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EROMANGA BASIN

GEOLOGICAL STUDIES

REPORTS

Submitted by

Delhi Petroleum Pty Ltd and Santos Ltd
1988

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PRIMARY INDUSTRIES
AND RESOURCES SA

ENVELOPE 8621

TENEMENT: Not applicable

TENEMENT HOLDER: Not applicable

CONTENTS OF VOLUME ONE

PLAN		Scale	Company plan no.	MESA NO.	
Plate 3	**Magier, P., 1965.** Gamma ray correlation of the Mesozoic (enclosure to missing French Petroleum Company [Australia] Pty Ltd regional geology report no. 505, 9/2/65).	1:2 400	RG505/11	8621-1	*>A0*

REPORTS:	**Swindon, V.G. and Moore, P.S., 1984.** Exploration and production, Eromanga Basin, Central Australia (August 1984).	**8621 R 1** Pgs 3-47
	Gausden, J., 1979. Landsat interpretation [of the] western Great Artesian Basin (consultant's report for Delhi Petroleum Pty Ltd, June 1979).	**8621 R 2** Pgs 48-60

PLANS		Scale		
Encl. 1	Lineament map.	1:1 000 000	8621-2	*>A0*
Encl. 2	Interpreted structure map.	1:1 000 000	8621-3	*>A0*

CONTENTS OF VOLUME TWO

REPORT:	**Moore, P.S., 1984.** Cretaceous stratigraphy of the southwestern Eromanga Basin. Part 1. General introduction, formation tops and log correlation diagrams for the interval Toolebuc Formation to 'C'-Horizon (Delhi Petroleum Pty Ltd, June 1982).	**8621 R 3** Pgs 61-105

PLANS		Scale	Company plan no.		
Encl. 1	Location of log correlation stratigraphic cross-sections (constructed between wells lying within the areas of PELs 5 and 6 and ATP259P).	1:1 000 000	82XG-1332	8621-4	*A0*
Encl. 2	Cross section A-B.	1:1 200	81XG-0747	8621-5	*>A0*
Encl. 3	Cross section C-D.	1:1 200	81XG-0746	8621-6	*>A0*
Encl. 4	Cross section E-F.	1:1 200	81XG-0744	8621-7	*B1*
Encl. 5	Cross section C-H.	1:1 200	81XG-0745	8621-8	*B1*
Encl. 6	Cross section G-J.	1:1 200	81XG-0748	8621-9	*A0*
Encl. 7	Cross section L-K.	1:1 200	81XG-0742	8621-10	*A1*
Encl. 8	Cross section K-N.	1:1 200	81XG-0743	8621-11	*B1*

REPORT:	**Taylor S. and Redfearn, J., 1988.** Eromanga [oil exploration] potential of the Nappamerri Trough [Oil Project 88-3] (Santos Ltd, September 1988).	**8621 R 4** Pgs 106-146

PLANS		Scale	Company plan no.	MESA NO.	
	Nappamerri Trough stratigraphic cross-sections:				
Encl. 1	Top Cadna-Owie Formation to top Nappamerri Formation.	1:1 572	PEL5-6 094	8621-12	*A0*
Encl. 2	Top Murta Member to top Namur Sandstone Member.	1:384	PEL5-6 093	8621-13	*>A0*
	Burley/McLeod/Kirby area time structure maps:				
Encl. 3	'C'-Horizon.	1:50 000	BUMCKI 001	8621-14	*A0*
Encl. 4	'H'-Horizon.	1:50 000	BUMCKI 002	8621-15	*A0*
Encl. 5	'C-H' time interval.	1:50 000	BUMCKI 009	8621-16	*A0*
Encl. 6	'C-V' time interval.	1:50 000	BUMCKI 011	8621-17	*A0*

CONTENTS OF VOLUME THREE

		MESA NO.
REPORTS:	**McColl, D., 1982.** Petrographic thin section descriptions of 76 selected Jurassic sandstone drill core and cuttings samples from wells Strzelecki 3 and 4, Mudera 1, Mudlalee 2, Murteree 1, Narcoonowie 1 and Pelketa 1 (Amdel Ltd contractor's report no. GS 4070/82 for SADME, 10/3/82).	**8621 R 9** Pgs 225-302
	Farrand, M., 1982. Petrographic thin section descriptions of 78 selected Jurassic sandstone drill core and cuttings samples from wells Beanbush 1, Packsaddle 3, Welcome Lake 1 and Cuttapirrie 1, plus results of the determination of sedimentary depositional facing from microlithological observations of rock textural characteristics in nominated core samples (Amdel Ltd contractor's report no. F 4590/82 for SADME, 6/5/82).	**8621 R 10** Pgs 303-336

CONTENTS OF VOLUME FOUR

REPORT:	**Royle, G., 1988.** Preliminary evaluation of Eromanga Basin seals [Oil Project 88-12] (Santos Ltd, 27/10/88).			**8621 R 11** [15 pages]	
PLANS		**Scale**	**Company plan no.**		
Encl. 1	Regional distribution of the Poolowanna Formation, Cooper Basin (SA portion).	1:250 000	COOSEC 046	8621-24	*>A0*
Encl. 2	Regional distribution of the Birkhead Formation (Facies 1), Cooper Basin [SA portion].	1:250 000	COOSEC 045	8621-25	*>A0*
Encl. 3	Regional distribution of the Birkhead Formation (Facies 2), Cooper Basin [SA portion].	1:250 000	COOSEC 047	8621-26	*>A0*

END OF CONTENTS

REGIONAL ISOPACH MAPS OF THE JURASSIC SEQUENCE IN THE EROMANGA BASIN: A PRELIMINARY APPROACH

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March, 1985.
MG/111/5

CONTENTS

Contents (Continued)

INTRODUCTION

The enclosed 5 maps were prepared by J.W. Hunt in collaboration with members of the Regional Studies and Exploration Teams, to illustrate spatial and temporal patterns of regional structural growth history in the Eromanga Basin sequence. They are not intended to serve as a tool for local appraisal and would need to be further refined against detailed well and seismic control for this purpose. A 1:1,000,000 scale isopach map of the Cadna-owie Formation/Transition beds has previously been prepared for the Eromanga Basin east of longitude 138^{0} (Drwg. 82XG - 0982 - C. Castro)

METHOD

1) The isopachs are based mainly on formation picks appearing in the Delhi data base constrained where possible by palynological data.

2) The southern Cooper Basin area (Enclosure 1) was worked at a scale of 1:250,000 and the resultant isopach reduced to a scale of 1:1,000,000.

3) Obvious anomalies and discrepancies in the data base have been resolved, and any significant changes marked on a computer printout of the relevant formation tops and thicknesses. Additional picks have been made where necessary and similarly recorded. Revised formation tops shown in several cross-sections currently in preparation by D. Johnstone and P. Stanmore, are also reflected in the isopachs.

4) Initial isopach contours, based on well control only, have been modified to reflect structural growth apparent in the several isochron and time structure maps identified in Enclosure 1.

5) The structural elements of a Nappamerri Formation isopach map east of longitude 138^{0} (Enclosure 1)(C. Castro - currently in drafting) are also reflected in the overlying formations. Permo-Triassic faults are generally assumed not to penetrate the overlying sequences, but may be reflected by thinning and drape.

RELIABILITY

(A) Eromanga Basin - Pedirka Sector.

Isopachs have been modified to agree with formation tops shown in cross-sections of the Jurassic sequence in the Pedirka and western Cooper Sectors (prepared by D. Johnstone and P. Stanmore - currently in drafting). Away from well control, isopachs reflect the general trends apparent in the C-J1 (top Cadna-owie Fm to top Poolowanna Formation) isochron map and C time structure maps (Enclosure 1). The top Hutton and Birkhead horizons have been picked mainly on the basis of sonic character, but the horizons are uncertain west of Macumba 1 and correlation with the Cooper Sector is equivocal. A base Murta time-equivalent horizon has not been picked across the Poolowanna Trough. Thus the isopach map of

Namur Sandstone + Westbourne Formation + Adori Sandstone (Enclosure 5) is likely to be up to 100 feet thicker (on a time equivalent basis) over the Poolowanna Trough, compared with the same interval over the Cooper Basin. However this does not affect the overall relationships apparent in the interval.

The Wallumbilla Formation interval has only been partly contoured in the Pedirka Sector because of the ?anomalously high isopach contour gradient on the Birdsville Track Ridge (BTR). Two significant gamma anomalies, 300 feet apart, are present in Koonchera 1 and Poonarunna 1; the upper anomaly is currently considered to correlate with the Toolebuc Formation.

Palynological data (A. Williams, Delhi Petroleum) in Poonarunna 1 in the south (sidewall core) imply that the Birkhead Formation overlies basement in that well, and this is reflected in the isopach patterns of Enclosures 2 to 5. These patterns suggest a complicated structural history in that area because a presumed pre-Birkhead Formation basement high is superseded by a depocentre, (possibly very localised on seismic evidence) equal in thickness to the Poolowanna Trough.

An alternative pattern of deposition in the Pedirka sector, based on a log-equivalent correlation (which ignores the palynological control of Poonarunna 1) is shown in Figures 1 to 4. Seismic work in the Pedirka Sector in 1985 should resolve this problem. An optimistic view of the extent of the shaly Birkhead Formation facies has been taken in Enclosure 4.

B. Eromanga Basin - Cooper Sector

a) C-H map (Enclosure 2). This map is considered to be the most reliable because of the consistency of the top Cadna-owie Formation pick and the thickness of the isopach interval compared with uncertainty in the top Hutton pick.

b) Hutton + Poolowanna map (Enclosure 3). Many older picks in the data base do not reflect the position of the Jurassic/Triassic boundary suggested by palynological data in the Patchawarra Trough area, where the Upper Triassic is now interpreted to be thick. The isopach is based on picks consistent with those in regional cross-sections (in drafting) by F. Ariesen, P. Stanmore and D. Johnstone and data base values may be thick by up to 100 feet. An uncertainty up to 50 feet may be present in the top Hutton Sandstone pick when sandy Birkhead facies are present. Generally the top of the sands showing a blocky character on the gamma log has been taken as the top of the Hutton, consistent with regional cross sections of F. Ariesen.

c) Birkhead map (Enclosure 4). Because of the uncertainty associated with the Hutton/Birkhead boundary compared with the thickness of the Birkhead Formation, this isopach may in future be subject to significant local revision. The boundary with the overlying Adori Sandstone is generally more reliable.

d) Namur + Westbourne + Adori map (Enclosure 5). The top and base of this interval are generally well defined except towards the basin margin where shaly facies are poorly developed. Uncertainties associated with the boundaries are probably small compared with the thickness of the interval and the map is considered to be reliable at the regional scale.

e) Wallumbilla and Coorikiana + Mackunda map (Enclosure 6). The top and base of the Wallumbilla Formation are generally well defined in the Cooper Basin sector. However on the Birdsville Track Ridge there is a large gradient between Koonchera 1, where two gamma anomalies are present, and Pandieburra 1 where only one anomaly is present. Several causes may be proposed to account for the high gradient including erosion or miscorrelation of the gamma anomalies on the ridge. This area has been left uncontoured until further evidence can be brought to bear on the problem.

The top and base of the Coorikiana + Bulldog interval in the southern Cooper Basin sector are generally well constrained.

DISCUSSION

The main feature of the isopach maps is the continuing influence of Permian structures in the overlying Jurassic/Cretaceous sequence.

a) C-H map (Enclosure 2)

The C-H map shows a regional pattern of structural growth in the Eromanga Basin following deposition of the major Jurassic reservoir of the Hutton Sandstone. It is essentially a map of structure on top of the Hutton Sandstone (H horizon) following deposition of the Cadna-owie Formation (C horizon). The C-H map is therefore useful in assessing regional migration pathways in the Hutton Sandstone, prior to Tertiary deformation. The fact that sandy facies correlatives, referable to the Birkhead Formation may have been excluded means that the C-H map essentially shows structure on top of porosity, and is therefore a true reflection of migration opportunities.

i) South Australia

The main troughs in South Australia capable of significant hydrocarbon generation are the Nappamerri, Patchawarra and Poolowanna Troughs. Updip from the Nappamerri Trough to the NW is the Gidgealpa-Merrimelia-Innamincka (GMI) ridge which is best defined and structurally higher to the SW. This suggests that the main potential for regional migration and trapping in the Hutton was in the Merrimelia/Gidgealpa area and possibly to the SW (Spencer region). Conversely the fact that the Innamincka area was structurally lower may also account for the lack of accumulations in that area.
Updip areas from the Nappamerri Trough to the SW are the NE trending Della-Nappacoongee high and the Murteree

Horst. If long distance migration from the Nappamerri Trough contributed to oil accumulations located on these trends then areas further to the SW may also be prospective given an adequate seal (Enclosure 4).
The Patchawarra Trough is considered to be less mature and to have generated fewer hydrocarbons than the Nappamerri Trough. The GMI trend was also favourably located to receive hydrocarbons migrating to the SE from the Patchawarra Trough.
Given the interpreted regional thinning onto the Birdsville Track Ridge a migration pathway (beyond Koonchera) to the Mulka block (Mungaranie area) in the SW is also hypothesised. To the NW data are sparse. However updip migration in this direction may have led to trapping in the northern BTR Block.
Although significant hydrocarbon generation probably took place in the Poolowanna Trough, the absence of a Birkhead seal over much of the area downgrades the potential of the Hutton level in the Poolowanna Block, particularly to the west. To the SE migration onto the Birdsville Track Ridge and trapping in updip areas to the SW may have taken place depending on the western limit of shaly Birkhead facies as a seal (Enclosure 4). Updip migration from the smaller trough shown at Poonarunna would also upgrade the prospectivity of the BTR and Miamiana-Miandana trend and areas to the south, depending on the presence of a seal.

ii) Queensland

The Nappamerri and Windorah Troughs are the major troughs capable of significant hydrocarbon generation in Queensland. The Pepita-Naccowlah-Jackson (PNJ) trend is updip from the Nappamerri Trough to the NE. Regional migration would have favoured hydrocarbon accumulations in the Hutton Sandstone to the SE end of this trend in the Jackson area, where the structure is higher and better defined. To the SE of the Nappamerri Trough a gentler dip out of the basin is present based on sparse data. To the south hydrocarbons would have been channeled through the north-trending Orientos nose,then southwards to the NE-SW cross-trending Roseneath-Ashby-Wolgolla and Sigma-Tickalara wrench trends. However these trends are subtle and are not apparent on the regional maps.
The C-H thin at Lambda is probably due to onlap of the Hutton on post-Nappamerri volcanics and thus the possibility exists for pinchout plays in the Hutton on the flanks of the structure.
Several strong updip trends from the Windorah Trough to the SE are apparent in Enclosure 2. However definition of the potential for trapping on these trends and the potential of areas to the NW requires better control than has been used to create these maps.

b) Hutton + Poolowanna Map (Enclosure 3)

Enclosure 3 shows the early post-Triassic development of the basin and was created for the combined interval because of difficulties in locating a Hutton/Poolowanna boundary.

i) South Australia

A feature of this map, which is not apparent in the overlying C-H map is the subdued relief of the Nappamerri Trough compared with the Poolowanna Trough, although the GMI trend is still developed. Major source beds were deposited in the Poolowanna and Patchawarra Troughs at this time. Regional thinning to the SE in the Cooper Sector is apparent in this interval. Early growth is shown on the NNW trending Miandana-Miamiana feature which extends southwards into the Lake Eyre Block. Thinning and onlap of the interval onto the Birdsville Track Ridge may also provide pinchout plays for the trapping of early generated hydrocarbons depending on the distribution of the Hutton, Poolowanna and Birkhead Formations in that area.

ii) Queensland

Early growth over the southern Cooper Basin is more subdued than in the overlying C-H interval, although the PNJ trend and Orientos nose are both present. Much stronger growth is shown adjacent to the Windorah Trough, but further work is required to confirm formation picks in this area.

c) Other isopach maps (Enclosures 4 - 6)

The importance of the spatial distribution of the Birkhead Formation shaly facies (Enclosure 4) has previously been discussed in relation to sealing Hutton hydrocarbon accumulations in the eastern Pedirka Sector. Structural growth in the Birkhead interval closely parallels that shown in the underlying Hutton + Poolowanna interval, except that the Nappamerri Trough is better defined.
The pattern of thickness variation shown in the Wallumbilla interval (Enclosure 6) varies significantly from the underlying C-H interval, because of the absence of the Windorah Trough and a high gradient between Koonchera 1 and Pandieburra 1 on the Birdsville Track Ridge. This raises the possibility that the spatial variation may be due to a factor other than growth. Several possibilities which could be considered are:

1) a change in the pattern of structural growth;
2) an hiatus to the NW within the Wallumbilla Formation;
3) the presence of high gamma response shales at several horizons and
4) the high gamma response may not be stratigraphically controlled.

CONCLUSIONS

Enclosures 2 to 6 provide a basis for predicting regional migration pathways in the major Jurassic reservoir prior to Tertiary deformation. Of these, the C-H map is the most useful for this purpose because it shows structure on the top of the Hutton Sandstone following deposition of the Cadna-owie Formation.

i) South Australia

The SW end of the GMI trend and SW Cooper Basin area in general was favourably located both with respect to early generation and trapping, and medium to long range migration. Similar significant potential may also exist on the southern extension of the Birdsville Track Ridge in the Mulka Block. Potential to the north on the Birdsville Track Ridge is poorly defined on the basis of present data.

ii) Queensland

The eastern end of the PNJ trend and Orientos nose to the south emerge as persistent high trends with early growth. Adjacent to the Windorah Trough in the north, the SE end of several SE trending features are also considered to be prospective on the same grounds.

FURTHER WORK

Improvement of the maps in areas away from close well control could be achieved by the Regional Studies Group using selective seismic control. The present contour interval of 100 feet represents about 25 millisecs equivalent 2 way time on a seismic section. To work the area at a 50 feet contour interval would require geophysical control accurate to about 10 millisecs. Such mapping is currently not available for other than the C seismic horizon on a regional basis and would be difficult to produce in the short term, given that the maps would need to be accurate as well as precise.

FIGURES 1 TO 4

Figures 1 to 4 show a pattern of growth in the southern Pedirka sector based on an alternative stratigraphy in Poonarunna 1. This stratigraphy is based on sonic log equivalent picks and infers that the basal shaly section is a correlative of the Poolowanna Formation and not the Birkhead Formation; the latter view is supported by palynological data. The sonic log equivalent interpretation of the stratigraphy in Poonarunna 1 is documented in Drawing 80XG - 0288.

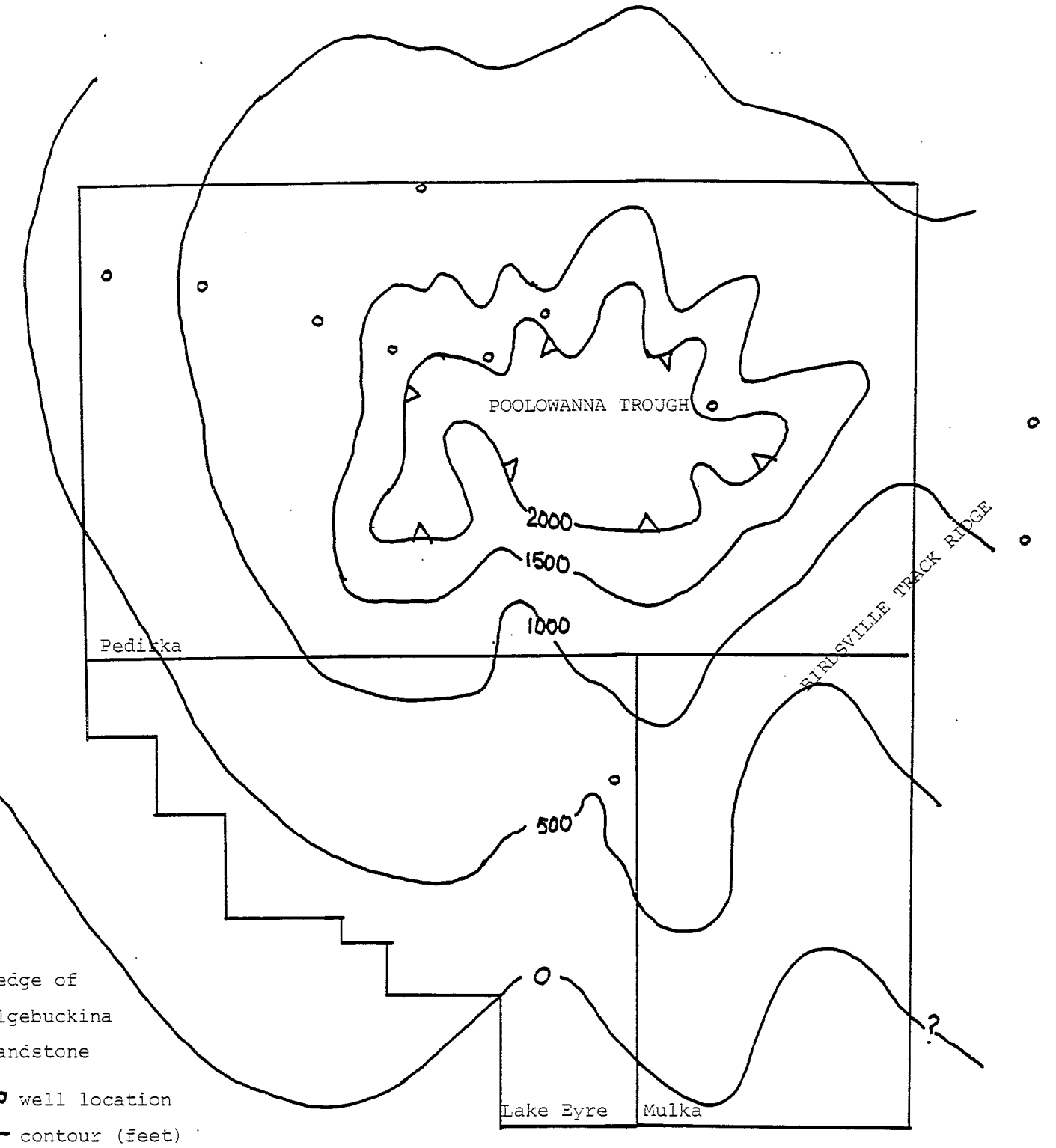


FIGURE 1

ISOPACH

POOLOWANNA FORMATION

(BASAL JURASSIC) +

HUTTON SANDSTONE

(log equivalent picks) J. Hunt, 1985

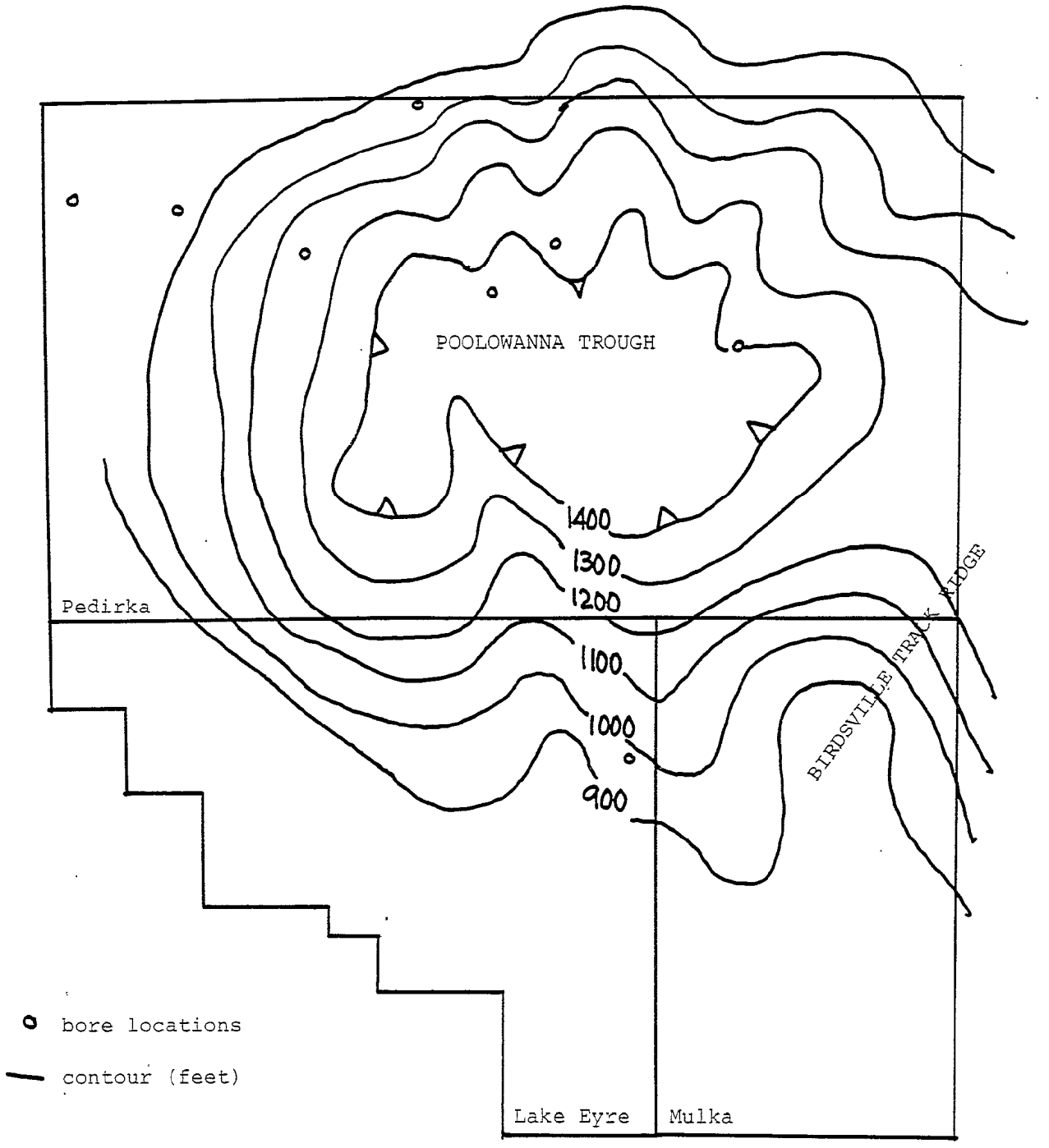


FIGURE 2

ISOPACH

C - H INTERVAL

(log equivalent picks) J. Hunt. 1985

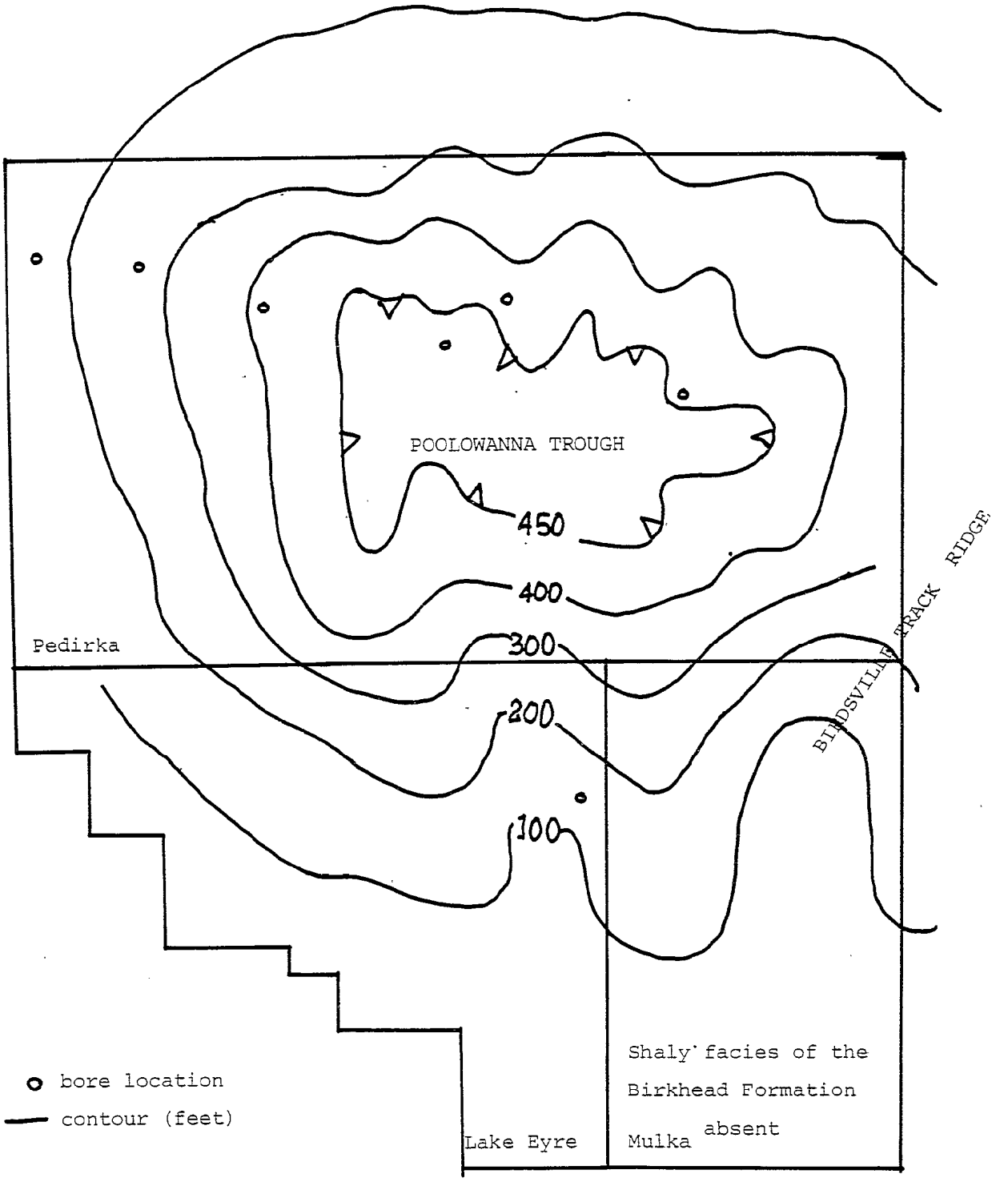


FIGURE 3

ISOPACH

BIRKHEAD FORMATION

CORRELATIVES

(log equivalent picks) J. Hunt, March. 1985

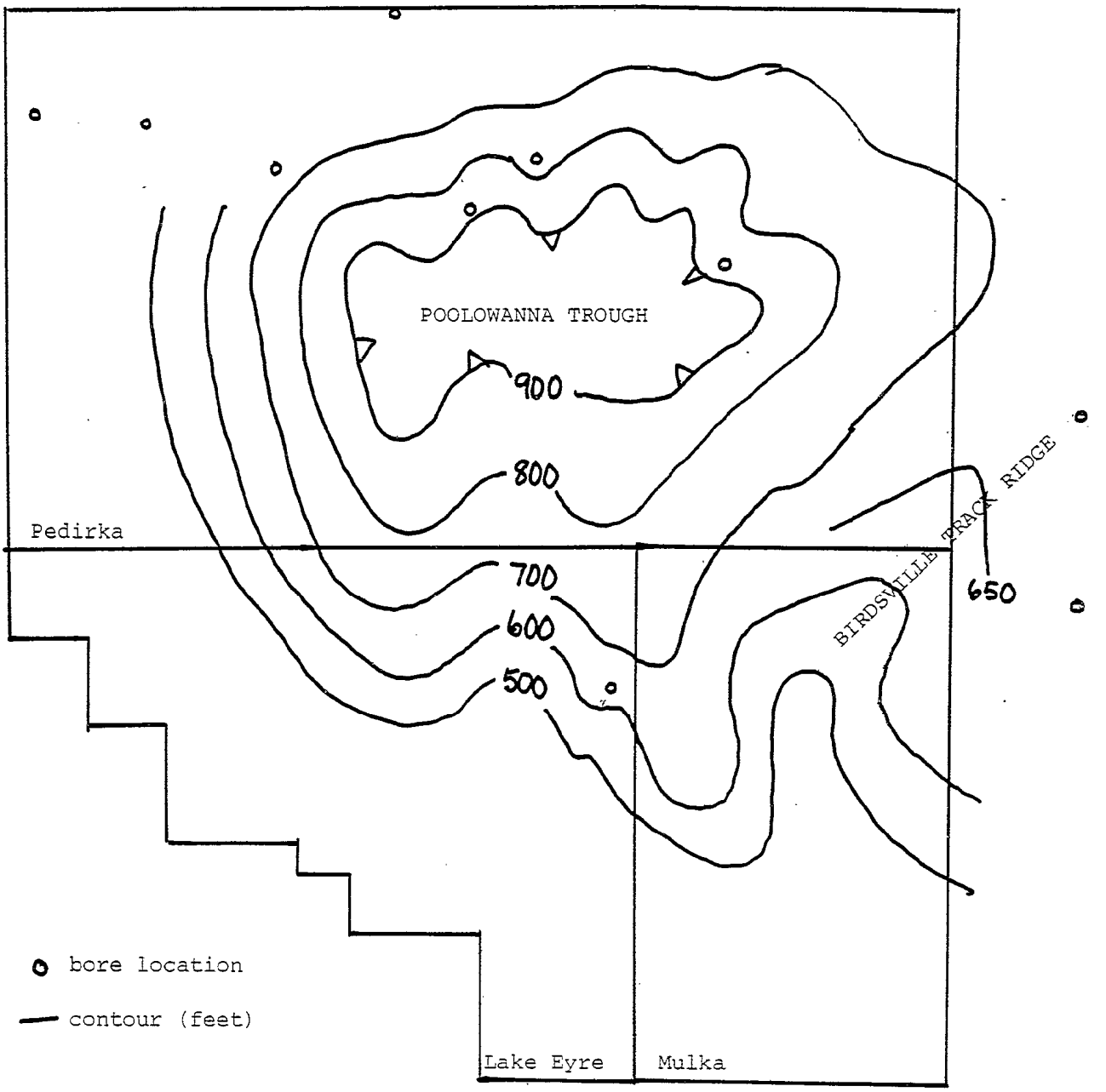


FIGURE 4

ISOPACH

NAMUR SANDSTONE +

WESTBOURNE FORMATION +

ADORI SANDSTONE

(log equivalent picks) J. Hunt, March, 1985

24 00 00S

5 : C time structure, Dwg 84XP-3015

6 : Jl time structure, Dwg 84XP-3016,

7 : C to Jl isochron, Dwg 84XP-3017

8 : C time structure, Dwg 85XP-3820

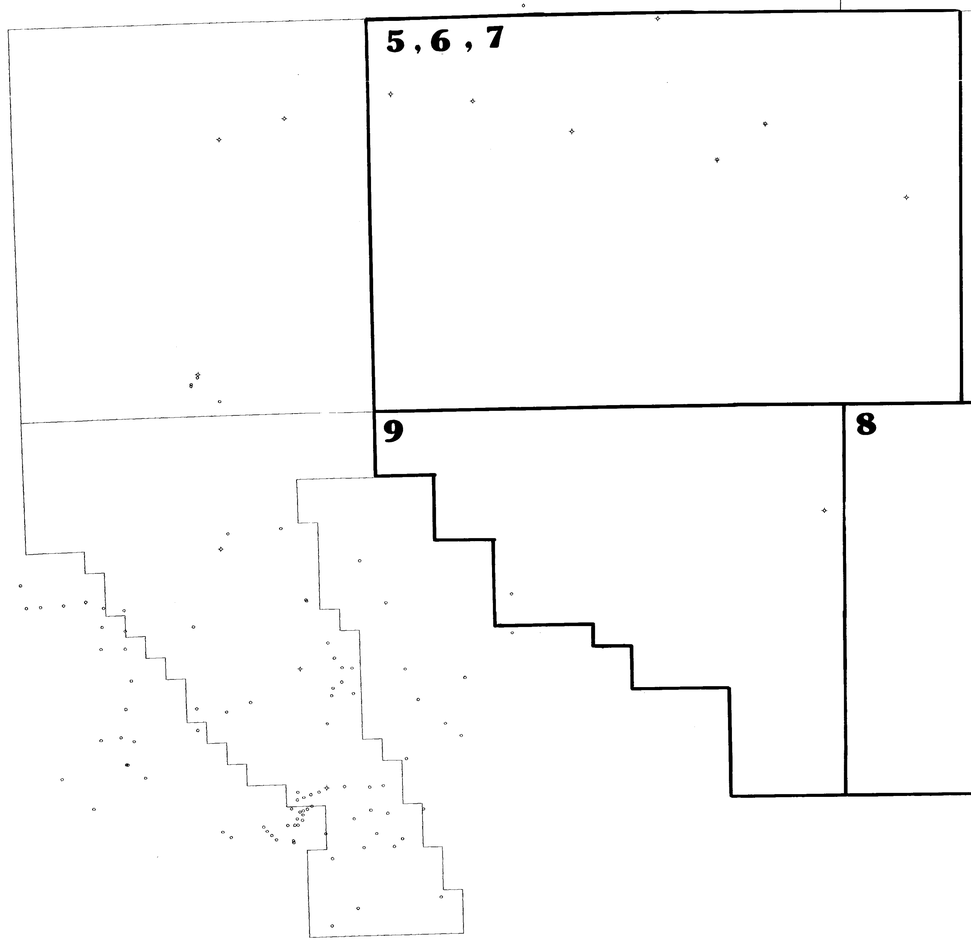
9 : C time structure, Dwg 85XP-38239

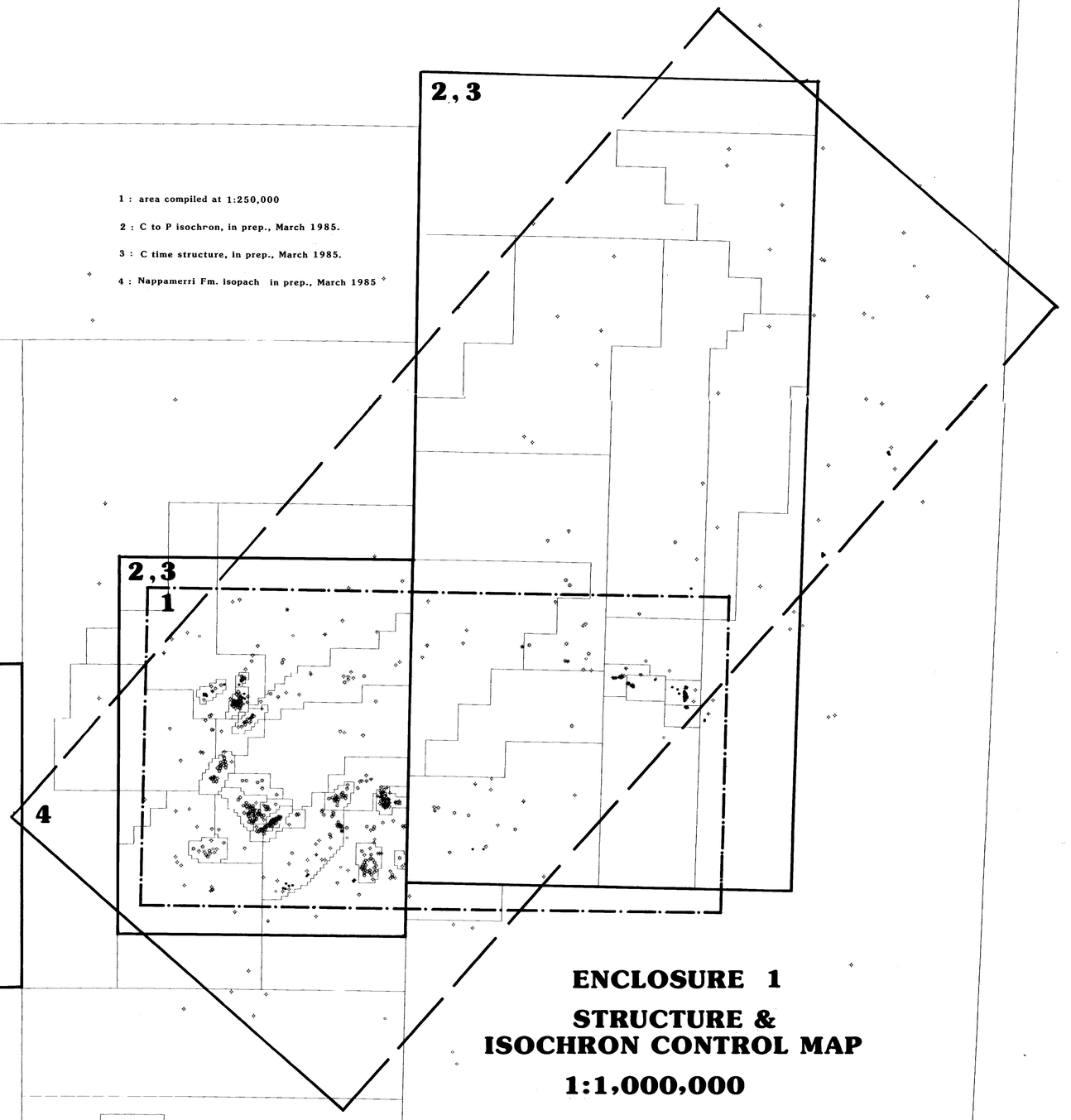
1 : area compiled at 1:250,000

2 : C to P isochron, in prep., March 1985.

3 : C time structure, in prep., March 1985.

4 : Nappamerri Fm. isopach in prep., March 1985





ENCLOSURE 1

STRUCTURE & ISOCHRON CONTROL MAP

1:1,000,000

Compiled by J. Hunt, DELHI PETROLEUM, March 1985.

30 00 00S

134 00 00E

144 00 00E

24 00 00S

POOLOWANNA TROUGH

Correlatives based on sonic log equivalent picks

BIRDSVILLE TRACK RIDGE

WIENDARAH TROUGH

PATCHAWARRA TROUGH

NAPPAMERRI TROUGH

Koonchera

ENCLOSURE 2
ISOPACH
C - H INTERVAL
1:1,000,000

Contour interval in feet

Based on well control and C time structure

Interpreted by J. Hunt, DELHI PETROLEUM, March 1985.

30 00 00S

134 00 00E

144 00 00E

8621-19

POOLOWANNA TROUGH

Correlatives based on sonic log equivalent picks

BIRDSVILLE TRACK RIDGE

WANDORAH TROUGH

Koonchera

Zero edge of Algebuckina Sandstone

ENCLOSURE 3
ISOPACH

POOLOWANNA FORMATION (BASAL JURASSIC) • HUTTON SST. & CORRELATIVES 1:1,000,000

Based on well control and C time structure

Contour interval in Feet

Interpreted by J. Hunt, DELHI PETROLEUM, March 1985.

8621-20

30 00 00S

134 00 00E

144 00 00E

94.1 cms reduced to 27.9 cms.

24 00 00S

POOLOWANNA TROUGH

Correlatives based on sonic log equivalent picks

sandy facies

Limit of shaly facies

BRUSVILLE TRACK RIDGE

PATCHAWARRA TROUGH

NAPPAMERRI TROUGH

WINDORAH TROUGH

MURTEE HIGH

Koonchera

ENCLOSURE 4
ISOPACH

BIRKHEAD FORMATION & CORRELATIVES
1:1,000,000

Contour interval in Feet

Based on well control and C time structure

Interpreted by J. Hunt, DELHI PETROLEUM, March 1985.

8621-21

30 00 00S
134 00 00E
144 00 00E

134 00 00E

POOLOWANNA TROUGH

Correlatives based on sonic log equivalent picks

BROOKVILLE TRACK RIDGE

WANDOAN TROUGH

PANCHAWARRA TROUGH

NAPPAMERRI TROUGH

MOUNTAIN HORST

ENCLOSURE 5

ISOPACH

NAMUR SST.
• WESTBOURNE FM.
• ADORI SST.
& CORRELATIVES

1:1,000,000

Contour interval in feet

Based on well control and C time structure

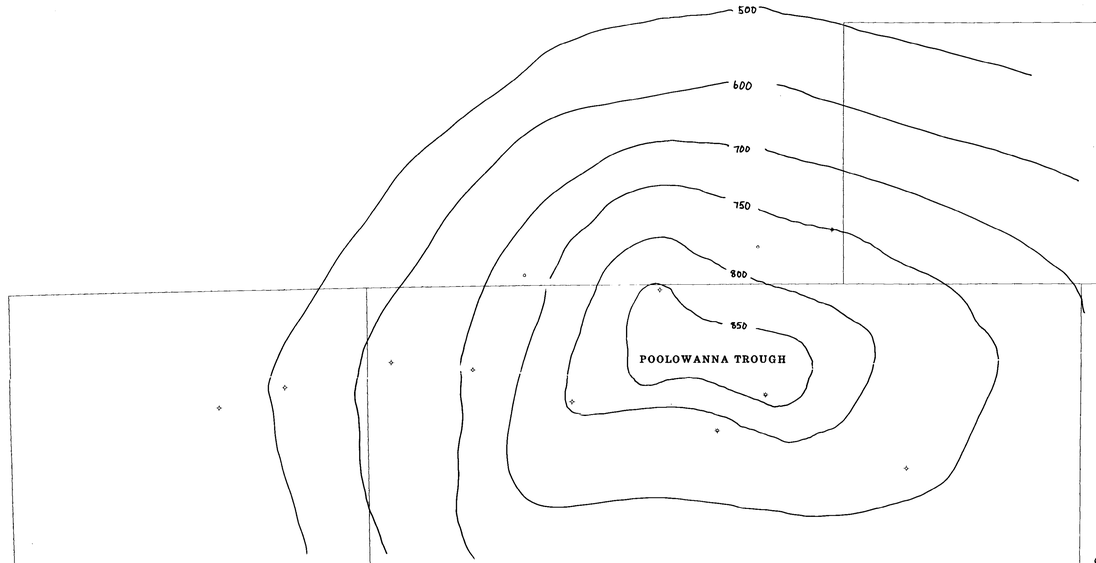
Interpreted by J. Hunt, DELHI PETROLEUM, March 1985.

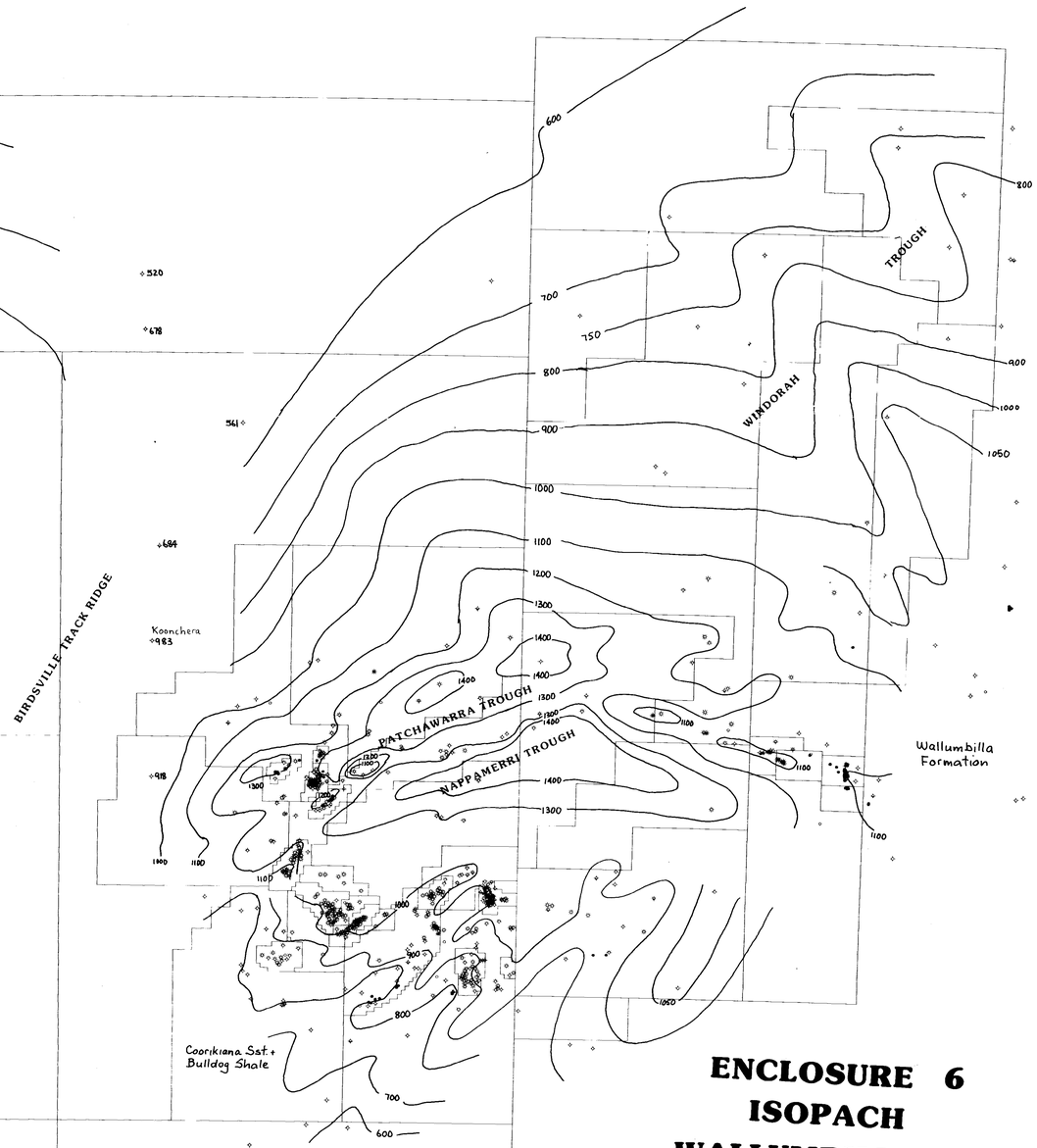
8621-22

144 00 00E

24 00 00S

Correlatives based on sonic log equivalent picks





ENCLOSURE 6
ISOPACH
WALLUMBILLA FM. & COORIKIANA SST. + BULLDOG SHALE & CORRELATIVES
1:1,000,000

Contour interval in feet

Based on well control and C time structure

Interpreted by J. Hunt, DELHI PETROLEUM, March 1985.

8621-23

30 00 00S

134 00 00E

144 00 00E