



DEPARTMENT OF MINES
SOUTH AUSTRALIA
GEOLOGICAL SURVEY

**THE HYDROLOGY OF PORTION OF
THE GREAT ARTESIAN BASIN
NEAR THE PEAKE AND DENISON RANGES**

by

R. I. CHUGG, Geological Assistant

REPORT OF INVESTIGATIONS No. 10

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The Hon. Sir A. Lyell McEwin, K.B.E., M.L.C., Minister of Mines*

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The Underground Water of the South-Eastern Part of South Australia (with maps). 28th December, 1940. Price 5s.

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GEOLOGICAL SURVEY OF SOUTH AUSTRALIA

Report of Investigations No.10

**THE HYDROLOGY OF THE GREAT ARTESIAN BASIN NEAR THE
PEAKE AND DENISON RANGES**

By

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Senior Geologist**

and

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Geological Assistant**

Letter of Transmittal

Geological Survey Office,
Department of Mines,
Adelaide, 21st August, 1956

Sir,

I have the honour to submit herewith a report by R.I. Chugg, Geological Assistant, on the Hydrology of the Great Artesian Basin near the Peake and Denison Ranges. The report has been jointly prepared for publication by E.P. O'Driscoll, Senior Geologist, Hydrology, and R.I. Chugg.

The hydrological survey was carried out concurrently with the geological mapping of the Peake and Denison region in 1953. While the geological work was concerned primarily with the bedrock outcrops, the hydrological survey was extended far out over the sedimentary basin rocks surrounding the ranges. All known water points were visited and sampled, a number of the samples being analysed in detail. The hydrological conditions were deduced from evidence of surface mapping; from bore records; from geophysical data; and from past reports covering the area.

The Great Artesian Basin has been the subject of intense study by a number of eminent geologists. The present report will serve to bring up-to-date previously published hydrological data; to present the geological facts in the light of the more recent investigation; and to provide a hydrological map for the use of pastoralists.

In this large region, sadly deficient in rainfall and surface water supplies, it is felt that the present report will serve a very useful purpose in assisting pastoralists and others to make the best use of the hydrological resources available.

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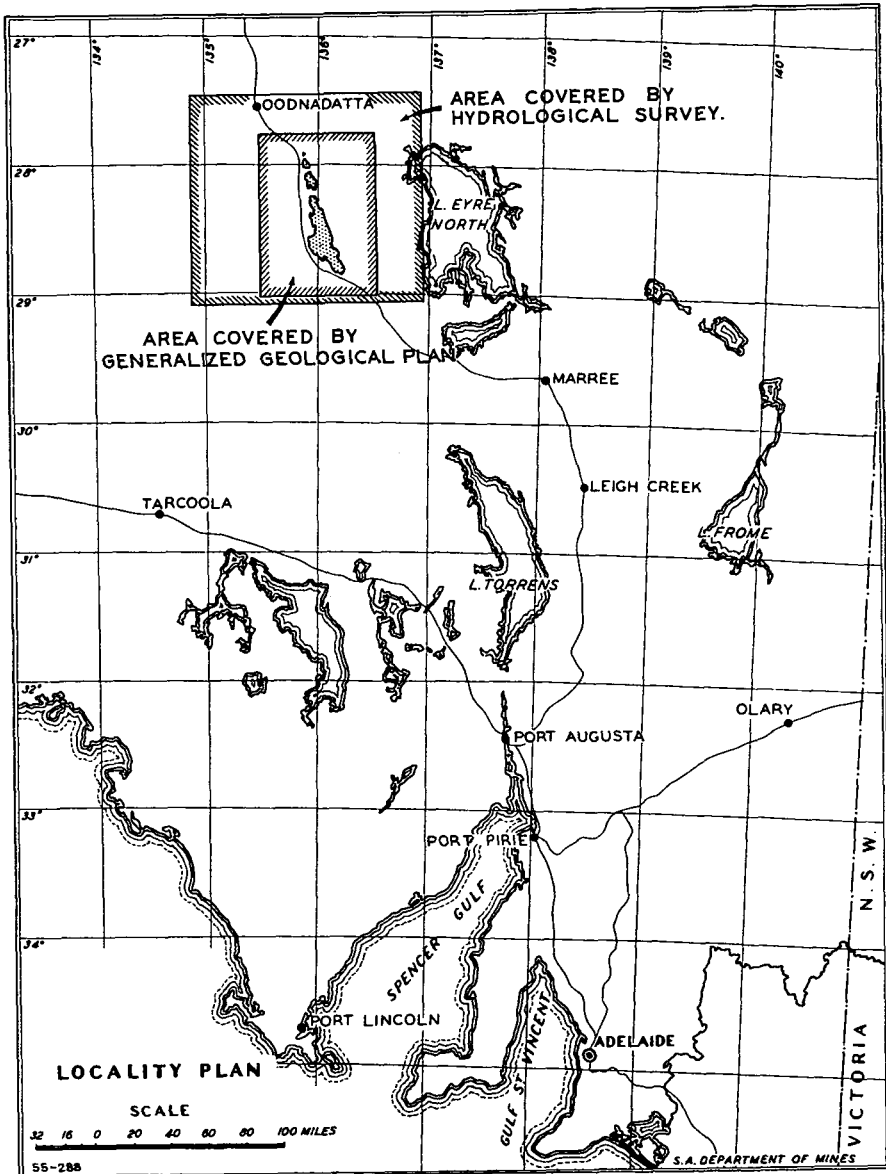
S. B. DICKINSON
Government Geologist

TO THE HON. SIR A. LYELL McEWIN, K.B.E., M.L.C., MINISTER OF MINES

Submitted for approval to print as a Report of Investigation of the Geological Survey.

Approved.

A. LYELL McEWIN
Minister of Mines



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Abstract

This hydrological investigation was done in conjunction with the geological survey of the Peake and Denison Region, covering the Military Sheets of Algebuckina, Nilpinna, Conway, Umbum, Boorthanna, Cadlarena, Anna and Delray.

The generally flat Mesozoic sediments forming the southwest portion of the Great Artesian Basin are interrupted by the Precambrian rock mass of the Mount Margaret - Mount Dutton Ranges, which impede the easterly surface drainage towards Lake Eyre, resulting in the swamp area of Lake Conway.

Rainfall is low, and only sparse vegetation grows on the sand ridges, clay pans, gibber plains and sandstone mesas.

Basin sediments observed are lower marine Cretaceous shales with fossiliferous thin limestones and underlying sandstone of probable Jurassic age resting unconformably on Precambrian rock. A silicified zone such as occurs at Mount Harvey as a resistant capping or "duricrust" is not considered to be a stratigraphical unit except in that it defines a zone developed during a period of peneplanation. Post Cretaceous beds were not recognised except as wind blown sands and river and flood plain alluvium.

The presence of a pre-(?)Jurassic sedimentary series west of the Mount Margaret Range, possibly resulting from glacial deepening in Permian time, becomes apparent from a consideration of the form of (?)Jurassic sandstone outcrops, gravity readings, bore log information and hydrological data.

The likelihood of glacial action is emphasized by the occurrence of tillite, lying unconformably on Precambrian rock on the western margin of the Mount Margaret Range, with any former overlying sedimentary deposits completely removed.

Good stock water is available from flowing bores and springs in the (?) Jurassic sandstone aquifer where the water is confined by overlying Cretaceous shales. Where the shales are absent, non-pressure waters are available in the sandstone.

The direction of movement of underground waters is complicated by the presence of the ranges, but consideration of hydraulic gradient and chemical similarities suggests that the waters move around the ranges toward the east from the north, west and southwest.

Introduction

From the 1st of May to the 14th October, 1953, a geological survey of the one mile military sheet areas of Algebuckina, Nilpinna, Neales, Conway, Umbum, Boorthanna, Cadlarena, Anna and Delray was made by the Fuel and Uranium Section of the Geological Survey of South Australia, covering approximately 4500 square miles and including the ranges of Mount Dutton, Algebuckina, Mount Kingston, Peake and Denison and Mount Margaret. Margined by faults and unconformities, these ancient Adelaide System rocks are inliers surrounded by Mesozoic sediments of the southwest portion of the Great Artesian Basin. Low rainfall, poor soil and sparse vegetation have limited the utilization of the land to stock, principally cattle grazing.

The general geology of the area has been recorded on standard one mile

scale maps with accompanying explanatory notes, and in addition, a geophysical report based on gravity meter traverses has been prepared. The substance of the present report will therefore be confined to hydrological matters, and such geological considerations as are incidental to a proper interpretation of the hydrology.

In the course of the survey all known data of hydrological interest were examined and 52 water samples taken for analysis, the information so gathered, together with the hydrological data already on file with the Department forming the basis of the report. Reference has also been made to Geological Survey Bulletins 5 and 14 by R. Lockhart Jack and Bulletin 23 by L. Keith Ward. (See References).

A number of aneroid reduced levels has been obtained, mostly in the course of geophysical traverses with W. H. Knapman, taking base barometric readings at twenty minute intervals. A few reduced levels were taken from Jack (1915).

Topography and Drainage

The Mount Dutton, Peake, Denison and Mount Margaret Ranges, with a maximum elevation of less than 1500 feet above the plain, follow roughly the north-west to southeast direction of the rail line from Mount Dutton siding to just south of the Anna Creek siding. In contrast to the gentle westward slope to Lake Conway and Weedina Creek at an elevation of approximately 250 feet above sea level, the ranges have a sharply defined eastern escarpment several hundred feet in height, below which the terrain declines from an elevation of about 230 feet in the vicinity of Spring Hill to some fifty feet below sea level at Lake Eyre.

The generally flat basin surface is broken by low mesas capped by resistant remnants of an older land surface, now reduced by peneplanation, while in the south west portion of the area low reddish sand ridges trending NW to SE are a prominent feature. Flat wind eroded clay pans generally occur between these ridges.

An outstanding surface feature of the area is the "gibber" covered flats and mesas. It has been suggested (R.L. Jack, 1915) that these stones represent broken and polished pieces of the old indurated duricrust, residually accumulated after uplift and consequent dessication of the underlying softer materials.

A "desert varnish" due to surface iron oxide staining and wind polishing gives a general similarity to the external appearance of the stones. Internally, however, they vary, being in places petrologically similar to underlying or nearby Precambrian or duricrustal rock of which they are clearly disintegration products.

The apparent widespread coverage of the former duricrust may explain in part the presence of gibbers even far from present outcrops. Such gibbers are predominantly siliceous in nature with some degree of surface iron staining but include various degrees of iron-silica ratios through jasper-like rocks to those predominantly ferruginous.

Apparently during peneplanation a lateritic effect with the leaching of solubles has been active in the soil with iron salts brought close to the surface in solution, deposited and later oxidized. This process is thought

to have resulted in an iron rich zone at the top, intermediate iron-silica mixtures, and a lower silica indurated zone enriched from downward working siliceous solutions. The silica rich zones give rise to the "porcellanites" as at Mount Harvey and other forms resembling "greybilly". The iron-silica zones or duricrust have been observed at Mount Harvey and again north of the area near Allendale homestead.

The range mass is intersected north of Algebuckina Hill and between Mount Kingston and Peake Hill by the eastward flowing Peake and Neales Rivers, the tributaries of which drain poorly the area west of the ranges, and after picking up some minor drainage streams from the eastern slopes, subsequently reach Lake Eyre. To the south, eastward drainage is effected by Umbum, Sunny and Douglas Creeks.

The general low relief and poor drainage conditions west of the ranges are highlighted by the occurrence of such shallow lakes as Cadibarrawirracanna, Conway, and Warrangarrana, which are possibly of aeolian origin, or may reflect a slight reverse tilting of a generally gradual easterly dipping slope with consequent ponding of surface flow, into which the surface runoff from a considerable area flows and is ultimately lost by evaporation.

Climate, Soils and Vegetation

The country has an arid climate and uncertain rainfall, as the Book of Normals No. 1 of the Commonwealth of Australia Meteorological Branch, containing monthly rainfall records for Oodnadatta and William Creek, shows. These stations bound the area to the north and south respectively and should be characteristic of that portion west of the ranges.

The following table shows rainfall in hundredths of inches, also the normal number of days of rainfall of 0.01 inches or more

Rainfall Records

Month	Oodnadatta		William Creek	
	Rainfall	Rain Days	Rainfall	Rain Days
Jan.	65	2	51	2
Feb.	59	2	59	2
March	31	2	25	2
April	20	1	25	1
May	27	2	33	2
June	53	2	53	3
July	17	1	19	2
August	22	1	28	2
Sept.	19	1	28	2
Oct.	57	2	54	3
Nov.	32	2	49	2
Dec.	42	2	75	2
Year	444	20	499	25

It will be apparent from this that quite apart from its meagreness (less than 5 inches per annum average at each locality) the rainfall is spread very uniformly over the whole year in a manner which may be expected to result in

maximum benefit to plant growth but a minimum of surface runoff and of downward percolation to the water table, except at favoured points. The ranges probably receive somewhat more rain because of their elevation but the flat land east of the ranges could be expected in consequence to be even drier.

Hot summers and high spring winds ensure high evaporation for some months of the year, but because of the sparse nature of the vegetative cover, transpiration losses are probably rather low.

The basin area may be divided into three characteristic types of differing soil and vegetative cover.

The gibber covered poorly drained flat plains provide very little vegetation, the gibbers being often closely packed with little soil apparent. Below this top layer the soil is fine and often gypseous, supporting a sparse growth of grasses, saltbush and other shrubs which provide some fodder for stock.

The low sand ridges found particularly in the Military Sheets of Conway, Boorthanna and Delray have little covering growth except close to the drainage lines, where some grasses and saltbush are found. The intervening clay pans are almost devoid of cover.

The (?)Jurassic sandstone exposures, frequently ferruginous on the surface, support a rather more abundant saltbush and grass cover and, in places of favourable drainage with better soil development and more soil water, shrubs, mulga and some acacias occur.

A fourth type of surface of lesser areal extent is represented by flat, marshy and often salt encrusted basins with small tussocks of wiry grasses.

On some of the well established creeks large eucalypts are found.

The ranges have a more varied and denser growth of grasses, acacias and some mallee, presumably the reflection of a slightly higher rainfall than on the plains.

Geology of the Basin Area

Precambrian

The area surveyed lies near the southwest limits of the Great Artesian Basin, the sediments of which are interrupted by a discontinuous ridge of Precambrian outcrops extending from north of Mount Dutton, southeast along the railway line to just south of Anna Creek siding. Small outcrops of the same age occur as inliers in the Mesozoic sediments east of the Mount Margaret Range at Spring Hill, Mount Charles, Lagoon Hill and by Milne Spring.

(?)Permian Till and Tillite

Glacial till and tillite (containing erratics of Sturtian tillite) lying on Precambrian basement were observed west of Mount Dutton siding, four miles north of Warrina siding, 4½ miles NNE of Duff Creek siding and 2½ miles NNE of Box Creek siding. The tillite is fairly well consolidated and displays some jointing.

(?)Jurassic

Outcropping extensively and lying unconformably on Precambrian rock is a medium to coarse-grained and usually felspathic sandstone, typically strongly cross-bedded and often ferruginous on its weathered surface. Towards its base and marginally in contact with the Precambrian are several layers of well rounded white quartz pebbles from half to two inches in diameter.

On Bull Dog Creek in the Umbum military sheet area, near the eastern edge of the Mount Margaret Range, a sixty foot cliff face was examined (Section No. 1 Fig. 3), where gypseous mudstones with marine fossils occur as flat lying beds. Exposed against the contact fault zone and dipping at about 25 deg. under these fossiliferous marine Cretaceous mudstones are the (?)Jurassic cross-bedded sandstones. Further upstream where they are exposed on a cliff face they are medium to coarse-grained with angular white to bluish quartz grains, gradationally bedded and with considerable kaolin. A faulted (?)Jurassic-Precambrian contact occurs also on Hawker Creek, and again at Douglas Spring. Elsewhere the contact is less disturbed, being observed as an unconformity in the vicinity of Algebuckina siding and again east of Boorthanna railway siding. Here, as in a number of other places, a rounded quartz pebble horizon forms the base of the (?)Jurassic sandstone immediately above the contact.

Marine Cretaceous (Lower Cretaceous)

Gypseous shales with thin limestone horizons (often fossiliferous) outcrop over a considerable portion of the area. These sediments fit the description (Ward and Jack) of the lower marine Cretaceous - Rolling Downs Formation, this being confirmed by field recognition of the fossil Maccoyella barklyi. Fossil beds are observed outcropping in brownish calcareous beds of about a foot thickness east and west of Mount Dutton siding, to the east of the Mount Margaret Range near Mount Charles and in the vicinities of Spring Hill and Fountain Springs. Jack, (1915 page 37), records the occurrence of the Cretaceous fossil Maccoyella barklyi in Raspberry Creek Bore (Serial No. 17).

Upper-Cretaceous

Field observations have not established Upper Cretaceous sediments, and it seems likely that the present land surface, with few possible exceptions, is stratigraphically below the top of the Upper Cretaceous.

Tertiary

Some stratification was observed on a cliff face (Section 1, Fig. 3) in material overlying the Cretaceous sandstones. The Upper fourteen feet of this rough material is a loosely compacted conglomerate of poorly sorted granite, quartzite and slate boulders and pebbles, becoming more rounded and stratified toward the contact with the underlying Cretaceous grey green gypseous shale. The area is close to the ranges on the west, and this material probably represents scree or fan-delta outwash subsequent to the marginal faulting. It may therefore be of late Tertiary age. Other than this minor occurrence, Tertiary sediments were not recognised and the chalcedonic or porcellanite capping found on some mesa tops, elsewhere referred to as Eyrian, is here considered to be a siliceous induration of the Cretaceous sediments, the process of silicification perhaps occurring in Tertiary times and in any case predating more recent faulting in the Mount Harvey area.

Quaternary

Stream and flood plain alluvials and wind blown sand ridges are obviously the youngest material occurring in the area, and are possibly Recent to Pleistocene in age. Irregular and often glacial-like boulders are widely scattered over the surface, and in the past there has been considerable discussion as to their origin. The present writers suggest that they are of two types. One, a highly silicified quartzitic material which often occurs in small isolated aggregations or exfoliated fragments far from any outcrop of pre-Mesozoic rocks, is thought to be a type of siliceous duricrust or "greybilly", such as is known to occur in other parts of the basin, and to be of secondary origin. The other type comprises boulders of differing rock type, including granite and striated Sturtian tillite, their occurrence being apparently limited to within a few miles of known pre-Mesozoic outcrops. It seems likely that these have been derived from older rock exposures, either Precambrian or (?)Permian, and have been washed and rolled to their present positions by surface runoff. Their roughly faceted surfaces are probably a reflection of the jointing in the parent rock, perhaps modified by wind action, or the boulders may perhaps be redistributed glacial material.

Inferred Permian to (?)Jurassic Sediments

Although only (?)Jurassic sandstone has been observed in direct if unconformable contact with the underlying Precambrian rock, there is good evidence that these contacts represent a marginal overlap, and that older basin deposits are also present.

Mound springs and numerous shallow bores yielding good flowing supplies occur in the vicinity of Old Nilpinna homestead, west of Warrina siding, the water coming from the (?)Jurassic sandstone, the top of which is very near the surface. The maximum known thickness of sandstone, as recorded in local bore logs, is only about 250 feet.

Gravity survey work by Knapman indicates a depth of at least 500 feet to basement rock at Old Nilpinna homestead and probably more than 1000 feet at Cootanoorina homestead, so that the existence of a quite considerable thickness of sediments below the known (?)Jurassic sandstone seems likely.

A diamond drill hole (Serial No. 68), penetrated 825 feet of younger sediments before reaching basement rock, but did not pass through any sandstone bed which might be correlated with the (?) Jurassic sandstone, although this outcrops near the Precambrian to the south and again one mile to the north, where it extends westward for two miles. (Refer Boorthanna one mile Geological Sheet). A perfect "soled" pebble recorded between 711 and 807 feet suggests a possible glacial origin for the sediments.

It should be noted that the bore site is less than a quarter of a mile from a Precambrian outcrop, indicating a shelving of 32 degrees or more, a fact not readily explicable by postulating a post-Jurassic fault, or folding, as any such structure would surely have disturbed the present outcrop of (?)Jurassic sandstone to the north. It would seem more probable that the sediments penetrated are (?)pre-Jurassic, and that a steep sided basin existed prior to their deposition.

To account for the apparent steep shelving of the basin, the possibility of glacial deepening is suggested, and having regard to -

- (a) the observed occurrence of tillite in several places,
- (b) the existence of sediments below the Jurassic aquifer,
- (c) the evidence of Bore No. 68,

it seems not unreasonable to suggest that the Jurassic sandstone is underlain, at least in this area, by up to several hundred feet of fine grained, sometimes carbonaceous sediments some of which may be Triassic, a Permian age being conditionally assigned to the glacial till elsewhere mentioned. Its thickness is variable, but in places quite considerable, as is apparent from other bore evidence.

Bangaboorana Bore (Serial No. 49) penetrates (Jurassic) "sand rock" from 140-160 feet from which non-pressure water is obtained, passing then into shale with a few bands of rock between 160 and 825 feet which suggests at least 625 feet of pre-sandstone sediments.

Boorthanna Bore (Serial No. 60) also passes through 197 feet of what appears to be the Jurassic sandstone, and then through an additional 1891 feet of earlier basin deposits without reaching bedrock.

Howchin (1928) mentions examination of five samples from this bore at depths from 1400 to 1950 feet. He describes, "a great uniformity in the composition of the rock, which might be described as an extremely fine mudstone, highly charged with carbonaceous material, including some small fragments of lignite but no true coal". He considers that because of "(a) the distinctly carbonaceous type of the sediments, (b) their remarkable uniformity and (c) the entire absence of marine organisms, there is presumptive evidence that the beds are of fresh water origin and probably of Triassic (or Jurassic) age".

The occurrence of these beds, and their possible type, is of considerable interest from a hydrological viewpoint. In other parts of the basin, sediments to a thickness of several hundred feet have sometimes been recorded below the Jurassic aquifer, and there has been speculation as to their age, and possibilities as aquifers. If they are of glacial origin and as fine grained as would seem to be the case, it seems likely that they can be disregarded as a potential source of water, in that part of the basin which lies around the Mount Margaret Range.

Hydrology

Ground Water Occurrence

The (?)Jurassic sandstone, already described, is the principal aquifer of the area both for pressure and non-pressure supplies.

Water under pressure, frequently artesian, occurs where the (?)Jurassic - Cretaceous contact is below the piezometric surface, in which case, the water is confined by the impermeable Cretaceous beds. Along zones of weakness in the Cretaceous cover, which may be the result of faulting, water is able to work upwards and even flow at the surface as artesian springs. In some cases the ground level is substantially below the piezometric surface, and fine sediment brought up by the rising water has formed a mound up to 20 or 30 feet above ground level. Most of these springs still flow. It is possible that wind blown dust may add to the bulk of the mound, but the maximum height is

believed to be limited by the piezometric surface. It is to be noted that dry mounds exist, suggesting that the piezometric surface has declined, and is now below the top of the mound.

Where the Cretaceous sediments are absent or where the Cretaceous-(?)Jurassic contact is above the piezometric surface, the water table is exposed in a number of water holes in depressions and particularly in permanent water holes along the Neales and Peake Rivers. These non-pressure waters have also been penetrated by bores just west of the ranges.

The Cretaceous sediments are argillaceous and do not carry useful supplies of water.

Similarly, the (?)Permian sedimentary series below the main sandstone aquifer is not recorded as having yielded water in the several bores which have penetrated it.

The few known bores in Precambrian rocks have not yielded large supplies, and these dense crystalline rocks are not regarded as good water bearing beds, although stock supplies could probably be obtained in localities having a favourable hydrological environment.

Ground Waters East of the Ranges

One crossbedded (?)Jurassic sandstone is the source of all good water supplies in the area. It is upturned against the faulted eastern edge of the ranges, but further away it has a very flat dip eastwards.

The numerous springs east of the Mount Margaret Range are probably along small fault lines, the sandstone having been observed to outcrop near Levi Springs (Nos. 51A and B) just north of the basement rock outcrops of Spring Hill. Levi Springs are apparently toward the top of the hydraulic gradient of the sandstone aquifer but Levi Bore (No. 50) to the westward has tapped pressure water, suggesting a local westward dip of the sandstone below confining Cretaceous shales.

West of the Spring Hill outcrops, more springs are found (Nos. 57 and 58) which form small pools of water at the surface without appreciable flow, their level apparently corresponding to the piezometric surface. They may well be analogous to Levi Springs.

Springs numbered 37, 38, 42, 43, 52 and 53 are all mound springs indicating confined pressure waters, their pattern together with the basement rock outcrops at Mount Charles and Lagoon Hill indicating some faulting which has disturbed the confining shales and which may be of minor character.

Except for the Douglas Creek area the sandstone outcrops are not so extensive east of the ranges as they are on the western flanks. The eastern edge of the Mount Margaret Range is in part a fault scarp against which the upturned edge of the sandstone is intermittently exposed. As these exposures are not always intersected by the watercourses, intake and recharge conditions are possibly rather poor except along Douglas Creek and possibly the Blyth River.

Direct intake to the beds east of the range from the Neales and Peake Rivers may not be very significant since along their courses on this side of the ranges, sandstone outcrops are few.

Ground Waters West of the Ranges

The sandstone aquifer overlaps the westward margins of the ranges and outcrops between the Mount Margaret and Denison Ranges and occurs again intermittently north of the Peake Range to about five miles northwest of Algebuckina Hill.

It has a gentle dip westward for some distance, having been observed to outcrop south of Edwards Creek as far as ten miles west of the ranges,

This extensive outcrop of the permeable sandstone allows for charging of the basin to the west by surface drainage from the ranges including Edward, Bungadillina, Duff and Anna Creeks. Where the Peake River crosses the sandstone there is opportunity for further recharge in times of river flow. This recharge appears to result in a periodic local rise in the watertable, which is reflected in the waterholes along the river, the levels of which decline in dry periods. If this is so, the available recharge head in wet periods is low, and the volume of recharge entering the aquifers would be correspondingly small.

With west and southwestern movement through the aquifer the water becomes confined by the Cretaceous shale cover resulting in pressure water with a hydraulic surface higher than the land surface at Willow Bore (No. 59), Warrangarrana Bore (No. 48), Weedina Springs (No. 47), Little Piabullina (No. 29), South Spring and Well (No. 28), One Tree Bore (No. 19), Cardajalburra Springs (No. 20), numbers 12A and B, and numbers 18, 22, 23, 30, 31, 32 in the vicinity of Old Nilpinna homestead. The Birribirriana, Weedina, Cardajalburra Springs, and numbers 12A and 12B may be a reflection of some minor faulting, although as sandstone was observed to outcrop near Old Nilpinna homestead it is possible that the lower Cretaceous shales are much thinner in this locality, and allow upward escape of the water along joints or lines of weakness.

The regionally east sloping Mesozoic sediments appear to be tilted by a movement which has hinge faulted the Precambrian of the Peake, Denison and Mount Margaret Ranges along a north-south line running through, say, Lake Conway and Weedina Creek and the resultant form is a basin within the Great Artesian Basin. Some miles west of the ranges the basin floor suddenly deepens, this being apparent not only from drilling but also from geophysical investigations. On the eastern shelf of this smaller basin several bores have been constructed, as follows:

- (a) Edwards Creek No. 2 Bore (Serial No. 41A), Commonwealth Railways, appears to have penetrated the sandstone aquifer at 454 feet cutting pressure water at 580 feet which rose to within 200 feet on the surface. The sandstone aquifer was observed east of the bore dipping gradually westward.
- (b) Bangaboorana Bore (Serial No. 49) as previously described has cut water at 150 feet in "sand rock", perhaps a lower member of the (?)Jurassic aquifer. The water rose only about ten feet.
- (c) Boorthanna Bore (Serial No. 60) has apparently tapped unconfined (?)Jurassic water in argillaceous sandstone above a clay horizon. The water level rose only slightly.
- (d) Except for a doubtful water analysis there is no water information for the Anna Creek diamond drill hole (Serial No. 68). It is also said to have been dry.

Further to the west, the sandstone shelves gradually upward until it is

exposed at the surface, where a further intake area occurs. Recharge water is therefore available from both flanks, and is of a quality reasonably suitable for stock.

Ground Waters in the Mount Dutton Area

The vicinity of Mount Dutton is somewhat analogous to that of the Mount Margaret Range in that -

(a) The small Precambrian outcrop is faulted along the southwest edge. Lower marine Cretaceous fossiliferous beds occur on the southwest side.

(b) To the northwest (?)Jurassic sandstone lies unconformably on the older rocks and declines gradually northwest to disappear below Cretaceous sediments. The sandstone continues around the southwest extension of the basement rock until cut off by the continuation of the fault mentioned in (a) above, the structure being anticlinal, closed to the southwest and faulted out to the southeast. Cadna-owie Springs lies along this fault line and their flow is pressure water from the (?)Jurassic aquifer at depth, rising along the fault zone.

Springs north of Cadna-owie do not show evidence of pressure water as they occur in sandstone without any overlying shales to confine the water. Bore (?) No. 2 does not flow but is believed to penetrate sediments younger than the main sandstone aquifer.

Mount Dutton bore flows out of a seven foot extension of the casing with considerable volume, pressure water occurring at 256½ feet in white sand and artesian water at 325 feet. The water temperature is about 85°F. The source of the water is again the (?)Jurassic sandstone, confined by marine Cretaceous shales, fossils from which were found a mile to the west and again to the northwest near Mount Harvey. Section 2 (Fig. 3) illustrates the local structure, and shows the manner in which the sandstone is displaced by the Mount Dutton fault.

Ground Waters in the William Creek - Anna Creek Area

The contact between Mesozoic and the Precambrian rocks is about a mile south of Anna Creek siding, and Bore No. 73A enters slate at shallow depth,

The fault zone of the ranges may continue southward for a considerable distance, probably to the southern edge of the basin, the line being marked by the occurrence of a series of mound springs of which Strangeways, Coward and Finnis Springs are the more prominent.

This fault zone probably does not result in continuous vertical displacement of the sandstone aquifer, which in plan has a tendency to extend around the northern and southern extremities of the Precambrian rock masses, overlapping the fault line.

Further evidence for such closure around the southern end of the Mount Margaret Range is provided by bores at Anna Creek homestead and William Creek, both of which penetrated sandstone. It seems probable that a post-Jurassic uplift of the Precambrian mass produced marginal doming of the sandstone, accompanied possibly by discontinuous hinge faulting.

Faulting of this type would not necessarily result in sufficient

dislocation of the aquifer to prevent west-east movement of water either to the north or south of the ranges.

Locally, Anna Creek homestead well obtains a large supply of water in sandstone below 25 feet of sandy clays, the volume and quality (35 grains per gallon) being a reflection of localized sweetening by surface flow in Anna Creek itself.

Little definite information was secured for well No. 73B on Anna Creek, used by the fettlers at Anna Creek siding. The water level is estimated at about 250 feet and salinity is apparently low as the water is successfully used for domestic purposes and supports a good garden including citrus trees.

William Creek bore (Serial No. 80) after passing through Cretaceous shale and limestone obtained water in a medium grained sandstone at 226 feet. The bore was said to flow before a break in the casing occurred, but in 1953 the water level was five feet below the surface. The log of this bore mentions a quartz boulder at 175 feet.

Douglas Bore (Serial No. 70) penetrated shales with thin limestones to 365 feet, before entering white sandstone in which pressure water occurred and there seems little doubt but that this is the (?)Jurassic aquifer.

Salinity and Source of Underground Waters

Salinity

An attempt was made to construct iso-halsines for the area, but the limited information prevented any reasonable results being arrived at, although the attempted contours did suggest a lessening of salinity from the southwest towards Lake Conway and again from the southeast toward Mount Charles, which may be the result of intake of waters from the ranges. It may be seen that the bulk of the waters are quite suitable for stock but useless to doubtful for irrigation except where freshened by local intake.

Sources of Underground Waters

Barometric determination of the surface levels of the various water points was attempted in the course of the survey and in conjunction with gravity traverses. Unfortunately, because of the rather long distances traversed over rough ground from base stations it was not possible to obtain reasonably accurate readings except in the places shown on the accompanying plans and tables. Even where the reduced levels are shown, errors as large as plus or minus 20 feet may be present for those points most distant from the surveyed levels at the railway sidings. From consideration of the levels obtained and reference to elevation previously determined (Ward, 1945), no major contradiction of the direction of movement of ground water as given by Ward is possible. However, on the western flank of the ranges, the sandstone has a westerly dip, and conditions are thought to favour local recharge along its eastern margin, which may result in a hydraulic head sufficient to balance any local tendency towards easterly flow in this rather limited subsidiary basin.

Without more precise levelling at a greater number of waterpoints it is not possible to determine in detail the directions of movement of ground water in this area. The picture is complicated by the existence of the Precambrian barrier to general westward flow, the variations in attitude of the sandstone aquifer, and the water loss from mound springs and from bores.

Piezometric levels available, however, do show an overall decline in gradient from west to east toward Lake Eyre in the area under survey. Insufficient evidence was obtained to make it possible to either confirm or modify the location of the neutral line adopted by L. Keith Ward.

In Bulletin 23, Ward (1945) produced a map of the Great Artesian Basin as a whole showing the general direction of movement of underground water based on an unpublished iso-potential map, and shows the water converging from east and west upon the area covered by this report, the outlet apparently being the mound springs.

It is possible that the question might be further clarified by a detailed study of the chemical characteristics of the pressure water, if a sufficient wide range of samples were obtainable. R. Lockhart Jack (1923) has computed from full analyses the equivalent of the sulphate radicle in terms of the carbonate radicle and compared the excess or deficiency of carbonate with respect to sulphate for a number of waters. Interpretation of the results has led him to suggest that waters from the east and northeast have an excess of carbonate while those from the north, northwest and southwest have an excess of sulphate.

Similar computations were done for this report and the results tabulated below. It will be noted that except for two anomalous bores (Nos. 13 and 54A) all the waters show a deficiency of the carbonate radicle, and as these particular bores are very close to Precambrian rock masses, the abundance of carbonate may be a reflection of purely localized conditions.

From these chemical similarities the waters sampled from within the survey area, including those east of the ranges, seem more likely to have their source in the north, northwest and southwest as Ward suggests. Additionally the aquifer in this part of the basin receives some local intake from surface waters both as run-off from the ranges and as flow along the Neales River and Peake Creek.

Water Analyses showing Deficiency of the Carbonate Radicle.

Bore No.	CO ₃	SO ₄	CO ₃ Equiv. of SO ₄	Excess CO ₃
1	9.90	22.30	13.94	- 4.04
1A	10.65	27.68	17.30	- 6.65
10	9.60	23.28	14.55	- 4.95
8	11.30	36.87	23.05	- 11.75
13	23.10	1.98	1.24	+ 21.86
15	11.60	21.97	13.73	- 2.13
17	10.20	52.65	32.90	- 22.70
18	10.80	33.29	20.80	- 10.00
19	10.03	47.03	29.40	- 19.37
20	9.00	42.18	26.35	- 17.35
22	10.20	32.92	20.55	- 10.35
23	9.60	28.80	18.00	- 8.40
27	7.19	55.76	34.85	- 27.66
29	14.85	84.91	53.05	- 38.20
30	9.90	30.49	19.05	- 9.15
31	9.90	30.62	19.15	- 9.25
32	9.36	36.50	22.81	- 13.45
39	9.00	63.08	34.42	- 30.42
44	7.20	33.66	21.03	- 13.83
47	10.80	49.07	30.67	- 19.87
48	13.95	37.39	23.37	- 9.42
49	10.65	77.22	48.26	- 37.61
54A	7.65	8.76	5.47	+ 2.18
56	7.65	39.59	24.75	- 17.10
58	8.25	44.74	27.95	- 19.70
59	10.20	154.02	96.25	- 86.05
60	2.25	74.76	46.72	- 44.47
63	8.70	40.37	25.23	- 16.53
70	1.95	35.76	22.35	- 20.40
75	10.05	45.44	28.40	- 18.35
80	9.00	43.84	27.40	- 18.40

Utilization**Stock**

The numerous waterholes and springs are a big factor in the suitability of the area for cattle grazing. However, although some of these supplies of good stock water are large, others are non-permanent, and the distribution of the flowing springs is such that supplementary bores or wells are necessary.

Additional bores could be used:-

- (a) to make water more readily accessible to existing herds,
- (b) to make more land available for grazing, and
- (c) possibly to increase the density of the cattle population

However, since the land is arid and has a poor soil cover, overstocking presents a serious danger, and it may be said that the availability of good stock water from bores is not the main factor in limiting the use of the country for grazing.

Successful bores could probably be located almost anywhere in the area underlain by basin sediments, provided the (?)Jurassic aquifer is tapped at points below the hydraulic gradient. Areas where the sandstone occurs at the surface may be considered uncertain for this reason. The overlying marine Cretaceous shales, and the underlying possibly tillitic rocks are not considered potential aquifers.

The Railways

The Commonwealth Railways require considerable low salinity water with a small degree of hardness. For this purpose they have a dam near Mount Dutton siding and a bore with treatment plant at Edwards Creek siding. They have not made use of additional bores because of small supply or high salinity and it seems unlikely that subsurface water of a quality suitable for their needs would be obtainable in sufficient supply.

Although the Mount Dutton dam and also one constructed west of Boorthanna for Nilpinna Station appear to be successful, the limited rainfall is a factor to be considered in connection with such works. Dams can only be satisfactorily located where surface runoff conditions are very favourable.

Garden and Domestic

Wells or bores near stream courses have provided low salinity waters suitable for garden and domestic purposes at Warrina, Nilpinna homestead, Anna Creek siding and Anna Creek homestead Nos. 24, 54A & B, 73B and 78. It was noted at Nilpinna homestead, Anna Creek siding and Anna Creek homestead that vegetables and citrus trees were successfully grown.

Other wells on carefully selected sites might also yield waters suitable for domestic and garden use, particularly if located where the sandstone outcrops along major stream courses or drainage lines, but supplies in each case would probably be limited. 4/1/56.

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TABLE 1

Bore Logs - Peake and Denison Region

Bore Serial	Military Sheet	Detailed Log
1	Oodnadatta Township	0-1 feet red loam with jaspery nodules; 1-12 ft. clay and gypsum; 12-33 ft. red clay with gypsum; 33-45ft. white pipe clay; 45-104ft. light grey clay; 104-105½ft. hard crystalline limestone (looks more like quartz and chert particles); 105½-111ft. grey clay and much sand; 111-113ft. jaspery quartz, chert-like, hardness +6; 113-143ft. dark clay; 143-162ft. red clay; 162-172ft. white clay; 172-204ft. yellow clay; 204-216ft. dark clay; 216-233ft. grey clay; 233-250ft. grey sandy clay; 250-263ft. carbonaceous earth and sand; 263-267ft. quartzose sand; 267-277ft. grey clay possibly carbonaceous; 277-282ft. quartzose sand; 282-470ft. dark grey clay with coarse gravel; 470-500ft. grey shale; 500-600ft. soft green argillaceous and micaceous rock; 600-800ft. grey clay typical blue shale; 800-1000ft. grey clay with belemnite fossils at about 1000ft; 1000-1218ft. grey clay with fossils; 1218-1219ft. blue calcareous rock with iron pyrites; 1219-1405ft. blue clay iron pyrites and marine fossils; 1405-1417ft. blue clay; 1417-1443ft. white sand with 6" band of quartz at 1422ft. and 6" band of limestone at 1427ft.; 1433-1444ft. calcareous rock; 1444-1491ft. clay and sand; 1491-1492ft. sandstone; 1492-1562ft. sand and clay.
1A	Oodnadatta	0-50feet surface soils and gypseous clay; 50-750ft. shale (traces of lignite 550-600ft.) - shell fragments at 700ft.; 750-800ft. sandy shale; 800-1000ft. sand; 1000-1015ft. sand and quartz pebbles; 1015-1035ft. slate; 1035-1055ft. argillaceous rock; 1055-1075ft. sandy shale; 1075-1095 ft. argillaceous rock; 1095-1117ft. sand.
5	Algebuckina	At 256½ feet white sand. Total depth 396 feet.
17	Cootnoorina	0-200 feet blue shale - possibly to 416 feet.
19	Nilpinna	0-2 feet surface gibbers and red clay; 2-20ft. grey clay; 20-131ft. blue clay with occasional streaks of black rock; 131-208ft. blue clay, more sandy in places; 208-217ft. boulders in blue clay; 217-260ft. blue clay, lighter in places; 260-280ft. blue clay, lighter in places; 280-282ft. hard rock, no sample obtained; 282-284ft. ended in hard rock.

Bore Serial	Military Sheet	Detailed Log
27	Cootnoorina	0-6 feet surface gibbers and red clay; at 11ft. light clay; at 20ft. dark clay; at 28ft. blue clay water at 41ft. in silty sand; at 105ft. blue clay with bands black rock; at 184ft. blue clay, water under band of rock; at 215ft. silty sand carrying water; at 217ft. band rock into white quartz sand; at 221ft. white sand rock and clay in bands; 221-282ft. sand rock containing coarse gravel and bands clay; at 311ft. sand rock with bands of clay 304 and 336 feet; at 355ft. very white sand rock; at 368ft. white clay; at 378ft. white sand rock with bands white clay; at 398ft. coarse bedrock; at 404ft. white clay; at 412ft. white clay and sand into white sand rock; at 468ft. dark clay and pebbles; at 469ft. white sandrock; at 475ft. bottomed in white sand rock.
39	Earelyana	0-10 feet red clay; 10-20ft. gravel; 20-40ft. blue white and yellow clay; 40-65ft. blue shale; 65-70ft. hard blue shale; 70-95ft. blue shale; 95-100ft. hard blue rock; 100-105ft. black sand; 105-228ft. blue shale.
41A	Conway	0-405 feet ?; 405-501ft. blue - probably soft slate; 501-528ft. soft blue slate with patches of clay and quartz (?); 528-532ft. very soft blue slate and clay; 532-553ft. blue shale; 565-623ft. sandstone.
41C	Conway	0-33 feet yellow clay; 33-35ft. yellow sandy clay; 55-56ft. sandstone bar; 56-75ft. brown sand and clay; 75-95ft. yellow sandy clay; 95-105ft. dark yellow sandy clay; 105-110ft. red sand; 110-120ft. fine white sand; 120-135ft. fine white sand; 135-137ft. white sand fairly coarse; 137-175ft. sand and clay; 175-192ft. white sand; 192-213 sand and clay; 213-230 sandy clay; 230-240ft. sand and clay; 240-265ft. sand and clay; 276-454 (?); 454-488ft. sandstone.
49	Conway	1-140 feet clay; 140-160 sandrock; 160-825ft. shale with a few bands of rock in between.
54A	Conway	0-5 feet red clay; 5-30ft. yellow sandstone; 30-95ft. white sandstone; 95-98ft. hard yellow sandstone 98-104ft. sand and white clay; 104-130ft. white sandstone extremely fine; 130-131ft. yellow clay.
59	Boorthanna	0-2 feet red clay; 2-12ft. blue clay; 12-45ft. hard blue shale; 45-50ft. hard blue rock; 50-140ft. blue shale; 140-145ft. hard blue rock; 145-149ft. sand.

Bore Serial	Military Sheet	Detailed Log
60	Boorthanna	0-25 feet surface soils; 25-45ft. sand; 45-70ft. sandy clay; 70-80ft. sand; 80-96ft. micaceous sandstone; 96-105ft. shale; 105-117ft. sand; 117-134ft. argillaceous sandstone; 134-162ft. white pipe clay; 162-185ft. shale; 185-197ft. sand; 197-2080ft. blue shale with occasional thin layers of limestone.
61	Boorthanna	0-5 feet red clay; 5-15ft. grey slate; 15-31ft. granite boulders; 31-75ft. blue slate; 75-81ft. hard granite.
65	Boorthanna	0-5 feet red clay; 5-15ft. sandy gravel; 15-52ft. hard blue shale.
68	Boorthanna	0-14 feet sand and gravel; 14-18ft. sandy clay; 18-34ft. yellow decomposed shale; 34-106ft. arenaceous shale; 400-500ft. dark grey shale, fairly hard and slightly carbonaceous (?); 500-711ft. greyish dark shale, nearly horizontal with bivalve casts ½" diameter; 711-802ft. dip about 30° a perfect soled (?) pebble; 802-825ft. thin bedded flatter shales and gypseous sandstone (dump from below ?)
70	Anna	0-17 feet sandy loam; blue shale; 65-66ft. blue limestone; 66-150ft. shale; 150-151ft. blue limestone; 151-240ft. shale; 240-242ft. blue limestone; 242-330ft. shale; 330-331ft. blue limestone; 331-365ft. gritty shale; 365-367ft. white sandstone; 367-378ft. white sandstone; 378-380 drift sand.
73A	Anna	0-10 feet loose sand; 10-20ft. yellow sandstone; 20-27ft. soft yellow sandstone; 27-37ft. hard slate; 37-57ft. slate carrying clay and quartz; 57-60ft. hard slate; 60-61ft. soft slate with clay and quartz; 80-98ft. soft slate; 98-168ft. soft slate with little clay; 168-240ft. soft slate with little clay; 240-300ft. hard slate; 300-355ft. harder slate; 355-400ft. hard slate; 400-410ft. harder slate.
80	Anna	0-3 feet loam; 3-8ft. brown sandy clay; 8-51ft. blue shale and gypsum - a few shells; 51-52ft. limestone; 52-87ft. blue shales; 87-88ft. limestone; 88-108ft. blue shale; 108-123½ft. black clay 123½-127ft. limestone; 127-160ft. blue shale; 160-161ft. limestone; 165-175ft. blue shale with quartz boulders; 175-190ft. blue shale; 190-192ft. limestone blue shale; 200-215ft. blue shale; 215-217ft. limestone; 217-226ft. grey sandy shale; 226-227ft. white sand, medium grained.

SUMMARY OF BORE RECORDS

Table No. II

Underground Water Survey of _____ The Poake and Denison Region.

Serial No.	Section No.	Total Depth Feet	Depth at which Water Cut, Ft. below Surface	Static Level, Ft. below Surface	Tested Output, Gall. per Hour	Analysis No.	Total Salinity, Grains per Gall.	NOTES ON USAGE FOR			SURFACE ELEVATION		Remarks and Strata	Occupier's Name
								Stock	Lucerne	Garden and Domestic	Form	Height above Sea Level		
23		85		Flows	100,000 gpd (old estimate)		195.08				Level	244	1 Mile Bore	J. & R. Scobie
24				10	Small		88	Yes			Level	About 330	Old Well, Warrina	J. & R. Scobie
25		60+		50			151	Yes			Level	339	Warrina Gov. Well	Commonwealth Railway
26				Flows Plus 1	Flows about 800		208	Yes			Level		Blyth Bore	Anna Creek
31		80	Flows was + 20	Flows	Flows about 1,000		142	Yes			Level	286	Old Nilpinna H.S.	J. & R. Scobie
32		Less than 80		Flows	Good flow		156	Yes			Level	287	Birribirriana Spring and Bore	J. & R. Scobie
34				Shallow			165	Yes			Level		Murra Murra Bore	
35								Abandoned			Level		Wammaturgaemana, sanded over.	Anna Creek Stn.
10		820					149.08	Yes			Level		Wood Duck Bore (Neales Military Sheet)	Anna Creek Stn.
16													Six mile Bore (Neales Military Sheet)	Anna Creek Stn.
27		475	311	4	500+		824.56 298.82					272	Mt. Berry Bore or Johnson No. 2 See bore log. (Cootnorina Military Sheet)	J. & R. Scobie
17		416	380	Flows	Did flow 1,250,000 gall/day		223.09	Yes	CONWAY			348	Rasperry Creek Bore. Odour H ₂ S	J. & R. Scobie
28				Flows			203	Yes			Level		South Spring and Well	
29		Shallow		Flows	Small						Level	272	Little Piabullina Bore	J. & R. Scobie
30		80		Flows			148.77						Garden Bore	J. & R. Scobie
39		228	68 95		Small 8000 gall/day		557.21	Yes			Level		Nilpinna No. 5 Bore (See bore log)	J. & R. Scobie

SUMMARY OF BORE RECORDS

Table No. II

Underground Water Survey of _____ The Peake and Denison Region.

Serial No.	Section No.	Total Depth Feet	Depth at which Water Cut, Ft. below Surface	Static Level, Ft. below Surface	Tested Output, Gall. per Hour	Analysis No.	Total Salinity, Grains per Gall.	NOTES ON USAGE FOR			SURFACE ELEVATION		Remarks and Strata	Occupier's Name
								Stock	Lucerne	Garden and Domestic	Form	Height above Sea Level		
40							227	Yes			Level	396		J. & R. Scobie
41A		623	140 580	120	7200		151		Railway boilers after treatment		Level	430	Edwards Creek Bore No. 2 - See bore log	Commonwealth Railways
41B		62			4000+		37		Domestic		Drainage	402	Railway Well	Commonwealth Railways
41C		580+	580	102	2400		151		Railway boilers after treatment		Level	493	Edwards Creek Bore No. 1. Not located accurately - See bore log	Commonwealth Railways
47				Flows			256.87	Yes			Level	315	Weedina Springs	J. & R. Scobie
48				Flows			224.86 252	Yes			Level	319	Warrangarana Bore	J. & R. Scobie
49		825	150	140			361.10				Level	443	Bangaboorana - See bore log	J. & R. Scobie
54A		135	13	Shallow	200		52.09	Yes	Not now used	Garden	Level	542	Nilpinna H.S. bore. Not now used as silts up - See bore log	J. & R. Scobie
54B		106		Shallow	200		54	Yes		Garden and domestic	Level	542	Nilpinna H.S. well 8ft. from bore	J. & R. Scobie
										UMBUM				
36				Flows	small		208				Level		Spring	Anna Creek Station
37A				Flows	Flow good									
37B				Flows	Flow		193				Level		Mound Spring	Anna Creek Station
37C				Flows			217				Level		Mound Spring	Anna Creek Station
38				Flows	About 500 Flows		214				Level		Mound Spring	Anna Creek Station
42				Flows	Small flow		212	Yes			Level	147	Fanny Springs. Along suspected fault	Anna Creek Station
43				Flows	Flow about 3000		227	Yes			Level		Large Mound Spring	Anna Creek Station

SUMMARY OF BORE RECORDS

Table No. II

Underground Water Survey of ————— The Peake and Denison Region.

Serial No.	Section No.	Total Depth Feet	Depth at which Water Cut, Ft. below Surface	Static Level Ft. below Surface	Tested Output, Gall. per Hour	Analysis No.	Total Salinity, Grains per Gall.	NOTES ON USAGE FOR			SURFACE ELEVATION		Remarks and Strata	Occupier's Name
								Stock	Lucerne	Garden and Domestic	Form	Height above Sea Level		
44		Shallow		Flows			235.49	Yes			Level		Little Perry bore and springs	Anna Creek Station
45		985		Flows	Large			Yes					Johnson No. 3 bore	Anna Creek Station
50				Flows	Flows about 500		174	Yes			Level	228	Levi bore	Anna Creek Station
51A				Flows	Small flow		178	Yes			Level	230	Levi Springs	Anna Creek Station
51B				Flows	Small flow		178	Yes			Level	230	Levi Springs	Anna Creek Station
52A		Not flowing									Level	134	Large Mound	Anna Creek Station
52B				Flows	Flows about 500		256	Yes			Level	134	Fountain Springs	Anna Creek Station
53A				Flows	Flows about 800		115	Yes			Level	120	Big Perry Spring. Mound about 20ft. high. Cretaceous at surface	Anna Creek Station
53B				Flows	Small flow		315	Yes			Level	121	Big Perry Spring Mound about 12ft. high	Anna Creek Station
53C				Flows 15ft. above base	Small flow		271	Yes			Level	121	Big Perry Spring Mound about 15ft. high	Anna Creek Station
55A				Flows	Small						Gully		Spring in quartzite	Anna Creek Station
55B				Flows			142				Gully		Edith Spring (?) in contorted slates near fault	Anna Creek Station
56				Flows	Small flow		682	Yes			Edge of hill		Spring Hill Spring Small mound	Anna Creek Station
57				Flows	Small flow		227	Yes			Level	196	Freeling Spring (group of six springs)	Anna Creek Station
58				Flows			329.56	Yes			Level		Hawker Springs	Anna Creek Station

SUMMARY OF BORE RECORDS

Table No. II

Underground Water Survey of _____ The Peaks and Denison Region.

Serial No.	Section No.	Total Depth Feet	Depth at which Water Cut, Ft. below Surface	Static Level, Ft. below Surface	Tested Output, Gall. per Hour	Analysis No.	Total Salinity, Grains per Gall.	NOTES ON USAGE FOR			SURFACE ELEVATION		Remarks and Strata	Occupier's Name
								Stock	Lucerne	Garden and Domestic	Form	Height above Sea Level		
46		1014									50	Piarooka Bore (Piarooka Military Sheet)		
								BOORTHANNA						
59		149	144	Flows	5000 g/day		654.87				Level	Nilpinna No.4. See bore log.	J. & R. Scobie	
60		2088	146	140			122.63	Yes			Level	Boorthanna Bore. See bore log.	J. & R. Scobie	
61		81						Not used			Level	Nilpinna Bore No. 1. See bore log.	J. & R. Scobie	
65		52						Heavy supply salt water - Abandoned			Level	Nilpinna Station Bore No. 3. See bore log.	J. & R. Scobie	
66A		10	Dry								Level	Boorthanna Trial Hole	J. & R. Scobie	
66B		10	Fallen	In dry							Level	Boorthanna Well	J. & R. Scobie	
68		988		No water							Level	Anna Creek Diamond Drill Hole See bore log.	Commonwealth Railways	
								CADLAREENA						
62							242	Yes			Level	Tarlton Springs near edge of ranges.	Anna Creek Stn.	
63		300		Flows	Flows about 3000		329	Yes			Level	Hope Creek Bore	Anna Creek Stn.	
67				Flows			315	Yes			Level	Loddon Springs	Anna Creek Stn.	
69		70	50		1000 per day		117				Level	Douglas Well	Anna Creek Stn.	
64				Flows			319	Yes			Level	Brinkley Springs mound spring. Cretaceous at surface.	Anna Creek Stn.	

Table No. III

DETAILED ANALYSES OF UNDERGROUND

Serial No.	Chlorine, Cl	Sulphuric Acid radicle, SO ₄	Carbonic Acid radicle, CO ₂	Nitric Acid radicle, NO ₃	Sodium, Na	Potassium, K	Calcium, Ca	Magnesium, Mg	Iron, Fe	Silica, SiO ₂	Total Saline Matter Grain/Gall.	Total Saline Matter Ounce/gall.	Calcium carbonate	Calcium sulphate
x 1	Oodnadatta	50.62	22.30	9.90	Trace	41.56		4.86	2.16		131.60	0.30	12.14	
x 1A	"	48.80	21.96	9.45		38.63		5.14	2.42	1.50	127.60	0.29	12.85	
5	Algebuckina										205.8		7.2	21.4
8	"	67.38	36.87	11.30	Trace						183.25	0.38	18.75	
10	Neales	59.32	23.28	9.60		50.48		4.07	0.93	1.40	149.08	0.34	10.17	
x 13	Nilpinna	84.35	1.98	23.10	Nil	72.68		0.21	0.24 (Flourine. 0.4)		182.56	0.42	0.52	
15	"	68.60	21.97	11.60	Nil	59.64		2.86	0.52		165.19	0.38	7.14	
x 17	Cootnoorina	82.91	52.65	10.20		49.11	3.63	17.29	8.16	1.60	224.95	0.51	17.00	35.66
18	Nilpinna	58.47	33.29	10.80		47.14	3.04	6.50	2.98	1.50	163.72	0.37	16.25	
19	Nilpinna	81.00	47.03	10.03	Nil	62.65		11.00	3.95		215.66	0.49	16.73	14.61
20	"	73.26	42.18	9.00		48.31	1.65	12.93	5.44	1.00	193.77	0.44	15.00	23.56
22	"	55.88	32.92	10.20		43.59	2.85	8.36	3.58	1.10	158.48		17.00	5.30
23	"	52.98	28.80	9.60		38.44	2.94	7.57	3.45	1.30	145.08	0.33	16.00	3.98
27	Cootnoorina	136.37	55.76	7.19	Nil	79.39		16.15	9.96		298.82	0.68	11.99	38.56
29	Conway	416.78	84.91	14.85		263.27	8.73	16.79	17.93	1.30	824.56	1.88	24.75	23.42
30	"	53.88	30.49	9.90		46.85	1.44	7.93	3.28	1.00	148.77	0.34	16.50	4.52
31	Nilpinna	53.89	30.62	9.90		41.35	1.36	7.79	3.17	1.00	149.08		16.50	4.04
32	"	61.77	36.50	9.36		45.42	2.80	9.15	3.67	1.20	169.81	0.38	15.50	10.03
39	Eurelyana	285.60	63.08	9.00		152.78		25.41	21.34		557.21	1.27	15.00	65.99
41A	Conway										151.2		14.4	17.4
44	"	106.78	33.66	7.20		70.48		13.15	2.72	1.50	235.49	0.54	12.00	28.39
x 47	"	109.17	49.07	10.80		66.76	4.69	14.29	8.64	1.50	264.92	0.60	18.00	24.10
x 48	"	91.79	37.39	13.95		58.81	3.60	11.15	7.47	0.70	224.86	0.51	23.25	6.29
x 49	"	146.51	77.22	10.65		75.43	2.83	34.08	12.18	2.80	361.10	0.82	16.75	93.09
54A	"	17.41	8.76	7.65		14.59		2.42	1.26		52.09		6.05	
56	Umbum	131.20	39.59	7.65		80.30		13.29	3.26	1.50	284.79	0.65	12.75	27.84
58	"	153.88	44.74	8.25		100.91		16.15	4.15	1.50	329.58	0.75	13.75	36.21
59	Boorthanna	266.00	154.02	10.20		169.43		26.61	28.61		654.87	1.49	17.00	67.29
x 60	"	235.97	74.76	2.25		143.76		31.58	5.56		493.88	1.13	3.75	102.27
63	Codlareena	157.37	40.37	8.70		105.80		12.43		0.70	329.47	0.75	14.50	22.54
70	Anna	160.65	35.76	1.95		107.71		7.29	3.56		316.92	0.72	3.25	20.36
75	"	184.24	45.44	10.05		122.85		16.94	3.39	2.20	358.11	0.88	16.75	34.81
80	"	168.31	43.84	9.0		110.54		15.72	4.34	0.60	354.25		15.00	33.05

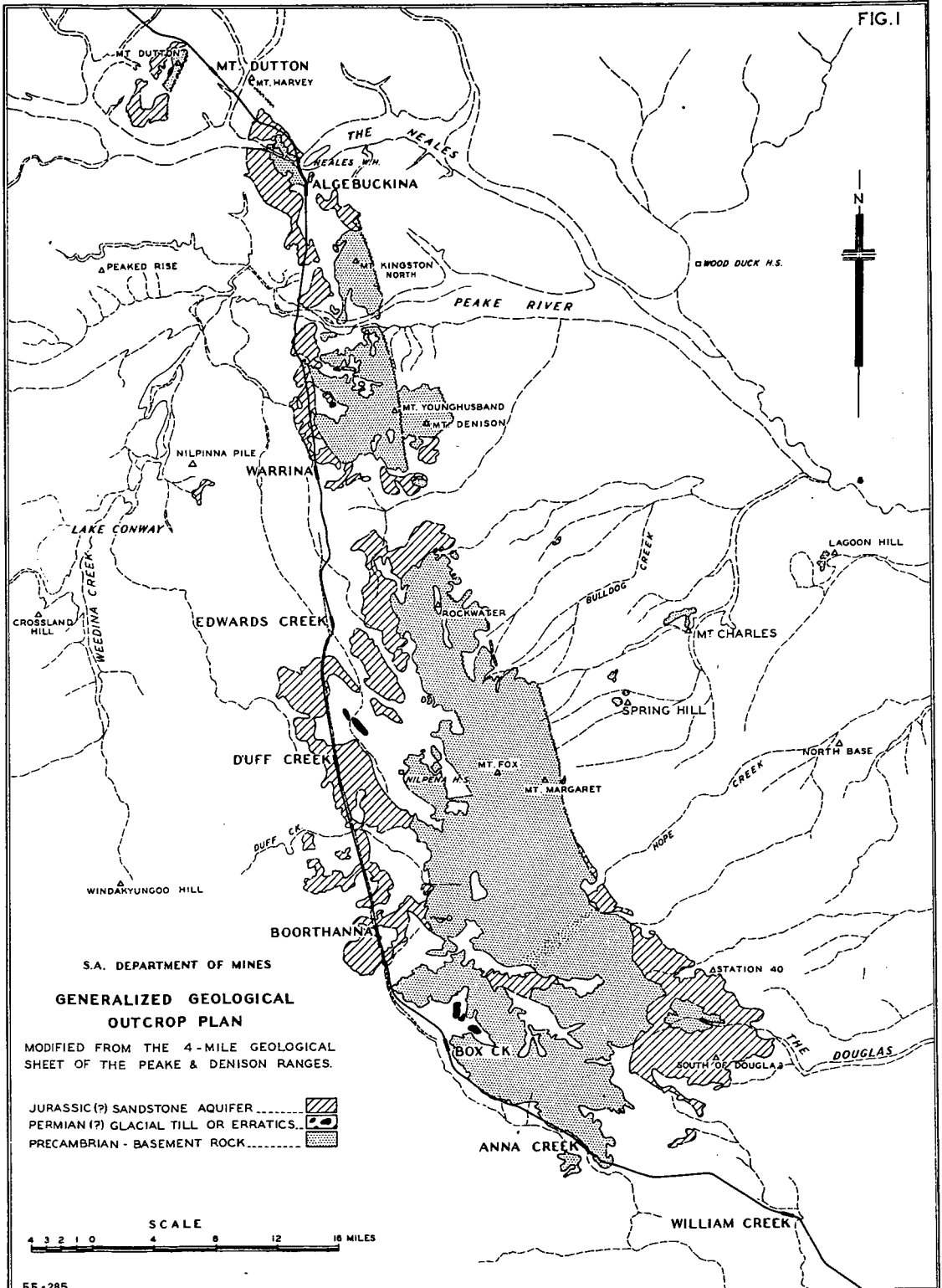
x Odour of Hydrogen Sulphide

WATERS IN PORTION OF THE PEAKE AND DENISON RANGES

ASSUMED COMPOSITION OF SALTS										HARDNESS (DEGREES ENGLISH)				
Magnesium carbonate	Magnesium sulphate	Magnesium chloride	Sodium carbonate	Sodium sulphate	Sodium chloride		Sodium nitrate	Potassium chloride	Silica	Total	Temporary	Permanent	Due to calcium	Due to magnesium
3.68	5.45			26.55	23.78		Trace			21.03	16.50	4.53	12.14	8.89
2.43	8.65			22.25	79.92				1.50	22.95	15.73	7.22	12.85	10.10
5.9				43.1	128.2					29.9	14.2	15.7	22.9	7.0
0.08	6.58			46.76	111.08		Trace			24.30	18.83	5.47	18.75	5.55
3.25			2.08	34.43	87.73+				1.40	14.05	14.05	Nil	10.17	3.88
0.83			39.22	2.93						1.51	1.51	Nil	0.52	0.99
1.86			10.67	32.49	113.09		Nil			9.28	9.28	Nil	7.14	7.14
	34.35	5.10			124.91			6.93	1.00	77.27	17.00	60.27	43.22	34.05
1.47	12.80			34.09	91.81		5.80	1.50		28.68	18.00	10.68	16.25	12.43
	19.55			31.23	133.54		Nil			43.72	16.73	26.99	27.47	16.25
	27.20			5.60	118.26			3.15	1.00	55.02	15.00	40.02	32.33	22.40
	17.90			21.98	92.76			5.49	1.10	35.84	17.00	18.84	20.90	14.94
	17.25			18.03	82.91			5.61		33.32	16.06	17.32	18.92	14.40
35.78		10.69			201.80		Nil			81.32	11.99	69.33	40.33	40.99
	85.47	3.32			669.63			16.67	1.30	116.80	24.75	92.05	41.97	74.83
	16.40			20.97	86.63			2.75	1.00	33.51	16.50	17.01	19.82	13.69
	15.85			22.32	86.77			2.60	1.00	32.70	16.50	16.20	19.47	12.23
	18.35			21.80	97.58			5.35	1.20	38.17	15.50	22.67	22.87	15.30
	20.68	67.20			388.34+					151.33	15.00	136.33	63.52	87.81
		17.3		40.9						45.3	14.4	30.9	27.2	18.1
	13.60			4.05	175+				1.50	44.22	12.06	32.22	32.87	11.35
	40.07	2.49			169.80			8.96	1.50	71.78	18.00	53.78	35.72	36.06
	37.35			4.54	145.86			6.87	0.70	59.05	23.25	35.80	27.87	31.18
	14.39	36.81			191.86			5.46	2.80	136.04	16.75	119.29	85.20	50.84
4.82	2.27			10.25	28.70+					11.23	9.34	1.89	6.05	5.18
	16.30			10.21	216.19+				1.56	46.83	12.75	34.08	33.22	13.61
	20.75			3.81	253.56+				1.50	57.69	13.75	43.94	40.37	17.32
	133.51	6.41			430.66+					184.25	17.00	167.25	66.52	117.73
	3.22	19.22			365.42+					101.82	3.75	98.07	78.95	22.87
	20.50			11.92	259.31+				0.70	48.18	14.50	33.68	31.07	17.11
	17.63			10.84	264.85+					32.87	3.25	29.62	18.22	14.65
	16.95			10.81	303.59+				2.20	56.50	16.75	39.75	42.35	14.15
	21.20			4.66	277.34+	0.80			1.70	57.41	15.00	42.41	39.30	18.11

+ combined Sodium and Potassium Chloride

FIG. 1



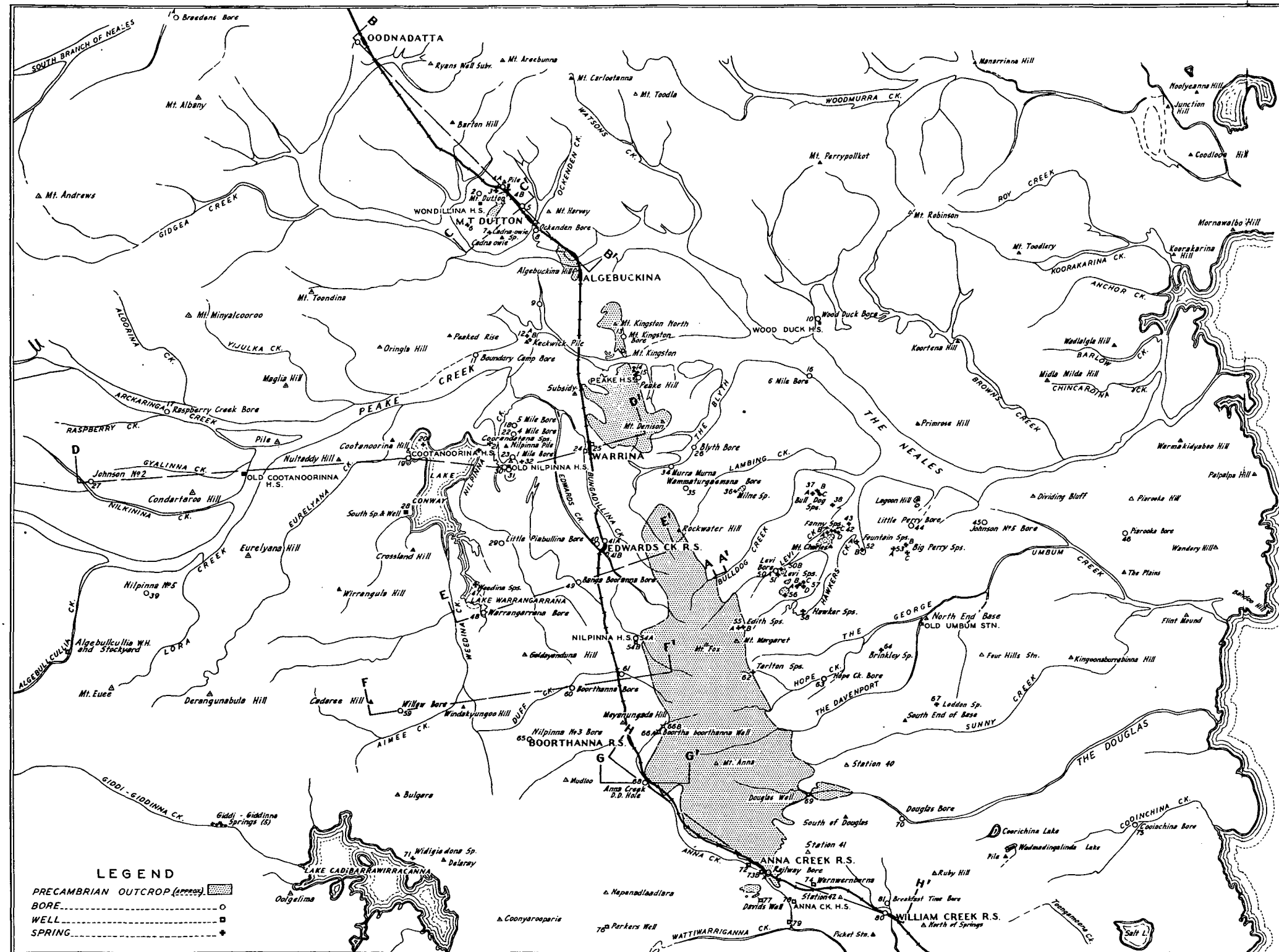
S.A. DEPARTMENT OF MINES

**GENERALIZED GEOLOGICAL
OUTCROP PLAN**

MODIFIED FROM THE 4-MILE GEOLOGICAL
SHEET OF THE PEAKE & DENISON RANGES.

JURASSIC (?) SANDSTONE AQUIFER [diagonal hatching]
 PERMIAN (?) GLACIAL TILL OR ERRATICS... [stippled]
 PRECAMBRIAN - BASEMENT ROCK..... [dotted]

SCALE
 4 3 2 1 0 4 8 12 16 MILES



NORTH
EYRE LAKE

BORE DETAILS FIG. 2

BORE #	TOTAL DEPTH-FT.	DEPTH WATER SURFACE FROM SURFACE (FT.)	DEPTH WATER STANDS FROM SURFACE (FT.)	SALINITY-GG/GAL	BORE #	TOTAL DEPTH-FT.	DEPTH WATER SURFACE FROM SURFACE (FT.)	DEPTH WATER STANDS FROM SURFACE (FT.)	SALINITY-GG/GAL
1	1571	1417 etc.	+34	131.60	418	62	-	-	37
1A	1117	800	-66	118.22	41C	580+	580	102	151
2	Well and bore (?)	flows	156	41	43	flows	-	-	212
3	spring	flows	414	43	43	flows	-	-	227
4A	spring	flows	217	44	44	shallow	-	-	235-49
4B	spring	flows	156	45	45	shallow	-	-	-
5	369	325 etc.	205.8	46	46	1014	flows	-	-
6	spring	flows	169	47	47	spring	-	-	-
7	spring and/or bore	flows	205	48	48	-	-	-	252
8	150	+10	183.25	49	49	825	150	140	361-10
9	-	-	-	50	50	-	-	-	174
10	820	-	149.08	51	51	-	-	-	178
11	spring	flows	-	52	52	spring	-	-	-
12A	-	+20	188	53	53	-	-	-	254
12B	-	surface	182.66	54	54	-	-	-	115
14A	spring and/or bore	flows	165	55	55	-	-	-	315
14B	spring	flows	-	56	56	-	-	-	271
14C	-	-	-	57	57	-	-	-	54
14D	-	-	-	58	58	-	-	-	52-09
15	150	-	165	59	59	spring	flows	-	54
16	-	-	-	60	60	-	-	-	142
17	416	380	flows	223.08	61	-	-	-	682
18	108	-	163.72	62	62	spring	-	-	227
19	284	-	212	63	63	spring	-	-	329-58
20	spring	flows	193.77	64	64	148	144	-	654-87
21	-	-	-	65	65	2088	146	140	122-45
22	15	-	158.48	66	66	81	abandoned	-	-
23	85	-	196.08	67	67	spring	-	-	242
24	-	-10	88	68	68	300	flows	-	329
25	60+	-	151	69	69	spring	-	-	318
26	-	+1	208	70	70	52	-	-	307y
27	475	311	-4	208-84	71	10	dry	-	-
28	shallow	flows	203	208-84	72	10	dry	-	-
29	40	-	147.77	668	668	spring	flows	-	315
30	80	-	147.77	67	67	988	dry	-	-
31	80	-	147	68	68	70	50	-	117
32	80	-	156	70	70	380	378 etc.	-	316-92
33	-	-	-	71	71	-	-	-	-
34	-	shallow	-	165	72	80	-	-	160
35	Abandoned	flows	-	73	73	410	88	80	318-4
36	spring	flows	208	74	74	250+	-	-	250
37A	-	-	183	75	75	1250	-	-	345-11
37B	-	-	-	76	76	-	-	-	-
37C	-	-	217	77	77	-	dry	-	-
38	-	-	214	78	78	-	-	-	-
39	228	38 etc.	-	657.21	79	85	10	-	38
40	-	-	-	227	79	82+	82 etc.	-	356-25
41A	623	580 etc.	120	151	80	228	-	-	345
					81	-	shallow	-	-

S.A. DEPARTMENT OF MINES

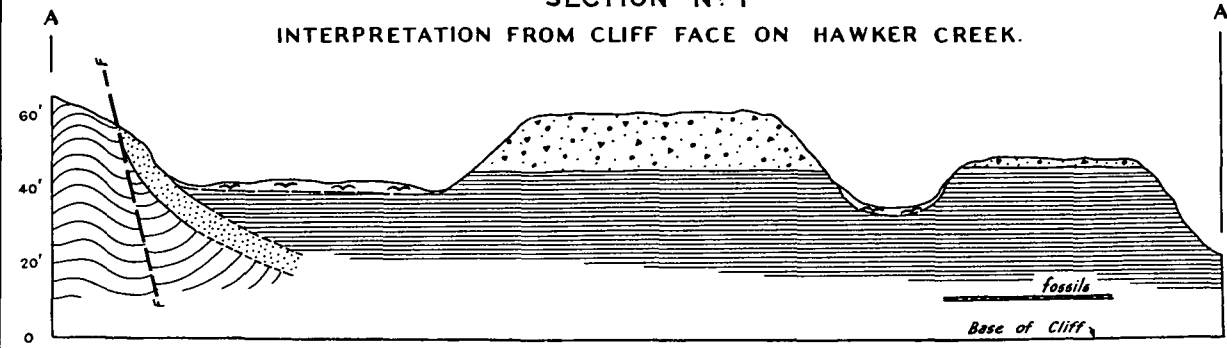
GREAT ARTESIAN BASIN
PEAKE - DENISON AREA
HYDROLOGICAL SURVEY

SCALE



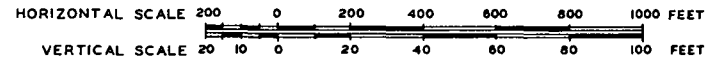
LEGEND
 PRECAMBRIAN OUTCROP (approx) [shaded box]
 BORE [dashed line with circle]
 WELL [dashed line with square]
 SPRING [dashed line with cross]

SECTION N° 1
INTERPRETATION FROM CLIFF FACE ON HAWKER CREEK.

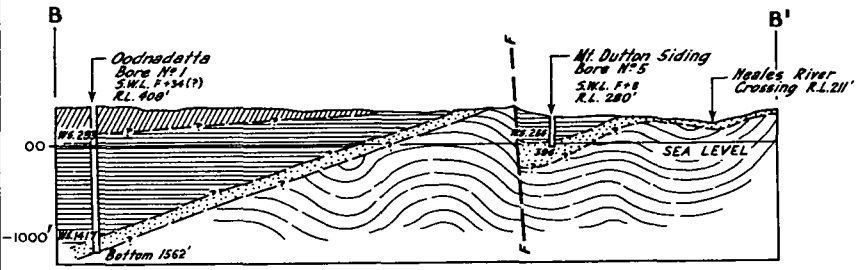


LEGEND - SECTION N° 1

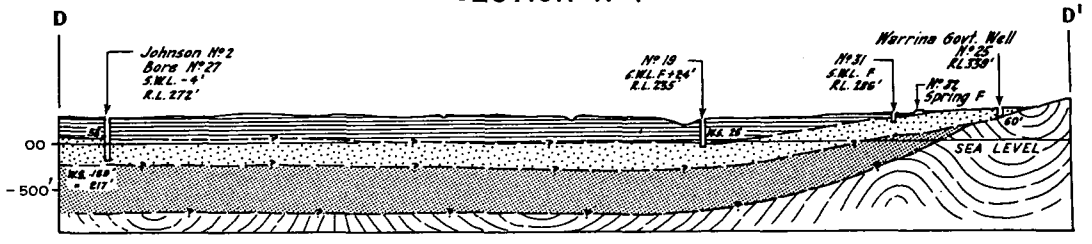
- ALLUVIUM
- BOULDER SILT, GRANITE QUARTZITE AND SLATE SUB-ANGULAR BOULDERS IN GYPSEOUS SILT BECOMING ROUNDED & STRATIFIED WITH GRAVEL AT THE BASE
- CRETACEOUS, GYPSEOUS SHALES WITH CRYSTALLINE GYPSUM AND FOSSIL HORIZONS
- JURASSIC (?) SANDSTONE, ARKOSIC, MED. TO COARSE GRAINED CROSS-BEDDED S.S. WITH PEBBLE HORIZONS
- PRECAMBRIAN



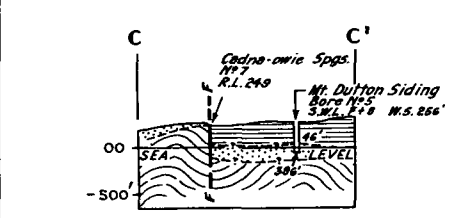
SECTION N° 2



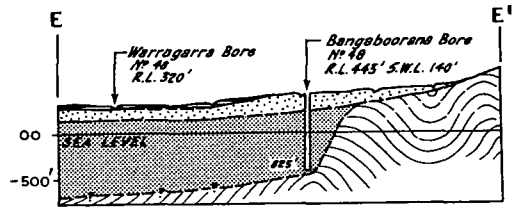
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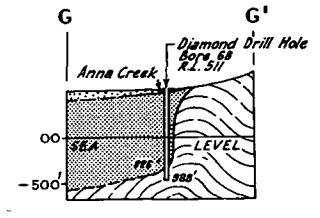
SECTION N° 3



SECTION N° 5

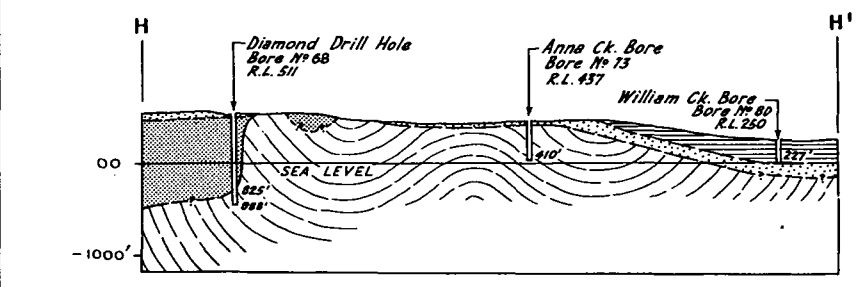


SECTION N° 7

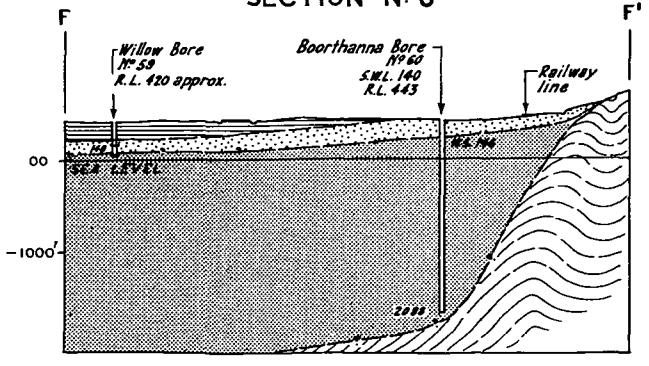


GREAT ARTESIAN BASIN
PEAKE - DENISON AREA
HYDROLOGICAL SURVEY
GEOLOGICAL SECTIONS

SECTION N° 8

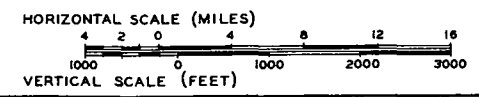


SECTION N° 6



LEGEND - SECTIONS 2-8

- MIDDLE OR UPPER CRETACEOUS (?)
- LOWER CRETACEOUS, MARINE SHALES WITH FOSSIL HORIZONS
- JURASSIC SANDSTONE, ARKOSIC, MEDIUM TO COARSE-GRAINED CROSS-BEDDED SANDSTONE WITH PEBBLE HORIZONS
- JURASSIC (?) OR TRIASSIC (?) SHALES WITH CARBONACEOUS MATERIAL AND POSSIBLE PERMIAN TILL.
- PRECAMBRIAN



S.A. DEPT. OF MINES 54-69/4 R.L. REDUCED LEVELS FROM SEA LEVEL, S.W.L. STANDING WATER LEVEL FROM SURFACE. W.S. DEPTH WATER STRUCK FROM SURFACE, F. WATER FLOWS.

BULLETINS OF THE GEOLOGICAL SURVEY OF SOUTH AUSTRALIA—*continued*

20. DICKINSON, S. B.—
The Structural Control of Ore Deposition in some South Australian Copper Fields, Part 1 (with maps).
28th February, 1942. (*Out of print*).
21. DICKINSON, S. B.—
The Structural Control of Ore Deposition in some South Australian Copper Fields, Part 2 (with maps).
1st February, 1944. Price 5s.
22. WARD, L. KEITH—
The Search for Oil in South Australia (with map). 17th October, 1944.
23. WARD, L. KEITH—
The Occurrence, Composition, Testing, and Utilization of Underground Water in South Australia, and
the search for further supplies (with maps). 13th September, 1945. Price 7s. 6d.
24. MILES, KEITH R.—
The Geology of the South Para Dam Project (with maps and appendices). 1st September, 1948. Price
7s. 6d.
25. BARNES, T. A.—
Underground Water Survey of Portion of the Murray Basin—Counties Albert and Alfred (with maps
and appendix). 15th May, 1950. Price 7s. 6d.
26. OFFICERS OF THE SOUTH AUSTR. DEPT. OF MINES AND THE C.S.I.R.O.—
Talc Deposits in South Australia (with maps). 24th August, 1950. Price 7s. 6d.
27. MILES, KEITH R.—
Geology and Underground Water Resources of the Adelaide Plains Area (with maps and appendices).
22nd May, 1950. Price 10s.
28. GASKIN, A. J. AND SAMSON, H. R. (C.S.I.R.O.)—
Ceramic and Refractory Clays of South Australia. 28th February, 1951. Price 7s. 6d.
29. SPRIGG, R. C.—
The Geology of the South-East Province, South Australia, with special reference to Quaternary
Coast-line Migrations and Modern Beach Developments (with map). 6th December, 1950.
Price 7s. 6d.
30. OFFICERS OF THE SOUTH AUSTR. DEPT. OF MINES AND THE C.S.I.R.O.—
Uranium Deposits in South Australia (with maps). 1954. Price 7s. 6d.
31. PARKIN, L. W.—
The Leigh Creek Coalfield (with maps)—Contributions by S. B. DICKINSON, C. KERR GRANT,
ANDERSON, and G. H. TAYLOR. 1953. Price 7s. 6d.
32. AITCHISON, G. D., SPRIGG, R. C., AND COCHRANE, G. W.—
The Soils and Geology of Adelaide and Suburbs (with colour plates). 1954. Price 7s. 6d.
33. MILES, KEITH R.—
The Geology and Iron Ore Resources of the Middleback Range Area (with maps, addendum, and
appendices). 1954. Price 10s.

METALLURGICAL REPORTS BY THE GOVERNMENT METALLURGIST

1. CONNOR, J. D.—
Notes on the Recovery of Copper from its Ores by Leaching and Precipitation, in the United States
of America, and on Appliances used in connection therewith. 16th March, 1916. Price 3s. 6d.
2. CONNOR, J. D.—
Notes on—
I. The Leaching of Copper Ores from Mount Coffin.
II. Wet Gravity Concentration of Pyritic Ore from Nairne.
III. The Milling of Barytes at Aldgate.
IV. The Treatment of Copper Ore from the Prince Albert Mine. 19th March, 1917. Price 3s. 6d.

RECORDS OF THE MINES IN SOUTH AUSTRALIA

- BROWN, H. Y. L.—
Record of the Mines of South Australia (Fourth Edition, with map). 1908 (*Out of print*).
- Reviews of Mining in the State of South Australia.
A Short Review of Mining Operations during the year 1903. No. 1 (*Out of print*)*.
Review of Mining Operations, commencing 1st January, 1904. Nos. 2 to 6, inclusive. (*Out of
print*)*.
Review of Mining Operations, published half-yearly, from period commencing 1st July, 1907. Nos. 7
to 26, inclusive. (*Nos. 7 to 20, and 21, 25 and 26 out of print*)*.
Mining Review, published half-yearly. Nos. 27 to 103 inclusive. (*Nos. 27, 28, 29, 31, 34, 37, 58, 59,
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9. MCKELLAR, J. B. A. and O'DRISCOLL, E. P. D.—
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