Rep.Bk.No. 179
G.S. No. 3225
Petroleum No. 4/65

DEPARTMENT OF MINES
SOUTH AUSTRALIA

GEOLOGICAL SURVEY

PETROLEUM SECTION

EXPLANATORY NOTES FOR A STRUCTURAL CONTOUR MAP OF PORTION OF THE GREAT ARTESIAN BASIN, REVISED SEPTEMBER, 1964

by

Ian B. Freytag
Geologist

S.R. No. 11/5/106

12th August, 1965

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SOUTH AUSTRALIA

EXPLANATORY NOTES FOR A STRUCTURAL CONTOUR MAP OF PORTION OF THE GREAT ARTESIAN BASIN REVISED SEPTEMBER, 1964

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EXPLANATORY NOTES FOR A STRUCTURAL CONTOUR MAP OF PORTION OF THE GREAT ARTESIAN BASIN REVISED SEPTEMBER, 1964.

SUMMARY

The structural contour map compiled in 1963 for the South Australian portion of the Great Artesian Basin has been revised with information available up to September, 1964.

The Transition Beds and equivalents are used as the structural datum formation and its hydrologic and seismic identification are discussed.

The map now presents a fairly reliable picture of the broad geotectonic features and regional structure of the area.

INTRODUCTION

A contour map using a Cretaceous structural datum covering most of the area of the Great Artesian Basin in South Australia was first prepared by the Petroleum Exploration Section in March, 1963 (Freytag, 1963). At that time datum control was limited to water bores concentrated near the Basin margin, a dozen or so oil exploration wells, and to widely separated reconnaissance seismic reflection traverses. A few anticlinal structures were covered by semi-detailed seismic survey, but large areas of the Artesian Basin in South Australia were completely unexplored in the sub-surface.

The ensuing two years have seen a steady increase in petroleum exploration and inflow of new data. Seismic surveys conducted by private contractors and the Mines Department have provided extensive direct datum control and structural evaluation.

The results of widespread gravimetric surveys show the intrinsic structural features of the Basin. The stratigraphic sequence and relationships to it of seismic events have been clarified by further exploratory wells.

Field reconnaissance by the Section in the Peake and Denison region has indicated important lateral variations in the datum formation used for this map, and Departmental mapping in the Marree and Oodnadatta areas has added to our structural and stratigraphic knowledge in the zones of marginal outcrop.

Revision of the earlier map has been made using information available up to September, 1964. Since then, further data continues to become available, notably from the little-known Simpson Desert, and this will be incorporated in future revision.

ACKNOWLEDGMENT

The subject of this report is a compilation and integration of data from various sources involving both company and individual. The contribution of all concerned is fully acknowledged.

In addition to information supplied in the course of normal lease requirements within the state, data from beyond the state boundaries has been supplied by Australian Aquitaine Petroleum Pty. Ltd., Beach Petroleum No Liability, Delhi Australian Petroleum Ltd., and French Petroleum Company (Aust.) Pty. Ltd. The co-operation of these companies is much appreciated.

Dr. H. Wopfner, Supervising Geologist Petroleum Exploration Division in directing the project has offered valuable advice.

Messrs. K.R. Seedsman, B.E. Milton and E. Moorcroft, then of the Seismic Section, Department of Mines, advised on the treatment of seismic data.

THE STRUCTURAL DATUM HORIZON

Although it is desirable for a structural contour study to use as datum a single stratigraphic horizon, this compilation is based on the "Transition Beds datum formation". Currently, Transition Beds is used in the sense of Whitehouse (1955), in subsurface stratigraphy of the central Artesian Basin, where well-logs can be correlated with those of the Transition Beds in south-eastern Queensland. The elevation or depth of the Transition Beds has been derived from stratigraphic, hydrologic and seismic information in different parts of the study area, but it has not been possible

STRUCTURAL DATUM FORMATION
AREAL STRATIGRAPHIC RELATIONSHIPS

	FINKE AREA (N.T.) (after Sullivan & Öpik, 1951)	OODNADATTA - PEAK & DENISON REGION	CENTRAL ARTESIAN BASIN (following Whitehouse, 1955)	MARREE - NORTHERN FLINDERS MARGIN (after Forbes 1965)
Lower Cretaceous	Rumbalara Shale	* Oodnadatta Shale	Roma Formation equivalent	Marree Formation
Lower Cretaceous	(not present)	* Cadnaowie formation / * Mt Anna Sandstone	Transition Beds equivalent	Pelican Well Formation
(?) Upper Jurassic	De Souza Sandstone	Algebuckina Sandstone	Mooga Sandstone equivalent	Village Well Formation

(N.B. Relative thicknesses not inferred)

FIG. 1

* Names to be formalized

To accompany report by I.B. Freytag

S.A. DEPARTMENT OF MINES

Approved	Passed	Drn. / Tcd. J.E. / Ckd. L.V.W. / Exd.	STRUCTURAL DATUM FORMATION AREAL STRATIGRAPHIC RELATIONSHIPS	D.M. / Req.	Scale / S 4473 / 994.2 + 81 / Date 27-7-65
Director					

to identify accurately by these means any one horizon over the whole of the area.

In the deeper portions of the Artesian Basin, the Transition Beds are precisely defined at top and bottom by both electrical and continuous velocity logs (see for example Fig. 2) and the formation consists predominatly of siltstones with fine sandy and calcareous interbeds.

In the western and southern parts of the report area, lateral changes in the Transition Beds to marginal facies became evident after the detailed study of the Mount Anna sequence by Wopfner and Heath, (1963).

Subsequent work by the Petroleum Section around the Peake and Denison Ranges and in the Marree area (Forbes, 1965) has clarified some lateral relationships which are tabulated in Figure 1.

To achieve a fair distribution of control over most of the study area, depths to datum have also been derived from hydrologic and seismic data.

Hydrologic Identification

Logs of oil exploration wells drilled in the deeper parts of the Great Artesian Basin show that the Transition Beds there lack permeability. Artesian water bores in these parts therefore penetrate the Transition Beds, and where lithological logs are poor or non-existent the depth to artesian water serves as a good indication of the base of the Transition Beds.

In the marginal areas, however, porous sandy facies of the Transition Beds form a good aquifer. As these sandstones seldom have been distinguished from the underlying Mooga equivalents (Algebuckina Sandstone, Village Well Sandstone) in waterbore logs, the depth to water in such bores may not be a reliable indication of stratigraphic level.

Details and locations of water bores have been taken mainly from Departmental records including Bulletin 23 (Ward, 1946), from N.S.W. Department of Mines Mineral Resources No. 36 (Kenny, 1934) and from the Queensland Irrigation and Water Supply Commissioner Artesian Bores Index.

Seismic Indentification

Seismic reflection surveys over much of the area of the Artesian Basin in South Australia have defined a consistent event, designated the "C" reflector, which originates at the lower part of the Lower Cretaceous sequence.

Precise correlation of the "C" reflector with the stratigraphic sequence is not clear, at least in some areas, but the nature of the reflector is probably influenced by velocity contrasts at both the top and bottom of the Transition Beds.

Marked composite velocity contrasts near the boundary of the marine shales (Tambo-Roma Formations) and the Transition Beds are recognized on continuous velocity logs of most oil exploration wells (see Fig.2), and it appears they have the greatest effect on the character of the "C" horizon.

The weaker contrast at the Transition Beds - Mooga Sandstone boundary, and the disposition of calcareous beds within the formation itself, probably also contribute to the nature of the horizon.

In using the "C" reflector as structural datum, the variation in stratigraphic interval probably will not be greater than the thickness of the Transition Beds, which seldom exceed 200 feet. This is a good approximation to a single datum horizon in a regional study such as this, and where the variation is of the same order as the contour interval.

BASE MAP AND COMPILATION

Compilation has been carried out on a 1-inch to 8-miles state geological base produced by the Department. The contour map attached to this report is a reduction to 1:1,000,000 scale, but copies of the original 8-mile compilation are available on application (plans L63-167, L63-167a).

SOURCE AND ACCURACY OF ELEVATION DATA

Depths to datum have been reduced relative to mean sea level. The only reliable surface elevations come from seismic and gravimetric surveys, well-head elevations, railway survey data and sparse topographic survey points. Most water bores have not been levelled and it has been necessary to estimate their elevations from the nearest known elevations.

GENERAL DISCUSSION

The contour plan in its present detail is useful in showing the broad geotectonic features of this portion of the Great Artesian Basin and in indicating the regional structural trends of Late Mesozoic and Cainozoic age.

If the marginal eroded areas are ignored, and it is remembered that surface elevations vary by only a few hundred feet over most of the contoured area, then the structural map approximates to a Cretaceous isopach map. Two major sub-basinal features are clearly defined, each one having developed throughout earlier Mesozoic time from ancestral Permo-Carboniferous basins in the southern Simpson Desert and and Coopers Creek regions respectively.

These major sub-basins are separated by a broad NNE - SSW basement ridge - the Birdsville Track "high", which also is reflected in the Mulka-Mount Gason-Clifton Hills Mid-Tertiary uplift. The Birdsville Track basement ridge merges to the north with the Boulia-Birdsville shelf area ("shelf" herein referring to the larger areas of relatively thin, uniform Cretaceous sediments resting on older basement) and to the south with the mildly upwarped region immediately north of the Flinders Ranges.

The southern Simpson Desert depression at this stage appears to approximate a square shape (with north-south oriented corners) controlled by intersecting rectangular sets of structural elements. To the south-west of it, a somewhat steeper structural gradient is related to the Lake Eyre Lineament (Wopfner, 1964). To the north-west a steady gradient from the Andado (N.T.) region is interrupted by NNE-striking lines of structure through Mount Alice-Anacoora (N.T.) and Macumba-Purni. The Boulia-Birdsville shelf and Birdsville Track "high" effectively delineate the sub-basin to the north-east and south-east respectively.

The Coopers Creek depression is considerably more complex. In broad aspect it is elongate to the north-east, deepening steadily from the Lake Blanche-Lake Gregory lineament, and is bordered on the north-west by the Birdsville Track "high" and on the south-east by a broad shelf area west and north-west of Tibooburra (N.S.W.).

The present map bears out in further detail the interplay of north-easterly and north-westerly structural trends and lineaments mentioned in earlier notes (Freytag, 1963). These sets of complementary trends form a tectonic framework which has largely influenced the development of the Great Artesian Basin and earlier Mesozoic sedimentation. They coincide with trends in Precambrian areas surrounding the Basin and the strong influence of basement tectonics during Basin history is evident. Deformation has resulted from epeirogenetic movements which have produced lines of severe fracture in near-margin areas of relatively thin sedimentary cover, and asymmetric folds where sedimentary thickness is several thousands of feet. This mode of tectonics and in particular the part played by transcurrent components has been discussed by Wopfner (1960).

It is now apparent that the major structural trends oriented north-east to south-west (e.g. Mt. Alice-Dalhousie-Anacoora, Oodnadatta-Macumba-Purni, structures of the Birdsville Track "high", Gidgealpa-Merrimelia-Innamincka, the Strzelecki Creek trend, and pronounced surface structures in south-western Queensland) are those of actual positive deformation as young as Middle Tertiary, where duricrusted Lower Tertiary sediments have been affected.

On the other hand lineaments in the north-west quadrant can be related rather to hinge-lines which have been intermittently active at least since Middle Mesozoic time (see Wopfner, 1964). These include the Lake Eyre Lineament, the Lake Blanche-Lake Gregory lineament, and the northward extrapolation of the Koonenbury-Waratta Fault (Tibooburra area).

At present there are relatively few published references to structure of the Great Artesian Basin in South Australia.

Reports of studies in the last decade include a synthesis by Sprigg (1961) of the geological history of the area now covered by the Artesian Basin and its surrounds, and a general description of Basin geology by Sprigg and Staff (1958). Webb (1958) has summarized tectonics and sedimentation in South Australia.

Structural development and history has been treated more specifically for particular areas of the Basin by Wopfner (1960; 1964).

The results of Mines Department field mapping in marginal areas of the Artesian Basin can be found in reports on the Peake and Denison region (Reyner, 1955), the Alberga 4-mile Military Sheet (Coats, 1963), and the Marree 4-mile Military Sheet (Forbes, 1965).

I. B. Freytag
per B.G.Forbes.

IBF:MG:AVR
12.8.1965

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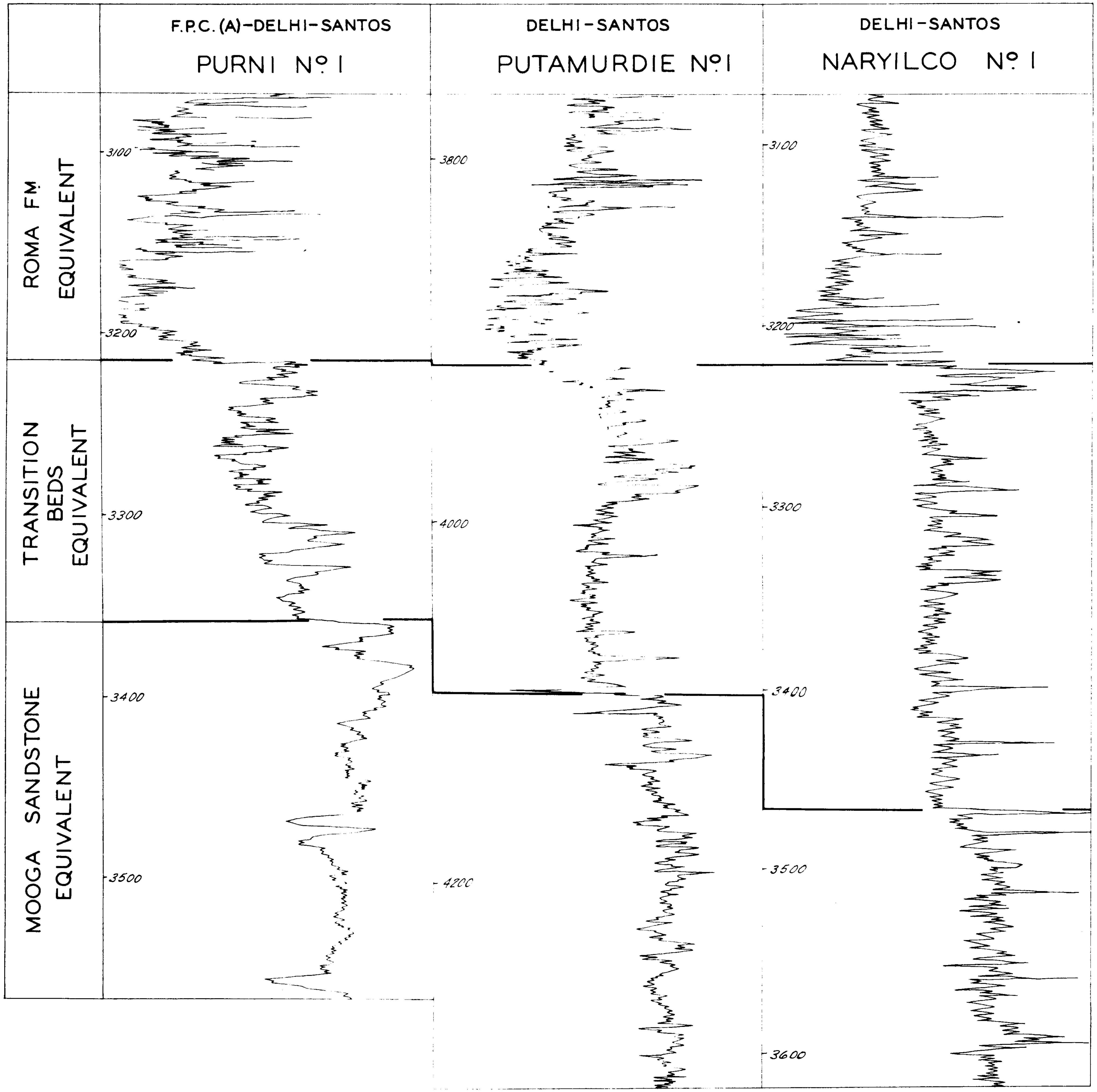
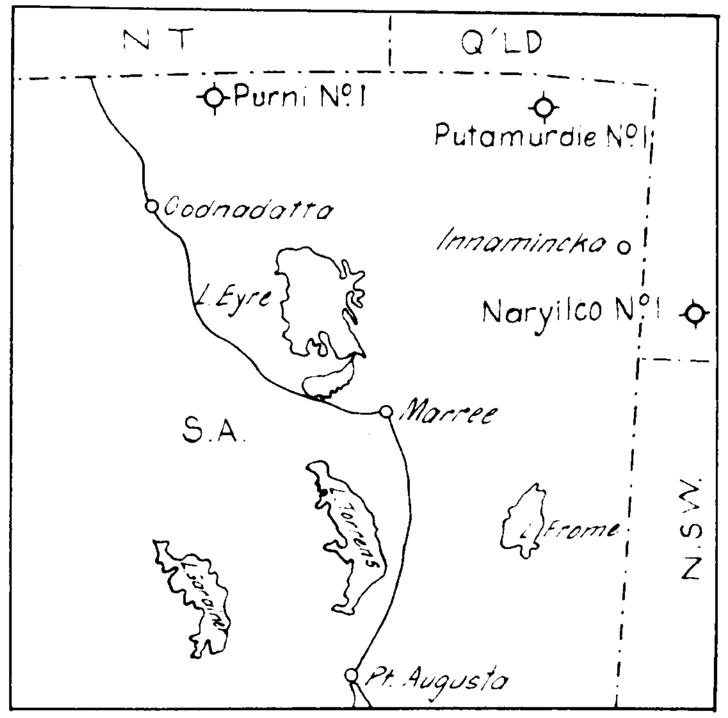


LOCALITY MAP



NOTE - Rock boundaries chosen on electrical log characteristics and lithology

Δt Increases to left

FIG. 2

DEPARTMENT OF MINES — SOUTH AUSTRALIA

CONTINUOUS VELOCITY LOGS THROUGH TRANSITION BEDS EQUIVALENTS

		Drn.	SCALE: Vert. 50 Feet to 1 Inch
		Tcd. B.L.S	64 – 872
		Ckd.	994.2/3
Director of Mines		Exd.	DATE: 10-8-65

S.A. DEPT. OF MINES
STRUCTURAL CONTOUR PLAN OF PORTION OF THE GREAT ARTESIAN BASIN
STRUCTURAL DATUM FORMATION IS LOWER CRETACEOUS TRANSITION BEDS
ELEVATION DATUM – MEAN SEA LEVEL
CONTOUR INTERVAL – 200 Feet (or as specified)
COMPILED BY I.B. FREYTAG AND M. BROWNHILL, MARCH 1963
REVISED BY I.B. FREYTAG, SEPT. 1964
EXPLANATION
Contours in area of good depth control
Contours in area of limited depth control or of contour interpolation. Contours conjectural in much of Simpson Desert – Lake Eyre region.
Meteor — Water bore to Mooga Sandstone
Purni No. 1 — Oil exploration well, abandoned or completed as artesian water well.
Gidgealpa No. 2 — Oil exploration well completed as gas producer
— Spring or mound spring
— Transition Beds equivalents: Cadnaowie formation and Mt. Anna sandstone of Peake – Denison region. Undifferentiated Transition — Mooga equivalents of Tibooburra (N.S.W.) region
— Mooga Sandstone equivalents: Algebuckina Sandstone of Peake – Denison region; De Souza Sandstone of Finke (N.T.) area
— Undifferentiated pre-Mesozoic outcrops.
Fault, established
Fault, inferred
Seismic surveys
Reflection, reconnaissance
Reflection, continuous profile
Refraction
SCALE
MILES
24 MILES
LOCALITY PLAN
OODNADATTA
ADELAIDE
GREAT ARTESIAN BASIN PROPER
AREA OF STRUCTURE PLAN
SHEET 2 OF 2
L63-167-a
994-2/3
L. GREGORY
L. BLANCHE
L. CALLABONNA
L. HARRY
Yandama Ck.
LAKE TORRENS
LAKE FROME
FROME R.
MARREE
LYNDHURST
LEIGH CREEK
COPLEY
BELTANA
NILPENA
EDIACARA H.S.
WOOLTANA H.S.
MURNPEOWIE H.S.
TIBOOBURRA
Mungerannie
Mulka
Montecollina
Yandama
New Tilcha
Lakeside No. 1
Black Oak No. 1
Glenmanye No. 2
Curnamona
Arkaba
Thurlooka
138°00'
139°00'
140°00'
141°00'
142°00'
143°00'
28°00'
29°00'
30°00'
31°00'

F 1


LAKE EYRE (NORTH)
LAKE EYRE (SOUTH)
LAKE TORRENS
LAKE FROME
L. BLANCHE
L. GREGORY
L. HARRY
L. CALLABA
L. CADIBARRAWIRRACANNA
L. CONWAY
L. LABYRINTH
L. YOUNGHUSBAND
L. ARTHUR
L. HOPE OR PANDO
Peake Ck.
Douglas River
Margaret R.
Frome R.
Yandama Ck.
Raspberry Ck.
WILLIAM CREEK
STRANGWAYS SPRINGS
COWARD SPRINGS
Curdimurka
MARREE
MURNPEOWIE H.S.
LYNDHURST
LEIGH CREEK
COPLEY
BELTANA
NILPENA
EDIACARA H.S.
MT. EBA H.S.
MT. PAINTER
WOOLTANA H.S.
BOORTHANNA
WARINNA
Bangaboorang
Warrangarranna
Willow
Mt. Anna
Mt. Woods
Murpoo
Montecollina
Lake Crossing No. 3
New Nichu
Yandama
Barlow No. 1
Arbeola
Culberta
Black Oak No. 1
Region of early Cretaceous uplift resulting in partial stripping of Algebuckina Sandstone followed by deposition of Mount Anna sandstone Datum Formation crops out intermittently or lies at shallow depth.
28°00'
29°00'
30°00'
31°00'
135°00'
136°00'
137°00'
138°00'
139°00'
140°00'
F 2

Windorah
Adria Downs
Birdsville Town
BIRDSVILLE
Diamantina R.
Bulamurtie No 1
IN THIS
CONJECTURAL
Goyders Lagoon
Warburton River
L. WARRANDRINNA
Kalaweina
INNAMINCKA
Merrumelia No 1
Poonarunna No
SCALE
LOCALITY PLAN
OODNADATTA
ADELAIDE
GREAT ARTESIAN BASIN PROPER
AREA OF STRUCTURE PLAN
SHEET 1 of 2
L 63-167
138°00'
139°00'
140°00'
141°00'
142°00'
143°00'
26°00'
27°00'
28°00'
-2600
-2800
-3000
-3200
-3400
-3600
-3800
-4000

F1


NO DATA
ON RECORD
CONTOURS IN THIS
REGION CONJECTURAL
Andado Nol
East
Edinda
ANDADO
Peebles
Anacoora
Allingo
Blood's Ck.
Opossum
Witcherrie No.1
Springs
Purni No.1
Pedirka
Dalhousie Springs
Stevenson R.
Macumba Storm Ck.
Mt Sarah
ALBERGA
Yardinna
Sandeodna No.1
Breaden
OODNADATTA
Allendale
Mt Dutton
Mt Toondina
Coolabarcoola
Wood Duck
Wilson's Ck.
Mt Arthur
Woodmurra
Poolcharmurrana
Neales or Macumba R
Snake Ck.
Finke R
Kallakoopah Creek
L. WARRANDRINNA
Poonarunna No.
Warburton River
Goyder's Lagoon
Diamantina R.
Pandieburra No.1
Dullingari No.1
Adria Downs
Birdsville Town
BIRDSVILLE
L. HOWITT
Kalladeina
Merrimelia No.1
Gidgealpa
Cooper Ck.
137°00'
138°00'
139°00'
140°00'
26°00'
27°00'

F 2