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EXPLANATORY NOTES FOR A STRUCTURAL CONTOUR MAP OF PORTION OF THE GREAT ARTESIAN BASIN

by

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I. INTRODUCTION

One of the first projects undertaken by the Petroleum Exploration Section was the production of a structural contour map of the South Australian portion of the Great Artesian Basin and areas immediately adjacent in neighbouring states.

Compilations by the writer continued intermittently throughout 1962. Subsequently with the assistance of Michael Brownhill, student geologist, the map accompanying this report was finalized in February, 1963.

New data will continue to become available regularly. Seismic prospecting and drilling in connection with oil exploration, surface geological mapping, and occasional boring for water will all provide information which will necessitate modification of the existing map and develop a truer and more detailed structural picture.

It is hoped to extend the map coverage westwards and northwards when more information, particularly hydrological, becomes available and when further mapping leads to a better understanding of the stratigraphy of the marginal zones of the Basin.

The writer wishes to acknowledge the helpful advice and stimulating discussions afforded by the Section Senior Geologist, Dr. H. Wopfner whose keen interest in, and wide knowledge of the Great Artesian Basin and its historical development have added much in recent years to our understanding of this important sedimentary basin.

II. THE STRUCTURAL DATUM HORIZON

Ideally, the structural datum should be a single stratigraphic horizon sufficiently widespread and continuous to provide control over a maximum area within the Basin. The (?)Jurassic and Cretaceous sediments offer the best possibilities for selecting a datum. Their sequence defined in type localities in Queensland is (after Whitehouse, 1955):

LOWER CRETACEOUS	Winton Formation Tambo Formation Roma Formation	ROLLING DOWNS GROUP
LOWER CRETACEOUS to ? UPPER JURASSIC	Transition Beds Mooga Sandstone Fossilwood "Stage" Gubberamunda Sandstone	BLYTHESDALE GROUP

Rolling Downs Group equivalents are recognized in the central and western part of the Basin but so far formational subdivision has not been achieved. Likewise the boundary between the equivalents of the Rolling Downs and Blythesdale Groups has not yet been defined in South Australia. These subdivisions however have been extrapolated, by means of physical well-logging techniques, from the eastern states as far westward as Betoota, Innamincka and Pandieburra. Beyond these localities sandstones underlying Cretaceous shales are regarded in a general sense, as Blythesdale equivalents. They constitute a recognizable vast hydrological unit, but stratigraphically they are insufficiently well-known to equate with any or all of the Blythesdale subdivisions.

The boundary between the dominantly silty, fine sandy and often calcareous sediments of the Transition Beds, and the coarser, cleaner and more porous sandstones of the Mooga Sandstone has been chosen as the most convenient datum. The division is suitably defined in oil exploration wells.

Inasmuch as the prolific artesian water in the Basin comes from upper Blythesdale beds, the depth of cutting artesian water (and therefore more porous sediments) has been used as an approximation to the top of Mooga Sandstone, the selected datum.

Seismic reflection work has proved the presence of a widespread regular event, designated the "C" reflector, occurring in the vicinity of the base of marine Cretaceous sediments. This reflector has been used as an approximation to the structural datum.

III. SOURCE OF SUB-SURFACE DATA

1. Artesian water bores

These have furnished the basic information for the map compilation. Most flowing water has been assumed to originate from the upper Blythesdale beds.

Certain sub-artesian bores near the margin of the basin are considered on drillers' logs, to have intersected Blythesdale equivalents.

Some of the older bores have no sample record and depth at which artesian water was cut has been used as depth to datum.

Details and localities of boreholes have been taken from departmental maps and records, including Bulletin No. 23 (Ward, 1946); from N.S.W. Department of Mines, Mineral Resources No. 36 (Kenny, 1934); from the Queensland Irrigation and Water Supply Commission Artesian Bores Index; and from sundry other sources.

2. Oil exploration wells

Exploratory wells drilled in recent years within the area of the map have supplied the most accurate control points for the structural datum. Unfortunately these number less than a dozen.

3. Seismic exploration

Seismic reflection surveys cover much of the north-eastern portion of the state. Traverses have also been run in the Oodnadatta area and intensive work is currently proceeding in the Dalhousie Springs region.

Seismic traverses are shown on the map. Where

seismic contour plans have been submitted with company or departmental reports, "C" reflection contours have been used on the structural map. Where reflection time sections only are available, depths to datum ("C" horizon) have been calculated using the time-depth curve derived for G.A.B. sediments by the Department's seismic section.

IV. SOURCE AND ACCURACY OF ELEVATION DATA

In compiling the structural map all depths were plotted relative to mean sea level. The reduction was handicapped by the lack of surface elevations for many bores.

The only reliable surface elevations come from levelled seismic shot-points, railway survey data, and sundry geophysical surveys, mostly gravimetric.

Where the surface elevation of a bore is accurately known, it is recorded in brackets following the name of the bore. Surface elevations where estimated or guessed have not been shown.

V. BASE MAP

The base map is portion of the 1 inch = 8 miles state geological base produced by the Department. Area of compilation has been confined, for the time being, within latitudes 25°S to 31°S, and longitudes 135°E and 143°E

Undifferentiated pre-Mesozoic basement rocks and Blythesdale Group equivalents are shown in outcrop.

VI. GRADING OF CONTOURS

An attempt has been made to show by grading, the reliability of contours from place to place.

1. Full line contours represent good control by seismic survey and/or well-logging.
2. Dash-dotted contours represent fairly reliable control with water bores.
3. Broken-line contours are conjectural, and in the Lake Eyre - Simpson Desert region, entirely speculative.

VII. GENERAL DISCUSSION

The contour plan is strictly a complex of hydrological, seismic and stratigraphic horizons. The possible presence of disconformities within the sequence, especially near the Basin margins, would add further complication.

However, for regional structural studies the approximations in compilation are within the bounds of usefulness, and limited information available at present does not allow for a map based on an alternative datum.

The most striking feature of the contour map is the general parallel alignment in both the NW-SE and (approx.)NE-SW directions, of many major lineaments, established faults, and trends of positive and negative regional structure. Most of the large drainage channels (e.g. Strzelecki, Cooper, Warburton, Finke - Macumba Rivers) follow these directions for long distances.

Dominant features with an (approx.) north-east trend are -

1. Broad upwarp of the Mulka - Mount Gason - Clifton Hills region.
2. The adjacent and parallel anticlinal trends of the Betoota - Nappamilkie and Morney - Curalle - Mount Howie structures.
3. The Nappamerrie - Innamincka anticlinal trend which lines up with the more gentle Strzelecki Creek highs. It is noteworthy that this line coincides approximately with the north-easterly protrusion of basement rocks in the Flinders Ranges.
4. The Tibooburra - Milparinka basement ridge.
5. Speculatively, the southern Simpson Desert depression is elongate in the north-easterly direction.
6. The western shoreline of Lake Frome which is notably straight over its entire length.

Dominant features with north-west trends are -

1. Peake and Denison basement ridge and Oodnadatta Anticline.
2. The major Northwest Fault system of the Willouran Ranges, and numerous associated lineaments.
3. A very marked trend from Tibooburra area (N.B. possibly related Koonenbury - Waratta Fault) passing between Dullingari and Innamincka and on towards Birdsville. It is noted that drainage in the north-eastern fringes of the Simpson Desert (e.g. Hay River, Field River and part of the Mulligan) is in sympathy with this trend over lengthy distances.
4. A general alignment of the margins of a number of lakes including L. Callabonna, L. Blanche, L. Gregory and the north-eastern shore-line of Lake Eyre is apparent, and is especially interesting in relationship to a fairly marked north-easterly structural gradient in their vicinity.

These parallel and complementary trends result from a tectonic pattern which has influenced the framework of the Great Artesian Basin since Permian times and possibly earlier. Many of the major tectonic trends of the surrounding Precambrian rocks coincide closely with these of the Artesian Basin. This fact implies a strong influence of basement tectonics during the Basin's structural history, one essentially of epeirogenesis and, as suggested by Wopfner (1960), trans-current movements.

Even within South Australia the Great Artesian Basin sediments have been deposited in a number of sub-basins each with its own late Palaeozoic to Recent history, and the sum total of which constitute the Basin as it is now. Combined structural and sedimentary studies to be undertaken should throw further light on these developments.

The greatest depth to datum recognized within the contoured area occurs 30 to 50 miles east of Innamincka, where it is approximately 7,500 feet below sea level. Tentative datum rises to 500 or 600 feet above sea level in the Mount Eba area, but the existence of Blythesdale Group equivalents in this area has not been proved.

Discussion in detail of the smaller individual structures has not been attempted in these notes.

Finally, this map is primarily a structural study, but it can be a useful aid for the prediction of depths to the main Artesian Basin aquifer in water boring operations.

VIII. SECURITY OF INFORMATION

Technical information supplied by oil exploration companies remains in security file for a period of six months where the operation is subsidized, and when not subsidized twelve months whereafter permission of the company is sought to circulate the information.

As certain of this information is added to the structure map when it comes to hand, the map may not be available to outside inspection unless with the written permission of the companies concerned.

IX. REFERENCES (referred to in notes only)

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