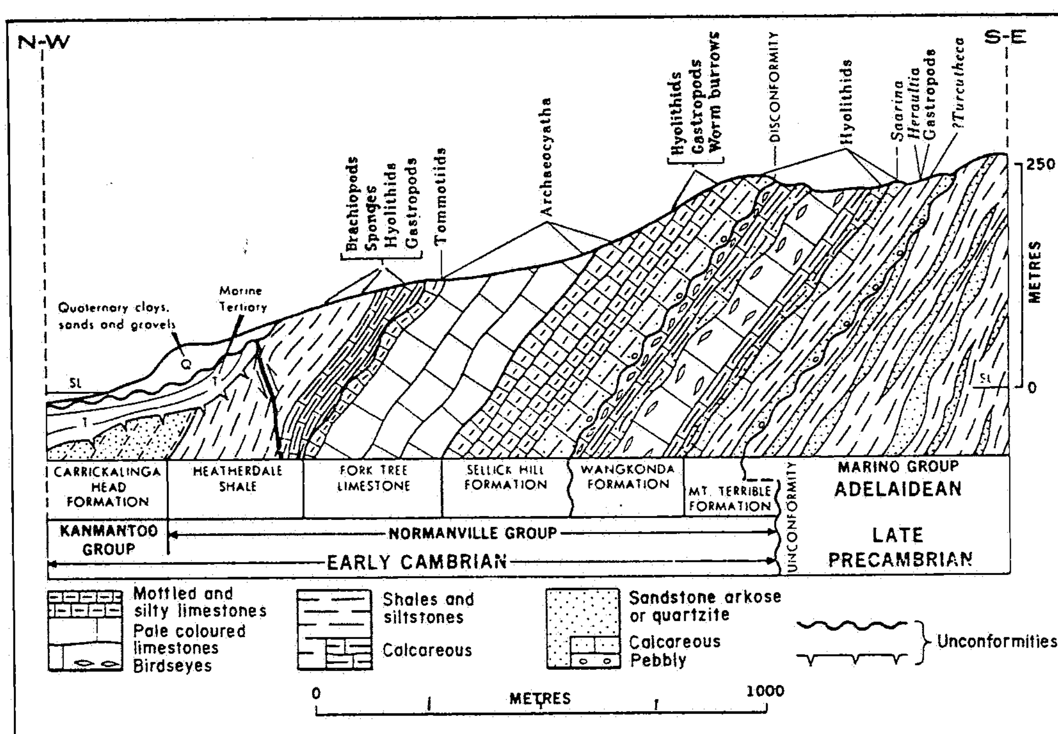

FIG. B3-3

GEOLOGICAL CROSS-SECTION, SELLICK HILL AREA
(From Daily et al., 1976)

The Fork Tree Limestone is conformably overlain by the Heatherdale Shale of Abele and McGowran (1959) which comprises a lower calcareous member, and an upper dark coloured to black shale and siltstone generally lacking carbonate. Nodules and stringers of black phosphate occur, particularly in the upper member (Daily et al., 1976). Lateral and vertical changes in carbonate content within the formation are quite marked (Daily, 1963, Daily et al., 1976). Hyolithids, sponges, brachiopods, and gastropods occur sparsely throughout.

In the Sellick Hill area some of the Early Cambrian formations show anomalously high lead-zinc concentrations (Wright, 1970, 1972). There are anomalous lead values at the arkose-siltstone contact of the Mount Terrible Formation; anomalous lead and zinc concentrations occur within the Fork Tree Limestone and to a lesser extent within the Wangkonda Formation. The positions of two small Mississippi Valley type deposits are shown in Fig. B3-2.

Near Carrickalinga Head the basal member of the Kanmantoo Group, the Carrickalinga Head Formation, conformably overlies the Heatherdale Shale. This represents the start of a new cycle of sedimentation and was triggered off by the Kangarooian Movement (Daily and Milnes, 1971), which interrupted the shallow water carbonate dominated marine sedimentation represented by the Normanville Group. The sediments of the Kanmantoo Group including probable turbidites were derived from newly emergent land masses (presumably predominantly Gawler Block crystalline basement) uplifted in the present Investigator Strait and Gulf St. Vincent areas, as well as from the Gawler Block (Daily, Moore and Rust, 1980, Jago and Daily, 1982).

The Kanmantoo Group as described by Daily and Milnes (1971, 1972, 1973) along the south coast of Fleurieu Peninsula consists of a very thick conformable sequence of metasandstone, metasiltstone and phyllite. There are eight formations, viz: Carrickalinga Head Formation (base), Backstairs Passage Formation, Talisker Calcsiltstone, Tapanappa Formation, Tunkalilla Formation, Balquhidder Formation, Petrel Cove Formation, and the Middleton Sandstone (eroded top). Daily and Milnes (1971, 1972, 1973) considered that the Kanmantoo Group was rapidly deposited in an offshore marine environment by strong traction currents. However, other workers (e.g. Thomson, 1969; Flint, 1978) have suggested that all units, except the Middleton Sandstone were deposited as proximal turbidites. The Middleton Sandstone is well laminated, shows low-angle cross-bedding and is of shallow marine origin.

The only unit of the Kanmantoo Group to be inspected on the B_3 excursion will be the Carrickalinga Head Formation as exposed at Carrickalinga Head. Apart from the inarticulate brachiopod, Lingulella, and a few trilobite fragments in a possible equivalent of the Carrickalinga Head Formation on Kangaroo Island, the only known fossils from the Kanmantoo Group are worm burrows and a few trails.

It is of interest to note that no trilobites have yet been found in any of the Cambrian sediments on Fleurieu Peninsula.

B_3 EXCURSION STOPS

Locality 1 (Fig. B3-2,-3) Old road quarry, Old Sellick Hill Road, 0.7 km SE of Victory Hotel.

The gradational contact between the dark blue-grey banded and mottled Sellick Hill Formation and the cleaner lighter-coloured Fork Tree Limestone is well exposed. Where the beds dip steeply to the east, they are overturned. In the eastern wall of the quarry there are small lenses of archaecyatha within the Sellick Hill Formation. The stylolitic Fork Tree Limestone contains abundant, although poorly preserved archaeocyatha.

Locality 2 (Fig. B3-2,3) Precambrian-Cambrian contact, Old Sellick Hill Road, 1.5 km SE of Victory Hotel.

There is a well-exposed unconformable contact between the interbedded quartzites and siltstones of the Late Proterozoic (Adelaidean) Marino Group and the basal arkose of the Early Cambrian Mount Terrible Formation. The base of the arkose is a fine conglomerate which fills in a small cut within a Marino Group quartzite. In the Adelaide region the top of the Marino Group is equivalent to the ABC Range Quartzite of the Flinders Ranges. However, in the Flinders Ranges there is a considerable sequence of Late Adelaidean sediments (Bunyeroo Formation, Wonoka Formation, Pound Quartzite) between the ABC Range Quartzite and the basal Cambrian sediments. Hence the unconformity exposed here is of regional significance. As at Locality 1 the sequence dips steeply to the east but cross-bedding indicates that it is west facing.

After inspecting the unconformity and the basal member of the Mount Terrible Formation, the party will briefly inspect the middle member (brown siltstone), of the Mount Terrible Formation, before climbing the hill to the south of the road to inspect the cavernous weathered upper member. This cavernous weathering is caused by weathering out of carbonate pods from the sandstones and siltstones. Bioturbation is found in the top of the lowest member and in the middle member.

Locality 3 (Fig. B3-2) Creek exposures, 2 km S of Victory Hotel. Sequence through the Wangkonda Formation, Sellick Hill Formation, Fork Tree Limestone and Heatherdale Shale.

As the party goes up the sequence it will inspect:

(a) the relatively clean Wangkonda Formation

(b) the characteristically dark grey mottled and banded silty limestones and calcareous shales of the Sellick Hill Formation.

(c) the clean archaeocyathid-rich lower member of the Fork Tree Limestone

(d) the strikingly mottled upper member of the Fork Tree Limestone, which contains inarticulate brachiopods and hyolothids

(e) basal Heatherdale Shale, interbedded black, pink to purple weathering, shales (phosphatic nodules) and flaggy dark limestones

(f) a thin sequence of laminated pink to purple shales (black when fresh) with thin dark-grey limestone bands and nodules elongated parallel to bedding. Small black phosphate nodules are an important feature. Fossils occur sporadically and include hyolithids, sponge spicules, brachiopods and gastropods.

Locality 4 (Fig. B3-2,-3) Road Cutting, Main South Road, 4 km SW of Victory Hotel

The contact between clean Wangkonda Formation and dark-grey Sellick Hill Formation, with hyolithids concentrated in pockets, is exposed at road level but is more clearly seen higher up in the cutting. The irregular contact was cut in consolidated limestone either by strong current action or submarine solution. Black phospatic material is concentrated at the contact. Sulphides occur in the Sellick Hill Formation, here very variable in facies. Prominent are bioturbated dark silts and sands and minor carbonates. The Wangkonda Formation limestones exhibit "birds-eye" structure, indicative of an intertidal to supratidal environment.

Locality 5 (Fig. B3-2,-3) Road cutting, Main South Road, 0.8 km south-east of locality 4.

The Cambrian-Precambrian contact is exposed in the road-cut. It is duplicated by a small fault. Note the irregularity of the bedding surfaces in the thinly bedded Marino Group sediments. This is a tectonic effect.

Locality 6 (Fig. Intro-1) Myponga Beach.

Excellent exposures of Sellick Hill Formation can be inspected on the wave-cut platform and cliffs on the southwest side of Myponga Beach, between the old jetty and the point. The rocks are strongly weathered and in places most of the carbonate has been leached to reveal the dominantly argillaceous to silty nature of the formation. Septate hyolithids, which are the commonest fossils, have been selectively sorted by current activity and are concentrated into bands. This is expressed by parallel alignment of specimens within the rock and serial insertion of as many as five cones, one within the other, so that in cross-section, the shells are concentrically arranged.

On the point hyolithids are concentrated in a conspicuous band of intraformational conglomerate. The limestone pebbles include fragments of cleaner limestones containing archaeocyatha. These have been derived from the reworking of archaeocyatha-rich mounds occurring at the same stratigraphic position within the formation. Such clean limestones, (occasionally glauconitic), formed only at times when deposition of clastics had virtually ceased. In fact, submarine corrosion of surrounding dark coloured limestones on which the domed mounds rest is indicated by the development of black phosphatised surfaces on them. Just beyond the point sandstone bands with abundant worm castings and other organic markings are prominent.

Locality 7 (Fig.Intro-1) Carrickalinga Head. Contact between Heatherdale Shale and Carrickalinga Head Formation

In a small cove just north of Carrickalinga Head there is a very sharp contact between the dark phosphatic and calcareous shales of the Heatherdale Shale and the overlying Carrickalinga Head Formation. The Heatherdale Shale contains limestone nodules some of which contain fossils, including sponge spicules and the gastropod Helcionella. At the northern end of the cove the calcareous siltstones of the Heatherdale Shale include bedding planes rich in hyolithids.

The Carrickalinga Head Formation is well exposed on the shore platform. It comprises interbedded green siltstone and greywacke exposed in beds 1 to 5 m across. The inarticulate brachiopod, Lingulella, is the only fossil known from this locality. Asymmetric folds are prominent, plunging 25° towards 220°.

Locality 8 (Fig. B3-1) Little Gorge.

High coastal cliffs are composed of strongly foliated grey-green mylonitic-phyllonitic basement schists. These contain a shallow southeast plunging mineral lineation which parallels all microfolds. This section overlies the overturned contact with the stratigraphically younger coarse pebble conglomerate at the base of the Aldgate Sandstone, which is exposed on the beach. The conglomerate is highly deformed with an LS fabric . Pebbles of differing competence show varying shape ratios. The intensity of shearing in places makes recognition of the unconformity difficult. The presence of sheared pegmatites confirm basement material. On the seaward side of the conglomerate, completely inverted grits and sandstone show similar high-strain features.

Locality 9 (Fig. B3-1) Second Valley

The high coastal cliffs at the back of Second Valley Harbour display excellent examples of minor, near similar style folds in strongly cleaved and layered Tapley Hill Formation (Fig. B3-4). All fold axes lie parallel to well developed intersection, mineral, and elongation lineations which plunge shallowly southeast into the cliff. From the head of the small peninusla containing boat sheds a view southeast to the cliffs reveals the complexity of the structural scheme as was first described by Campana (1953) - see fig. B3-4. The peninsula itself is composed of Brighton Limestone now recrystallised to an indurated marble with a congruous tectonothermal fabric.

CLIFFS AT SECOND VALLEY JETTY

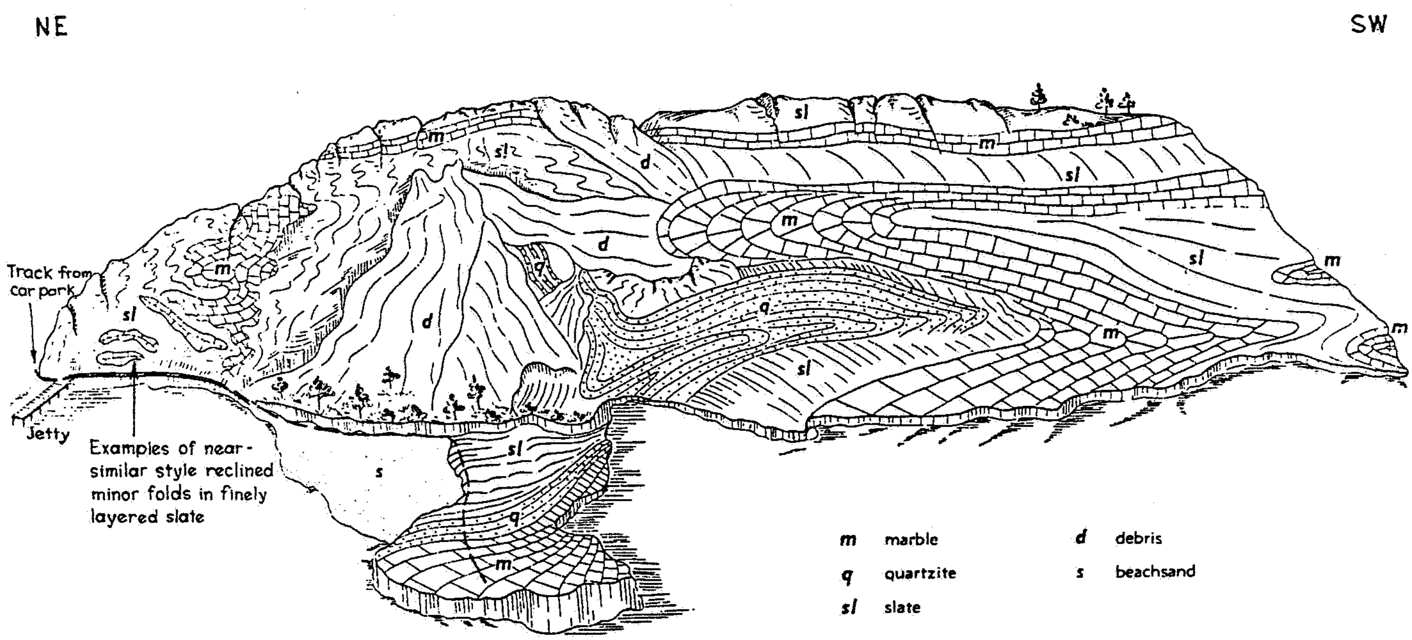

FIG. B3-4
BLOCK DIAGRAM, SECOND VALLEY JETTY AREA.
(Modified from Campana et al., 1953)

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TRAVERSE OF THE ADELAIDE HILLS TO REEDY CREEK

by R.L. Oliver

The traverse across the Adelaide Hills from west to east will be through increasingly metamorphosed metasediments of the Adelaide Supergroup and overlying Kanmantoo Group culminating in intrusive granitoids flanked by extensive migmatitic terrain.

The route follows the Torrens River from Adelaide to Gumeracha and Birdwood thence via Tungkillo to Palmer and vicinity on the edge of the Murray River plain (Figs. B4-1,-2,-3).

Locality 1 - Torrens River gorge. Tightly folded phyllites, quartzites, and recrystallised dolomites of the Burra Group of the Adelaide Supergroup, metamorphosed to chlorite-biotite grade. Vertical fold axial planes, characteristic of F_2 at this locality. Crenulations of earlier S_1. Development of new metamorphic layering parallel to S_2.

Locality 2 - Torrens River gorge dam site, (stone monument). Retrograded schistose gneisses of the pre-Adelaidean basement. These are part of the Houghton inlier (Figs B4-1 and B4-2). Elsewhere in the Houghton and other basement inliers on Fleurieu Peninsula are occurrences of metagranite and an enigmatic calcsilicate-like rock. The latter is called the Houghton "Diorite". It has been dated at 870 Ma (Cooper & Compston, 1971).

Locality 3 - Talc mine, east of Gumeracha. Aluminous rocks at this locality contain sillimanite. The metamorphic grade has thus increased rather abruptly compared with the last locality. Intermediate grade andalusite and staurolite bearing schists occur to the south but have been faulted out on this traverse (see Fig. B4-4).

The talc is thought to have formed by metasomatic leaching of biotite (Whittle, 1951). Granitic and pegmatitic rocks occur in the area and may be involved in the above mentioned leaching together with soda metasomatism presumably responsible for associated albite veining and small crosscutting albitite bodies.

Locality 4 - 2 km east of Tungkillo (see Fig. B4-3). Migmatitic Kanmantoo Group metagreywacke. Quartzofeldspathic veining is both cross cutting and parallel to mesofolded layering. Biotite segregations margin the quartzofeldspathic veins.

The migmatites of the Palmer area have been investigated by White (1966) who concludes that they have formed by metamorphic differentiation rather than by partial melting. This conclusion is based on the excessively rich potassic composition of the granitic veins (Fig. B4-5) and their trace element ratios, e.g. high K/Rb, high Sr/Rb, high Ba/Rb, and high Ba/K.

Locality 5 - Palmer Granite (see Fig. B4-3). This weakly lineated body is considered to have been emplaced as a differentiated magma during the Delamerian folding. It has been dated at between 514 ± 15 Ma (White et al., 1967, Milnes et al., 1977).

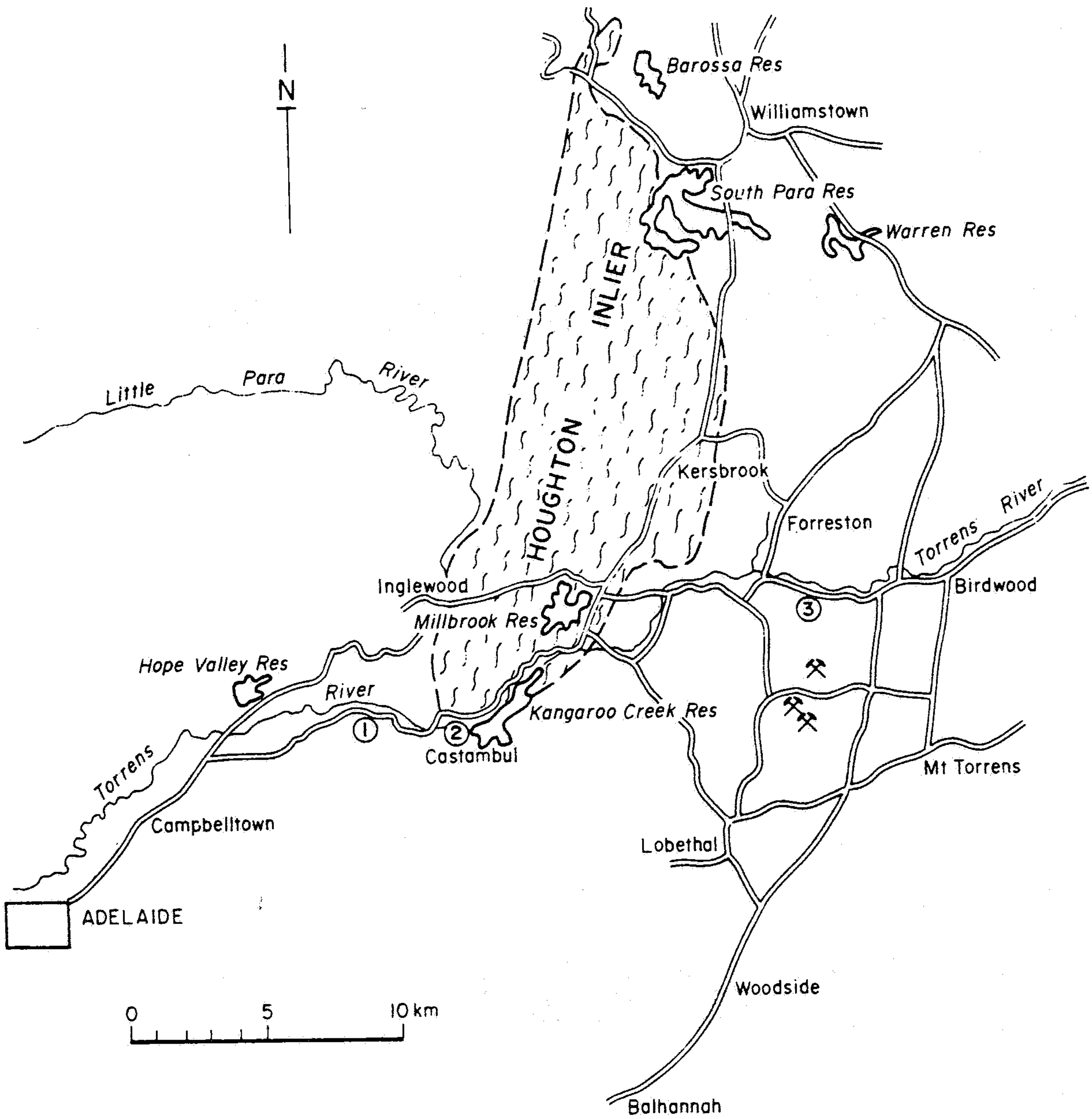


FIG. B4-1

ADELAIDE TO BIRDWOOD, LOCALITIES NO. 1 TO 3

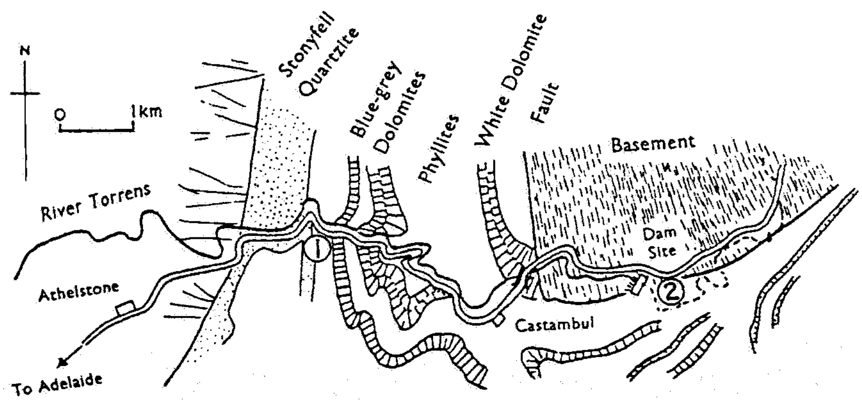


FIG. B4-2
GEOLOGICAL MAP OF THE GORGE AREA OF THE RIVER TORRENS SHOWING THE RELATIONSHIP OF THE BASEMENT TO THE LOWERMOST GROUP OF THE ADELAIDE GEOSYNCLINAL SEDIMENTS.

(Modified from Talbot and Nesbitt, 1968)

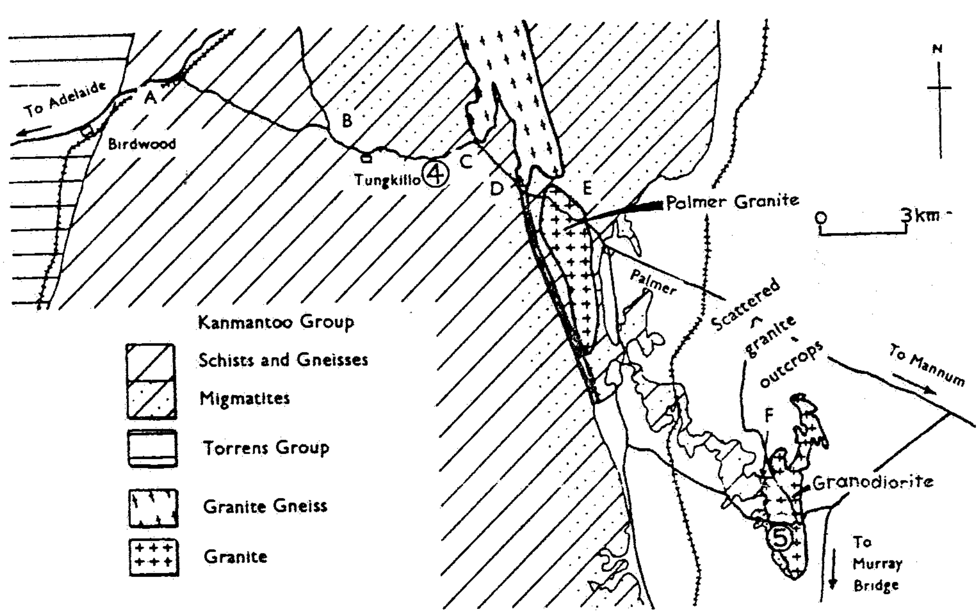


FIG. B4-3
GEOLOGICAL MAP OF THE GRANITE AREAS NEAR PALMER

(Modified from Talbot and Nesbitt, 1968)

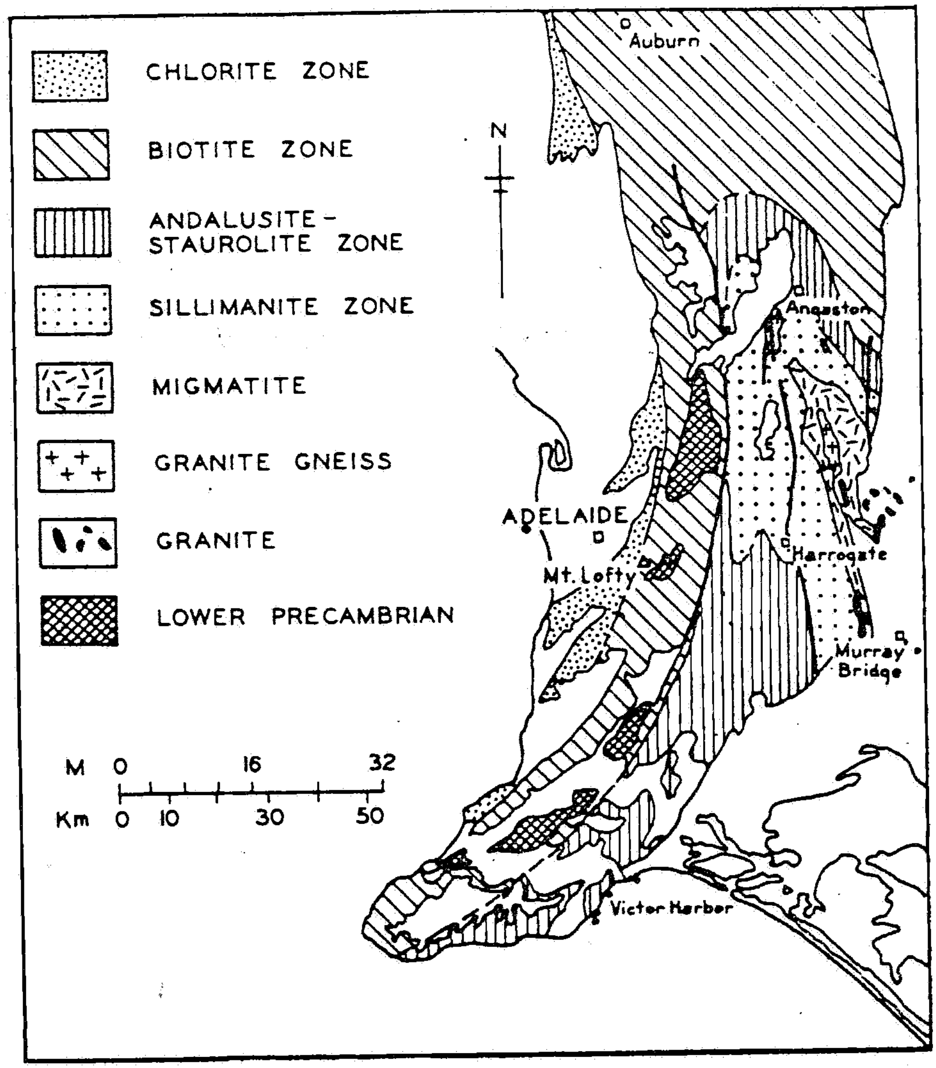


FIG. B4-4

METAMORPHIC ZONES IN THE MOUNT LOFTY RANGES

(Modified from Fleming, 1969)

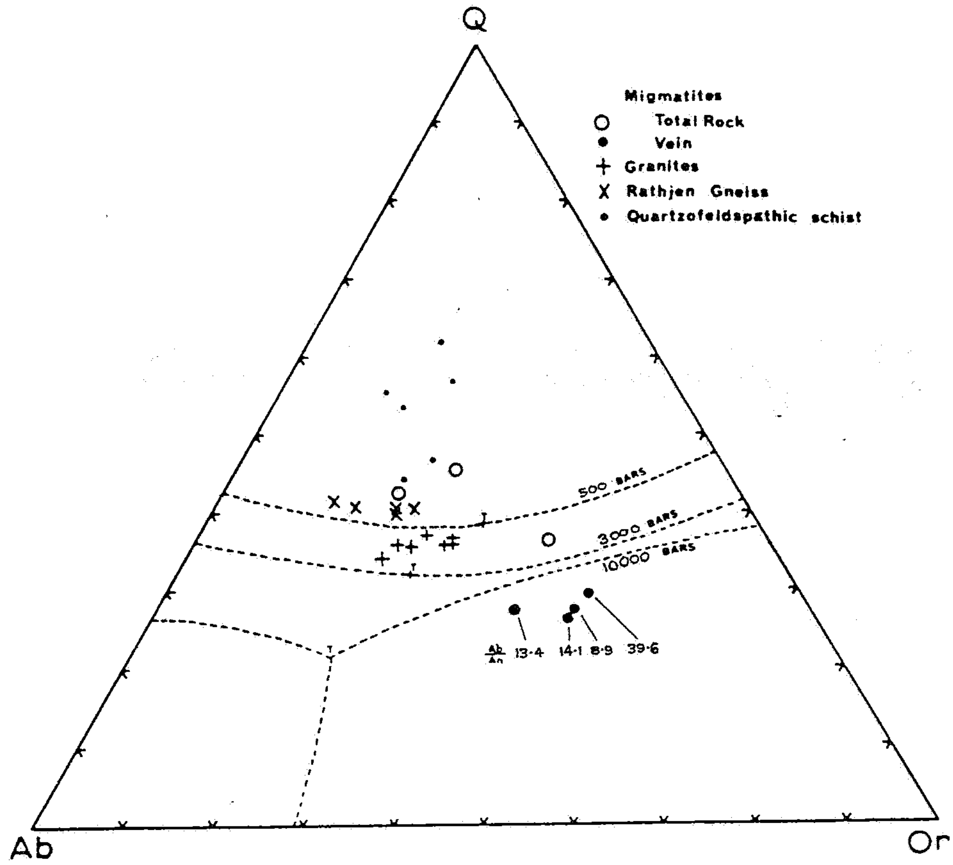


FIG. B4-5

NORMATIVE PERCENTAGES OF QUARTZ, ALBITE AND ORTHOCLASE PLOTTED ONTO THE SYNTHETIC GRANITE SYSTEM. THE NUMBERS ALONGSIDE THE GRANITIC VEINS GAVE TO THE NORMATIVE Ab/An RATIO.

(From White, 1966)

Other granitoid bodies occur in the area and their composition compared with that of the Palmer Granite is shown in Fig. B4-5.

Locality 6 - Reedy Creek (see Fig. B4-6). Reedy Creek is a small tributary of the Murray River. Fresh exposures of a granodiorite pluton and its contact with Kanmantoo Group metasediments outcrop in the creek bed.

Granitic phases of the pluton are also present. Closely associated are microgranite intruding the granodiorite, diorite intruding and intruded by the granodiorite, and the not yet defined Summerfield Granodiorite.

Recent work (Moeller, 1980) suggests:

(i) Initial partial melting of a metasedimentary source resulting in magma with a composition approaching that of a minimum melt (Palmer Granite?).

(ii) Further, non minimum, melting of this metasedimentary source produced most of the granitoid variants of the Reedy Creek area. Compositional variation within and between the granodiorite, its granitic phase, the diorite and microgranite is ascribed to varying degrees of separation of restite from melt during emplacement. The chemistry of these bodies is that of an I-type granitoid (Chapell and White, 1979) despite the presumed metasedimentary origin. The chemistry of the Summerfield Granodiorite is that of an S-type granitoid and is thought to have originated independently.

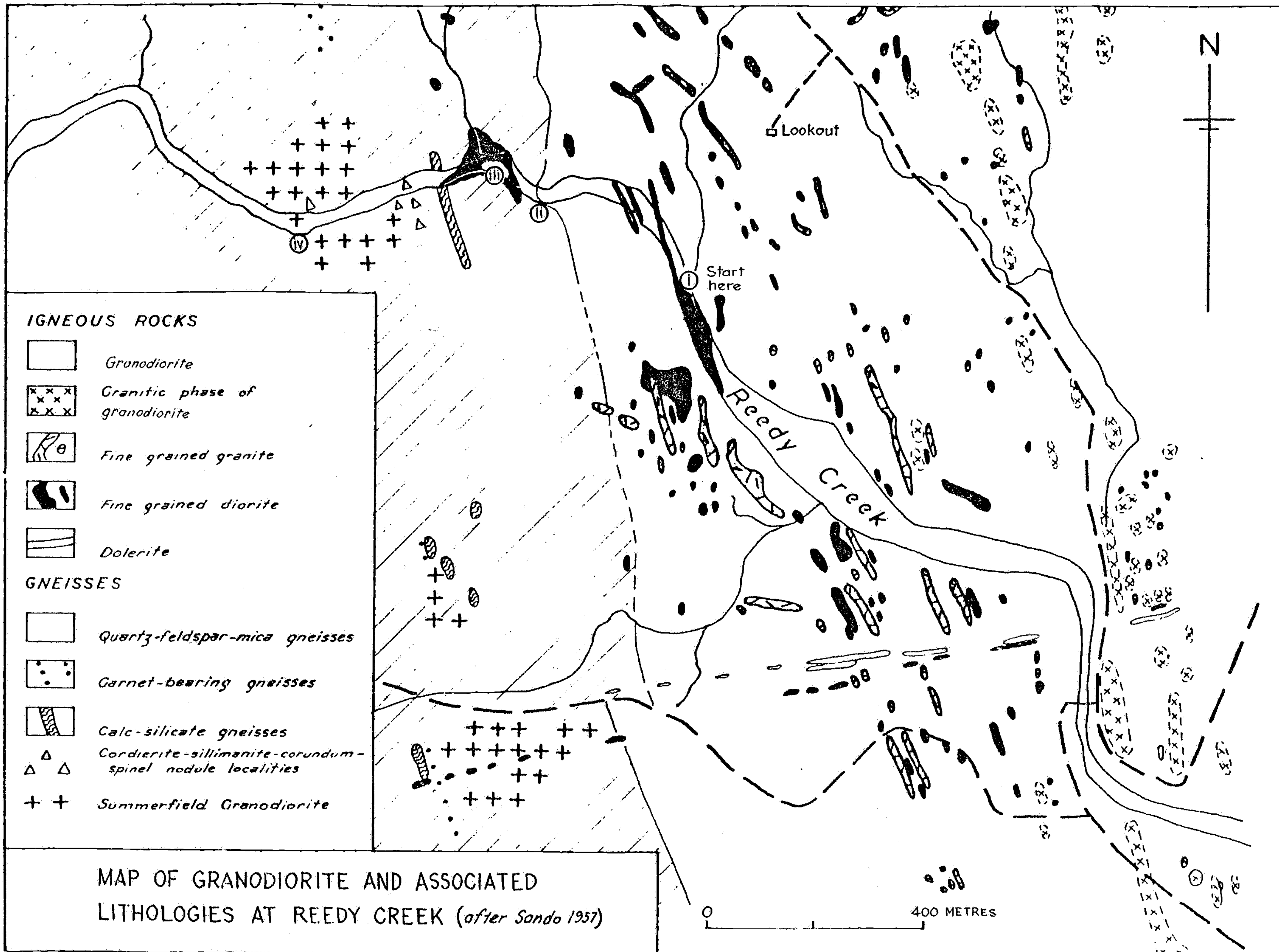
Stop (i) - In creek bed (Fig. B4-6)

Contact of granodiorite and diorite. Xenoliths of diorite in granodiorite. Granodiorite consists of megacrystic alkali feldspar, finer grained plagioclase, biotite and quartz. Diorite consists of hornblende, biotite, and plagioclase. Ilmenite and sphene are abundant accessories in both lithologies. The granodiorite has well developed foliation.

Stop (ii) - In creek bed, further upstream (Fig. B4-6)

Contact of granodiorite and migmatitic country rock. Note foliation in granodiorite parallel to that in country rock. Contact is relatively sharp. Near this location, downstream of the contact, granodiorite contains: (i) clusters of feldspar megacrysts representing disaggregated granodiorite, (ii) granodiorite xenolith with foliation oblique to that of the country rock, (iii) basic xenoliths of enigmatic origin.

The migmatites show textural evidence of a felsic melt phase. Biotite from migmatite and the I-type igneous bodies have Fe/Mg ratios, plotted according to experimentally determined biotite stability relations at P total = 2,070 bars (Wones and Eugster, 1965), which indicate a temperature of crystallisation of 790-810°C (Moeller, 1980). This supports a partial melt origin for these contact migmatites, in contrast perhaps to those at Locality 4.



MAP OF GRANODIORITE AND ASSOCIATED LITHOLOGIES AT REEDY CREEK (*after Sando 1957*)

FIG. B4-6

Stop (iii) - Further up creek (Fig. B4-6). Diorite is intrusive into metasediment. Only the metasediment is migmatised, supporting a pre-diorite emplacement of the granodiorite. Diorite shows foliation due to parallelism of biotite and hornblende.

Stop (iv) - Further up creek (Fig. B4-6). Summerfield Granodiorite. Fine to medium grained, equigranular. Distinguished by presence of euhedral muscovite, in addition to aligned biotite, plagioclase, alkali felspar, and quartz.

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