DEPARTMENT OF MINES
SOUTH AUSTRALIA

PRELIMINARY NOTES ON THE GEOLOGY OF THE BIRKSGATE 1:250,000 SHEET AREA

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Rept.Bk.No. 66/122
G.S. No. 3983
D.M. 1401/58

12th June, 1968.

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ABSTRACT

This progress report summarises field characteristics of the major rock types of the BIRKSGATE 1:250,000 sheet area.

The crystalline basement rocks are granite gneisses and granites of the Musgrave Block. These are of uncertain age and are referred to as Older Precambrian. These rocks are overlain, nonconformably, by the basal conglomerate of a sandstone sequence of Adelaidean age. There was apparently continuous deposition from Marinoan into the Cambrian, of micaceous sandstones and arkoses.

All these sediments were folded gently, probably in the Upper Cambrian.

This mild tectonic event was followed by a sill-like intrusion or flow of a tholeiite which was in turn succeeded by a sandstone and siltstone sequence. The K-Ar age of the tholeiite is a minimum of 480 million years (i.e. Lower Ordovician) but the age of the overlying sediments is not known with any certainty.

Silcrete was developed close to a land surface during the Tertiary. Chalcedonic limestone was later deposited in shallow fresh-water lakes in the Late Tertiary or the Early Quaternary.

A superficial deposit of sand dunes from a Quaternary arid period covers much of the sheet area.

INTRODUCTION

The BIRKSGATE 1:250,000 sheet area includes gneisses and granites of the Musgrave Block and sediments of the Officer Basin.

Reconnaissance mapping on the BIRKSGATE area was carried out in 1960 by J.A. Johnson and, in 1966, R.B. Major

and J.A. Teluk completed all but the Nakuka 1:63,360 sheet area in more detail. B.P. Thomson, Supervising Geologist, visited the area both in 1960 and 1966 and B.G. Forbes, Senior Geologist, in 1966. This enabled them to see the rocks in the field and to assist in the interpretation of critical areas.

Compilation of the map is in progress.

The BIRKSGATE area is covered by O.E.L. 28 and both Exoil Pty. Ltd. and Continental Oil Co. Pty. Ltd. have conducted surveys in the area. These surveys (aeromagnetic, seismic and geological reconnaissance) culminated, in early 1967, with the drilling of the Birksgate No. 1 well by Continental Oil Company. The total depth was 6,162 feet and although no oil or gas was found, valuable stratigraphic information was obtained in an area of poor outcrop. Although none of the surface rocks can be correlated with any confidence with those found in the well, an age determination of 845 million years (minimum age) was obtained from a shale at 5,160 - 5,188ft. by Rb/Sr methods. (Compston, appendix to Henderson and Tover, 1967).

ROCK SEQUENCE ON THE BIRKSGATE 1:250,000 SHEET AREA

Quaternary	Sand dunes and sand spreads
Tertiary-Quaternary	Chalcedonic limestone (Mangatitja Limestone equivalent)
Tertiary	Silcrete
?Palaeozoic - ?Mesozoic	Boongar Sandstone equivalent
	Nature of contact not known
	Sandstones, kaolinitic siltstone, feldspathic sandstone, khaki micaceous siltstone and grey calcareous siltstone
	Nature of contact not known
	White and red micaceous and feldspathic sandstone and siltstone
Ordovician	Nature of contact not known
	Kulyong Volcanics with unnamed greywacke and siltstone.
	Unconformity
Cambrian	Kirrildar Formation
"Upper" Proterozoic - Adelaidean	Punkerri Sandstone (Pound Quartzite equivalent
	Para conformity?
	Wright Formation
	Pindyin Sandstone
"Older" Precambrian of Musgrave Block	Nonconformity
	Coarse grained granite, adamellite and medium grained biotite-granite with minor allanite
	Dolerite and olivine-dolerite dykes
	Coarse grained hornblende-biotite porphyritic gneissic adamellite
	Medium grained hornblende-biotite granitic gneiss.

The "Older" Precambrian Crystalline Basement

The oldest rock type which has been found on the BIRKGATE (1:250,000 sheet) area is a medium grained hornblende-biotite granitic gneiss. The foliation is due to planar concentration of the dark minerals and has a general north-northeastern orientation. The largest continuous masses are found at Mt. Sir Thomas and Mt. Lindsay but outcrops of the rock can be found across the northern third of the area.

This gneiss has been intruded by a coarse grained porphyritic gneissic adamellite with hornblende-biotite and oriented phenocrysts of alkali feldspar. Where seen, this orientation and that of xenoliths is always parallel to that of the gneiss and so, these orientations may have a common origin. The contacts are sharp and straight, and because neither rock appears to have been affected; the nature of the intrusion can be determined only in a few places where tongues of the porphyritic granite can be seen in the gneiss. The xenoliths are dark hornblende-biotite-feldspar-quartz clots, presumably the basic remnants of blocks of the gneiss. They are either elliptical or roughly rectangular but in both cases the long axes are parallel to the foliation of the granitic rocks.

There are very minor aplite dykes in the porphyritic granite on the western side of the BIRKGATE (i.e. 1:63,360 sheet) area.

At Belundinna Hill, Precambrian sedimentary rocks (Pindyin Sandstone) rest nonconformably on a coarse grained light coloured porphyritic biotite granite. Here the granite has been intruded by a dyke of fine grained red acid rock which, after thin section examination, was classified as a spherulitic rhyolite (A.M.D.E.L. Report MP2738/68).

Five miles west-southwest of this area this granite

has been intruded by a medium grained pink biotite granite which has some potassium feldspar phenocrysts. One and a half miles south-southeast of Belundinna Hill the porphyritic granite is in contact with a grey medium grained equigranular hornblende-biotite granite. This contact did not indicate the relative ages of the rocks and no other contact has been seen. The bulk of the grey granite is found between Unmoorinna Hill, Yareona Hill and Cheesman Peak. The lack of foliation of the dark minerals in this granite and lack of orientation of the phenocrysts in the porphyritic granite suggests that these rocks are younger than those to the northwest. The lack of dolerite dykes in the un-oriented granites suggests that they may have post-dated these basic intrusions, although all younger granites intruding the Musgrave Block gneisses elsewhere in the Northwest Province have themselves been intruded by basic dykes. The only positive evidence of a post-dolerite intrusion was seen 2 miles northeast of Mt. Poondinna where a dyke is cut by feldspar-quartz-?amphibole rock and massive milky quartz.

A grey granitic similar to that at Cheeseman Peak occurs at Tjatamanngs Rock Hole but here it contains minor amounts of allanite, some development of feldspar phenocrysts and a foliation. In an area three to eight miles south-southwest of the rock hole are scattered small outcrops of a similar granite but this has larger phenocrysts and a more strongly developed northeast-southwest foliation.

Basic dykes: "Older" Precambrian

Outcrops of dolerite and gabbro dykes appear to be confined to the gneiss and oriented-porphyritic granite in the northern third of the area. They are massive, unstressed and unfolded and therefore post-date the metamorphic and tectonic effects which are seen in the acid rocks.

The main trend is northwest - the one main exception being at Germano Hill where it is east-west. Three miles east of Mt. Sir Thomas a thin east-west dyke appears to cut (photo-interpretation) a wide north-west dyke. This contact has not been examined in the field and so, at the time of writing, a suggestion that the east-west dykes are younger cannot be confirmed. However, support for this idea is found at Cartumconinna Hill, 110 miles east of here on LINDSAY (i.e. 1:250,000 sheet) where an east-west trending dyke cuts a north-northwest dyke.

Olivine occurs in the northwest dykes but has not been seen in the east-west ones (possibly because there are not many of them). The occurrence of olivine appears to be irregular even along the strike of the same dyke. On WOODROFFE (i.e. 1:250,000 sheet) thin section examination of many dolerite specimens has shown that olivine is found only in the northwest trending dykes and not in the northeast ones. An extrapolation to the BIRKSGATE area would suggest that, here also, dykes of different trends came from different magmas. This further supports the idea that the dolerites of this area are of different ages. The only metallic mineral seen in the dolerites is magnetite in accessory amounts.

The Sedimentary and Volcanic Rocks

Southwest of a line between the Streich Hills and Coffil Hill occur scattered outcrops of sedimentary rocks ranging in age from Adelaidean to post-Ordovician (perhaps Mesozoic). On Kulyong (i.e. 63,360 sheet) are volcanic rocks (tholeiites) which have been dated (by K-Ar methods) at 480my i.e. lower Ordovician.

Rocks of Adelaidean Age

Pindyin Sandstone (New name)

The oldest of the sediments has been named the Pindyin Sandstone and is seen at the Pindyin Hills (Pindyin 1:63,360 sheet area on LINDSAY 1:250,000 sheet area) Coffin Hill, Belundinna Hill and Streich Hills. At the first three places a basal conglomerate member rests nonconformably on gneiss and porphyritic granite. The thickest and most complete section (approximately 1,500ft.) is at the North Pindyin Hills but the conglomerate is thickest (15ft.) and the nonconformity is best exposed at Belundinna Hill. At this locality the contact is sharp and planar and no scour and fill structures were observed. Here also, the porphyritic granite is friable but there is no leached or clay zone below the contact. At the Pindyin Hill, however, the contact is not so well exposed and, in some places, the granitic gneiss has been kaolinized.

The basal conglomerate at Belundinna Hill varies from perhaps one foot thick to a maximum of 15ft. and is composed of white rounded quartz pebbles in a coarse grained arkosic matrix. The remaining overlying succession comprises of at least fifty feet of sandstone and quartzite with scattered quartz pebbles, cross bedding, ripple marks, heavy mineral bands and mud cracks (due probably to shrinkage under water or under sediment cover; there is no other separate evidence that these rocks were ever exposed to the air during deposition). At the Pindyin Hills this succession is conformably overlain by pale green siltstones and shales with thin interbeds of grey chert. Limestone and dolomite (seen only as float) are the youngest units in the sequence; if there is anything younger than these then it is covered by sandstone cobble float from the hills.

Wright Formation (new name)

The Wright Formation is a sequence of sandstone, siltstone chert and a black oolitic chert. Its greatest thickness, 6,500 feet, is seen northwest of the Wright Hills (Wright 1 mile sheet in LINDSAY,) where ridges of sandstone are separated by sand-dunes and mulga flats from half to one and a half miles wide, and consequently the lithology of the greater part of the sequence is not seen. A patch of calcrete near the top of the sequence may reflect an underlying calcareous rock and the black oolitic chert, which is seen only as float in this area, is probably a silicified oolitic limestone.

There is no direct evidence of the relationship of the Wright Formation with either the underlying Pindyin Sandstone or the overlying Punkerri Sandstone as no contacts with either have been seen. It is assumed that the Pindyin Sandstone and Wright Formation are in continuous sequence because they appear to be structurally conformable. However, there may be a break between the Wright Formation and the overlying Punkerri Sandstone because a very thin and minor pebble conglomerate containing reworked black oolitic chert has been found in the Punkerri Sandstone in the Punkerri Hills area. A paraconformity is suggested because, in the three areas (Wright Hills, Punkerri Hills and Patricia Hills) where they are seen in close contact, they are structurally conformable.

Punkerri Sandstone (New name)

The Punkerri Sandstone can be divided into two members, a lower red sandstone and an upper white sandstone. The lower member is interbedded red sandstone, quartzite and siltstone with ripple marks, scour casts, clay galls and bedding limeation. The upper member is generally harder, consisting of pink quartzites and feldspathic sandstones which have cross-bedding, shale galls, various scour casts, ripple

marks and heavy mineral bands with associated load structures. One fossil trace has been found - it resembles Rangea (Glaessner, 1966) which is found in the Pound Quartzite at Ediacara, see Beltana 1 mile sheet on COPLEY. On this basis the Punkerri Sandstone is correlated with the Pound Quartzite and is assigned to the Youngest Marinoan time subdivision of the Adelaidean.

Rocks of Presumed Cambrian Age

Wirrildar Formation (New name)

In Wirrildar, Poondinna, Kulyong and Pintumin sheet areas a sequence of poorly outcropping rocks overlies the Punkerri Sandstone although the contact is not exposed. The Wirrildar Formation underlies the (?) lower Ordovician Kulyong Volcanics and are therefore taken as being of Cambrian age. The formation is expressed as trend lines can be seen clearly on aerial photographs but, in general, only float material is found on the ground. Towards the base the formation comprises coarse grained to granule-sized arkoses and feldspathic sandstones; higher in the sequence micaceous sandstone, siltstones and flaggy dolomites are present. There is structural conformity with the underlying Punkerri sandstone and therefore sedimentation was presumably continuous.

The relationship between the sediments of the Wirrildar Formation and the overlying Kulyong Volcanics is not known with certainty. The volcanics have a calculated dip of half a degree to the west and are conformably underlain by a grey siliceous greywacke and red and green fine grained micaceous sandstones. These sediments are unnamed, and differ in lithology from the Wirrildar Formation.

The dip of the Wirrildar Formation east of the volcanics is not known and the trend lines are gently curved but no contact is seen. In southeast Wirrildar the sediments

are also folded but since the volcanics are flat lying, there is probably an angular unconformity between these rocks. The folding of the Mirrildar Formation probably occurred in Upper Cambrian or Lower Ordovician and would be related to the folding which resulted in the unconformity at Chambers Bluff (Chandler 1 mile sheet on EVERARD). At Chambers Bluff, the Chandler Sandstone, which is equated with the Upper Cambrian to Lower Ordovician Pacoota Sandstone of the Amadeus Basin, rests unconformably on tillite and volcanics of the Adelaide System (Umberatana Group). This would indicate that folding of the Adelaidean rocks occurred probably in Upper Cambrian and hence this would be the most probable time of the folding of the Mirrildar Formation and underlying Adelaidean rocks.

Rocks of Presumed Ordovician Age

Kulyong Volcanics (Major and Teluk, 1967)

This hard, red-brown tholeiite has been found only on Kulyong. It is 10 feet thick and the unnamed greywacke and micaceous sandstones conformably underlying it, are at least 20 feet thick and contain thin dolomite laminae. No fossils have been identified in the sediments. The sequence has a near horizontal attitude over the entire sheet area but it is not known whether the igneous rock was intrusive or extrusive because no rocks have been found which both overlie and are in contact with them. Lack of gas bubbles and flow bands and evenness of grain size would suggest a hypabyssal emplacement but, nowhere on the sheet area do the volcanics cross cut the underlying sediments - a situation more in keeping with a flow than a sill.

The Kulyong Volcanics have been given a minimum age of 480 m.y. (i.e. Lower Ordovician) by K-Ar methods.

Sedimentary rocks - ?Palaeozoic - Mesozoic age

In the middle of Kulyong and between the two main volcanic areas are scattered outcrops of white and red micaceous and feldspathic sandstone with some siltstone. They are generally flat lying with dips up to 10° and probably overlie the volcanics but the relationship is now known because no contact is seen.

Throughout the southwest part of BIRKSGATE are scattered outcrops of flat-lying sandstones, kaolinitic siltstone, feldspathic sandstones and (from cuttings on seismic shot holes) khaki micaceous siltstone and grey calcareous siltstone.

Boongar Sandstone (New name)

In the southeast (on Arrunga) is a clean sandstone which resembles the Boongar Sandstone. The latter is seen on Boongar (i.e. southwest LINDSAY) where it crops out as flat-lying clean sandstone with vertical tubes which superficially resemble worm burrows. These tabular structures may be solution channels associated with formation of silcrete.

None of these rocks have been found in contact with any other rock and so their ages are unknown. They are presumed to be younger than the Kulyong Volcanics but there is no evidence at present to support this interpretation.

Tertiary

In the southwest part of BIRKSGATE, large patches of ferruginised silcrete pebbles form low rises amongst the mulga thickets and sand dunes. In the same region a few areas also occur which are covered by pebbles, and cobbles of grey silcrete; these form the tops of escarpments ("breakaways") in southeast Nakuka. These deposits are tentatively assigned

to the Tertiary.

Tertiary - Quaternary

A cream chalcedonic limestone is found scattered over most of BIRKSGATE. It is similar to the limestone seen on other areas in the northwest of South Australia. On MANN and WOODROFFE a few outcrops of the rock have yielded fossils such as stoneworts, ostracodes and gastropods (Coxiella sp.) These favour a Quaternary age for the limestone but the possibility exists for a Tertiary age. Deposition probably occurred in widespread, shallow, fresh or brackish water lakes.

Quaternary

Between areas of outcrop and claypans, BIRKSGATE is covered by a veneer of sand dunes and sand spreads; except for the crests of the dunes the sand is fixed by vegetation such as spinifex and mulga. In the northern two-thirds of the area the dunes are oriented northwest-southeast but are east-west in the southern third.

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RBM:OB:CC
12.6.1968

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