COMMONWEALTH OF AUSTRALIA.

---

DEPARTMENT OF NATIONAL DEVELOPMENT.

BUREAU OF MINERAL RESOURCES
GEOLOGY AND GEOPHYSICS.

---

**RECORDS.**

RECORDS 1958/106

# GEOLOGICAL NOTES, INSPECTION TRIP, 1958

by

M.A. Condon.

# GEOLOGICAL NOTES, INSPECTION TRIP, 1958

by

M.A. Condon.

RECORDS 1958/106.

In August to October, 1958, I attended the A.N.Z.A.A.S. Meeting at Adelaide and from there visited Alice Springs and the Jervois Range and Georgina parties.

The following notes record some of the geological observations made.

## SOUTH AUSTRALIA

### SELWYN'S ROCK, INMAN VALLEY

On an excursion on 23rd August, 1958, I visited Selwyn's Rock which is a glacial pavement well exposed in the stream bed of the Inman River about eight miles from Victor Harbour (Howchin, 1926, p.105).

The exposed area of the pavement is about 10 x 5 yards. The pavement is developed on steeply dipping hard dark laminated to thin-bedded siltstone and quartz greywacke of the Kanmantoo Group (Sprigg & Campana, 1953). It is overlain by boulder clay - clay with scattered boulders, cobbles and pebbles including boulders of granite similar to that of Victor Harbour. This boulder clay is undoubtedly a ground moraine tillite of Permian age (Howchin, 1926).

The erosional features of the pavement include the following: (1) parallel flutings from 6 inches wide and 1/8 of an inch deep to three feet wide and 1/2 inch deep. Most of these flutings cross the exposed area. Smaller flutings are included in some of the larger.

The flutings are eroded by large blocks (boulders or cobbles) carried in the bottom layer of the ice. They indicate the trend of the movement of the ice but not its direction. In this case they indicate a north-west/south-east trend.

(2) Striations mainly but not invariably parallel to the fluting. The striations are generally not more than three inches long and less than 1/16 inch in width and depth.

The striations are eroded by small particles, as hard or harder than the bedrock, held in the bottom of the ice. They indicate the trend of movement of the ice, both the main movement by the dominant trend of striation direction and some of the "convective" movements within the ice body.

(3) Gouging marks up to 6 inches long; these are ½ inch deep at one end gradually becoming wider and shallower towards the other end. These are probably formed by a pebble hard enough to be forced into the bedrock but soft enough to be abraded in its passage over the pavement. They indicate the direction of movement of the ice - from the narrow deep end towards the wider shallow end. This agrees with the evidence of the Victor Harbour granite erratics in the boulder clay that the ice was moving north-westwards.

NAIRNE PYRITES

The Nairne Pyrites mine, 19 miles south-east of Adelaide, was visited during an excursion on 24th August, 1958. The pyrites is mined in two open cuts. The ore, containing more than 12% sulphur, is confined to three bedded deposits each 50 to 100 feet thick stratigraphically, although there is much pyrites in the beds between and on either side of the ore beds. The beds are part of the Kanmantoo Group of possible Cambrian age, (Sprigg & Campana, 1953) and dip steeply east. The pyrite and pyrrhotite occurs in laminae, interlaminated with dark siltstone. Small amounts of other sulphide minerals including galena, chalcopyrite, sphalerite and arsenopyrite, are found mainly in small "pods" transgressive to the bedding.

The pyrite has generally been accepted as of syngenetic origin; it has similar field relationships to those of the sulphides of Mt. Isa viz. the sulphide is mainly confined to laminae or thin beds but in places is transgressive in thin veins; the host rock and the sulphide are contorted into folds that are most probably slump folds; the sulphide is crystalline but generally fine-grained.

SOUTHERN FLINDERS RANGE

The Upper Proterozoic, Cambrian, Ordovician and ?Triassic of the Southern Flinders Range were seen during an excursion, under the leadership of Dr. A.W. Kleeman, from 27th to 31st August.

An unusual sedimentary rock was seen in the Torrensian at Germein Gorge east of Port Pirie. This is a sedimentary magnesite consisting of beds of sand-size particles of magnesite, intraformational breccias of fine-grained magnesite and laminae of chert.

The Sturt Tillite was seen west of Quorn; there the rocks are bedded boulder siltstone and sandstone containing beds and lenses of dolomite, and dolomitic cement in some of the terrigenous beds. Impact structures are developed in the sediment below many of the boulders. I regard the deposit as an "aqueo-tillite" formed by the dropping of englacial material from floating ice.

The Brighton Limestone overlies the Sturt Tillite; it was seen to consist of intraformational breccias of fine-grained dolarenite fragments in calcilutite, with algae stromatoliths.

The Marinoan "Series" was seen in the Warren Gorge area west of Quorn. The dominant lithology in dark greenish gray laminated greywacke siltstone and quartz greywacke. It is commonly dark red brown at the surface. Laminae of malachite were seen in the upper part of the sequence. The "A.B.C. Quartzite" is a formation of bedded quartz greywacke in the middle part of the sequence.

In lithology and stratigraphic position relative to the glacial sediments and to the fossiliferous Cambrian the Marinoan "Series" is similar to the Pertatataka "Series" of the Macdonnell Ranges.

The Pound "Quartzite" was seen north-west of Quorn and at Wilpena Pound (the type locality). It consists dominantly of medium-grained quartz sandstone, cross-laminated

in sets 6 inches to 3 feet thick. This grades down into dark grey interbedded fine-grained and medium-grained quartz greywacke and greywacke siltstone that weather red-brown like the Marinoan. Beds of finely laminated fine calcarenite occur near the base. No fossils were seen in the field but a varied fauna of problematica including probable jelly-fish and annelid worms are found in these lower beds at Ediacara (Sprigg, 1947, 1949). Because this fauna is completely different from anything known in the Cambrian the Pound "Quartzite" is now referred to the Precambrian and its top is regarded as the boundary between the Cambrian and Precambrian.

The lowermost Cambrian beds were seen north-west of Quorn, where Archaeocyatha and fragmentary trilobites and small brachiopods are present in hard grey calcilutite overlying Pound "Quartzite"; the fossils are found well above the base of the limestone. At Sellick's Hill, 30 miles south of Adelaide, the Cambrian limestone (laminated calcilutite with intraformational breccias and Archeocyatha and Hyolithes) rests on a sequence of bedded quartz greywacke and siltstone.

The Triassic of the Springfield Basin, 26 miles north-east of Quorn, was visited with Mr. W. Johnston of the South Australian Geological Survey. Triassic sandstone, siltstone, shale and conglomerate occupy a small basin (3 miles by 1½ miles) in Precambrian slate and tillite. Thin seams of low-grade brown coal are present. In a small mesa near the south end of the basin the sediments are lateritized and include several ash beds from the burning of coal seams and an igneous-looking rock formed by the fusion of the sedimentary rocks probably mainly by hot gases escaping from the burning seam. Mr. Johnston relates the burning of the coal to its exposure in the face of the mesa, but the mesa has developed since lateritization; the coal would not have survived the lateritization process, whereas the natural slag may have, and in the synclinal basin the seams would be exposed at the surface and could take fire there.

The basin appears to have been in existence before the deposition of the sediments; it may have been scoured by Permian glacial ice.

## ALICE SPRINGS AREA

### HEAVITREE SANDSTONE

Mr. Jones showed me casts of pyrites crystals up to 4 mm. cubes in the upper part of the Heavitree Sandstone in a quarry on the east side of Heavitree Gap.

Mr. J. McLeod (Frome-Broken Hill Company) pointed out invertebrate burrows in the upper part of the Heavitree Sandstone about 10 miles west of Alice Springs.

### MAREENIE SANDSTONE

In the Tempe Bar area a locality in the Mareenie Sandstone was visited where, near caves with poor aboriginal paintings, Upper Ordovician fossils were reported in situ in the Mareenie Sandstone. The fossils were re-located and found to be in rock of lithology unlike the Mareenie Sandstone, and not in place but in large blocks. Following upstream these blocks were found to originate in the

underlying formation which is part of the estabilghed Ordovician sequence. A thin conglomerate bed was seen at the base of the Mareenie Sandstone.

QUARTZITE OF CHEWING'S RANGE

The quartzite of the Chewing's Range, which has been described as metamorphosed Heavitree Sandstone by Prichard and Quinlan (m.s.) and by N.O. Jones (personal communication) was examined at Standley Chasm and at Simpsons Gap.

At both places the rocks exposed are hard meta-quartzite with accessory muscovite and, in "members" from 10 to about 100 feet thick, schist, including mica schist and (?) tremolite schist, that weathers more readily than the quartzite. These schist members are of the same lithology as schist in the Arunta Complex in the same area, and the quartzite and included schist are structurally conformable with the Arunta Complex to the south; north of Simpson's Gap there appears to be an east-west fault separating the quartzite from the schist to the north.

At Simpson's Gap the metaquartzite grades into underlying schist. The quartzite forms an anticline with the schist tightly folded beneath. The plunge of the small folds in the schist is the same ($10^{o}$ west) as the main fold in the quartzite and the difference in folding results from the different competence of the quartzite and schist. What may be an underlying competent quartzite is exposed on the east bank of the stream beneath the schist.

There is no possibility that the meta-quartzite of the Chewing's Range is metamorphosed Heavitree Sandstone as its thickness and lithology are different from those of the Heavitree Sandstone and it is part of the Arunta Complex sequence and structurally conformable with it.

BITTER SPRINGS LIMESTONE

At the type locality of the Bitter Springs Limestone (Joklik, 1955) N.O. Jones (personal communication) reported that the Bitter Springs Limestone was metamorphosed. The area was examined in company with Jones.

The Bitter Springs Limestone consists of thin-bedded and laminated dolarenite and calcilutite, very strongly contorted. To the north of the type locality, the Bitter Springs Limestone is in contact with a sequence of calc-silicate rocks, laminated marble and schist dipping at 60 to 75 degrees west. Immediately west of the contact the Bitter Springs Limestone dips $30^{o}$ west. There is no metamorphic gradient between the carbonates of the Bitter Springs Limestone and the metamorphic carbonate rocks which are structurally conformable with Arunta Complex schists. South of the contact with the metamorphosed carbonate rocks, the Bitter Springs Limestone is in contact with metaquartzite mapped by Joklik as Heavitree Quartzite but actually belonging to the Arunta Complex sequence. West of this the Bitter Spring Limestone overlies Heavitree Sandstone, both dipping steeply east. The Heavitree Sandstone and Bitter Springs Limestone apparently fill a north-trending valley eroded in the rocks of the Arunta Complex, with bedding nearly parallel to the unconformity on the west side and abutting the unconformity on the east side.

There is no evidence of metamorphism of the Bitter Springs Limestone.

## ALCOOTA AND BARROW CREEK FOUR-MILE SHEETS

During a charter flight by Connellan's Cessna aircraft from Alice Springs north to Taylor Well (Lat.21° 15', Long.134°07') gently dipping sediments were seen in several east trending synclines between Mount Harper (Lat.22°12', Long.134°01') and Taylor Well. Steeply dipping rocks, probably metamorphic, occupy the areas between the synclines and also trend east. The sediments in the synclines may be the westward extension of the Cambrian of the Sandover River.

## HUCKITTA FOUR-MILE SHEET

I spent eleven days with the Jervois Party. The following notes refer only to new observations made by myself.

### MOUNT CORNISH SEQUENCE

At Mt. Cornish, in the eastern part of the sheet a sedimentary sequence rests unconformably on Arunta granitic gneiss containing beds of quartz schist and cut by quartz reefs. The surface of unconformity has moderate and sharp relief (of the order of 100 feet). The unconformity is very well exposed in a number of places.

Up to 30 feet of hard bedded coarse-grained to very coarse-grained quartz greywacke and thin-bedded medium grained quartz greywacke rest on the gneiss. The greywacke is overlain by 20 to 50 feet of laminated to thin-bedded calcilutite and dolerenite with calcareous algae, and beds of calcareous coarse quartz greywacke and sandstone. This carbonate member is overlain, apparently conformably, by a thick sequence (at least 800 feet thick by estimate) of glacigene sediments. There are two main lithologies; the dominant lithology is hard bedded blue green boulder siltstone with impact structures under some of the boulders; the other lithology is hard laminated cyclic siltstone and fine sandstone. I interpret these as being aqueotillites (i.e. englacial material deposited directly from floating glacier (or ice-sheet) ice, and varves. The aqueo-tillite members range in thickness from about 20 feet to about 200 feet, the varved members from 5 to 20 feet.

This glacigene sequence is very similar to a part of the glacigene sequence east of the Field River on Tobermory four-mile sheet (Noakes, 1957, p.233).

As doubts have been expressed whether these sequences are glacial, it is necessary to state the criteria on which the glacial origin of the sediments is established: the aqueotillites have the "tillitic" texture- a dominant fine-grained ground in which are scattered fragments ranging in size from fine-sand to boulders; the rough bedding and the impact structures under some of the larger fragments indicate deposition through water - aqueo-tillites <u>not</u> ground moraine; the shapes of the larger particles are those typical of englacial material - well rounded and polished with concave surfaces also polished, wedge shaped, pyramidal, and kidney-shaped; the cobbles are striated and rarely faceted. Absence of graded bedding and turbulence structures preclude these deposits being turbidity current deposits.

The varves consist of cyclic siltstones and fine-grained sandstone, with very little gradation between them; the siltstone laminae commonly have a faint fine lamination such as has been reported from Plaistocene varves and which were the subject of controversy as to whether these fine laminations or the larger cycles were annual deposits; they show the minute faulting also characteristic of Pleistocene varves; they include very few large fragments, all of which show impact structures beneath.

These aqueo-glacial sequences have some similarities to the Sturt Tillite of South Australia and are probably related to the same Proterozoic glaciation.

## GLACIAL SEDIMENTS NEAR OORABRA ROCKHOLES

I revisited the locality where I had found glacial sediments in June 1957. The sediments are very well exposed in a cliff on the right (west) side of a creek, 2¼ miles north-north-east of Oorabra Rockholes.

A ground moraine boulder clay rests on a surface of decomposed coarse granite sloping north at about 30°. The boulder clay contains boulders and cobbles of granite and cobbles and pebbles of quartz and quartzite. It is unbedded and about 10 feet thick; it is overlain conformably by about 15 feet of laminated sandy (tillitic) siltstone and 5 feet of laminated cyclic (varved) siltstone and claystone.

This is overlain conformably by unbedded pebble clay (ground moraine) three feet thick that is overlain by 20 feet of laminated cyclic (varved) siltstone and claystone. The top surface of this is scoured and contorted and overlain by an unbedded boulder clay about 25 feet thick with boulders and cobbles of granite and quartzite and a large granite erratic 10' by 40' x 8'. This ground moraine is overlain by bedded siltstone and quartz greywacke.

There is no outcrop between this and Cambrian dolomite dipping north about one hundred yards upstream.

About one mile south of this locality K.G. Smith showed me similar sediments underlying the Oorabra Arkose.

## OORABRA ARKOSE

Mr. K.G. Smith had found cobbles with englacial shapes in the Oorabra Arkose and thought that this unit might be included in the glacigene sediments that crop out in the vicinity.

He showed me these in a very well-exposed section that he intends to make the type section of this unit. There the coarse arkose is interbedded with siltstone, the arkose in beds 2 to 5 feet thick, the siltstone up to one foot thick. The contact between the base of an arkose bed and the top of a siltstone bed in many places shows turbulence structures (Kuenen and Menard, 1952, p.91), including isolated asymmetrical ripples on the surface of the underlying siltstone and pinched out wedges of siltstone developed from the crest of such ripples. The overlying arkose is very coarse and not graded; it shows convolute lineations that I interpret as produced by turbulent motion within the bed immediately before movement stopped.

The cobbles of glacial shape are present mainly at or near the base of arkose beds. Those at the base commonly

depress the underlying siltstone. They were transported in the turbidity current of coarse arkose and because of their size settled to the bottom of the bed. The bulk of the current apparently was not fluid enough to allow differential settling after it came to rest although there had been some earlier separation of the finer fraction which deposited as an overlying bed with little gradation between the two.

The glacial cobbles were almost certainly derived from another part of the glacigene formation which underlies the arkose at this place.

DULCIE SANDSTONE

The Dulcie Sandstone (Joklik, 1952) was examined in a section eight miles east from Huckitta homestead, and near Point Spring, 16 miles east-south-east of Huckitta. It consists of strongly cross-bedded clean quartz sandstone with a calcareous silty sandstone member at the top of the middle third of the exposed sequence and a siltstone member near the top. The top is an erosion surface; the Dulcie Sandstone has a maximum preserved thickness of about 2,000 feet. (Measured by K. Gough).

A basal conglomerate including pebbles of the underlying Ordovician sandstone was found (only in detached blocks) in the scarp one mile north of Point Spring. This, and the marked change in lithology compared with the thin-bedded calcareous sandstone and siltstone of the fossiliferous Ordovician, indicate that the Dulcie Sandstone is unconformable on the Lower Ordovician sequence and therefore, probably post-Ordovician in age. The only fossils found in the Dulcie Sandstone are some Problematica in the calcareous silty sandstone member.

"TARLTON GLACIALS"

Eleven miles south of Tarlton Downs Homestead (Lat. 22°36'S, Long. 136°50'E.), on Tobermory 4-mile sheet, glacial rudite was found to include rounded pebbles of fossiliferous Ordovician sandstone. In a scour on the south scarp of a mesa 6-2/3 miles south-east of No. 2 Bore, Tarlton, a good exposure of the sequence was observed. There a ground moraine boulder clay three feet thick rests unconformably on Ordovician siltstone. The boulder clay contains boulders, cobbles, and pebbles of quartzite, granite, schist and limestone, and pebbles of sandstone, in a dominant claystone matrix. The boulder clay is scoured, and overlain by strongly cross-bedded coarse-grained silty sandstone, conglomerate, and siltstone of fluviatile type. This is overlain by bedded silty sandstone and sandy siltstone.

The whole sequence, including the underlying siltstone, is lateritized.

The sequence is interpreted as a ground moraine, fluvioglacial sediments and lacustrine sediments.

The glacial sediments are preserved in a valley eroded in the Ordovician sediments.

Similar glacial sediments were found to be distributed widely on the Tobermory, Mt. Whelan and Glenormiston 4-mile sheets although nowhere else was such a good exposure seen.

Well silicified fossil coniferous wood is found in

the fluviatile sediment above a ground moraine near Burnt Well, Tobermory and in the same area Cretaceous silty sandstone containing Rhizocorallium overlies the glacial sediments.

The age of the glacial sediments is thus established as between Ordovician and Cretaceous, and the coniferous wood indicates that it is not older than Permian. As the Permian glaciation is well-established in Australia, these sediments are most probably Permian in age.

I found a glacial pavement developed on ?Lower Cambrian, "Sylvester Sandstone" about 60 miles south-west of Boulia and about 33 miles south-south-east of Glenormiston Homestead. Large shallow flutings and medium scale gougings (but no striations) indicate ice movement towards the north-east. In the same area, a boulder conglomerate dominantly of silicified "Sylvester Sandstone" and a boulder clay occur between the "Sylvester Sandstone" and the Cretaceous Wilgunya Shale but are not exposed in contact with the pavement.

## MT. WHELAN 4-MILE SHEET

### ARKOSE OF SUN HILL, GLENORMISTON

The arkose of Sun Hill (about 12 miles east of Glenormiston Homestead) is very similar to the Oorabra Arkose in lithology, in containing pebbles, cobbles and boulders derived from glacial sediments and in having turbulence lineation within the thick beds and "anti-dune" ripples on the bedding planes. There is no known outcrop of the Proterozoic glacial sediments in the Sun Hill area and the arkose, as a turbidity current deposit, may have travelled very far.

The rudite contained in the arkose is scattered through the beds although there is some concentration at the bottom of each bed; many hard rock lithologies are represented - quartz, quartzite, gneiss, schist, pegmatite, jasper; the rudite particles are broken by jointing - this distinguishes them from the Permian material and indicates that the Permian material in this vicinity did not derive from the arkose.

The Cretaceous ferruginous sandstone with silicified wood and pelecypods and silty radiolarite rest unconformably on both the arkose (one mile west of Sun Hill) and on the ?Permian glacials (Half a mile south of Sun Hill).

### SYLVESTER SANDSTONE

The "Sylvester Sandstone" is a hard silicified fine-grained quartz sandstone with cross lamination and ripple-marks. In this it appears to be a normal stable-shelf sandstone but in some beds contains structures which appear to be turbulence lineation and in the same beds, bedding plane features that have the characteristic of antidune ripples (Lamont, 1957). These beds showing turbulence structures have the same clear quartz sandstone lithology as the rest of the sequence. If they were transported and deposited as turbidity currents, there must have been a matrix present capable of supporting the quartz grains and holding them apart. This matrix has completely disappeared. As the sandstone has been silicified probably by surface processes an argillaceous matrix may have been removed by the same

processes or the matrix may have been an organic slime that certainly would more easily be removed by weathering, without leaving any trace.

I have not seen such structures in sediments of this lithology nor have I seen any report of them. It may represent a departure from the common environment of turbidity current deposits.

Boulders of the silicified "Sylvester Sandstone" are included in the ?Permian glacial deposits near the "Sylvester Sandstone" outcrops. Therefore the "Sylvester Sandstone" was silicified before the deposition of the ?Permian material. Silicification of similar sandstone results from the lateritization process in younger sediments (e.g. The Cretaceous Longsight Sandstone three miles north-north-east from 20 Mile Bore Glenormiston Station on the road from Glenormiston to Carlo) and therefore the silicification of the "Sylvester Sandstone" may indicate a pre-Permian lateritization.

## CHALCEDONY AND SINTER OF SUGARLOAF, MT. COOLEY AND MT. WHELAN

At Sugarloaf and Mt. Whelan bedded siliceous sinter rests unconformably on an irregular lateritized surface of Cretaceous siltstone. Roughly bedded chalcedony overlies the sinter.

The deposit is almost certainly of the same age and general origin as the Austral Downs Limestone: lake or, more likely, swamp deposits laid down on broad valley floors; the lime and silica probably were brought in in groundwater draining the laterite profile and directly associated with the lateritization process. Where the surface rocks in the vicinity are limestone and dolomite the deposits are dominantly limestone, where only terrigenous sediments outcrop the deposits are siliceous.

As the deposits commonly contain detrital laterite pisolites in the lower beds, or rest directly on a laterite surface, the laterite must have been well developed before the deposition of these sediments started. They are deeply dissected by post-laterite erosion and are therefore probably late Tertiary in age.

## MT. WHELAN AND GLENORMISTON SHEETS

### "Strathelbiss (OR MARION) SANDSTONE"

I examined outcrops of the "Strathelbiss Sandstone" on the road from Glenormiston to Boulia about two miles west of Boulia, and 17 miles west of Marion Downs Homestead.

The "Strathelbiss Sandstone" was confirmed as unconformable on the Ordovician dolomite and Cretaceous siltstone. The rock is billied - opalized by lateritization - and was probably originally a sandy siltstone. The formation name should not be "Sandstone" but either "Billy" or "Formation".

The conglomeratic beds at the base include angular fragments of the Cretaceous siltstone. This suggests that the lateritization of the Cretaceous siltstone was well

developed when the "Strathelbiss Formation" was deposited: unless hardened by lateritization the soft Cretaceous siltstone would not produce angular fragments. As the Strathelbiss is itself lateritized its age must be late Tertiary.

## ORDOVICIAN OF BANNOCKBURN HILLS, GLENORMISTON SHEET

The Ordovocian sediments of the Bannockburn Hills in the north-western corner of the Glenormiston Sheet may be correlated with the Ninmaroo Limestone (Casey et al, MS.) but should not be included in that formation because of the differences in lithology. The Ninmaroo Limestone is composed predominantly of hard limestone of several main types whereas in the sediments of the Bannockburn Hills, hard limestone is a minor constituent. Hard dolomite is more common but dominant over both are soft beds of siltstone, fine sandstone and soft calcilutite.

These sediments have a very gentle dip to the south-west and extend across the south-western corner of the Urandangi Sheet. The lithologies are well shown in the spoil heap of Wanda Well on the border fence.

## ORDOVICIAN EAST OF GEORGINA RIVER

On the east side of the Georgina River north and south of Roxburgh Downs the Ordovician sediments consist dominantly of hard dolomite with minor hard limestone and soft silty beds, and contain the same type of Problematica as occur in the Ninmaroo Limestone.

There is a big break in outcrop between the north end of these sediments and the outcrop of dolomite to the east of Urandangi township, but the regional dip and the relationship to the higher sequence of the Bannockburn Hills suggest that the outcrop east of Urandangi is Ordovician. No fossils have been found in the outcrop, 2 to 15 miles east of Urandangi and no mappable lithological units are distinguishable. This area was mapped as Middle Cambrian Barkly Group and Precambrian on the first edition (B.M.R. 1951) of the Urandangi Sheet and as Proterozoic Camooweal Dolomite with large outliers of Ordovician Ninmaroo Limestone on the second edition (B.M.R., 1958).

## CAMBRIAN SEDIMENTS - GLENORMISTON AND URANDANGI SHEETS

The Cambrian sediments were examined in the type localities of the Quita Formation and Steamboat Sandstone, in the Ardmore area and in the Mungerebar Area.

### RIVERSDALE FORMATION

The lowermost Cambrian sediments seen were the greywacke breccia and dolomitic greywacke at Ardmore, overlain apparently conformably by dolomite, equivalent (Öpik, 1957, p.13) to Thorntonia Limestone. The contact between these lower ferruginous sediments and the dolomite is gradational and is thought likely therefore to be conformable.

These sediments, called "redbeds" by Öpik, are red only at the surface - recently dissected material is dark green.

Sandstone and quartz greywacke were seen resting unconformably on Precambrian gneiss two miles west of Yarrie Rockhole. They are overlain by contorted chert, similar to that exposed at the surface of the Thorntonia Limestone equivalent in the Ardmore area.

In their colours and lithology these sediments are like the "Mt. Baldwin formation" of the Jervois Range area and the "Arumbera Greywacke" of the Macdonnell Ranges.

THORNTONIA LIMESTONE

In the area visited between D69 and D74, Urandangi Sheet (B.M.R., 1958) and 6½ miles east of Ardmore, the formation mapped as Thorntonia Limestone consists dominantly of siliceous dolomite, medium- and fine-grained. It rests conformably on dolomitic greywacke or unconformably on Precambrian gneiss. On weathered (or as I believe lateritized) surfaces this formation exhibits much chert including some laminated, some brecciated and some strongly contorted, and fine-grained granular siliceous rock, commonly very fossiliferous. The ridge on the north side of Split Creek 6½ miles east of Ardmore Homestead has abundant fossiliferous chert on the moderate slope to the north and only very little outcrop of dolomite; on the steep and dissected south slope into the Creek the outcrop below the rounded top of the ridge is entirely of fresh dolomite, horizontally bedded. No fossils can be seen in this dolomite.

BEETLE CREEK FORMATION

Pale, fine-grained granular siliceous rock, a weathered siliceous dolomitic calcilutite, is one of lithological types present in the "Thorntonia Limestone" and is the dominant lithology of the "Beetle Creek Formation" (Öpik, 1957, p.17). In the Ardmore area it appears to me that the sediments have been mapped as "Thorntonia Limestone" where fresh and "Beetle Creek Formation" where weathered: one changes laterally and abruptly into the other and the only change in lithology is that caused by weathering.

"BLAZAN SHALE", "QUITA FORMATION" and STEAMBOAT SANDSTONE

These three formations were examined in the area bounded on the north by Pinnacle Bore and D69 and on the south by the sheet margin (Urandangi Sheet, 1958).

The "Blazan Shale" (Öpik, 1957) in this area consists of weathered rock (pale fine-grained siliceous rock and laminated chert). The lower part of the "Quita Formation" here consists of laminated friable and hard calcilutite, calcarenite and dolarenite, and is the fresh equivalent of the weathered rock that is mapped as "Blazan Shale". The upper part of the "Quita Formation" consists (in the type locality) of fresh laminated friable fine calcarenite and friable and hard laminated calcilutite with beds of calcareous fine sandstone, of intraformation breccia (calcilutite) and dolomite with many sponge spicules.

The "Steamboat Sandstone" consists of weathered pale reddish thin bedded sandstone and granular fine-grained siliceous rock, which are the products of weathering of the upper part of the Quita Formation. In several places this was established by walking along beds from fresh to weathered

exposures in places (e.g. the hills one mile south of Pinnacle Bore) where, on Dr. Öpik's photo-scale map, a boundary between "Quita Formation" and "Steamboat Sandstone" had been mapped.

It is my opinion that only one formation of the lithologies of the "Quita Formation" as mapped, is present in this area, and that the areas mapped as "Blazan Shale" and "Steamboat Sandstone" are weathered parts of that formation. These parts can of course be separated by fossil content. This opinion has been discussed with Dr. Öpik, who can neither agree with it nor convince me that it is incorrect. The issue could be settled only in the field.

TOP SPLIT CREEK BORE, ARDMORE

In the area east of Top Split Creek Bore, Ardmore, which is mapped (Urandangi Sheet, 1958) as Blazan Shale over Camooweal Dolomite, the following section is exposed in the low hills south of the creek.

TOP - 1 to 4 feet sandy billy

20 to 25 feet silty medium and coarse sandstone with beds of silty radiolarite.

1 foot Silty coarse sandstone with very small pebbles.

UNCONFORMITY

5 to 20 feet weathered white calcilutite.

6" to 1 foot ferruginous chert and ferruginous dolomite.

20 to 30 feet (down to alluvium) fresh laminated fine-grained dolomite with intra-formational breccia beds.

The top part of the section above the unconformity is probably Cretaceous.

The weathered and unweathered carbonate sediments are part of a single formation, and I saw no reason why it should not be included in the Quita Formation, particularly as, at D47 fossils characteristic of the "Blazan Shale" have been found (Öpik, Carter and Noakes, 1958).

CRETACEOUS OF WESTERN QUEENSLAND

The Cretaceous sediments were examined along the roads from Dajarra to Boulia, and Boulia to Roma, and the type localities at Roma and Minnie Downs (Whitehouse, 1956 p. 10 ) visited.

Mindyalla Radiolarite (Casey et al MS.) was found to outcrop along the Dajarra-Boulia road from about half a mile south of Valley Creek to Alderly. There are some outcrops of the underlying Wilgunya Shale in valleys and low flats. Much of the radiolarite is overlain by ferruginous pisolitic laterite.

Along the road from Alderly to Boulia bentonitic shale and siltstone of the Wilgunya Shale are dominant in outcrop. The overlying Mindyalla Radiolarite occupies small synclines and caps some hills. There appear also to be beds of radiolarite in the upper part of the Wilgunya Shale.

The Wilgunya Shale (Casey et al.MS.) and the Mindyalla Radiolarite (Casey et al. MS.) can be traced from Boulia to Winton where the Winton Formation appears to be below the Radiolarite and in the same stratigraphic position as the Wilgunya Shale. The Roma Formation has the same general lithology as the Wilgunya Shale. The lithology of the Tambo Formation (sandy glauconitic calcarenite, calcareous, glauconitic sandstone and soft calcilutite) is not seen in the western area.

Small outliers of Cretaceous sediments unconformably overlie Cambrian sediments about one mile west-north-west of Quita Bore, and east of Top Split Creek Bore, Ardmore. These are mentioned in the explanatory notes (Opik et al. 1958), but not shown on the Urandangi Sheet (B.M.R. 1951 and 1958).

A small outlier of Cretaceous sediments overlies Cambrian sediments about three miles west of Yarrie Rockhole, Glenormiston Sheet, and many outliers of Cretaceous sediments rest on a surface of marked relief on Ordovician sediments two to eight miles east of Georgina River and south of Roxburgh Downs homestead. The surface of unconformity includes several pinnacles around which the Cretaceous sediments have steep dips probably largely original.

## REFERENCES


Bureau of Mineral Resources, 1951 - The Urandangi 4-mile geological sheet. Bur.Min.Resour.Aust. Map Sheet. F 54-5 (1st Ed.).

Bureau of Mineral Resources, 1958 - The Urandangi 4-mile geological sheet. Bur.Min.Resour.Aust. Map Sheet. F 54-5 (2nd Ed.).

Howchin, W., 1926 - The geology of the Victor Harbour, Inman Valley and Yankalilla districts, with special reference to the great Inman Valley glacier of Permo-Carboniferous age. Trans.Roy.Soc.S.Aust., 50, 89-119.

Joklik, G.F., 1955 - The geology and mica fields of the Harts Range, Central Australia. Bur.Min.Resour.Aust. Bull. 26, 226 pp.

Kuenen, P.H. and Migliorini, H.W., 1952 Turbidity currents, grades and non-graded deposits. J. Sed. Pet. 22, 83-96.

Lamont, A., 1957 - Slow anti-dunes and flow marks. Geol. Mag. 94 (6), 472-480

Noakes, L.C., 1957 - Upper Proterozoic and Sub-Cambrian rocks in Australia. Bur.Min.Resour.Aust. Bull. 49, 213-238. (Reprint from Symposium El Sistema Cambrico, su Paleogeografie y el Problema de su Base, 20th Inter. Geol. Cong. Mexico, 1956.)

Öpik, A.A., 1957 - Cambrian geology of Queensland. Bur.Min.Resour.Aust. Bull. 49, 1-24.

Öpik, A.A., Carter, E.K. and Noakes, L.C., 1958 - Explanatory notes on the Urandangi 4-mile geological sheet. Bur.Min.Resour.Aust. Explan. Notes. 1 (2nd Ed.).

Skinner, B.J., 1958 - The geology and metamorphism of the Nairne pyritic formation, a sedimentary sulphide deposit in South Australia. Econ. Geol. 53 (5).

Sprigg, R.C., 1947 - Early Cambrian (?) jellyfishes from the Flinders Range. Trans. Roy. Soc. S. Aust., 71 (2), 212-224.

Sprigg, R.C., 1949 - Early Cambrian "jellyfishes" of Ediacara, South Australia and Mount John, Kimberley District, Western Australia. Trans. Roy. Soc. S. Aust., 73, 72-99.

Sprigg, R.C. and Campana, B., 1953 - The age and facies of the Kanmantoo Group. Aust. J. Sci., 16, 12-14.

Whitehouse, F.W., 1954 - The geology of the Queensland portion of the Great Australian Artesian Basin in "ARTESIAN WATER SUPPLIES IN QUEENSLAND". Dept. Co-ord.-Gen. Pub. Wks. Qld. Brisbane: Govt. Printer. Appendix G. 20pp.