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Hydrological Implications of Recent Geological Work in the Great Artesian Basin

by

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Notes prepared for a meeting in March, 1969, of the Great Artesian Basin Subcommittee of the Technical Committee on Underground Water.

It is doubtful if there is agreement on the full extent of the Great Artesian Basin because of the two-fold use of the term in both a geological and a hydrological sense. If the definition of Artesian Basin given in the report of the Fifth Interstate Conference on Artesian Water is followed, the Great Artesian (hydrological) Basin must include at least part of the Bowen Basin (for example the Triassic Clematis Sandstone on the Springsure Shelf) even though the Bowen Basin is traditionally excluded from the Great Artesian (geological) Basin.

Equally, aquifers in the Cretaceous Rolling Downs Group are traditionally excluded from the Great Artesian (hydrological) Basin, and are regarded as a 'Perched Artesian Basin', again following the definition in the Report of the Fifth Interstate Conference on Artesian Water. The Rolling Downs Group is very much a part of the Great Artesian (geological) Basin. Recent mapping in the Eulo area has shown that there, aquifers are present throughout most of the Rolling Downs Group and that studies of these aquifers cannot be divorced from study of the traditional "main" aquifer system. Without wireline logging of the bores it is difficult, in areas of structural complexity, to decide whether an aquifer is in the Rolling Downs Group or in the underlying Hooray Sandstone.

In the notes that follow, I use the term "Great Artesian Basin' for the hydrological basin which includes aquifers in both the Rolling Downs Group and the underlying sequence. The sedimentary basins which make up the hydrological basin are parts of the Permo-Triassic Bowen and Galilee Basins, and the Jurassic-Cretaceous Surat, Eromanga and Carpentaria Basins.

The most recent comprehensive report on the geology of the Great Artesian Basin in Queensland is that of Whitehouse (1954). Whitehouse's work was based upon mapping of outcropping rocks and interpretation of drillers' logs of water bores. Except for the Cretaceous Rolling Downs Group, he suffered from lack of palaeontological control in sequences lacking continuous exposure and where lithological similarities of several units made correlation hazardous. His work predated the general availability of air photos, and most of the drillers' logs had no geological control. Inevitably he presented an essentially simple interpretation of a limited number of stratigraphic divisions with great extent and little internal variation. Variations in yield of some aquifers were ascribed to differences in the clay content of otherwise uniform sandstones. It was implicit that outcropping units were reasonably typical of those in the subsurface.

The most recent comprehensive report on the Great Artesian Basin in New South Wales is that of David and Browne (1950), although there is a more recent summary by Brunker, Offenberg and Rose (1967). Stratigraphic divisions quite distinct from those of Queensland are used for the outcropping sequences, although an attempt is made to relate them to Whitehouse's (1954) nomenclature, with an implication of time equivalence. A more recent report by Hinds and Helby is due to be published by the Geological Society of Australia in the volume "The Geology of New South Wales" about mid-1969; I have not yet seen a copy of this report.

The geology of the Great Artesian Basin in South Australia is reported in "The Geology of South Australia" (Glaessner & Parkin, eds, 1958). Again, outcropping sequences have local names, but the subsurface interpretation leans heavily on Whitehouse's, even though difficulties in extending Whitehouse's divisions are noted.

There is no comprehensive account of the Great Artesian Basin in the Northern Territory.

Whitehouse's (1954) report is, therefore, a useful base from which to consider developments in the hydrogeological understanding of the Great Artesian Basin in Queensland. Inevitably this must also be reflected in studies in other states and the Northern Territory.

Study of the Great Artesian Basin has been considerably advanced since Whitehouse's time by several factors, most of which are applicable in all states:

(a) The general availability of air photos and modern photo-interpretation techniques, which have allowed reliable, rapid, reconnaissance mapping of very large areas to be achieved.

(b) Many more geologists have been available for geological mapping. Together with the availability of air photos, this has meant that the whole of the Permo-Triassic Bowen and Galilee Basins and the Jurassic-Cretaceous Eromanga and Surat Basins in Queensland and New South Wales have been mapped, with the exception of the Homeboin, Dirranbandi and St George 1:250,000 Sheet areas. These 3 sheet areas and the southern third of the Carpentaria Basin are programmed for mapping during 1969. Mapping of the rest of the Carpentaria Basin should be completed in 1971. Some parts of the western margin of the basin in South Australia and the Northern Territory have also been mapped.

(c) The new discipline of palynology has given palaeontological control in terrestrial sequences.

(d) Active oil exploration has extended geological control into many areas and parts of the sequences previously little known.

(e) Extensive programmes of wireline logging of water bores (principally gamma-ray logging) have provided the basis for a more reliable interpretation of the sequence penetrated by the bores than had previously been possible from drillers' logs. In turn this allows better use to be made of chemical analyses of water samples.

(f) Drilling rigs suitable for shallow stratigraphic holes have been available for use by geologists mapping in the basin.

(g) A government laboratory is available for routine porosity and permeability measurements on outcrop and core samples.

The direct result of this is the accumulation of a mass of data, interpretations and ideas. Some are published, some unpublished but available for study, and some are being prepared for distribution. The data are accumulating so rapidly that one must be either an assiduous reader or an active worker in the basin studies to keep track of developments.

An urgent need is the compilation and maintenance of a comprehensive bibliography.

My direct concern has been with the regional mapping and subsurface study of the Great Artesian Basin in Queensland as part of a joint project by the Bureau of Mineral Resources and the Geological Survey of Queensland. The most significant new developments in recent years in Queensland are as follows:

(a) Outcrop mapping of the Jurassic to early Cretaceous sequence has shown that facies changes are characteristic (Fig. 1). The facies changes reflect differences in the terrestrial environments at the time of sedimentation and differences in provenance of the sediments. Many of the changes resulted from the influence of contemporary volcanicity or uplift of nearby source areas. As the most permeable beds are quartzose sandstone there is direct relationship between stratigraphy and aquifer yields.

(b) In the Surat and southeastern Eromanga Basins facies change in the Jurassic to early Cretaceous sequence is more common around the margin of the basin than between the margin and central parts of the basins. Thus nearly all the aquifer-bearing formations outcrop at the margins and theoretically some recharge is possible.

(c) The outcropping Jurassic to early Cretaceous sequence in the Tambo area is typical of a large part of the Eromanga Basin. This can therefore be regarded as the 'type area' of the Eromanga Basin. By contrast, the Roma area, which was Whitehouse's basis for discussion, is typical of only part of the Surat Basin.

(d) In the northern Eromanga Basin outcropping sequences of Jurassic to early Cretaceous age are thin, marginal, sandstone facies, not typical of the sequence in more central parts of the basin (Fig. 2). The Ronlow Beds on the eastern margin grade into the Hutton Sandstone and provide direct access for recharge. The Hooray Sandstone thins eastwards almost to extinction, and probably lacks an adequate recharge connection with the

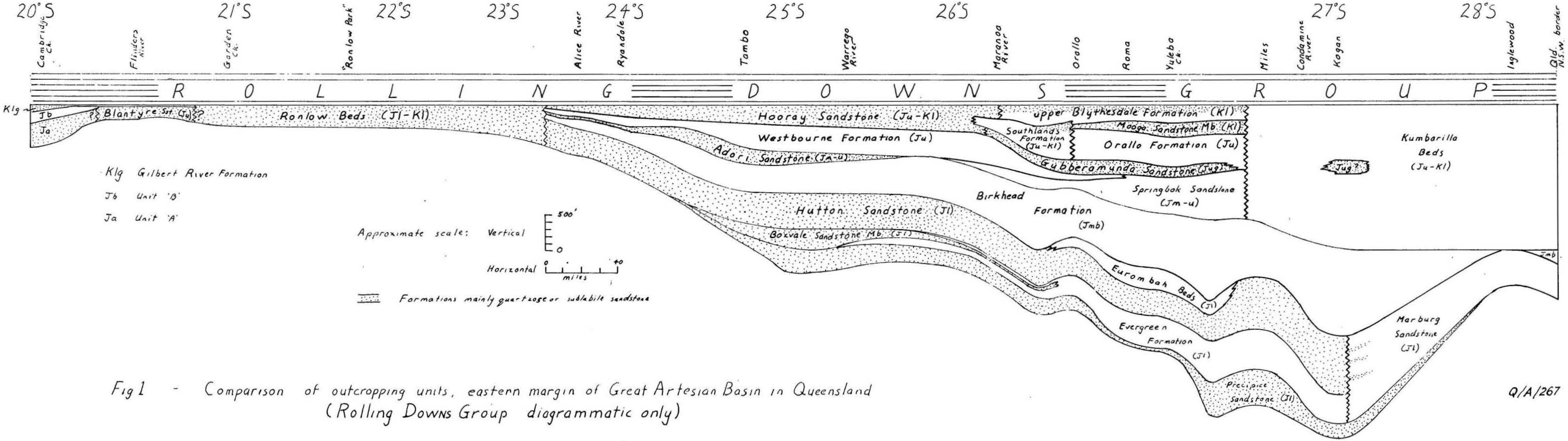

Fig 1 - Comparison of outcropping units, eastern margin of Great Artesian Basin in Queensland (Rolling Downs Group diagrammatic only)

Q/A/267

To Accompany Record 1969/56

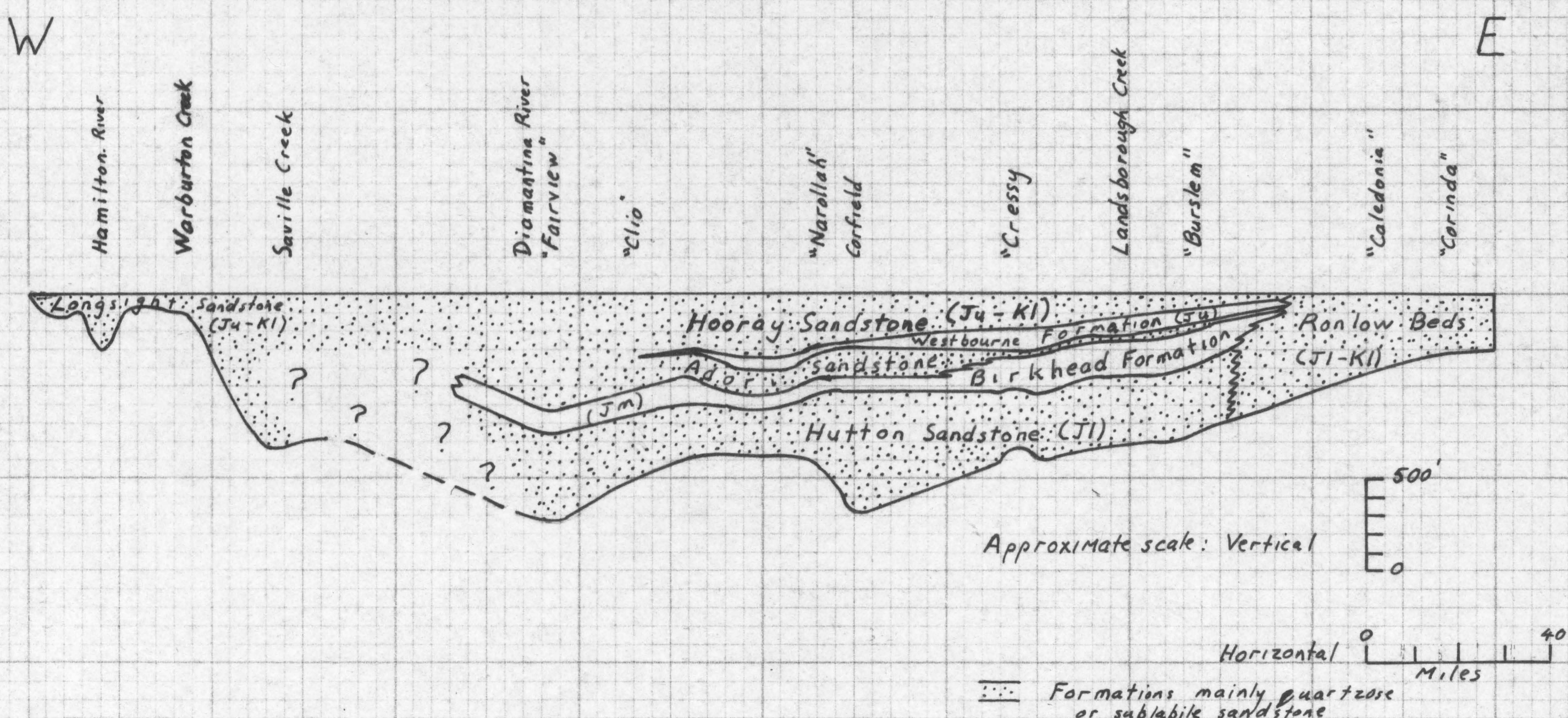

Fig 2 -

Comparison of subsurface units, northern Eromanga Basin

Q/A/268

To Accompany Record 1969/56

Ronlow Beds. Both the Hutton and Hooray Sandstones appear to grade into the Longsight Sandstone on the western margin, but this is an area where data are poor. Additionally, the efficiency of the western intake is not known.

(e) Problems of correlation in the Innamincka area on the Queensland/ South Australian border are possibly due to a similar western marginal facies change from the typical basinal sequence.

(f) Marked thickness variations in some of the aquifer-bearing formations near the north-eastern margin of the basin mean that some conclusions previously made from generalizations are suspect. Outcrops of Mesozoic sandstones in the Flinders River, north of Hughenden, have traditionally been regarded as a main intake of the basin. Some doubt has been cast on this by shallow drilling at the point where the Blantyre Sandstone dips below the Rolling Downs Group. The hole was drilled almost to the bottom of the Blantyre Sandstone, to about 200 feet below the bed of the river. Cores recovered have very high porosity and permeability, yet no water was encountered, even though air was used as the drilling fluid. The underlying Triassic sandstone is very argillaceous. Where drilled by bores to the east, it lacks adequate aquifers, and the only usable supplies appear to come from Upper Permian sandstone.

In order to identify positively the intakes it will be necessary to carry out hydrodynamic studies for each formation.

(g) Some possible alternative intakes were revealed during regional mapping. For example, Torrens Creek floods out into sandy alluvium south-east of Hughenden (Fig. 3); the floodout approximates the subcrop of the Ronlow Beds on the Alice Tableland. The groundwater-charged alluvium may provide a better source of water to the Ronlow Beds by being available during the whole year than the periodic floods along a narrow channel crossing the outcrop of other Mesozoic sandstone beds.

(h) The most reasonable interpretation of the subsurface geology of the area around Muttaburra is that the Lower Jurassic Hutton Sandstone rests unconformably on a truncated surface at which the whole Triassic sequence (Rewan Formation, Clematis Sandstone and Moolayember Formation) subcrops. The Clematis Sandstone is quartzose and has good permeability. Water pressure in the Clematis Sandstone appears to be greater than in the Hutton Sandstone, so this is possibly an area where the Hutton Sandstone is being replenished from below.

(i) Study of gamma ray logs of water bores in the area extending some 50 miles around Richmond indicates that several bores are tapping aquifers in Triassic sandstone. Analyses from these bores show that most produce water which is suitable for irrigation as the salts are not dominated by sodium bicarbonate. Most bores nearby tapping only Jurassic aquifers produce sodium bicarbonate waters which cause compaction of clay soils. Study in this area possibly could lead to selective development of one aquifer for intensive agriculture.

(j) In the Eulo area the size of flows appears to be directly related to the thickness of the Hooray Sandstone where it is wedging out against hills projecting through the Jurassic sandplain that eventually became islands in the Cretaceous seas and swamps.

Similar situations occur in the Carpentaria Basin. Mt. Brown and Mt. Fort Bowen are old hills that project through the Cretaceous sequence and there are small leakages nearby. Some bores have inadequate supplies because only very thin sandstone or conglomerate were drilled before reaching basement.

(k) Because very good permeability is present in major aquifers throughout large parts of the basin, lower pressure and generally thin aquifers in formations of mainly argillaceous sediments or of labile sandstone are commonly overlooked. These formations are, in fact, commonly regarded as aquicludes. The exceptions are where the formations are relatively thick and close to the surface. There, subartesian bores become common. An example is the area west of Taroom where many bores are tapping aquifers in the Birkhead Formation.

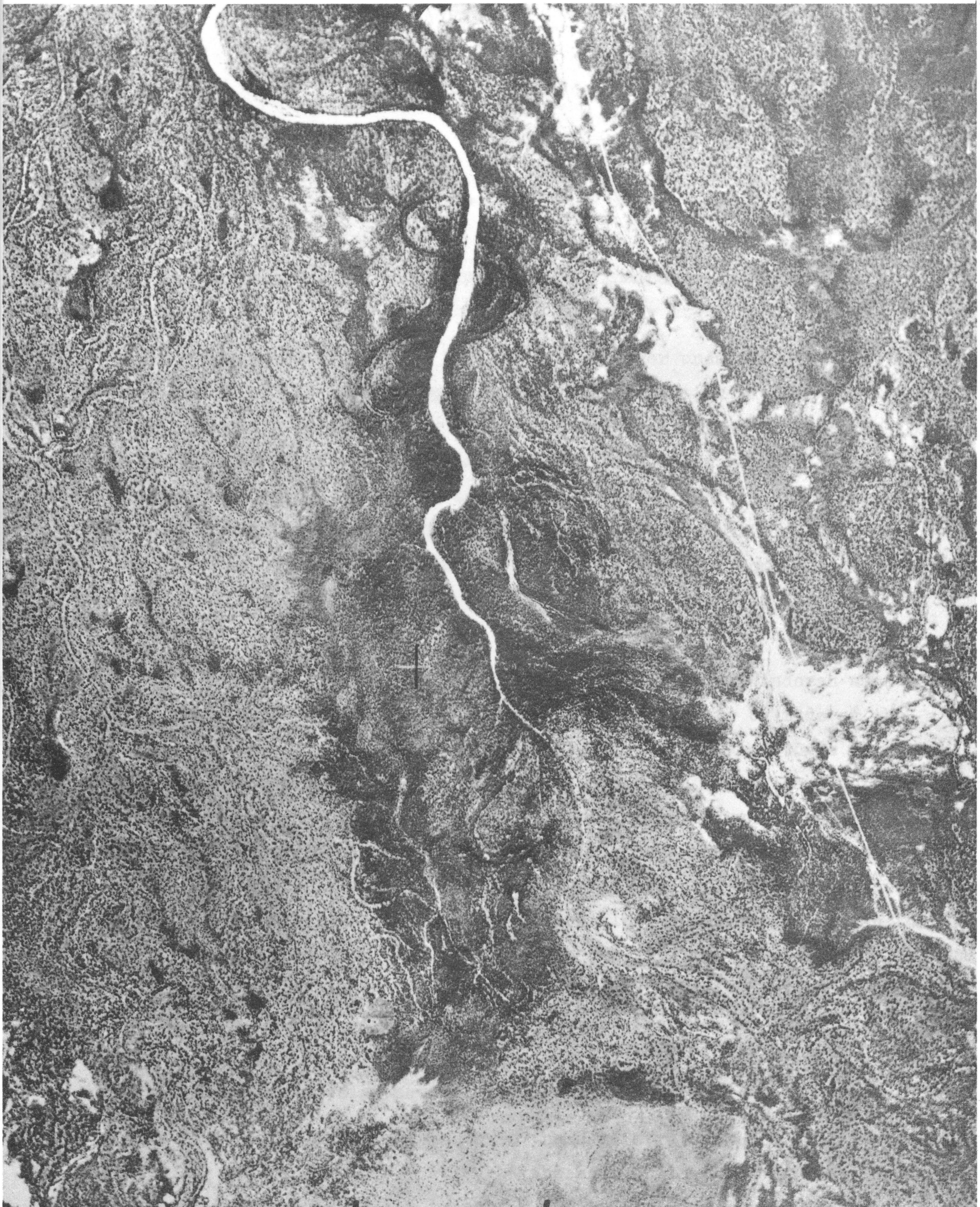

Fig. 3. Floodout of Torrens Creek.

Micrologs of oil exploration wells indicate that fairly thin permeable beds are fairly common in the generally argillaceous sequences.

(l) Regional mapping has resulted in a better understanding of the stratigraphy of the Rolling Downs Group, and in particular, recognition of several arenitic formations or members containing aquifers. Intakes for most of these are within the broad 'rolling downs' and nothing is known of their efficiency. On, and adjacent to, the Eulo Ridge the Rolling Downs Group is thin and dominantly arenitic; several aquifers are recognizable. The possibility must be considered that some of the recharge of the aquifers is by cross-bed transfer from the underlying Hooray Sandstone.

(m) Extrapolation from oil exploration wells in the Windorah area using seismic results enables a reasonable prediction to be made of the position of the base of the Winton Formation. In this area there is a widespread sandstone member at the base of the formation with good permeability yielding good supplies of stock (and possibly domestic) water which has been tapped by only a few bores. The potentiometric surface of this aquifer approximates the land surface in the major valleys, and some of the bores tapping it are artesian. Most have ceased flowing and one, Windorah town bore, was abandoned soon after drilling as the flow was very small. Salinity is appreciably greater than water from the deeper Hooray Sandstone. This is an area where Ogilvie (1954) recorded a marked increase in salinity of artesian water. Possibly this is an incorrect conclusion resulting from generalizing all artesian aquifer data.

The aquifer appears to be at the same stratigraphic position as one previously recognized (Ward, 1946) at the base of the Winton Formation in northeastern South Australia, so any further development must be considered in connection with possible effects across the state border.

(n) During 1968 the programme of gamma-ray logging was supplemented by temperature logging, using a differential temperature tool. The high sensitivity of the tool enables very small variations in the temperature gradient in a bore to be recorded. The logs have proved useful in resolving doubts in interpretation of many of the gamma ray logs, and also appear to indicate the presence of aquifers behind casing. The temperature anomalies are most marked in non-flowing bores or bores with small flows.

(o) A direct result of the regional mapping and bore logging has been the provision of basic data suitable for mineral exploration. There is a possibility of development of an oil shale industry by one company and several are exploring for uranium with reasonable chance of success. Any mineral treatment plants will require water, and in the case of oil shale the requirement may be large. Inevitably there will be pressures exerted to use some of the water from the Great Artesian Basin for these requirements.

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