Rept. Bk. No. 53/143
G.S.No. 2180
D.M. 1790/59
Hyd. 1396

DEPARTMENT OF MINES
SOUTH AUSTRALIA

GEOLOGICAL SURVEY

THE GEOLOGY OF THE
MILANG MILITARY SHEET
(EXPLANATION OF THE GEOLOGICAL MAP)

by

B.P. Thomson, Senior Geologist
Geochemical Section

and

R.C. Horwitz, Geologist
Regional Mapping Section

with

Appendix

HYDROLOGICAL NOTES

by

C. Bleys
Geologist

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21st November, 1961

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The High level deposits:

Dunes fixed by Kunkar:

Recent

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GENERAL

INTRODUCTION

The Milang one-mile Military sheet is defined by latitudes $35^{\circ}15'$ and $35^{\circ}30'$ and by longitudes $138^{\circ}30'$ and $139^{\circ}00'$. It is situated south of Adelaide, on Fleurieu Peninsula and comprises mainly parts of the counties of Adelaide and Hindmarsh.

The principal townships are Strathalbyn, Willunga, Goolwa, Milang and Mt. Compass.

The area include comprises a range of hills which is the continuation, to the south, of the Mt. Lofty Ranges. It is bordered by two plains. To the north are the Willunga plains. To the southeast, and covering nearly half the area of the military sheet, are the Milang plains, which are a marginal extension ~~extent~~ of the Murray basin plains. From the east, the approach to the hills is fairly smooth. On the western side, however, the edge of the ranges is limited abruptly by the Willunga Scarp.

In the ranges the summits are broadly concordant, reaching nearly to 1400 ft.

The main water courses flow southeast into the freshwater basins of Lake Alexandrina and the Goolwa or Lower Murray River. They are, from north to south the River Bremer, the Angus River, the Finniss River, the Tookayerta Creek and Currency Creek.

Climatically, the region is temperate with an average annual rainfall slightly over 20 inches on the Willunga plains and slightly less on the eastern side of the ranges. In the hills the rainfall ~~it rises,~~ approaches approaching 30 inches.

Both plains are cultivated for cereal crops and are also used for sheep pastures. The hills are only locally cultivated and provide mainly dairy cattle and sheep pastures, with some pine plantations ~~occur~~ in the Spring Mount and Kuitpo areas.

For the geological map, Horwitz carried out field work, initially under the direction of B. Campana and later under that of B.P. Webb (Senior geologists). Mapping was done during the summer seasons from 1954 to 1956. The results were described in 1958 (published 1960). In 1958, B.P. Thomson, assisted by A.R. Crawford, remapped and subdivided the Kanmantoo Group on this military sheet. Valuable field assistance was given by students of the University of Adelaide: D. Taylor, K. Mills and F.B. Pontifex.

reference?

Palaeontological age determination was done by N.H. Ludbrook, Senior Palaeontologist, Geological Survey. Later petrological work was done at Parkside Laboratories by H.W. Fander in 1958. Mapping was carried out on Adastra vertical air photographs, at a scale of 4" to 1 mile. For publication, the sheet has been drawn by W. Rossini of the Map Preparation Section, Geological Survey, using a military base map at an approximate scale of 40 chains to the inch.

PART I. LOWER PALAEOZOIC AND PRECAMBRIAN

ARCHAEAN

Archaean rocks outcrop in the core of a regional anticlinorium and form an irregular strip, averaging 2 miles in width, and oriented northeast-southwest, passing through Mt. Compass.

They consist essentially of metasediments, including felspathised quartzites, generally with epidote. The latter are useful marker beds in the Archaean metasediments. Relict cross bedding has been observed in epidote quartzite 2 miles west of Spring Mount. These epidote quartzites are comparable in genesis, possibly also in broad stratigraphical position, with the Houghton "epidiorite" of the Archaean in the Adelaide Ranges as described by Spry (1951).

Locally, in the synclinal areas, zones of sericite schists occur which are interpreted as due to retrograde metamorphism through stress from the original gneisses.

PROTEROZOIC (ADELAIDE SYSTEM)

TORRENSIAN SERIES

These beds rest, with angular unconformity, on the crystalline basement and often commence with a basal conglomerate. They are particularly well exposed near Fernbrook. The basal psephitic beds are felspathic, heavy mineral banded and cross-bedded. Recent mapping for the Barker 4 mile Military sheet suggests that they are, broadly, the equivalent of the Stonyfell Quartzite (Horwitz 1961). Thus, the overlying slates, below the

Sturtian Series, are all assigned to the Upper Phyllites and Beaumont dolomites of Mawson and Sprigg (1950).

The bulk of the beds are laminated phyllitic slates. Sandy units often occur, they are locally pebbly and felspathic. On the western side of the ranges, occasional greywacke lenses and actinolitic bands are present.

The Torrensian beds vary in thickness from 3000 to 4500 feet. The thickest sections are in the Hope Forest region, the thinnest are in the Mt. Magnificent region.

STURTIAN SERIES

The overlying Sturtian Series is composed of interbedded phyllites and quartzites with tillite at the base, and laminated phyllitic slates at the top. The base of this series is placed at the lowest member of a group of quartzites, thus adopting and continuing the boundary established on the Echunga Sheet to the north. The quartzites and interbedded phyllites are part of the complex lower glacial sequence as defined by Campana and Wilson (1955).

There are usually three bands of quartzite, but locally ~~,~~ the number increases. They are lenticular, vary in thickness from 5 to 30 feet and vary in composition from fine grained quartzite to coarse grained arkose. Locally, they are psephitic, the pebbles being often distributed in pockets.

The interbedded phyllites are similar to those in the underlying Torrensian but there is a higher proportion of siltstone laminae in the Sturtian beds.

Tillite occurs usually on top of these beds. In one spot, near Cragellen, tillite has been noted also at the base.

This whole unit of the lower part of the Sturtian Series varies in thickness from 1000 to 3000 feet in thickness.

The upper part of the series is composed of laminated phyllitic slates and siltstones. In places, the lower members are dark slates with traces of oxidised pyrite. These beds are part of the interglacial sequence and are correlated with the Tapley Hill Slates. At the top, a limestone usually occurs. It is correlated with the Brighton Limestone.

The Tapley Hill Slates equivalents are constant in facies and in thickness (2000 feet). A very slight increase in metamorphism occurs in the Ashbourne region.

MARINOAN SERIES

This series overlies the Tapley Hill Slates equivalents and has been subdivided into a lower group, composed of glacial sediments, and an upper group of post glacial beds.

The lower group varies in facies and in thickness from east to west across the Archaean anticlinal cores.

this is confusing

The beds reach a maximum thickness (2000 feet) on the western side, where they are grey-green and brown in colour and where the lowest units are still fine grained. The upper glacials are here defined by coarse grained material and appear only a few hundred feet above the base of the Marinoan. They are arkosic grits in pockets, lenses, and as scattered grains in a siltstone matrix. The grouping of these beds as glacials is based on their similarity in facies to beds of the same stratigraphic position in other regions which pass to tillite. (Webb and Horwitz 1959).

On the eastern side of the anticlinal cores, near Ashbourne, the beds are psephitic from the base of the Marinoan upwards, with tongues of grit and greywacke interbedded with marmorised beds which are recurrences of carbonate bands similar to the Brighton Limestone equivalent in this region. The beds of this lower group are grey in colour. Grits are well exposed in a cutting in the bow of the road approximately 2 miles just east of north from Ashbourne.

The upper group of the Marinoan Series has a uniform thickness of the order of 1000 feet. On the western side, the beds are brown siltstones and quartzites. At the top there is a thin and persistent band of finely laminated purple shale. The quartzites and siltstones interfinger extensively and the whole sequence suggests sedimentation in a paralic environment. Ripple marking~~s~~ is a characteristic feature of these beds.

On the eastern side, near Ashbourne, the succession is less differentiated, consisting of grey phyllites and phyllitic siltstones with ripple marks and only minor quartzite lenses. The beds here contain pyrite crystals scattered in the sequence.

LOWER PALAEOZOIC

CAMBRIAN STRATIGRAPHY

The Cambrian sediments can be conveniently considered as belonging to two main subdivisions located respectively east and west of the Archaean anticlinal cores.

1) The Cambrian on the Western Side of the Archaean Cores

This sequence contains, at its base, an arkose which is coarse grained at its lower contact. This contact has been proven to pass to an angular unconformity further south (Thomson and Horwitz 1961). The arkose is succeeded, with a gradual passage, by ~~to~~ siltstones and sandy silts with flaggy carbonate beds. These beds can locally be more or less carbonate rich, depending on original composition, complicated by more recent surface decalcification. They are approximately 500 feet thick.

They are overlain by an Archaeocyatha limestone consisting of approximately 100 feet of massive, grey limestone which is, in turn, overlain by banded and nodular shales with phosphate nodules in bands. These are the youngest Cambrian beds on this side of the ranges on the Milang Sheet.

2) The Cambrian on the Eastern Side of the Archaean Cores

Rocks assigned to the Lower Cambrian rest unconformably upon the eroded Adelaide System on the eastern side of the sheet. Sprigg and Campana (1953) proposed the name "Kanmantoo Group" for ~~to~~ a part of this sequence characterised by a greywacke facies. and this definition was used by Horwitz, Thomson and Webb (1959) Horwitz (1960) applied this name to all the Cambrian sequence on the east ~~this~~ side of the Archaean cores, because analogous greywacke facies occur throughout. However the original definition ~~has been used by Horwitz, Thomson and Webb (1959) and it will be used~~ as used in these notes. Thus here, the Cambrian is divided into lower basal beds and the overlying Kanmantoo Group deposits.

A) The basal beds.

These ~~They~~ are composed of greywacke-quartzites with dark phyllitic slates which ~~that~~ contain phosphate and limonite near Mt. Magnificent and pyrite near Ashbourne, with locally, marble at the base. These beds have not been recognised everywhere at the base of the Cambrian on this side of the ranges. In the Mt. Magnificent region they interfinger with a predominantly greywacke-phyllite assemblage, that itself locally rests directly on the Adelaide System. However, evidence in the Truro area (Coats and Thomson 1959) suggests that local unconformities can also sometimes account for the absence of this facies at the base of the Cambrian.

A section of the basal Cambrian is well exposed along the Finniss River, and is here 300 feet thick.

The basal arkose, recognised on the western side of the Ranges, does not exist as such, but one mile south of Wood Cone, the base of the Cambrian is represented by a grey argillaceous and felspathic quartzite.

B) The Kanmantoo Group

These sediments, overlying the basal beds, are subdivided as follows -

Greywacke and phyllites occur at the base. They are variable in thickness. In the Mt. Magnificent region, they exceed 2000 feet. In this latter locality, a marble lens appears interstratified in the greywacke.

A predominantly coarse grained, impure arkose which has been described by Forbes (1957) as the Inman Hill Formation, forms the next unit. Local lenses of greywacke occur interstratified in the arkose, and conglomerates are present towards its top. Cross-bedding is frequent. The lower boundary of the arkose unit is not well defined, because it interfingers extensively with the underlying greywacke.

This formation is very variable in thickness, being 2000 feet thick north of Ashbourne, and thickening to 14,500 feet in the Mt. Magnificent section; this thickening is associated with a subsidence fault that follows McKay Creek, where the formation abuts against the Adelaide System basement. Towards the south, the formation thickens still further to reach 18,000 feet in the Spring Mount - Peeralilla Hill section. These drastic thickness variations are a reflection of a much more rapid zone of subsidence towards the ~~southeast~~.

The upper contact is generally well defined, the overlying units consisting of greywacke and phyllitic shales. The latter often bear pyrite, The lower bands being in the approximate the stratigraphic position of the Nairne Pyrite horizon. The greywacke and phyllites average 7000 ft. in thickness.

Overlying these beds is a sequence of massive greywacke members alternating with minor slatey bands which represents part of the Brownhill Creek beds of Forbes (op. cit.) A band of phyllites occurs in these beds. Overlying are greywacke with calc-silicate members that are exposed in the McFarlane Hill region. These beds show evidence of increasing metamorphism.

The thickness of all beds above the interbedded phyllites and greywacke with lenticular pyrite is of the order of 2000 feet in the Currency Creek region.

STRUCTURE

The main folding took place during the Lower Palaeozoic. Fold axes are generally oriented north-south and are arranged in a right-handed "en echelon" pattern within the regional northeast-southwest alignment of the ranges. However, at the junction with the Echunga sheet, a left handed pattern occurs. It can be seen in the folding of the western side of the Archaean-Proterozoic contact, just below the northern boundary of the sheet. This reverse coincides with a region where the Cambrian is thin.

In the Archaean synclinal areas, between major anticlinal cores, an intense ~~shearing~~ shear zone occurs. 1½ miles northeast of Mt. Compass, such a zone is developed and is injected by basic rocks.

In the north, the pitches of the major Archaean anticlinal cores at the contact with the Proterozoic/ are vertical to overturned. Towards the south, on the other limb, they are normal and of the order of 60°.

The major folds observed at the Archaean - Adelaide System contact decrease rapidly in intensity in the overlying Adelaide System and Cambrian beds on the western side of the Archaean anticlinal cores, so that in the upper part of the stratigraphic succession, the structure is simply that of the western limb of the regional anticlinorium.

East of the Archaean cores, the fold pattern of Archaean - Adelaide System contact is repeated in the Cambrian. Regional pitches are mainly towards the south. Five miles north of Mt. Observation, the upper part of the Adelaide System is tightly folded. Still further north, the lower beds of the Adelaide System are affected by tight imbrication.

PART II. UPPER PALAEOZOIC AND CAINOZOIC

PERMIAN

The Permian deposits are exposed only in the ranges. They consist of isolated elements, sands and silts with boulders in beds as well as scattered. They are glacigenes, infilling three broad glacial valleys and their subsidiaries. The infilling material is poorly lithified so that erosion in post Permian times has rejuvenated a glacial topography (Campana and Wilson 1955). Depending on successive heights of base levels, the broad glacial valleys have been foci of erosion or of local accumulation, and younger reworked sandy material is sometimes hard to separate from the original Permian glacigenes.

The valleys bifurcate and join again, (all three join eventually on the adjoining sheets towards the west) and have smaller affluents. In a broad sense the present day rivers are occupying the old Permian valleys. The three main glacial valleys have been referred to (Horwitz 1960, op. cit.) as the Finniss River, the Upper Hindmarsh and the Inman glacial valleys. All three differ in their erratic assemblages.

The Finniss River glacial valley includes the areas drained by the Finniss River and the Tookayerta Creek, as well as areas draining north and west, west of Mt. Compass. It contains, in addition to locally derived Adelaide System and Cambrian rocks, erratics of pink and white quartz-felspar and quartz porphyries as well as porphyritic granite. Erratics rarely exceed one foot in length. Similar assemblages occur in the pre-Permian granite bosses in the Murray Basin to the southeast. (Fander 1958*).

Gravels, sands and silts predominate over glacial till in this valley; they are well exposed in the meanders of the Finniss River east of Mt. Observation. Till is exposed in a cutting on the road from Ashbourne to Strathalbyn.

The Upper Hindmarsh glacial valley includes the area drained by the Hindmarsh River upstream from the falls. This glacier is presumed to have joined that of the Finniss to the west near Myponga (Yankalilla sheet). Exposures are poor, erratics are small and have been extensively reworked in post-Permian times. The observed erratics are all of local origin.

* Verbal communication.

The Inman glacial valley is partly on the southern part of the sheet and extends further south. Its northern edge forms the very conspicuous scarp of Peeralilla Hill, Tower of Babel and Inman Hill. Active dissection and an absence of younger deposits makes this an ideal region for the study of the Permian. Erratics of Victor Harbour granite (Encounter sheet), sometimes several yards in diameter, are abundant. The material is richer in till and clay beds than that of the exposures in the other two glacial valleys.

A glacial floor occurs in the bed of the Inman River in the extreme southwestern corner of the sheet. It was discovered by Selwyn in 1859 and is ~~. This was~~ the first record of glacials in Australia. Crawford (1960) gives a concise account of this discovery.

Howchin (1926) made the first and most complete study of the Permian glacials in this and the adjoining areas.

The source provenance of the erratics together with the striae on glacial floors, has led previous authors to the conclusion that the many direction of glacier movement ~~major flow~~ was from south of east to north of west. This direction and that of the regional tectonic trend in the basement (west of south to east of north) gives two directions that predominate in Permian-basement contacts.

CAINOZOIC

TERTIARY

No Mesozoic sediments have yet been recognised in the area covered by the Milang sheet.

The Tertiary sediments occur in four different settings as follows:- 1) The Murray Basin sediments; 2) The Tertiary sediments in the Upper Hindmarsh and Myponga Permian depressions; 3) The subsurface deposits of the Willunga Basin; and 4) The continental deposits of the high plateau and the Permian troughs in the ranges.

1. Murray Basin sediments.

In the Strathalbyn area transgressive Oligocene-Miocene limestones and sandstones are exposed at several places overlapping Kanmantoo bedrock. These are mostly littoral or shallow water sediments with numerous sharks' teeth and a sparse foraminiferal fauna including *Sherbornina atkinsoni*. These are synchronous with the lower part of the Mannum Formation. (Ludbrook, 1957)

At the base, the beds are conglomeratic and contain glazed pebbles and limonite pisolites. Recent headwater stripping of the beds reveals a smooth pre-Oligocene-Miocene surface marked by abundant glazed pebbles and iron pisolites shed from the conglomerate. On the published Milang Sheet these surfaces have been mapped in the same unit as the basal conglomerate of the limestone

I do not understand the meaning of [illegible]

2. Tertiary sediments in the Upper Hindmarsh Glacial Valley.

These are predominantly mottled sands, with marine limestone bands. . . . .

. . . . A sample from a bore 204 feet depth on Section 38, Hundred of Encounter Bay, County Hindmarsh, ~~se~~ near Cloverdale, ~~contains~~ and 'limestone floaters' collected on Section 52, Hundred of Encounter Bay, contains *Operculina victoriensis*, *Amphistegina lessonii*, *Gypsina howchini* and *Calcarina verriculata*, a "Batesfordian" (Lower Miocene) assemblage (Ludbrook op. cit.)

1) The Murray Basin sediments

In the Strathalbyn area, fossiliferous flat lying limestone of Ludbrook (1957) considers etc Oligocene - Miocene age outcrops. "It is a transgressive element of the Oligo-Miocene .... deposition was littoral" (Ludbrook 1957). ~~At the base, the beds are conglomeratic and contain glazed pebbles and limonite pisolites.~~ Recent headward stripping of these beds reveals a smooth pre Oligo-Miocene surface marked by abundant glazed pebbles and iron pisolites shed from ~~the~~ a basal conglomerate of the limestone. On the published sheet the surfaces have been mapped in the same unit as the basal conglomerate of the limestone. Surfaces with abundant elements similar to these of the basal conglomerate occur sporadically elsewhere on the sheet; the elements being older than the Oligo-Miocene, these surfaces are tentatively assigned to the pre-Tertiary surface of erosion.

this is not clear

One mile roughly southeast of Strathalbyn, unlithified sands with abundant sharks teeth are exposed in the road cutting. They are also assigned to the Oligo-Miocene.

2) The Tertiary sediments in the Upper Hindmarsh Glacial Valley

These are predominantly mottled sands, with marine limestone bands. They outcrop one mile southwest of Mt. Jagged and near the falls of the River Hindmarsh, where borehole information shows they are associated with lignitiferous beds. A sample from one bore at 204 feet in depth (Section 38, Hd. Encounter Bay, County Hindmarsh) very near Cloverdale, contains "*Amphistegina lessonii*, *Operculina victoriensis*, *Gypsina howchini* and *Calcarina verriculata*, a Batesfordian (Lower Miocene) assemblage". (Ludbrook op. cit.). By extrapolation (fig. II) this occurrencei is overlain by over 500 feet of brown ferruginous sands, cross bedded and mottled (brown ferruginous sands - Pliocene - on published sheet) which are capped by a crust of limonite cemented gravels. Upon this evidence, the latter are tentatively assigned to the Pliocene. The ferruginous sands that occur below the limonite cemented gravels are similar to those that appear in the Boundary Ridge region, which is already part of the Myponga plains (of Yankalilla sheet) where similar Tertiary limestones occur in depth. These are taken as evidence as previously recorded (Campana and

Wilson 1954) that Tertiary beds occupy rejuvenated glacial valleys in this area.

3) Subsurface Deposits of the Willunga Basin

Tertiary sediments are known to occur at depth beneath Quaternary deposits in the extreme northwestern portion of the sheet.

The sediments consist essentially of a paralic succession of sands and silts, with carbonaceous intercalations, varying in age from Eocene to Lower Miocene, overlain by unfossiliferous sands and silts of Pliocene to Pleistocene age. (Glaessner and Woodard; Ludbrook, in Cochrane 1956). A bore two miles northwest of Willunga penetrated these beds to a depth of 680 feet without reaching bedrock.

itised

4) The Laterised Surface of the High Plateau and the Limonite Cemented Gravels in the Permian Troughs.

Viewed from the north, the plateau like concordance of summits of the Willunga scarp is striking. Cappings of this elevated area are composed of ferruginous deposits and underlying oxidised bedrock of lateritic origin. The ferruginous material contains quartz fragments from the immediately underlying basement. Locally, gravels cemented by limonite are present. The ferruginous cappings are lower where developed over old Permian valleys. (Fig. I). In such lower areas, the ferruginous deposits are thicker and, where dissected, locally form a double bench of the order of 15 feet of bedded deposits of limonite cemented gravels and laminated limonitic sands. A specimen from two miles west of Tooperang shows shrinkage cracks. These limonite cemented gravels are continuous from the high plateau to the limonite cemented gravels in the Upper Hindmarsh glacial valley that overlie the Tertiary sediments and are thus assigned to the same age (Pliocene).

The lateritic cappings and their extensions downwards towards lower lying areas form strong physiographic features. Systematic mapping on the ground was combined with selected photo interpretation of such features to delimit the distribution of this formation. Local cappings of strongly silicified sands in the Myponga region seemed to coincide in height with the ferruginised level on adjoining hills.

STRUCTURE

The Pliocene ferruginous cappings are the youngest rocks to be significantly affected by structures that also broadly define the Tertiary basins. Thus, the tectonic is dated as Cainozoic.

The Willunga Fault

This fault limits the ranges against the plains in the northwestern corner of the sheet. It forms a prominent scarp which has partly receded by erosion. North of Willunga, the fault trends north-northeast. South of this township, its trend changes to northeast. A later period of rejuvenation of the southern segment is suggested by a small scarp at the end of the basement outcrops which still exhibits facets.

The total throw of the fault is estimated as being of the order of 2000 feet. Evidence from the general region (Glaessner and Wade, Webb, in Glaessner and Parkin 1958) suggests that movement along the fault commenced in earliest Tertiary, with a maximum in late Tertiary to Pleistocene times.

The outcrop trace of the southern fault segment is very straight, indicating that the fault plane is probably steep. It is assumed that it is a normal fault rather than a steep upthrust.

In the ranges, the ferruginous cappings all tilt away from the fault, thus having ~~weak~~ gentle dips to the east and southeast on the upthrown block. This attitude persists eastwards up to the Hope Forest region, in the north of the sheet, and up to the Tower of Babel region in the southern part of the area investigated.

Myponga plains fault line

A scarp that limits the Myponga plains (Yankalilla sheet) to the northwest is tentatively assigned to a fault or a fault line. Its trace is strikingly linear along the Honeysuckle Flat road. and Its effect on the distribution of Permian suggests that it is either a pre-Permian feature, controlling the ~~flow~~ orientation of the glacial valley, or a younger fault.

McFarlane Hill area

The McFarlane Hill - Wright ridge is interpreted as a horst feature bounded by faults. Along the western flank of the ridge the Permian terminates abruptly and the lateritised surface is offset. On the eastern side, the basement ridge is bounded by low plains underlain by Tertiary sediments of the Murray Basin. A fault or fault line is postulated because of the scarp, the Tertiary distribution and the linear trace of the basement edge.

Wood Cone region

In the Wood Cone - Mt. Jagged region, as well as two miles northwest of these hills, the Pliocene overlying the contact of basement with Permian locally has very steep dips towards the northeast. Near Marydale, the Permian shows evidence of small movement. If those features are tectonic, it implies a warp or fault directed northwest-southeast and situated at the junction of the Permian and the basement north of Wood Cone.

QUATERNARY

The subdivision of the Quaternary into Pleistocene (?) and Recent is based on the recognition of an older and younger cycle of erosion. The deposits of the younger cycle are still being formed and therefore assigned to the Recent. The older unit is tentatively assigned to the Pleistocene by analogy with similar deposits elsewhere in the region.

Pleistocene (?)

These deposits ~~thus~~ belong to an older cycle of erosion. They are locally well cemented by kunkar.

The High level deposits:

These are the oldest of the Quaternary subdivisions in this region. They form remnants, usually above present day base level, topped by a well defined surface. In section, they are composed of gravels and silts, fluviatile beds and slope deposits.

The surface ~~at the top~~ is recognisable in both ~~areas of~~ plains ~~that~~ border the ranges and can be followed within the ranges along the Permian valleys. Everywhere, the surface dips gently away from the ranges. It intersects base level in the Lake Alexandrina region.

Dunes fixed by Kunkar:

The dunes rest on the previously described surface. They are aligned west northwest and fringe the ranges on the southeastern side. Where the limit of the ranges is interrupted by broad valleys (Tookayerta Creek), the dunes extend further northeasterly into the ranges, suggesting that the controlling wind regime was parallel to them. They are thus longitudinal dunes.

In the southeastern corner of the sheet, where the surface on which they rest passes below base level, the interdunal depressions are occupied by small salt pans.

Recent

Alluvial flats have been separated from sloping deposits on the published map by an oriented flow line symbol. Both these units locally form terraces (that are however younger than the Pleistocene ? high level).

In the ranges, sands from weathered Permian and Tertiary deposits have been reworked by aeolian action. In the plains on the southeast side of the ranges, Pleistocene(?) sands are considerably reworked.

GEOLOGICAL HISTORY - SUMMARY

Little is known of the Archaean in this region. Rock types include definite metasedimentary units.

The Archaean was folded and metamorphosed prior to the Adelaide System (Upper Proterozoic) sedimentation.

The Adelaide System sediments transgressed onto the crystalline basement. The lowermost beds of this system are absent in this region where the first sediments to occur are broadly equivalent to the Stonyfell Quartzite of the type area. These first sediments are believed to be equivalent to tillitic beds that occur in the northern part of the State.

The Cambrian is transgressive in the east and south side of the ranges on this sheet, where it is also thicker. This stronger subsidence was accompanied ~~with~~ by one recorded subsidence fault.

The Cambrian and preceding units were severely deformed resulting in accompanying cross folding, or en echelon arrangements of structures. A left hand pattern appears in the most northerly area, elsewhere, a right hand pattern dominates. The shearing related to this orogeny locally reverted the Archaean gneisses to schists.

There is no geological record in between this orogeny (lower Palaeozoic) and the Permian deposits.

The Permian sediments are glacigenes, infilling broad glacial valleys. The direction of ice movement was from east to west. The glacial material is sometimes considerably reworked.

The glacial valleys have had a strong control over topography since Permian times.

The Lower Miocene is transgressive onto the margins of the present day ranges. It invades Permian glacial valleys.

A lateritised surface and associated ferruginous grit is assigned to the Pliocene. This follows a peneplaned surface that warps downwards over Permian troughs. This surface is the last Tertiary unit to be greatly effected by Cainozoic Tectonic. This and the Permian troughs have controlled the morphology of the whole of the late Tertiary and Quaternary.

The thickest Quaternary deposits ~~are~~ mainly ~~thick in~~ occur in the plains. They dip Gently ~~mildly~~ away from the ranges. A posthumous ~~movement of the~~ late Tertiary movement ~~structures~~ might be partly responsible for this ~~disposition.~~ distribution.

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21st November, 1961.

<u>REFERENCES</u>

CAMPANA, B. and WILSON, B. 1954. The Geology of the Jervis and Yankalilla Military Sheets.
Geol. Surv. of S. Aust., Rept. of Invest. 3, pp. 1-26.

CAMPANA, B. and WILSON, B. 1955. Tillites and Related Glacial Topography of South Australia.
Ecl. Geol. Helv., 48, 1, pp. 1-30.

COATS, R.P. and THOMSON, B.P. 1959. Geological Atlas of South Australia, Sheet Truro.
Geol. Surv. of S. Aust.

COCHRANE, G.W. 1956. The Geology and Hydrology of the Willunga Basin.
Geol. Surv. of S. Aust., Rept. of Invest. 8, pp. 1-18.

CRAWFORD, A.R. ~~1956.~~ 1960 Selwyn's Rock.
Geol. Survey, unpublished report No. 50/153.

FORBES, B.G. 1957. Stratigraphic Succession East of Grey Spur, South Australia.
Trans. Royal Soc. of S. Aust. 80, pp. 59-66.

GLAESSNER, M.F. and PARKIN, L.W. ed. 1958. The Geology of South Australia.
Journ. Geol. Soc. Aust. 5, 2.

HORWITZ, R.C. 1960. Geologie de la region de Mt. Compass.
Ecl. Geol. Helv., 53, 1, pp. 211-263.

HORWITZ, R.C. 1961. ~~Notes on~~ The Lower Boundary of the Sturtian Series of the Adelaide System.
Aust. Journ. of Science. 23, 11. p.377.

HORWITZ, R.C., THOMSON, B.P. and WEBB, B.P. 1959. The Cambrian - Precambrian Boundary in the Eastern Mt. Lofty Ranges Region, South Australia.
Trans. Royal Soc. of S. Aust. 82, pp. 205-218.

REFERENCES (Contd.)

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: pp. 89-119.

LUDBROOK, N.H. ~~N. H.~~ 1957. Palaeontological Notes, Milang Military Sheet.
Geol. Survey, unpublished report ~~No. 44/20.~~ Pal. Ref. 7/57. GS 719.

MAWSON, D. and SPRIGG, R.C. 1950. Subdivision of the Adelaide System.
Aust. Journ. of Science, 13, 3, pp. 69-72.

SPRIGG, R.C. and CAMPANA, B. 1953. The Age and Facies of the Kanmantoo Group.
Aust. Journ. of Science, 16, 1, pp. 12-14.

SPRY, A.H. 1951. The Archaean Complex at Houghton, South Australia.
Trans. Roy. Soc. S. Aust., 74, 1, pp. 115-134.

WEBB, B.P. and HORWITZ, R.C. 1959. Notes on the Boundaries of the Marinoan Series of the Adelaide System.
Aust. Journ. of Sci. 21, 6, p. 188.

APPENDIX

HYDROLOGICAL NOTES

by

C. Bleys

Geologist

HYDROLOGY

The groundwater quality and the volume of water likely to be available from drilling are largely controlled by the rock type. Broadly speaking, there are five main categories.

1) Recent-Tertiary

Waterbearing beds of Recent to Tertiary age occur in three areas, of which the largest is the Strathalbyn - Milang - Goolwa region. In these beds, laid down in a saline water environment, the groundwater was originally salty, and any improvement in quality is the result of local intake, either from stream flow or by direct downward percolation.

Along the peninsula extending southeast from Sandergrove and lying between the Finniss River and Lake Alexandrina, intake has been more restricted than elsewhere, and the water along the centre line of the peninsula varies in salinity from being poor stock water to quite unusable. On each side of this poor water zone the salinity improves, but except in the extreme northeast is still suitable only for stock. Along the lower reaches of the Angas River, irrigation quality water is available.

The northwest corner of the Milang Sheet includes part of the Willunga Basin, where quite large irrigation supplies are often available at depths of less than 300 feet. However, the water bearing horizon is usually a rather marly and fine sand, which presents~~s~~ difficulties when the supply is being developed.

The third area is a restricted occurrence in a valley forming the headwaters of the Hindmarsh River, upstream of Hindmarsh Tiers. This valley was filled with fluvioglacial clays and sands during Permian times, and intruded by the Tertiary sea, which rewashed the sands and also deposited a core of bryozoal marly sand along the valley centre. Irrigation supplies are available from this bryozoal marly sand.

2) Permian

Throughout the central and western areas, nearly all of the lower valleys have been infilled with Permian fluvioglacial clays, sands and sandy clays varying in thickness to as much as several hundred feet. Originally deposited in a saline environment, the beds now yield water, the salinity of which reflects the local intake from a fairly high rainfall and rarely has a salinity exceeding 200 grains per gallon. Usually it is of better quality, but because the sands are in the main rather clayey, bores cannot be expected to obtain more than stock or domestic supplies. Along the valley floors a well is often a better proposition than a bore.

3) - Cambrian

These rocks underlie a broad zone crossing the area from northeast to southwest. They are possibly the least suitable local source rocks ~~one of the worst of the locally known rocks as far as being a source rock for us~~able water, as the whole suite apparently contain ~~has~~ minerals which tend to ~~rather~~ readily decompose in contact with the groundwater, and yield salts into solution. Except in very exceptional conditions, where bores are sited along valleys where local intake is high, the water available from these rocks is of poor stock quality only. Drilling conditions are also generally unfavourable because of the hardness of the rock in many areas.

An exception to this is the marble which occurs as isolated thin bands in a very few places on the eastern side of the Archaean cores and the limestone bands of the western side of the Archaean cores. These can be regarded as good source rocks where intake conditions are favourable, but the occurrences are too limited to make them of general value.

4) Adelaide System

The slates and shales will usually yield water having a salinity of 300 grains per gallon or less, in this high rainfall area, and in sufficient supply for stock use, although bores should be sited in or as near as possible to the stream valleys.

The quartzites, if drilled close to where they are intersected by watercourses, will provide rather better quality water and may in favourable localities yield enough water for limited irrigation. Because of the topographic relief, such sites are not common.

The limestone bands can be regarded as good source rocks where intake conditions are favourable.

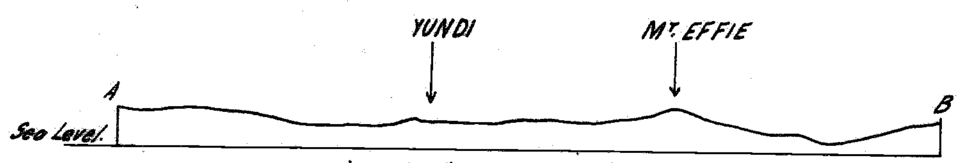
5) Archaean

Usually exposed as a highland "core", the Archaean rocks will usually contain stock quality water in poor supply. Drilling can be recommended only along the gully lines where the elevation is not unreasonably great, and intake from surface sources is at a maximum.

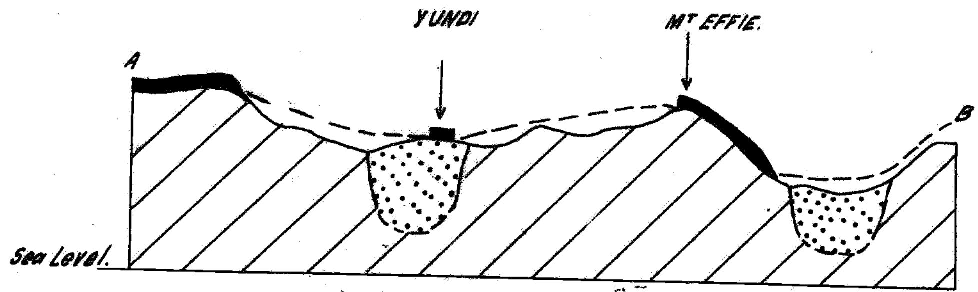
GENERAL

Over most of the central and western two-thirds of the sheet, hydrological conditions can vary ~~sharply~~ rapidly within short distances. Drilling should never be undertaken on the high hill masses, but confined to the valleys and lower slopes.

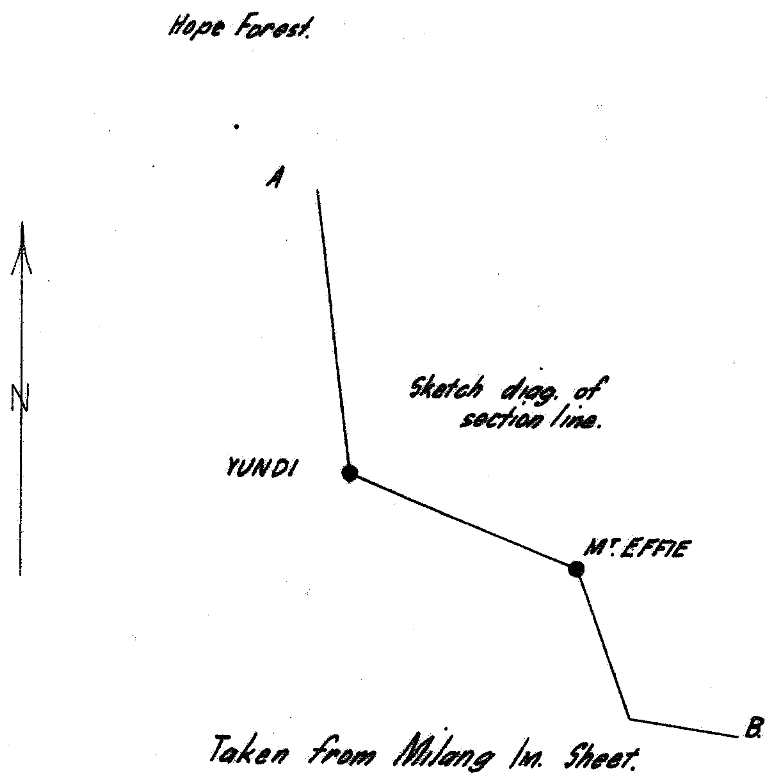
FIG. 1



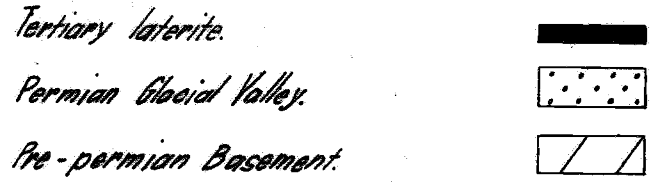
Vertical Scale = Horizontal Scale 1" to 1 mile.



Vertical Scale exaggerated 4 times



Taken from Milang 1m. Sheet.



To accompany report by R.Horwitz.

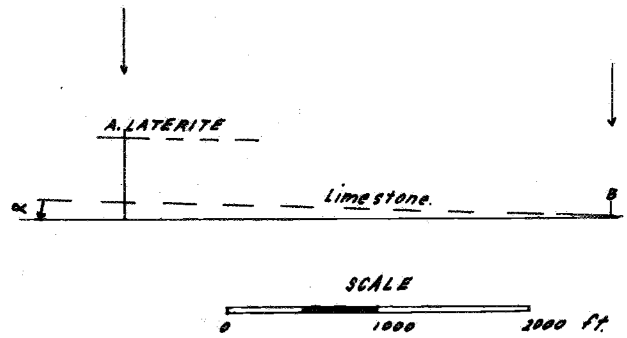
S.A. DEPARTMENT OF MINES

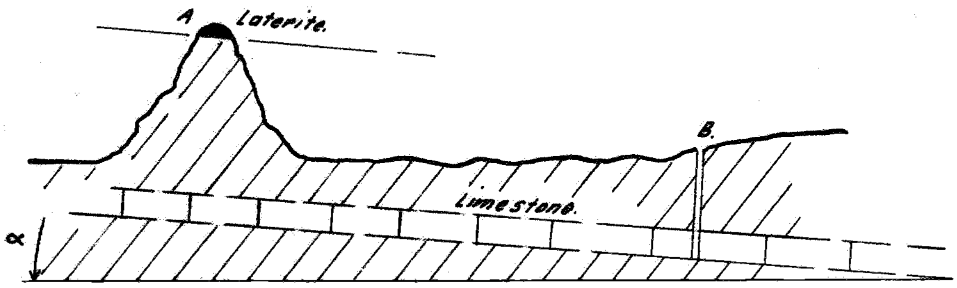
Approved	Passed	Drn.	Sections in the Yundi region, showing that Tertiary laterite surfaces are lower where developed on Permian glacial valleys	D.M.	Scale 1" to 1 mile
		Tcd. G.K.W.		Req.	S2772
		Ckd. R.R.			Hc4.
Director		Exd.			Date 2-5-61

200 — 6.60 7701

FIG. 2

DRAWN TO SCALE.





SKETCH DIAGRAM.

A ÷ Position of laterite capped hill.

B ÷ Position of bore, near Cloverdale.

α ÷ Regional tilt of $1\frac{1}{2}^{\circ}$ towards the east
measured on laterite surface of adjoining area to the south.

To accompany report by R. Horwitz.

S.A. DEPARTMENT OF MINES

Approved	Passed	Drn.	Tertiary Laterite-Limestone relationship diagram. Section E-W through Cloverdale. Upper Hindmarsh Valley.	D.M.	Scale APPROX 1150' to 1"
		Tcd. G.K.W.		Req.	S 2774
		Ckd. R.R.			Hc 4.
Director		Exd.			Date 3-5-61.

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