DEPARTMENT OF MINES
SOUTH AUSTRALIA

# Explanatory Notes

# for the

# PARACHILNA 1:250,000 geological map

by

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## ABSTRACT

The Parachilna 1:250,000 map area is about 250 road miles north of Adelaide, South Australia, and includes the eastern shore of Lake Torrens, the central Flinders Ranges and part of the Lake Frome Plains. The ranges are composed of folded Adelaidean (late Precambrian) and Cambrian sedimentary rocks intruded by diapirs, composed of a breccia of the Lower Adelaidean Callanna Beds, which were active during sedimentation. Flanking the ranges are older Pleistocene dissected gravels, younger Pleistocene alluvium and Recent soil and sand ridges. Recently worked economic minerals are barytes and galena.

## INTRODUCTION

The following pages are explanatory notes arranged in the style used by the Bureau of Mineral Resources, Canberra.

GEOLOGICAL SURVEY OF SOUTH AUSTRALIA

1:250,000

GEOLOGICAL SERIES

Explanatory Notes

# PARACHILNA

South Australia

Sheet H.54-13,

Australian National Grid

Compiled by B.G. Forbes.

The PARACHILNA 1:250,000 map area extends between latitudes 30°00' and 32°00' south and longitudes 138°00' and 139°30' east. Hawker, the principal town, is in the south-west of the area and is about 250 road miles north of Adelaide. The area includes, to the west, the eastern shore of Lake Torrens, the central Flinders Ranges and, to the east, part of the Lake Frome Plains. The ranges are composed of folded upper Precambrian and Cambrian marine sedimentary rocks, while the flanking plains represent a veneer of largely continental Tertiary and Quaternary sediments.

The climate is semi-arid and most of the region receives less than 10 inches of average annual rainfall. Average maximum and minimum temperatures for January (summer) and July (winter) are respectively 95°, 65°F and 60°, 40°F.

Vegetation may be classified under the general categories of mallee, low-layered woodland and shrub steppe. Common Eucalypts are mallees, or along water courses, red gums; other common trees are Casuarina, Callitris (native pine) and Acacia. Among smaller plants are porcupine grass, blue bush and salt bush.

Hawker lies at the northern end of the sealed section of National Route 83 which continues on to the north as a good unsealed highway through Brachina siding and Parachilna in the western part of the area. Another unsealed main

road takes tourist and station traffic northerly from Hawker through the Flinders Ranges via Wilpena Pound to Blinman, the only other town in the area, and "Wirrealpa" on the north-eastern edge of the ranges. "Wirrealpa" may also be reached by an eastern route through "Martins Well". The Commonwealth Railways 4'8½" gauge line to Alice Spriggs runs through the western part of the area. An old 3'6" gauge railway line is in disuse.

The main sources of income in the region are wool, tourism and barytes.

Air photos used during geological mapping were on a scale of 1:47,520, based on photography by the South Australian Department of Lands about 1955 to 1958, original scale about 1:48,000 or 1:60,000. The Department of Lands photographed the region again in 1966 on an original scale of 1:74,000 (EC9). One-mile air photo mosaics are available from the Department of Lands and a 1:250,000 topographic map has been published by the Commonwealth Division of National Mapping.

One-mile base maps were prepared by the slotted template method by the Cartographic Section, South Australian Department of Mines, which also carried out all the remaining drafting work prior to printing.

Other geological maps available within the area are the Blinman and Oraparinna 1:63,360 sheets and the Blinman Special Series map. Published geological maps adjoining the area are COPLEY, ANDAMOOKA, TORRENS, PORT AUGUSTA, and ORROROO.

These notes are compiled partly from a preliminary typescript by C.R. Dalgarno and J.E. Johnson, who mapped the area. Since the mapping was done in the period 1962 to 1965, more recent work will also be referred to. The mapping was part of the South Australian Geological Survey's 1:250,000 scale regional mapping programme covering the Adelaide Geosyncline.

## PREVIOUS INVESTIGATIONS

The first geological exploration in the region appears to have been the visit by A.R.C. Selwyn (1860) whose notes include a description of Wilpena Pound and the rock sequence exposed there. In 1906 Walter Howchin (1922) made a traverse from Parachilna Gorge to the Lake Frome plains. Benson (1909) was the first to describe the basaltic rocks within the Blinman Dome Diapir. In 1925 Howchin described fossiliferous Cambrian rocks south of Hawker and in the Parachilna and Wirrealpa areas.

Mawson has been one of the main contributors on the geology of the Flinders Ranges and in a series of papers between 1938 and 1949 described the Sturtian, Marinoan and Cambrian sequences. Subsequent papers dealing with the stratigraphy of the area are those of Spry (1951a, 1951b), Daily (1956), Webb (1961), Dalgarno (1962, 1964), Coats (1964), Thomson et al (1964), Dalgarno and Johnson (1968) and Daily et al (1969). The PARACHILNA map of Dalgarno and Johnson (1966) was the first regional geological coverage of the area.

Outlines of the geology and geomorphology of the Flinders Ranges are provided by Corbett and Twidale in Corbett, 1969.

## PHYSIOGRAPHY

The two main elements in the topography of the region are the hard-rock ridges of the ranges, mainly in the central part, and the flanking alluvial plains leading down to Lake Torrens and Lake Frome.

The scenery of the ranges is a consequence of broad up-doming and the differential weathering and erosion of folded Precambrian and Cambrian sedimentary rock layers of varying resistance and thickness. The most significant rock unit in this regard is the Pound Quartzite. Wilpena Pound, for instance, results from the presence of a synclinally folded thick bed of resistant Pound Quartzite. Uplift of the ranges probably dates from the Tertiary and has resulted in such

prominences as St. Mary Peak, which is 3,900 feet above sea level and about 3,500 feet above the Lake Torrens plains, and Mt. Aleck, Point Bonney, Mt. Plantagenet and Mt. Caernarvon which are all over 3,000 feet above sea level. Another consequence of uplift is the cutting of rocky gorges by streams near the edge of the ranges. To the west, Parachilna and Brachina Gorges are well-known examples, but on the east Wirrealpa, Balcoracana and Ten Mile Creeks have also cut down deeply.

The plains flanking the ranges result from the accumulation of alluvium, ranging in grain size from reddish clays to large boulders, largely derived from the ranges during the Pleistocene. The settlement of Parachilna lies on an alluvial fan which has its source in Parachilna Gorge. Some remnants of older gravel layers, shown as Qp on the map ("High-level dissected piedmont gravels") form table-lands well above present-day stream beds.

Stream channels generally take a fairly direct course, with slight meandering, away from the ranges and toward the sandy depressions of Lake Torrens and Lake Frome. However, the main channel of Parachilna Creek runs south-south-west on reaching the edge of the ranges, under the influence of the alluvial fan. East of Commodore the drainage resumes a westerly direction.

Near the eastern and western edges of the map area gravelly alluvium and well-marked stream channels are succeeded by a reddish sand spread. In the larger area of sand near Lake Torrens there is a system of longitudinal dunes trending in a south-easterly direction with occasional intermediate clay pans.

## STRATIGRAPHY

Table 1 summarizes the stratigraphy of the PARACHILNA area, which includes mainly sedimentary rocks, formed during Proterozoic, Cambrian, ?Permian, Tertiary and Quaternary time. Important features are movement of piercement structures during sedimentation, a thick Proterozoic glacial sequence and good exposures of the Lower Cambrian. Relationships between stratigraphic units are

shown in Fig. 1.

Proterozoic.

Carpentarian.

Within the crushed core rocks of the Blinman Dome diapir (Coats, 1964, p. 15) there are blocks of rapakivi granite, granite porphyry and other granitic rocks which resemble the older Precambrian basement near Mount Painter. These have presumably been broken off and brought up during movement of the diapir.

Adelaidean: Adelaide System

Callanna Beds.

The Callanna Beds, the basal rock group of the Adelaide System, occur almost entirely in diapirs, where they are considerably crushed and dismembered and out of their normal stratigraphic position. Outcrops may be readily seen in the Arkaba Diapir north-east of Hawker and the Blinman area. These rocks include grey and reddish siltstones with salt casts and quartzite with dark heavy mineral laminae. Similar siltstones and quartzites are present in normal sequence below the Emeroo Quartzite south-west of Yadlamalka Woolshed in the PORT AUGUSTA map area.

Within diapirs there are also greenish greywacke and siltstone, laminated slate and phyllite, dolomite rock and calc-silcate rock.

Prominent in the Blinman Dome diapir are blocks of dark greenish melaphyre which are in places amygdaloidal, are probably part of the Wooltana Volcanics (Coats, 1964, pp.9-11), and have the chemical composition of trachy basalts. Component minerals are acid plagioclase, actinolite, chlorite, calcite, epidote and iron. Amygdales are often composed of siderite and calcite. The melaphyres are interbedded with sediments which include tuffs.

Volcanics.

Also within the Blinman Dome Diapir are dark greenish altered dolerite plugs which may have been emplaced after, or late in, the movement of the intrusive breccia. The plugs could thus be as young as Cambrian in age. These

rocks are very similar in composition to the melaphyres. Epidote and asbestos are commonly associated with the dolerites.

Burra Group.

Rocks of the Burra Group cover only small areas south-west and south-east of Hawker. At the northern end of the Emeroo Range there are steeply-dipping feldspathic quartzites and minor grey siltstone of the Emeroo Quartzite, approximately 2,400 feet thick. These beds form a rough, rocky terrain and are partly flaggy. South-east of Hawker and south-west of "Worumba" is the Yednalue Quartzite of Spry (1952b, p.170) comprising about 750 feet of coarse-grained quartzite, shale and minor carbonate rock. This is probably equivalent to the Emeroo Quartzite.

At each of the above localities the quartzite sequence is overlain by dolomite and magnesite beds of the Skillogalee Dolomite. The carbonate beds form a much more subdued topography. Dolomites are grey, partly flaggy and frequently accompanied by nodular and bedded dark chert. Magnesite occurs as a pale edgewise? breccia or conglomerate, arenite or laminated bed. Dolomite rocks occasionally show algal structures, while the cherts are similar to those containing algal filaments described by Schopf and Barghoorn (1969) from the Skillogalee Dolomite east of Port Augusta. Sedimentary structures include slumps, ripple marks, small-scale cross bedding and mud cracks. Thickness in the south-west is 1000 feet and south-east of Hawker is 2500 feet.

Succeeding the Skillogalee Dolomite is a monotonous sequence of grey and green-grey siltstones, silty dolomite and quartzite (calcareous siltstones of Spry, 1952, p.174) probably equivalent to the lower Auburn Dolomite of the BURRA region. These outcrop to only a minor extent in the map area. Siltstones are cross bedded in places. Total thickness is about 6800 feet.

The upper, most exposed unit of the Burra Group is pale grey feldspathic quartzite with interbedded siltstone and silty dolomite, thickness 1500 feet. On the ORROROO map area this has been named Cradock Quartzite, and is possibly equivalent to

the Watervale Sandstone Member of the Auburn Dolomite. A small area of this is shown near the edge of the map south-east of Hawker.

The depositional environment of the Burra Group was probably shallow marine to paralic. The initial thick deposition of coarse sands (Emeroo Quartzite) was possibly in a deltaic environment adjacent to a raised granitic area to the west. The Skillogalee Dolomite may represent succeeding more stable paralic conditions when the interaction of unusually alkaline waters in marginal lagoons with sea water precipitated magnesium carbonate (Spry, 1952b, p.173; Forbes, 1961, p.220).

Umberatana Group.

This rock group is represented by thick and widespread siltstones and pebbly beds which in places contain large foreign boulders best explained by a glacial origin. It is probable, however, that some pebbly formations in the group are not entirely of glacial origin, but are partly of slump or turbidite origin.

The oldest beds of glacial origin in the map area are sandstones and siltstones with minor conglomeratic lenses and thin dolomitic interbeds below the Holowilena Ironstone in the core of the Willippa anticline, north of "Bibliando". Granite boulder-bearing siltstones, siltstones and quartzites in the core of the Bibliando dome are probably equivalent to these beds and may be equivalent to the Appila Tillite which underlies the Braemar Iron Formation in the OLARY and BURRA regions. The thickness of 400 feet is probably a minimum value. Erratics of schist, quartzite, granite and pegmatite up to 6 feet in length suggest ice transport from the Willyama Complex in the OLARY region (Mawson, 1949, p.164).

The type section of the Holowilena Ironstone is about three miles south of "Mattawarrangala". The Holowilena Ironstone (Dalgarno and Johnson, 1965) generally occurs near the base of the Umberatana Group as exposed in the PARACHILNA map area. Origin of the Ironstone is probably by chemical precipitation as is inferred for the Braemar Iron Formation (Whitten, 1970, p.28). East of Oraparinna Asbestos Mine there is a 25 cm. drop stone in laminated siltstone, suggesting glacial conditions during deposition (Daily and Forbes, 1969, p.27).

The Wilyerpa Formation (or Wilyerpa Quartzite, as originally defined) is a siltstone-quartzite sequence exceeding 4000 feet in the Bibliando dome. Here and in the Willippa anticline included boulders resemble rocks of the Willyama Complex in the OLARY region; there are also boulders of Holowilena Ironstone. Feldspathic quartzites of the Wilyerpa Formation give rise to high ridges and are interbedded with greenish and grey siltstone.

The above sequence is termed the Yudnamutana Sub-Group of the Umberatana Group and is overlain by the Tindelpina Shale Member of the Tapley Hill Formation, forming the lowermost formation of the Farina Sub-Group. The Tapley Hill Formation is only about 1,000 feet thick in the south-west of the map area but is over 5,000 feet thick elsewhere. The Mount Caernarvon Greywacke Member has been recognised only in the Oraparinna-Blinman region (Mawson, 1938, p. 349) and is composed of fine- and medium-grained, partly argillaceous greywacke and quartzite, and sandy slate. The Greywacke outcrops more boldly than the adjacent shales of the Tapley Hill Formation.

The Wockerawirra Dolomite, equivalent to the Brighton Limestone, is composed of about 1,600 feet of grey laminated dolomitic siltstone and yellow-weathering dolomite rock. Basal cream-coloured dolomites are indistinctive and the formation may be seen near Mount Burns and "Oraparinna".

The Etina Formation, of 3,800 feet, is characterized by interbeds of sandy and oolitic limestone in grey dolomitic shales. The limestones give rise to hogback ridges which are particularly notable in the Mount Caernarvon area and western flank of the Blinman dome. Near the Oraparinna Asbestos Mine the Etina Formation contains pebbles derived from the Enorama diapir.

Less prominent beds between the Etina and Trezona Formations are green-brown-grey laminated dolomitic shales of the Enorama Shale. In contrast, the Trezona Formation forms the scenic Trezona Range made up of successive cliffs of limestone (hieroglyphic beds of Mawson, 1935, p.351). In Enorama Creek north-east of Elatina Hut there are large masses of wavy, concentrically laminated stromatolites

in the Trezona Formation limestones.

The uppermost formation in the Umberatana Group in the map area is the Elatina Formation, considered to form part of the Willochra Sub-group which is a western reddish-coloured facies of the upper Umberatana Group (Thomson, 1969, pp.69-71). The Elatina Formation is not well exposed and is composed of pale reddish feldspathic sandstone and pebbly siltstone.

Wilpena Group.

The Wilpena Group was defined in the PARACHILNA map area by Dalgarno and Johnson (in Thomson et al., 1964, pp.12-15) and may be seen over many parts of the area. The best known and most prominent formation is the Pound Quartzite which forms the ramparts of Wilpena Pound and most of the higher western rim of the ranges. Sedimentary structures suggest a shallow marine origin for much of the Wilpena Group, possibly withoccasional subaerial exposure on a delta or tidal flat. The Group can be seen near Wilpena Pound and in Parachilna Gorge.

The base of the group is generally well marked by the Nuccaleena Formation, a pinkish laminated dolomite rock up to 30 feet thick which may form a low ridge. This is followed by the Brachina Formation, a thickness of about 4,000 feet of brownish or pale reddish and grey-green siltstone, minor sandstone and feldspathic greywacke. Jointing produces blocky siltstone fragments.

The A.B.C. Range Quartzite forms ridges such as the A.B.C. Range North of Wilpena Chalet. This formation features in Hans Heysen's water colours "Three Sisters of Aroona" and "Hills of Oratunga". It appears to become thinner to the east, and is absent near Reaphook Hill.

Predominantly reddish siltstone and shale of the Bunyeroo Formation follows the A.B.C. Range Quartzite. In places there are pale greenish-grey beds. The formation generally forms valley floors and may support dense stands of Native Pines (Callitris columellaris). The shales readily break into small chips.

Next in sequence is the Wonoka Formation, grey limestones and shale, which consistently forms foothills to the higher ranges of the Pound Quartzite. A readily accessible section occurs along the Blinman-Wirrealpa road, but the formation may be seen in many other places.

The Pound Quartzite forms the most prominent quartzitic ridges in many parts of the Flinders Ranges and is the youngest rock unit of the Adelaide System in the map area. Approximately the lowermost one-third of the formation is composed largely of reddish feldspathic sandstone (Bonney Sandstone Member) in contrast with the white sandstones and quartzites (Rawnsley Quartzite Member) of the upper Pound Quartzite (Forbes, 1971). The upper boundary of the reddish member is shown on the map. Fossil worms and jelly fish of the Ediacara fauna (Wade, 1970) have been found in the Rawnsley Quartzite Member of the Pound Quartzite between Bunyeroo and Parachilna Gorge and other places north-west to north of Hawker.

Cambrian.

Hawker Group.

The Hawker Group represents a return to marine conditions in the Lower Cambrian. Although the sequence from Precambrian to Cambrian seems broadly conformable, there was some minor erosion of the Pound Quartzite prior to deposition of the Parachilna Formation, as evidenced by pebbles at the base of the Cambrian, irregularity of the contact and penetration of Diplocraterion burrows into the Precambrian (Dalgarno, 1964, p.134). The base of the Cambrian can be readily seen in Parachilna Gorge and south-east of "Merna Mora".

The Wilkawillina Limestone is characteristically massive and contains fossil biohermal banks of Archeocyatha, notably near Wilkawillina Gorge (Walter, 1967).

The Parara Limestone is contrastingly well bedded but not as continuous as the Wilkawillina. The Bunkers Sandstone is restricted to the Wirrealpa region where it may form hogback ridges; it is overlain by the Oraparinna Shale which is discontinuous and poorly outcropping.

Billy Creek Formation and Wirrealpa Limestone.

The Billy Creek Formation is reddish in colour, contrasting with the greens and greys of the underlying marine Hawker Group, and also contrasting in its sedimentary environment which was probably paralic (alternating continental and marine conditions). There is probably a disconformity at the base of the Billy Creek Formation since in the Blinman region it overlies the Wilkawillina Limestone in some places (Dalgarno, 1964, p.139). There then followed a widespread shallow marine deposition represented by the Wirrealpa Limestone.

Lake Frome Group.

This group is composed predominantly of reddish clastics and may be seen west and south of "Wirrealpa". Daily (Daily and Forbes, 1969, p.25) indicates that the Moodlatana Formation is Middle Cambrian in age and that thus the Grindstone Range Sandstone may possibly extend into Ordovician time. The environment was probably partly deltaic and terrestrial.

Permian.

Outcropping Permian boulder clays in South Australia are best known on southern Fleurieu and Yorke Peninsulas, but there are similar deposits of restricted extent two miles south of Blinman which may be an outlier of the Permian glacials. A detailed description is provided by Coats (1964, p.39) who indicates that facetting and striation of boulders, the foreign nature of the boulders (granite, schist, green metamorphics) and the presence of pink garnet favour a Permian glacial origin.

Tertiary.

There are only minor scattered outcropp of Tertiary rocks, the most common of which is silcrete. This has resulted mainly from the silicification of Tertiary sands and may be seen on the western flanks of the ranges as near Brachina Hut. North-east of Mount Frome and south-east of Dawson Hill there are grey shale and siltstones with a basal conglomerate of polished quartz pebbles and pebbly calcareous

sands and silts; these beds may be equivalent to the lower Tertiary Murnpeowie Formation of the Marree region.

The thickest recorded subsurface Tertiary in the map area is under Lake Torrens where stratigraphic bore No. 3A records Tertiary dolomite and carbonaceous sand and clay between 261 and 887 feet. Beds below 600 feet are at least partly Eocene in age (Johns, 1968, pp. 10-12).

Quaternary

The oldest Quaternary deposits exposed in the map area are Pleistocene clays and limestones and east of Mount Frome, a jasper breccia. The Nilpena Limestone (Leeson, 1970, pp. 33-34) is a yellow-brown lacustrine gastropod limestone which may be seen just east of "Nilpena". In stratigraphic bore No. 3A in Lake Torrens much of the upper 261 feet of brownish gypseous, silty and sandy clays is probably Pleistocene in age.

One of the more prominent older Quaternary formations is the Pleistocene high-level piedmont gravel, probably Telford Gravel (Firman, 1967a, pp. 4-6). This is a veneer of rounded pebbles and boulders derived from the ranges by stream activity during a more active period of uplift of the ranges. Subsequent uplift has raised the gravels well above presentday creek level. Small remnants of these gravel sheets may be seen along the western flanks of the ranges; wider areas occur north-east of "Wirrealpa".

The most extensive Pleistocene deposit is the Pooraka Formation, composed of reddish brown alluvial clays and gravels which may be seen in the walls of many creek channels. The areal extent of the Pooraka Formation corresponds to the map units Qrt and Qra. Frequently developed within the top of the Pooraka Formation is a white calcareous mottling, the most obvious expression of the Pleistocene Loveday Soil (Firman, 1966; 1967b, p.175).

Younger Quaternary deposits include longitudinal reddish sand ridges, thin veneers of Recent loam or clay soil, creek-bed gravels and lacustrine gypseous and saline sand, silt and clay. In the dune field east of Lake Torrens convergence

of sand ridges indicates south-easterly transport of the sand which was probably winnowed from the Pooraka Formation.

## STRUCTURE

The map area includes, to the west, part of the Torrens hinge zone, (Thomson, 1969, p.24 and 1970, p.207) at the eastern edge of the Gawler Platform and, in the ranges area, part of the Adelaide Geosyncline. The western edge of the geosyncline is marked in the south by the Arden fault, underlying alluvium at the south-west corner of the map area, and in the north by a possible continuation of the Mt. Deception Fault (Leeson, 1970, p.38). It is not known whether these faults extend far into the map area. The only outcrop of older rocks in the Torrens hinge zone is near Nilpena, where there is gently dipping Cambrian and Pound Quartzite.

Within the more strongly deformed rocks of the Adelaide Geosyncline there are two major anticlines, the Worumba-Bibliando structure and the Oraparinna - Blinman structure, which respectively trend approximately east-west and north-south. These conflicting directions approximate to the axial trends of the Olary arc and the Flinders Ranges. Other important structural features of the ranges are the tighter north-easterly oriented folds near Hawker and north-west of there, and intrusive breccias of diapirs. The zone of tight folding occurs at the western margin of the geosyncline and may be related to this.

Diapirs have been described by Coats (1964) and Dalgarno and Johnson (1968). They contain mainly brecciated siltstones and dolomite of the Callanna Beds which flowed upward from below, forcing aside the overlying younger rocks. Partly from evidence outside the map area, movement appears to have begun prior to deposition of the Umberatana Group and to have continued well into the Lower Cambrian, and probably later in the Palaeozoic. Factors favouring diapirism appear

to be plasticity, higher temperature and lower density of the intrusive breccia and the presence of a regional stress field. Diapirism may have been a prime factor in folding and fracturing of post-Willouran rocks. This is partly evidenced by the north-east trending graben structure north-east of the Oraparinna diapir which gave rise to a down-sunken block of thicker Lower Cambrian sediment as in Wilkawillina Gorge.

Within the ranges there is a marked preferred orientation of faults in a north-easterly direction. These faults are probably Palaeozoic or older. An important fault in the Torrens hinge zone is the Ediacara Fault (Leeson, 1970, pp.40-41) which extends from about two miles west of "Nilpena" to two miles west of "Motpena". Leeson (1970) shows this to be a normal fault which has had some 100 feet of post-silcrete movement. Kendall (1966) estimates the downthrow near "Motpena" to be about 2000 feet to the west. This fault might be expected to run further south and would concievably meet the extension of the Arden Fault near "Moralana". It was probably movement on these faults which allowed the accumulation of Eocene to Pleistocene sediments in the Lake Torrens depression.

Basinal structures of hydrologic interest are the Pirie-Torrens Basin, corresponding to the area west of the ranges, and the Frome Embayment, a part of which occupies the north-east corner of the map area. In the north-east, water bores suggest an accumulation of over 600 feet of Tertiary and Quaternary sediments (Ker, 1966, Plates, 1 and 3).

An airborne magnetic survey was made by the Bureau of Mineral Resources in 1965 (Tipper and Finney, 1966). Fig. 2 is a smaller-scale version of their aeromagnetic map. The broad background pattern is an expression of the depth to magnetic basement which exceeds 25,000 feet near the centre of the area. Local anomalies are frequently related to diapirs while near the southern boundary the effect of the Holowilena Ironstone becomes evident.

Rocks formed in the Adelaide Geosyncline in the map area are very little metamorphosed: the common micaceous constituent is muscovite, sometimes with chlorite.

## GEOLOGICAL HISTORY

From the evidence of blocks within diapirs the original floor of the depositional basin was partly granitic. Upon this basement in Willouran time there encroached a shallow sea, the position of which fluctuated and gave rise to deposits of sand, clay and dolomite mud. There were episodes of volcanism and gradual downwarping of the basin. Similar predominantly shallow marine conditions prevailed in the Torrensian with a significant proportion of detritus coming from the Gawler Craton to the west.

In early Sturtian time there was local uplift around diapirs which caused erosion of some Burra Group sediment. There ensued a general glaciation giving rise to tillites and associated fluvioglacial rocks of the Yudnamutana Sub-group. Deeper marine conditions then followed, as exemplified by the Tapley Hill Formation laminated slates, then a final weaker phase of glaciation in the Marinoan (Elatina Formation).

Later in the Marinoan the seas shallowed and sands spread from the west, possibly accompanying uplift of the Gawler Craton.

In the early Cambrian there was renewed transgression of the sea and Archaeocyathid biostromes were widespread. There was continued local movement of diapirs and related faults giving rise to varying conditions across the basin. In the late Lower Cambrian the BIlly Creek Formation marks a time of regression and minor volcanism. Red beds and other clastics of the Lake Frome Group are the final sedimentary record prior to the Delamerian orogeny of the Ordovician when the contents of the Adelaide Geosyncline were folded.

In the Precambrian there may have been local glacial centres as suggested by the boulder beds near Blinman. In the Tertiary, fluviatile sediment spread from higher areas to form sand deposits in local basins. Depression of the Lake Torrens region led to a thicker accumulation of more clayey sediment. There later developed in the sandy deposits an opaline or quartzose layer, to be exposed subsequently as silcrete. Renewed up-doming of the ranges in the Pleistocene gave rise to marginal sheets of gravels (Telford Gravel) later to be eroded and succeeded at a lower level by reddish floodplain and creek-bed clays and gravels (Pooraka Formation). These became partially re-worked by strong winds which separated out the sand component to form longitudinal dunes.

## ECONOMIC GEOLOGY

There is a variety of metallic and non-metallic minerals in the region but the only currently economic deposits are of barytes and galena. Quantities of these produced in 1969 were respectively 32,024 and 21 tons (lead). Barytes and many of the metallic minerals are associated with diapirs, either as impregnations in rafts within diapirs or as veins.

### Barytes.

The main production of barytes in South Australia comes from the mine of S.A. Barytes Ltd. about 9 miles northeast of "Oraparinna". The barytes is of high grade and occurs in veins related to faults radiating from the Oraparinna diapir. It was probably derived by solution from the enclosing Brachina Formation shale (Nixon, 1962, p.15). Production from here in 1969 was 26,708 tons. The barytes is treated in a plant at Quorn, southwest of Hawker.

Other productive barytes mines of similar origin in the map area are near "Oraparinna", Martins Well, Carey Hill, Moralana, east of Mount Falkland (Oratunga barytes) and near Mount Frome.

Lead and Silver.

The Baratta and Eukaby silver-lead mines (Ridgeway and Johns, 1950) were discovered in 1887 and are still being worked. Many small lodes of calcite and galena are found over a length of a mile, and have been opened by numerous shafts and an open cut. Country rock is grey slate and the lodes seem to occupy a system of fractures along a synclinal keel. The mines produced 73 tons of lead, 2,942 oz. silver, and 67 oz. gold from 1920 to 1948, but several small parcels of ore have been produced since that time. Secondary minerals noted were cerussite and, rarely, the lead molybdate, wulfenite. The galena, beside carrying silver and gold, is remarkably free from bismuth and other undesirable contaminants.

Other lead mines, non-productive at the time of writing, are as follows:

Wirrealpa (Ridgway, 1947a), in the brecciated top of the Wilkawillina Limestone on the margin of the Wirrealpa diapir; Wepowie, (Brown, 1908, p.91) north-west of Blinman, in a breccia dyke on the southern margin of the Oratunga diapir; Mt. Emily or Mallee Hut, (Brown, 1908, p.78) eighteen miles north-northwest of "Oraparinn in a quartz-siderite mass, part of a small dolomite raft on the northern margin of the Enorama diapir (galena, chalcopyrite, bournonite, chalcocite and malachite dissemination); Wilpena (Brown, 1908, p.193), a quartz reef in a fault cutting the ?A.B.C. Range Quartzite about two miles north-east of "Wilpena"; Fountain Head (Brown, 1908, p.173), thin veins of galena in the Oraparinna Shale.

Galena of possible sedimentary origin has been noted in dolomite in the Balcoracana Formation near the mouth of Brachina Gorge and in the base of the Wirrealpa Limestone.

Copper.

The Blinman copper mine (Coats, 1963, p.43) has been the major copper producer of the area. The mine was developed in a raft within the Blinman diapir. Mineralisation occurs in a bed of dense, yellow, flinty-textured dolomite, named the "Mine Type dolomite" by Coats. Chalcopyrite, in part altered to copper oxides and carbonates, together with a little barite and galena, occurs as cross veins in the

dolomite, and as granules disseminated through the rock, often concentrated along bedding, and sometimes lining small cavities. The bedded, disseminated copper sulphide is probably a syngenetic deposit of Willouran age, pre-dating the diapir, with some copper sulphide having been remobilised into cross-fractures and voids during diapiric emplacement of the raft. In its 40 years of production between 1862 and 1918, this mine produced 9,740 tons of copper from stoped out workings over a length of 550 feet with a maximum width of 50 feet and depth of 480 feet. The whole orebody, assaying over 3% Cu, seems to have been removed, although substantial tonnages assaying 1% Cu remain. The mine was equipped with a small smelter, but a falling metal price and lower ore grade forced its closure in 1918.

Brief details of some other mines are as follows: Appealinna (Wade and Cochrane, 1952a) produced 280 tons of copper between 1858 and 1911 and occurs in a fault extending from the Oraparinna diapir; Oratunga (Brown, 1908, p.108) is in a pipe-like vein of "siderite," chalcopyrite, chalcocite and malachite in grey shales; Niltibury or Ivy Queen (Mansfied, 1948) is in a faulted sliver of Elatina Formation with mineralization in the Nuccaleena Formation dolomite; Mt. Mary (Brown, 1908, p.94) contains chalcocite and malachite in brecciated Etina Formation.

Minor stratiform copper mineralization, mainly malachite, is associated with the Tindelpina Shale Member of the Tapley Hill Formation, the Trezona Formation, the Bunyeroo Formation, the Billy Creek Formation and the Balcoracana Formation.

Cobalt.

Young's Cobalt Mine (Coats, 1963, p.44) is in a diapir raft containing siderite, chalcopyrite, tetrahedrite and the secondary minerals erythrite, cervantite, malachite and azurite.

Gold.

The Baratta and Eukaby silver-lead mines produced 21 oz. gold for 21 tons of lead in 1969. The Mt. Mary copper mine has yielded a little gold.

Manganese.

Mixed pyrolusite and psilomelane occur in the Eregunda Mine in a fault breccia in the Wilkawillina Limestone. There are other manganese deposits also associated with limestones.

Iron.

The Holowilena Ironstone is the major potential iron ore of the region, but beds sampled southeast of "Holowilena" contained only 14 to 33% Fe.

Asbestos.

Blue crocidolite asbestos occurs as veinlets dispersed through crystalline dolomite rafts in diapirs. The Oraparinna Asbestos Mine (Ridgway, 1947b) produced 100 tons from 1941 to 1942.

Limestone, dolomite, magnesite.

There are large reserves of limestone and dolomite in the region and impure magnesite occurs in the Skillogalee Dolomite. Some of these deposits are outlined by Johns (1963). The thickest unit is the Wilkawillina Limestone in the Brachina area where a 3,000 feet outcrop width varies from 93% calcite in its upper part to 86% dolomite in its lower part. Diamond drilling has proved large reserves of high-grade limestone (95-96% calcite; Cramsie, 1967).

Water.

Underground water supplies may be geographically classified into three regions: the Frome Embayment, the hilly region of the Flinders Ranges and the Pirie-Torrens Basin. The indifferent quality and quantity of water in all of these regions is a reflection of climate.

Moderate supplies of stock water are obtainable in the Frome Embayment north and south of Wyambana, but artesian water of local origin is available in the Wirrealpa sub-basin south of Mount Frome. The aquifer in the sub-basin is a sand, possibly of Tertiary age (Ker, 1966, p.9).

In the ranges, bores and wells are commonly located near creek channels. They are about 50 to 400 feet deep and produce moderate supplies of water with salinity

about 500 to 4,000 p.p.m. There are a number of springs in the Blinman region; Parachilna Gorge spring provides Parachilna's water supply.

The Pirie-Torrens hydrogeological basin has been described by Chebotarev (1958). Most bores are in the eastern part of the basin not far from the railway line and are generally 100 to 200 feet deep. Salinities are mostly between 1,000 and 3,000 p.p.m.

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10.3.1971

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TABLE 1 - Stratigraphy of Parachilna Sheet Area

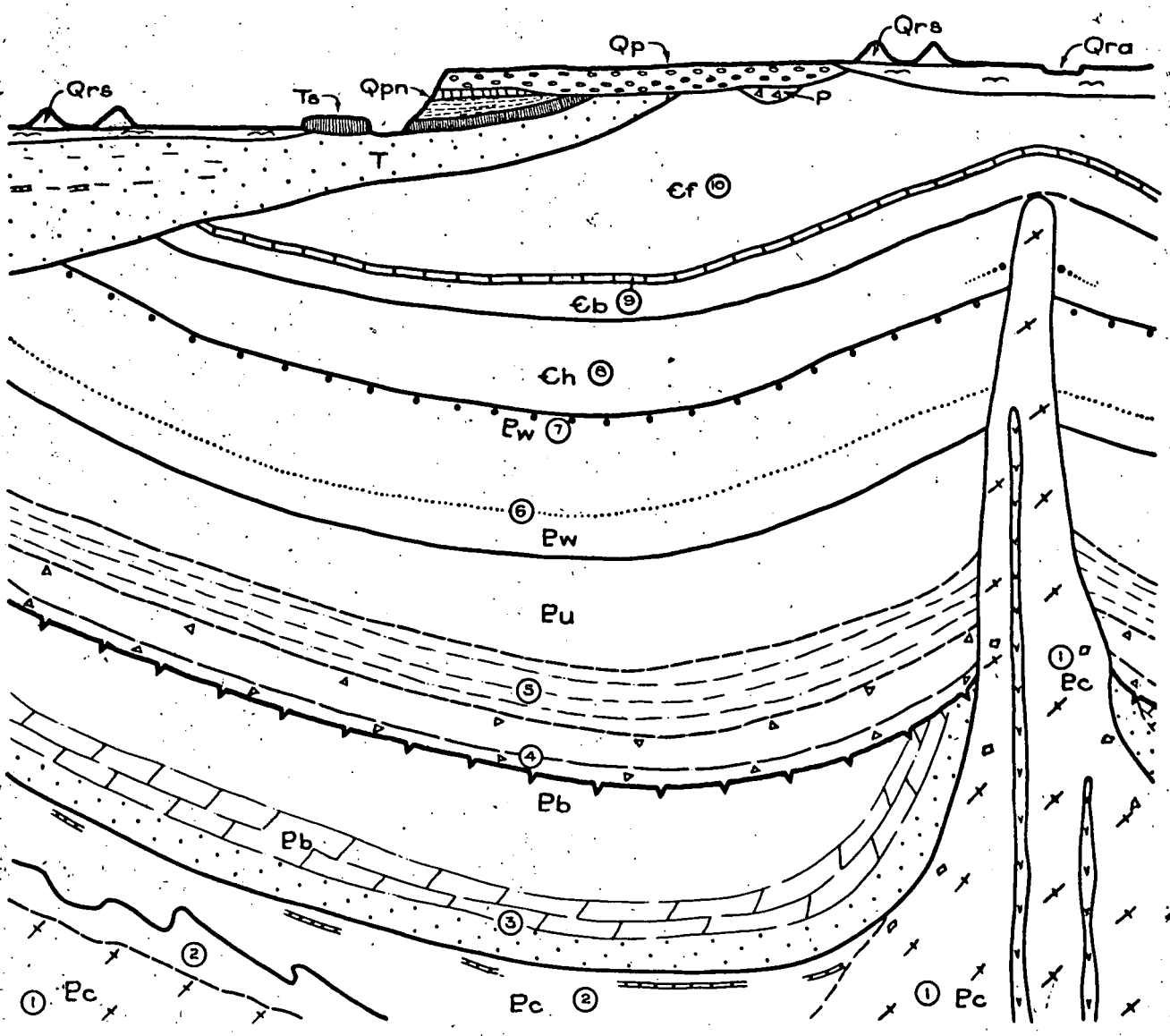
| Age | | Rock unit and Symbol | Thickness (feet) | Lithology | Remarks |
|---|---|---|---|---|---|
| | Quaternary | | | Gypseous clays, saline silts and quartz sands. | Lake deposits. |
| Cainozoic | | Qrs | | Reddish sand. | Recent sand of dunes and sand spread. |
| | | Qra | | Alluvium of drainage channels and flood plains. | Include exposed and thinly-covered Pleistocene Pooraka Formation with Loveday Soil. |
| | | Qrt | | Low angle slope deposits Scree deposits. | |
| | | Qp | | Gravel, calcite-cemented conglomerate. | High-level Pleistocene gravels probably mainly equivalent to Telford Gravel. |
| | | Qp | | Lacustrine sediments, gypsite, limestone, jasper breccia. | |
| | Tertiary | Ts | | Silcrete | Developed on Tertiary sands. |
| | | T1, T? | | Grey shale, polished-pebble conglomerate, pebbly calcareous sand and silt. | Probably lower Tertiary, partly equivalent to Murnpeowie Formation. |
| Palaeozoic | ?Permian | | | Grey sandy boulder clay. | Possible Permian glacials containing facetted and striated boulders. |

| Age | Rock Unit and symbol | Thickness (feet) | Lithology | Remarks |
|---|---|---|---|---|
| Cambrian | Lake Frome Group f: | | | |
| | Grindstone Range Sandstone | 1,400 | Sandstones: quartzite pebbles in upper part. | Possibly extending into Ordovician; cross-bedded. |
| | Pantapinna Sandstone | 4,500 | Pink argillaceous sandstone | Cross-bedded on large scale; slump structure. |
| | Balcoracana Formation | 1,500 | Reddish and green micaceous siltstone, thin grey dolomite rock. | Upper Middle Cambrian. Trilobite tracks common. |
| | Moodlatana Formation | 1,300 | Reddish feldspathic sandstone, shale; thin dolomite near base. | Cross-bedded. Middle Cambrian. |
| | Wirrealpa Limestone g | 350 | Grey nodular and shaly limestone, some oolitic limestone. | Brachiopods and trilobites; lower Middle Cambrian. |
| | Billy Creek Formation b | 3,300 | Red-brown micaceous sandstone and shale; minor tuff and limestone. | Late Lower Cambrian regressive phase; rare trilobites, some salt casts; rain-drop impressions. Probably contemporaneous volcanism. Underlain by disconformity. |
| | Hawker Group h: | | | |
| | Narina Greywacke | 2,000 | Grey-green calcareous siltstone, chloritic sandstone. | Transitional contact with Oraparinna Shale. |
| | Oraparinna Shale | 700 | Green silty shale. | Lower Cambrian trilobites, Hyolithes, brachiopods, rare archeocyathids. |
| | Bunkers Sandstone | 600 | Feldspathic sandstone with calcareous interbeds. | Cross-bedded, lenticular. |

| Age | Rock Unit and symbol | Thickness (feet) | Lithology | Remarks |
|---|---|---|---|---|
| | Parara Limestone | 2,000 | Dark flaggy limestone and shale. | Thickness varies from 5,000 to 200 feet. |
| | Wilkawillina Limestone | 750 | Lower more thinly bedded dolomite, sandstone shale, algal and oolitic; overlain by pale grey massive archeocyathid limestones. | Lower Cambrian; partly biohermal; Archeocyatha, hyolithids, brachiopods. |
| | Parachilna | 220 | White argillaceous sandstone, minor calcareous silt and shale, oolitic limestone. | Vertical U-shaped burrows of Diplocraterion. Pebbles in basal layers. |
| Proterozoic Adelaidean | Wilpena Group Pw: | | | |
| | Pound Quartzite | 3,000 | Reddish and white feldspathic sandstone and quartzite, minor shale. | Cross-bedding, mud cracks; fossil worms, jellyfish. |
| | Wonoka Formation | 1,500 | Grey limestone and flaggy dolomitic shale. | |
| | Bunyeroo Formation | 2,300 | Reddish, or sometimes greenish-grey, siltstone and shale. | Ripple marks, flute casts. |
| | A.B.C. Range Quartzite | 390 | White, flaggy, laminated, fine-grained feldspathic quartzite. | Cross-bedding, ripple marks, mud cracks, heavy mineral laminae. |
| | Brachina Formation | 4,000 | Greenish and pale reddish siltstone, minor sandstone, feldspathic greywacke. | Equivalent to Ulupa Siltstone and Tregolana Shale Member of the Tent Hill Formation. |
| | Nuccaleena Formation | 30 | Laminated, yellowish-brown weathering, pale reddish-brown dolomite rock. | Very useful marker bed. |

| Age | Rock unit and Symbol | Thickness (feet) | Lithology | Remarks |
|---|---|---|---|---|
| | Umberatana Group Pu: Elatina Formation | 200 | Pale reddish feldspathic sandstone and pebbly siltstone. | Possibly of glacial origin; equivalent to the Pepuarta Tillite. |
| | Trezona Formation | 800 | Reddish and grey partly stromatolitic and oolitic limestone with flake breccias; greenish-grey calcareous shale. | Mawson's "hieroglyphic limestones." |
| | Enorama Shale | 1,600 | Green-brown-grey, laminated, dolomitic shale. | |
| | Etina Formation | 3,800 | Grey dolomitic shale, sandy and oolitic limestone, feldspathic quartzite. | Pebble beds near Enorama Diapir. |
| | Wockerawirra Dolomite | 1,600 | Grey laminated dolomitic siltstone and yellow-weathering dolomite rock. | Equivalent to the Brighton Limestone |
| | Tapley Hill Formation | 5,100 | Grey and greenish laminated shales. Mt. Caernarvon Greywacke Member. Tindelpina Shale Member (basal black finely laminated shale). | |
| | Yudnamutana Sub-Group: Wilyerpa Formation | 2,700 | Greenish and grey siltstone, feldspathic quartzite, pebbly siltstone and sandstone. | Originally defined as Wilyerpa Quartzite. |

| Age | Rock Unit and Symbol | Thickness (feet) | Lithology | Remarks |
|---|---|---|---|---|
| | Holowilena Ironstone | 400 | Hematite siltstone, reddish shale, grey siltstone; sandstone; pebbly ironstone, dolomite and sandstone. | Probably equivalent to the Braemar Iron Formation. |
| | No name | 400 | Boulder beds with sandy, silty matrix. | Possibly in part equivalent to Appila Tillite. |
| | Burra Group: Pb: No name | 1,500 | Feldspathic quartzite, siltstone, silty dolomite | Named Cradock Quartzite on Orroroo 1:250,000 map. |
| | No name | 6,800 | Grey, green-grey siltstone, silty dolomite, quartzite. | Probably equivalent to lower Auburn Dolomite. |
| | Skillogalee Dolomite | 2,500 | Grey dolomite rock, dark chert, magnesite rock, shale, magnesite conglomerate. | Mud cracks, algal structures. |
| | Emeroo Quartzite | 2,400 | Pale pink and white feldspathic quartzites, siltstone. | Probably equivalent of Rhynie and Aldgate Sandstones; cross-bedding, ripple marks, mud cracks, heavy mineral laminae. |
| | Callanna Beds | 1,000 | Pinkish and grey siltstone and sandstone, dolomite. | Mainly within diapirs. |




ROCK RELATIONSHIP DIAGRAM FOR PARACHILNA 1:250000 SHEET.

① Crushed Callanna Beds and igneous rocks of diapirs.
② Less-disturbed Callanna Beds in normal sequence.
③ Emeroo Quartzite and Skillogalee Dolomite of the Burra Group.
④ Boulder beds of Yudnamutana Sub-Group, Umberatana Group.
⑤ Tapley Hill Formation.
⑥ A.B.C. Range Quartzite of the Wilpena Group.
⑦ Pound Quartzite.
⑧ Hawker Group.
⑨ Wirrealpa Limestone.
⑩ Lake Frome Group.

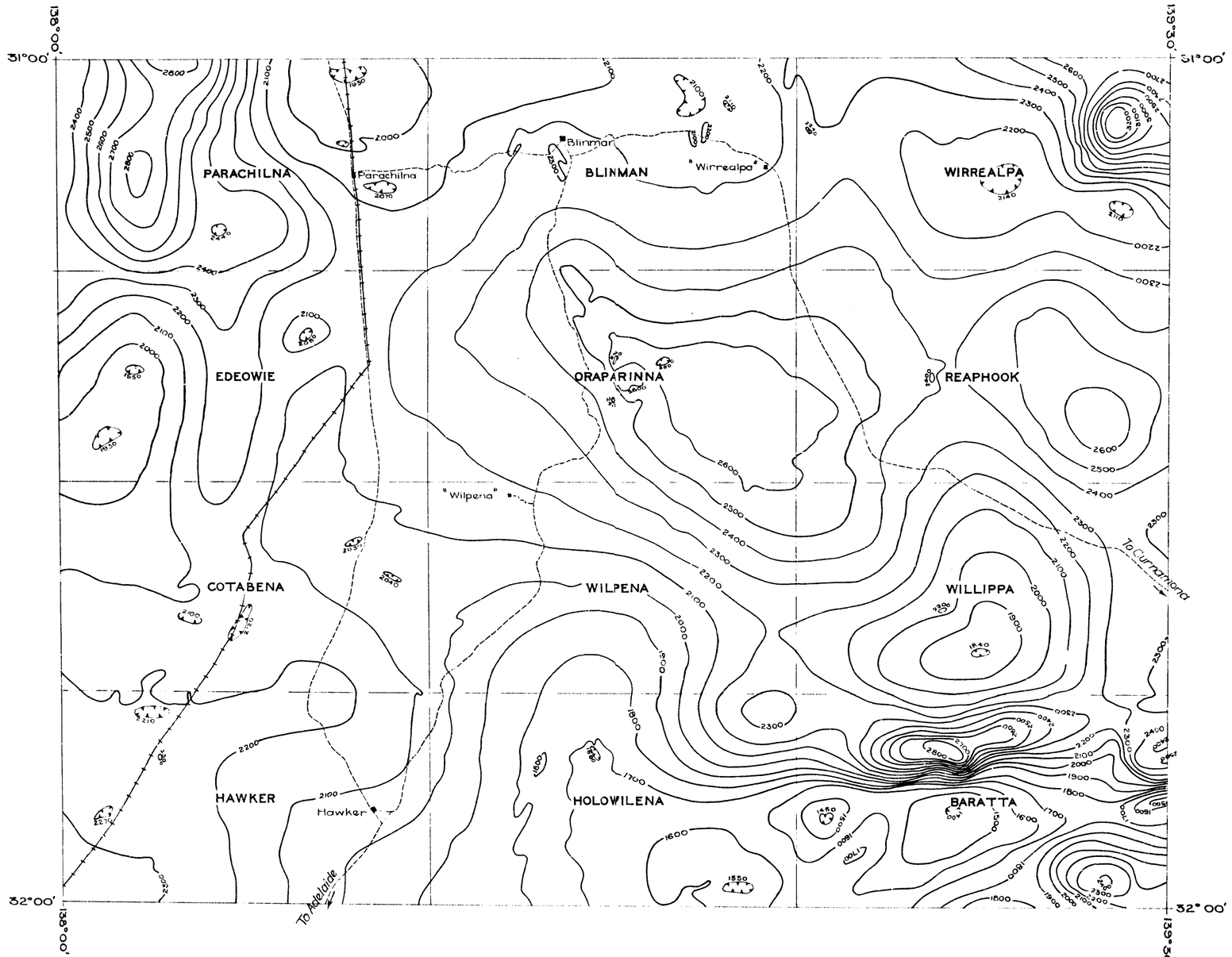
P ? Permian boulder beds.
T Tertiary sandy clays.
Ts Tertiary silcrete.

Qpn Nilpena Limestone overlying Pleistocene clays.
Qp Telford Gravel. Qrs Recent sand ridges.
Qra Creek alluvium and outwash on Pooraka Formation.

FIG. 1

| | | |
|---|---|---|
| REGIONAL MAPPING SECTION | DEPARTMENT OF MINES — SOUTH AUSTRALIA | Scale: DIAGRAMMATIC |
| Compiled: B.G.FORBES | PARACHILNA 1:250000 SHEET | Date: 5 MARCH 1971 |
| Drn. A.G.R. Ckd. L.V.W. | ROCK RELATIONSHIP DIAGRAM | Drg. No. S 9167 Fa |

1M—2.70 A1810




## LEGEND

- Total Aeromagnetic Intensity Contour (Interval 100 gamrnas)
- Aeromagnetic Low.
- Road and track.
- Railway.

SCALE IN MILES

8 0 8 16 24 32 40

10 0 10 20 30 40 50 60

SCALE IN KILOMETRES

Plan based on map compiled by Exploration Geophysics Section. S.A. Department of Mines.

FIG.2

| | | |
|---|---|---|
| REGIONAL MAPPING SECTION | **DEPARTMINT OF MINES – SOUTH AUSTRALIA** | Scale: 1 : 500000 |
| Compiled: B.G.FORBES. | PARACHILNA 1:250000 SHEET | Date: 18 MARCH 1971 |
| Drn. A.G.R. \| Ckd. | AEROMAGNETIC MAP OF TOTAL INTENSITY | Drg. No. 71-180 |

1M--2.70 51811