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OEL 20 AND OEL 21, PEL 5 AND PEL 6

REGIONAL GEOLOGICAL STUDIES

TECHNICAL REPORTS AND DATA

Submitted by

Delhi International Oil Corp., Delhi Petroleum Pty Ltd and Santos Ltd
1993

Enquiries: Customer Services
Ground Floor
101 Grenfell Street, Adelaide 5000

Telephone: (08) 8463 3000
Facsimile: (08) 8204 1880

PRIMARY INDUSTRIES AND RESOURCES SA

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TENEMENT: OELs 20 and 21; PELs 5 and 6

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RESERVOIR DEVELOPMENT OF THE TIRRAWARRA SANDSTONE AND PATCHAWARRA FORMATION IN THE CENTRAL PATCHAWARRA TROUGH

(Oil Project 89-10)

By

G. AMBROSE

Volume 1 of 2

TEXT

Date: March, 1990

ABSTRACT

This study concentrates on the reservoir distribution within the Patchawarra Formation and Tirrawarra Sandstone in the area of the Central Patchawarra Trough. Reservoir trends are based on facies modelling and regional net and gross sand maps all of which will provide a valuable guide in future exploration efforts. The Patchawarra Formation was reviewed in the context of a five-fold stratigraphic subdivision based on regionally correlatable coals while the Tirrawarra Sandstone was treated, in a regional sense, as a sheet sand.

The reservoir potential of the Patchawarra sub-units summarises both facies and structural controls, and reservoir distribution is shown on net and gross sand maps. Reservoir potential decreases from the southwestern portion of the study area to the northeast due to a combination of:

1. a thinner sedimentary section with reduced gross sand; and

2. lower net/gross sand ratios due to both depth of burial and facies variations.

Overall, the predicted gas potential of existing prospects has increased as a result of higher net sand counts. In the relevant portion of the Patchawarra East Block well data from several fields indicate that the reservoir potential of the Patchawarra is fairly low; the most attractive prospects in this area are Pennie and Tallerangie. Sand quality improves in the Patchawarra Central Block, where the best plays occur on the western flank (Yasmin) and to a lesser extent in the trough area (eg. Grey). In the Merrimelia-Innamincka Block net sand counts are also high and the most attractive prospects are Coopers Creek (updip) and Cooba. The plays in the Patchawarra Southwest Block have high net sand counts, but lower potential pay based on the results of Nulla 1 where only 18% of the total net sand can be mapped as pay. Deeper into the basin the ratio of net sand to net pay increases.

A study of existing fields (Patchawarra reservoirs) reveals most are filled very close to spill and hence possible gas is generally restricted to a halo around the edge of structures, thereby often negating the need for appraisal drilling. Those areas with possible reserves requiring appraisal

are the Kanowana Field and possibly Fly Lake-Brolga. In addition there is gas potential to the south of Tirrawarra Field in the Gooranie area; this region lies above possible LKG's, but reservoir development is a major constraint.

Stratigraphic plays, at the Patchawarra level, have been considered in the context of net sand development in crestal locations combined with the degree of down flank thickening related to structural growth. The aim is the definition of down flank traps with viable reservoir development. The most favourable reservoirs (fluvial) occur in the 'V_2'-'Vc' interval which should be targeted for down flank stratigraphic plays. Conversely, the 'V'-'V_2' and 'Vc'-'W' isochrons relate to dominantly delta plain facies with relatively sparse reservoir development. Structures in the study area which exhibit most growth are Tirrawarra, Moorari-Woolkina, Fly Lake-Brolga, Coonatie, Kudrieke and Andree-Leleptian. Net sand development is highest in the southern portion of the study area (eg. Andree-Leleptian) while to the north (eg. Kudrieke, Mitchie, Lake MacMillan and Coonatie) net sand development is a major constraint and stratigraphic potential is downgraded. Additional scope for stratigraphic traps within the Patchawarra Formation occurs on the northwestern flank of the Patchawarra Trough and on the southerly plunging nose of the Merrimelia High.

Reservoir development in the Tirrawarra Sandstone is closely related to gross sand development and depth of burial. Gross sand thickness is closely related to formation thickness while net sand trends are controlled by a combination of gross sand development and structure. The thickest net sand trends occur over the Tirrawarra Field and the southern portion of the Merrimelia nose due to a combination of depositional facies and structural setting. Within the study area, Tirrawarra Sandstone reservoir development is largely restricted to the Patchawarra Central and Merrimelia-Innamincka Blocks. In Patchawarra Central the most attractive Tirrawarra play is the Yasmin prospect (0.32 mmbl reserves) on the western flank of the trough. In the Merrimelia-Innamincka Block the Cassia and Cooba prospects (1.3 and 0.17 mmbl of reserves respectively) are the most attractive in terms of anticipated net pay and potential reserves. Other areas prospective at this level are the southerly plunging nose of the Merrimelia High and the southern limits of the Tirrawarra Field.

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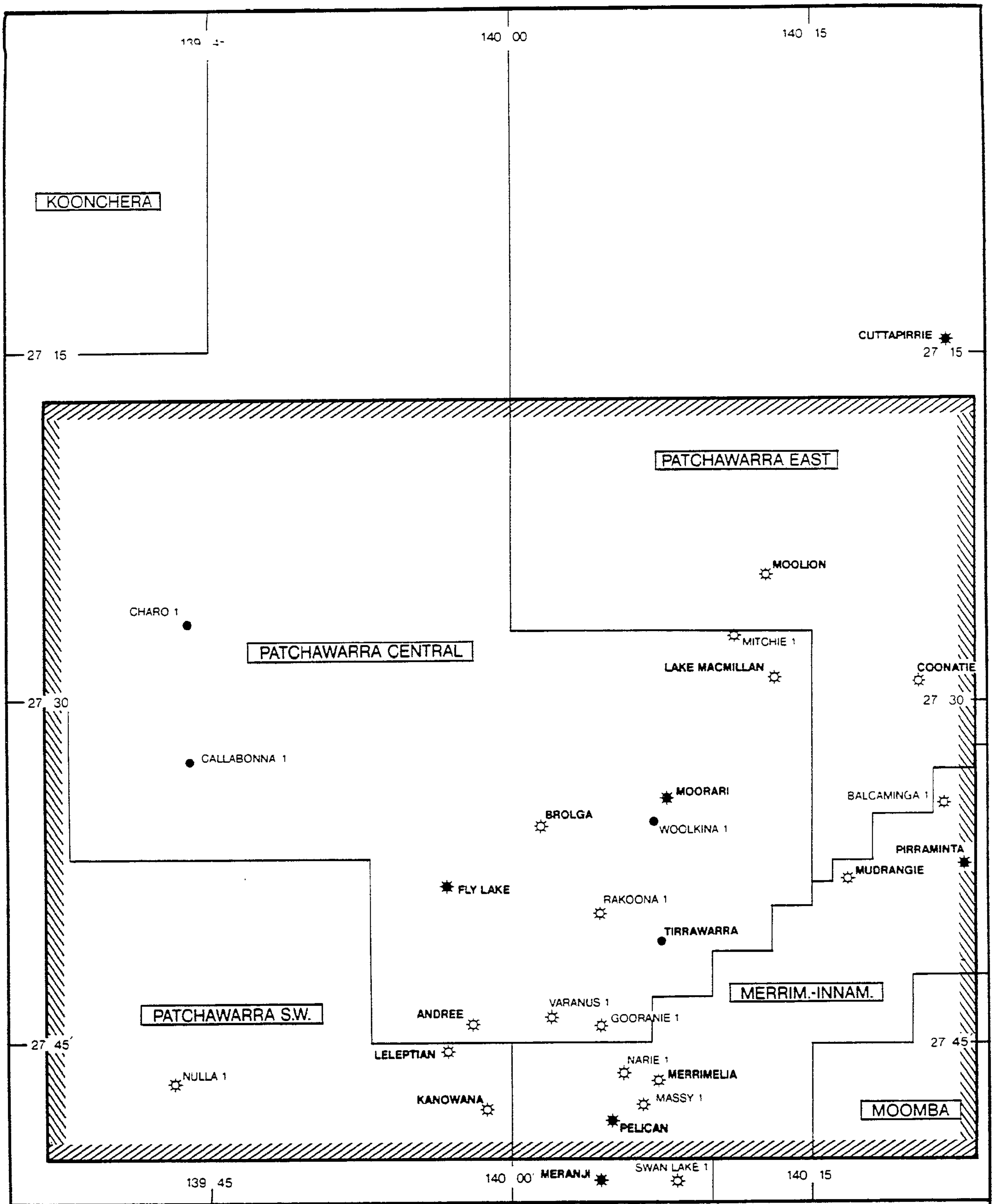
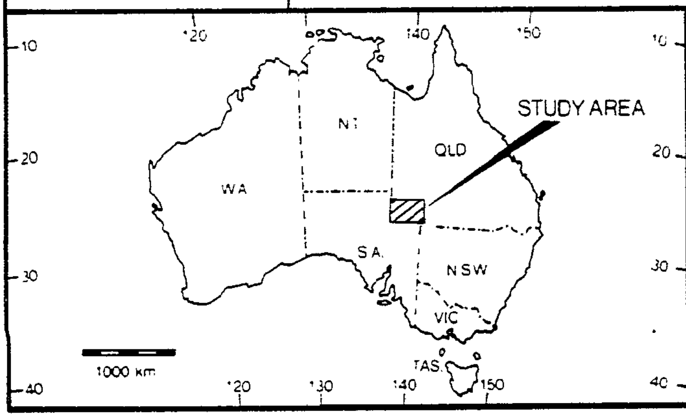
1. INTRODUCTION

This study reviews the reservoir development of the lower Permian Tirrawarra Sandstone and Patchawarra Formation in the central Patchawarra Trough. The study area is concentrated in the Patchawarra Central Block but also impinges on the Patchawarra Southwest, Patchawarra East and Merrimelia-Innamincka Blocks (Figure 1). This area includes numerous oil and gas discoveries concentrated toward the central portion of the trough and its significance is demonstrated by the fact that the oil reservoired in the Tirrawarra Sandstone in the Patchawarra Central Block makes up 40% of the total volume of oil known from all oil reservoirs in PEL's 5 and 6. Also in this area there are significant reserves of liquids-rich gas largely concentrated in the Patchawarra Formation.

Only a few small structural plays exist between the generative kitchen, associated with the central portion of the trough, and the western edge of the Cooper Basin. However if suitable traps can be delineated hydrocarbon charge is almost assured. Evidence that hydrocarbon migration can occur is provided by Cuttapirrie 1 (in Patchawarra East) which flowed 4 mmcfd from the Patchawarra Formation. Further evidence can be drawn from the fact that the Tirrawarra Sandstone is apparently full to spill in the Tirrawarra Field and updip migration of some oil towards the flank is likely. The main aim of this study is to determine the geographic distribution of commercial lower Permian reservoirs (ie. Tirrawarra, Patchawarra) in the study area and to develop depositional models which will aid the process of commercial reservoir prediction.

A recent study by SAOGC (1988) aimed at outlining the prospectivity of the Tirrawarra Sandstone and Patchawarra Formation in the Patchawarra Central Block. The report extracted information from the densely drilled Patchawarra Trough and projected this to the relatively sparsely drilled western flank. This study has a similar approach but is more expansive in the area of reservoir development and its implications for further exploration. The work was focussed mainly in the trough area where the bulk of data is concentrated.





SANTOS LIMITED

S.A. EXPLORATION

P.E.L. 5&6

LOCATION MAP

STUDY AREA

10 KM

Original Scale		Drafted GJK	Fig. 1
Date DEC 1989		Author G.Ambrose	

PATCEN 021

2. REGIONAL SETTING

The basic components of the study area are the Patchawarra Trough and the associated western flank. The Patchawarra Trough is a Permo-Triassic, assymetric sub-basin of the Cooper Basin located northwest of the Gidgealpa-Merrimelia-Innamincka (G.M.I.) Anticlinal complex. Within the Patchawarra Central Block the trough is split by two prominent ridges, namely the Fly Lake-Brolga and Tirrawarra-Mitchie Trends, both of which exhibit growth, probably via drape and compaction, during Patchawarra time. The trough formed as part of regional downwarping of pre-existing basement lithologies and the formation of intra-cratonic rift-like grabens and half-grabens during the Late Carboniferous (Kanstler et al., 1983). Sedimentation was continuous from the early Permian to the mid-Triassic except for a period of uplift and erosion near the end of early Permian time. This uplift was associated with the Daralingie Unconformity and was responsible for the first major expression of the G.M.I. Trend in the study area. The Tirrawarra and Patchawarra sequences are variably eroded from the G.M.I. trend contrasting with the Patchawarra Trough where Cooper Basin thicknesses exceed 2400 ft. The western flank records a history of slow subsidence and sedimentation with associated gentle basinward flexuring and basin margin disconformities. An increasingly abbreviated Permian section is preserved towards the basin margin as successive unconformity surfaces converge. The most important unconformities are those associated with the Daralingie erosional event and the mid-late Triassic uplift.

This report concentrates on the geology of the Tirrawarra Sandstone and the Patchawarra Formation and a summary description of these units follows.

The Tirrawarra Sandstone is a braided fluvial unit of early Permian age which interdigitates with the underlying, glacial Merrimelia Formation (Williams and Wild, 1984). Thick multistory channel sandstones, of quartz arenite composition, characterise the sequence which in part comprises reworked Merrimelia Formation. Sheet like sands were deposited by braided streams probably located down palaeoslope from supra-glacial outwash fans. The Tirrawarra isopach gradually increases from the basin edge to over 200 ft in the centre of the trough. The overlying Patchawarra Formation (Gatehouse, 1972) comprises interbedded channel lag conglomerates, massive cross-bedded and laminated sandstones, overbank lacustrine siltstones and shales, together with abandoned chute, backswamp and shallow lake coals. Thickness gradually increases from the basin edge to 1300 ft in the centre of the trough. Palaeoenvironment varies up through the sequence from lower delta plain, to coal swamp-fluvial channel (high sinuosity), to coal swamp fluvial channel (low sinuousity), to lower delta plain and finally delta front-lacustrine.

3. METHODOLOGY

Over one hundred and twenty wells have penetrated the Permian section in the study area. Greater than fifty percent are located in the Tirrawarra Field with the remainder sited on highs near this field and generally confined to highs in the thick axial regions of the trough. Electric logs and cores from these wells were used to determine the vertical lithological and sedimentological succession of the early Permian sequence.

To achieve the main aim of this report, ie., the resolution of reservoir trends in the early Permian, it was necessary to subdivide the sequence into viable stratigraphic units (Figure 2). The Tirrawarra Sandstone, although comprising several different facies was treated as a single unit. The Patchawarra Formation was divided into five stratigraphic subunits each comprising one or more cycles of clastic sedimentation intervening between relatively thick and extensive coal seams. The Patchawarra subdivision was based on regional cross-sections incorporating all the wells in the study area although only strategic wells were taken from the Tirrawarra Field. Formation tops and subunit tops are shown on the accompanying cross-sections (Enclosures 26 and 27) and the data is tabulated in Table 11.

Reservoir data has been collated for all the wells listed in Table 11 with gross sand, net sand and isopach maps prepared for each of the Patchawarra subunits and also the Tirrawarra Sandstone. Reservoir trends were compiled from well data where the following limits for net and gross sand were applied:

<u>Tirrawarra Sandstone</u>

Gross Sand: <90 API (GR) <90ms (Sonic)
Net Sand: Porosity >9%, Vsh <30%

<u>Patchawarra Formation</u>

Gross Sand: <90 API (GR) <90ms (Sonic)
Net Sand : Porosity >8%, VSH <35%

Gross sand was measured directly from the GR and sonic well logs. Net sand was derived using the Lithofacies programme which utilized the Overton Porosity Equations (Patchawarra area 1 and Tirrawarra) for porosity and the gamma ray equation for Vsh. The above criteria are consistent with Unit guidelines and have been applied uniformly over the study area to allow a more rigorous treatment of porosity trends. In addition sand reservoir maps were integrated with relevant depositional models and allowances were made for present day structure. The latter aspect applied particularly to the deeper areas of the Patchawarra Trough.

Interpretation of the environment of deposition for each of the Patchawarra subunits included study of the subunit isopachs, gamma ray-sonic log signatures, sand development and existing core descriptions.

As part of the study all the available flow capacity data was assembled. For fields on production the flow capacity data is often based on post completion isochronal tests and is quite accurate. However inaccuracies are inherent when only open hole DST data is available and when an extrapolation between widely spaced wells is required. These problems are amply demonstrated in fields where there are extremely rapid variations in flow capacity eg Tirrawarra Field. Thus it is concluded that flow capacity maps on a field basis can be useful but mapping on a regional basis is not viable and hence regional kh maps are not included in this report.

4. TIRRAWARRA SANDSTONE

The Tirrawarra Sandstone is essentially a sheet like unit characterised by several depositional facies but dominated by braided fluvial sediments which were the end product of an evolving glacio-fluvial system. Although sand dominated there are minor shaley units which facilitate subdivision of the Formation. Gostin (1973) recognised three lithological units in the Tirrawarra Sandstone from the Tirrawarra Field. SAOGC (1988), in a more regional study, adopted a tripartite subdivision which was essentially synonymous with that chosen by Gostin (see Figure 2). The three Tirrawarra Facies associations adopted by SAOGC, (1988) are summarised below.

4.1 Facies Association 1

This is a relatively thin, basal association made up of conglomerate and coarse sandstone with a smaller percentage of mudrock. These sediments were deposited in moderate to low sinuosity fluvial systems. Predominantly fine-grained sandstones in upward coarsening sequences are interpreted to have been deposited in a progradational lake delta.

4.2 Facies Association 2

This is the thickest and most common Association within the Tirrawarra Sandstone and generally provides the best reservoir within the unit. The unit comprises mainly coarse to very coarse-grained sandstone with minor conglomerate and mudrock components. The environment of deposition is defined as low sinuosity fluvial.

4.3 Facies Association 3

Most of this unit comprises fine to coarse grained sandstone but locally mudrock dominates the sequence. Minor conglomeratic sandstone occurs at the base of upward fining trends indicating a fluvial system of moderate sinuosity.

Although the subdivision outlined above is acknowledged to be valid, for the purposes of this report the Tirrawarra Sandstone was treated as a single unit. This was due to the fact that the three subunits do not possess a rigid time connotation and all do not occur in each well. In addition, the area of study was far larger than that around the Tirrawarra Field where the Tirrawarra subdivision originated and whether the correlations can be rigorously applied outside this area is uncertain.

The SAOGC (1988) study also found that reservoir quality in the Tirrawarra Sandstone was dependent on a number of factors including:

(a) Mineralogy: the more lithic grains the greater the loss in porosity. Also variable early compaction was found to be a significant factor influencing the distribution of porosity and permeability.

(b) Grainsize: there is a clear trend of increasing permeability with increasing grain size. In addition horizontally bedded bedforms were found to be most commonly associated with better reservoir.

(c) Depth of burial: a detailed review of log responses by SAOGC (1988) indicated the approximate loss of 2% porosity for the 1000 ft depth increase between 9,000-9,500 and 10,000-10,500 ft. As a result of data acquired during this study a cross plot of net/gross sand ratio against Top Tirrawarra depth (subsea) was undertaken for all wells in the study area. The data was scattered but, as expected, there was a definite trend indicating a decrease in the net/gross sand ratio as depth increased. However the spread of data points probably precludes use of this plot as a guide to defining net/gross sand ratios in exploration wells.

An additional consideration is the inhibition of diagenesis by the presence of hydrocarbons. The possibility of porosity and permeability preservation due to hydrocarbon presence has been considered in the Nappamerri Trough (S. Taylor pers. comm.) and it is common in the Cooper Basin for reservoir quality to deteriorate off the flanks of fields. This is true for example in the Tirrawarra Field where it is noted that downflank diagenesis increases and reservoir quality deteriorates. This is possibly explained by the progressive filling of structures by hydrocarbons resulting in improved reservoir quality in crestal areas as there was less explosure to diagenetic processes below the hydrocarbon water contact.

The Tirrawarra isopach (Enclosure 1) shows thickening of the formation from an eroded basin margin to over 250 ft in the main depocentre. Thinning over major highs in the trough (ie. Tirrawarra, Fly Lake and Moorari) indicates structural growth in some areas at the time of deposition. The sequence is eroded from the crest of the G.M.I. trend but updip thinning in several wells could be indicative of onlap. The depositional environment of the Tirrawarra Sandstone has already been discussed and core and test data indicate that Facies Association 2 (ie. the main braided fluvial unit) provides the most consistent reservoir facies. Most of the data come from fields in the trough area where reservoir quality is closely related to depth. The thickest net sand counts occur over the Tirrawarra Field and the southern portion of the G.M.I. Trend (Pelican Field) and generally relate to a combination of depositional facies and structural setting (Enclosure 3). Gross sand counts (Enclosure 2) generally follow isopach trends with the highest formation thicknesses and gross sand values occurring along the southern margin of the G.M.I. Trend.

One of the aims of this study was to determine whether the Tirrawarra fluvial system which deposited reservoir quality sands in the trough area was also active in the flank areas. Efforts were hampered by a dearth of well information and by the fact that seismic offers little assistance due to the poor definition of the Tirrawarra Sandstone seismic response and the large distances between well ties. However several wells have intersected possible Tirrawarra facies on the flank including Callabonna 1, Lycium 1 and Daer 1. Daer 1, in Patchawarra East Block, intersected 118 ft of possible Tirrawarra Sandstone comprising interbedded sand and shale with 34 ft of net sand. To the south, Lycium 1 was drilled on the western flank of the Patchawarra Trough in the Patchawarra Southwest Block. The well was located 11 km east of the Permian zero edge and intersected the top Tirrawarra at -7070 ft. The Tirrawarra Sandstone was 116 ft thick and contained 49 ft of net sand with an average porosity of 10.8%. The recently drilled Callabonna 1 intersected 68 ft of Tirrawarra Sandstone which contained about 20 ft of net sandstone in the upper part.

The well data is corroborated in part by recent SANTOS seismic mapping which indicates the Tirrawarra zero edge is largely erosional on the western flank of the Patchawarra Trough. This means the Tirrawarra palaeodepositional edge was actually located beyond the current Cooper Basin margin. Hence reasonable quality reservoirs could be expected to the very edge of the present margin and although this has yet to be verified by drilling the results from Daer 1, Lycium 1 and Callabonna 1 provide some encouragement.

5. PATCHAWARRA FORMATION

The agenda for this study was that an understanding of the Patchawarra Formation stratigraphy and palaeogeography should precede a detailed review of reservoir distribution. An overview of the stratigraphy of the Patchawarra Formation was gained largely by the use of regional cross-sections. A total of nine regional sections (2 of which are included in Enclosures 26 and 27) gave a near complete coverage of wells in the study area. The Patchawarra Formation was divided into five stratigraphic subdivisions based on regionally continuous coal markers (Figure 2). The subdivision was largely based on well logs and to a lesser degree seismic character was checked between wells where some ambiguity existed. Several of the subdivisions have seismic definition and in particular the tops of Units P2, P4 and P5 correspond to the Vc, V2 and V seismic reflectors respectively. The general criteria used to define the boundaries of the Patchawarra subdivisions are outlined below:

Unit P1 Top is defined by the first laterally continuous coal above the Tirrawarra Sandstone.

Unit P2 Top is defined by the thick 'Vc' coal which has an associated seismic marker.

Unit P3 Top is defined by a set of double peaked coal units above the major 'Vc' coal marker.

Unit P4 Top is defined by the first major coal sequence below the Murteree Shale. This coal corresponds to the 'V2' coal and associated seismic horizon.

Unit P5 Top is defined by the base of the Murteree Shale which is determined where the GR log departs from the Murteree Shale line. This corresponds to the 'V' seismic horizon.

STRATIGRAPHIC CHART - EARLY PERMIAN SEQUENCE
PATCHAWARRA CENTRAL BLOCK

AGE	BIOSTRATIGRAPHY	FORMAL STRATIGRAPHY		SANTOS SUBDIVISION	SANTOS DESIGNATED SANDS: FLY LAKE/ BROLGA	ANDREE/ LELEPTIAN	MOORARI	TIRRAWARRA	VARANUS	GOORANIE	WOOLKINA	LAKE MacMILLAN	KUDRIEKE	MAJOR SEISMIC REFLECTOR	DESCRIPTION
EARLY PERMIAN	PP3		MURTEREE SHALE											V	
	PP3 / PP2	GIDGEALPA GROUP	PATCHAWARRA FORMATION	UNIT P5	85·9 86·7 87·7			87·7 88·2		89·0	90·7			V2	TRANSITIONAL : LOWER DELTA PLAIN - DELTA FRONT - LACUSTRINE.
	PP2			UNIT P4	88·2 88·4	93·2	90·7	89·3 89·5	89·3 89·5 89·7	89·3 89·5	91·6				LOWER DELTA PLAIN GRADING TO ? PROXIMAL FLUVIAL TO THE WEST.
				UNIT P3	88·6	94·4 94·6	91·3 91·6	89·8 90·0	89·8 90·0	89·8 90·0	91·3	98·1	96·9	Vc	MAINLY LOW SINUOSITY CHANNEL SYSTEM GRADING UPWARDS INTO SCATTERED COALSWAMP AND OVERBANK FACIES.
				UNIT P2	89·3 89·5 90·3 90·5	95·3 95·6 96·2 97·3	92·6	90·9 91·8	90·9 91·2	90·9 91·2	92·6	98·8	98·1 98·7		COAL SWAMP WITH HIGH SINUOSITY FLUVIAL CHANNEL SYSTEM.
	PP2 / PP2.1			UNIT P1	91·0 91·4 93·0 93·3	97·8 98·0 98·2		92·1 92·6 93·4 93·8 94·0	91·8 92·6 93·0 93·4 93·8 94·0 95·0	92·6 93·0		99·4 99·7 100·2 100·4 101·0 101·5	99·9	W	LOWER TO MIDDLE DELTA PLAIN. ? FLUVIAL FACIES TOWARDS THE WESTERN BASIN MARGIN. MAIN FACIES ARE BACKSWAMP, HIGH SINUOSITY FLUVIAL AND CREVASSE SPLAY.
	PP1.2		TIRRAWARRA SANDSTONE	TIRRAWARRA SANDSTONE	93·4 94·0		96·0 97·0		95·5		96·0		101·2	X	3. LOW TO MOD. SINUOSITY FLUVIAL SYSTEM. 2. BRAIDED FLUVIAL SYSTEM. 1. MODERATE SINUOSITY FLUVIAL SYSTEM AND DELTA FRONT.
			MERRIMELIA FORMATION												

TIRRAWARRA 11 — SYNTHETIC SEISMOGRAM

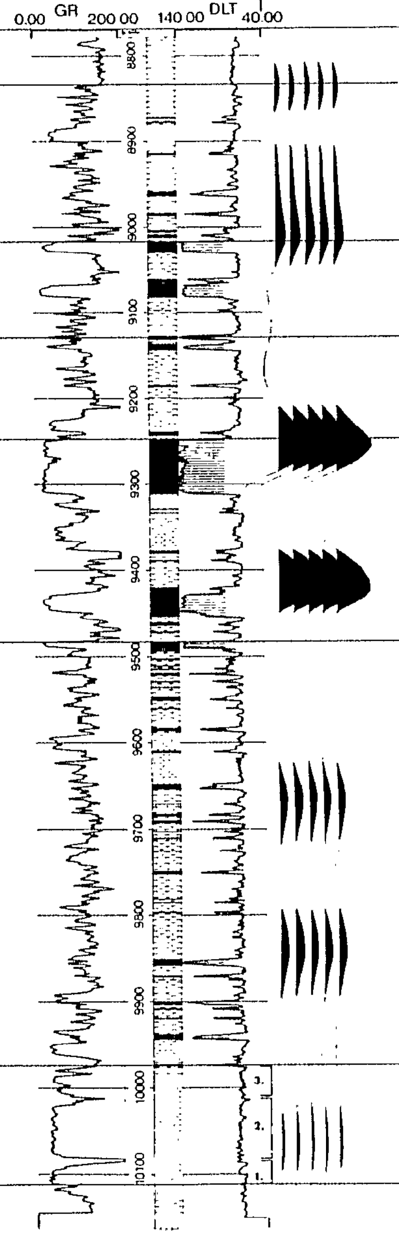


FIG 2

The Patchawarra Formation thickens away from an erosional edge on the northwest margin of the basin. Within the basin the section thickens from north (336 ft in Mitchie 1) to south (1304 ft in Yarowinnie 1). The well data thus indicates a depositional hinge or platform to the north in the Moolion - Coonatie area whereas the main depocentre lies to the south in the Kanowana - Yarowinnie area. Isopach data also indicates significant thinning over the Tirrawarra and Moorari highs probably due to drape and compaction during early Patchawarra time.

The reservoir quality of the Patchawarra Formation is controlled by factors similar to those affecting the Tirrawarra Sandstone. These include mineralogy, sorting, grainsize (in part controlled by depositional environment) and depth of burial. As for the Tirrawarra Sandstone, the inhibition of diagenesis by the presence of hydrocarbons is also an important consideration which could explain the improvement of reservoir quality towards the crestal areas of known fields.

Reservoir quality in the Patchawarra Formation is treated within the framework of the five-fold sub-division already described with additional reference to palaeoenvironment and present day structure. A summary of these aspects for each of the various sub-units is outlined below:

5.1 Unit P1

This is the most extensive of the Patchawarra subunits and extends from an eroded zero edge on the flank of the Birdsville Track Ridge, across the Patchawarra Trough and G.M.I. Ridge, and into the Nappamerri Trough (Enclosure 4). The unit was extensively eroded from the G.M.I. Ridge during the Daralingie structuring and only Merrimelia 1 contains a full sequence (329' thick). To the south, on the southern extension of the G.M.I. trend, the sequence is 450' thick in Pelican 1. This compares closely with thicknesses in the Patchawarra Trough and it appears the G.M.I. Trend was only weakly developed during Unit

P1 time. However, structural growth, probably via drape and compaction, is apparent over the Tirrawarra and Moorari highs. Also, further to the north pronounced growth is recognised over the Toonman and Coonatie highs.

The apparent northward thinning of Unit P1 is deceptive because the data points are generally located at crestal locations and do not reflect downflank thicknesses. However, 'Vc'-'W' isochron mapping (SAOGC, 1988) gives support to the concept of a hinge in the Coonatie-Moolion area with major thickening to the southeast.

5.1.1 Palaeogeography

This unit includes a number of gross depositional environments including lower - middle delta plain and fluvial (Enclosure 5). Log data indicates a major fluvial zone trending northeast through Nulla 1, Welcome Lake 1 and Regolith 1. This zone, which contains meanders greater than 3 km wide, grades eastwards into middle delta and lower delta facies. Here the rapid differential compaction of coal prone areas relative to sand rich channel belts has led to extensive autocyclic channel avulsion into interchannel swamps and shallow bays. Also major channel systems would be expected to bifurcate around active structural highs (eg. Moorari and Tirrawarra) during this period. The middle delta plain comprises areas of lake - backswamp deposits together with channels and crevasse splays. The lower delta plain consists of interdistributary lake - swamp deposits, distributary channels and thin splays. On the western margin of the basin subordinate fluvial-alluvial fan systems, as indicated in Callabonna 1, may have drained eastwards from the Birdsville Track Ridge however the dominant fluvial input would have been parallel to the main trough axis.

5.1.2 Reservoir Development

The main facies capable of yielding hydrocarbons at commercial rates are listed below in order of importance:

(a) distributary and fluvial channel sands;

(b) crevasse splay and upward coarsening lake fill cycles;

(c) flood deposits.

Table 1 lists the major producing sands from Unit P1 together with flow rate (open hole DST), total net sand and sedimentary facies. The data indicates that fluvial - crevasse splay facies in the Fly Lake - Brolga area are the most productive with DST rates varying between 1 and 6 MMCFD. One of the main producing facies are channel sand reservoirs at the base of the unit. This is a lower energy meandering fluvial facies which succeeded the braided fluvial Tirrawarra Sandstone and is productive in Brolga 2 and Fly Lake No's 1, 6 and 7. Net and gross sand mapping (Enclosures 6 and 7) generally reflect the palaeogeographic mapping (Enclosure 5). Both net and gross sand trends are thickest in the main channel areas to the southwest (eg. Nulla 1, Welcome Lake 1 and Regolith 1) but the thick channel and splay facies which are developed in these wells are either tight or wet. Net sand counts diminish to the north and east and zero net sand is predicted in the central portions of the Patchawarra Trough.

Overall from the reservoir mapping it is apparent that the most consistent net sand trends occur over:

(a) the Nulla, Welcome Lake, Regolith trend;

(b) the western edge of the Fly Lake - Brolga trend;

(c) the Kanowana - Leleptian trend.

One proposition that emerged from SAOGC's (1988) report was that a major meander belt could be located to the west of the Fly Lake - Brolga Field. This conclusion was based on the possible presence of large crevasse splays developed in wells on the western edge of this Field. The interpretation drew on core data from Brolga 1 and additional log data from surrounding wells. The interpretation of a crevasse splay from the Brolga 1 core is viewed to be dubious in view of its upward fining aspect; a fluvial channel facies seems more appropriate and would be consistent with the degradation of the Tirrawarra braided fluvial facies. However several crevasse splay facies are recognised in the area, although these are not viewed to be major indications of a channel belt to the west of the Fly Lake - Brolga Field.

Table 1 Unit P1 - Reservoir Data

Well	Flow (MMCFD)	Sedimentary Facies	Total Net Sand (ft)
Andree 2	0.42	channel/splay	23'
Brolga 1	3.3	upper channel	22'
Brolga 2	0.16	basal channel	25'
Fly Lake 1	1.9	basal channel	14'
Fly Lake 1	5.9	splay/channel	22'
Fly Lake 2	2.5	splay	7'
Fly Lake 6	1.1	basal channel	16'
Fly Lake 7	rec. 2700' oil	basal channel	25'
Coonatie 1	0.2	thick splay	4'
Pelican 3	4.2	thick splay	8'
Pelican 3	0.1	channel	15'
Lake MacMillan 1	0.18	thin splays/channel	13'
Tirrawarra 6	0.61	u.f. channel-splay	14'
Tirrawarra 2	0.63	u.f. channel-splay	11'
Tirrawarra W1	2.35	distributory channel	20'
Tirrawarra 32	1.2	u.f. channel	11'
Toonman 1	0.17	thin splays	4'

5.2 Unit P2

This unit extends from an eroded edge on the flank of the Birdsville Track Ridge and thickens to about 200 ft in the Patchawarra Trough (Enclosure 8). The sequence has been largely eroded from the G.M.I. Trend although a full section is preserved on the southern margin of this trend eg. Massy 1, Merrimelia 1. The thinning recorded in these wells indicates at least minor structural growth over the high during Unit P2 time, probably via drape and compaction. Structural growth is also recognised over the Coonatie High where the P2 section has thinned considerably.

5.2.1 Palaeogeography

The lower portion of Unit P2 comprises varying proportions of silt, shale, sand and coal while the top of the unit is marked by a thick ubiquitous coal, the 'Vc' coal, which is up to 70 ft thick in the study area. The palaeogeography of the lower part of the sequence comprises a meander belt parallelling the main axis of the Patchawarra Trough with varying proportions of silt and coal deposited in adjacent overbank areas (Enclosure 9). Thick channel developments occur in Kanowana 1 (50 ft thick) and Andree 2 (65 ft thick) and here the channels have a maximum width of 0.6 km with a meander wavelength of up to 7 km. Thicknesses are greatest in the centre of the trough and it is here the dominant channel and splay developments occur; the main depocentre is in the southern portion of the study area in the vicinity of the Andree - Leleptian Field. Capping the flood-plain meander belt sequence is the 'Vc' coal which was deposited in a major coal swamp in a middle delta plain setting.

5.2.2 Reservoir Development

The main facies capable of flowing hydrocarbons at commercial rates are fluvial channels including point bar sands. Table 2 lists the major producing sands in the unit together with DST flow rates and net sand counts. This data shows that the P2 reservoirs are not widespread producers and that channel sands associated with the mapped meander belt are the most productive reservoirs with crevasse splays being of secondary importance. Flow rates are generally low with the exception of Andree 1 and Leleptian 1 where fluvial channels and crevasse splays are the main producing reservoirs.

Net sand mapping (Enclosure 11) indicates the best reservoir developments occur in the southern portion of the study area, in the vicinity of the Andree - Leleptian Field, and are associated with the main northeasterly trending meander belt. Gross sand trends (Enclosure 10) demonstrate a similar pattern with the thickest trends also defined by the limits of the interpreted meander belt.

Table 2 Unit P2 - Reservoir Data

Well	Flow (MMCFD)	Sedimentary Facies	Total Net Sand (ft)
Andree 1	0.67	stacked channels	19
	3.00	channel	31
Andree 2	0.43	channel/thick splay	24
	0.15	channel	30
Fly Lake 2	0.56	channel/thin splay	14
Kudrieke 1	0.28	stacked channels/? splay	27
Leleptian 1	6.04	thick splay/thin channel	20
	0.14	thin splay	10
Kanowana 2	0.27	thin splays	4
Moorari 5	0.20	channel	10
Tirrawarra 2*	18.00	stacked point bars	12
Tirrawarra 5	0.13	stacked point bars	14

* composite test; additional reservoirs included.

5.3 Unit P3

This is the most prolific gas producer in the study area and contains most of the known gas reserves in this area. Figure 3 is a histogram demonstrating the relative amounts of proved and probable OGIP in the five Patchawarra subunits; Unit P3 is

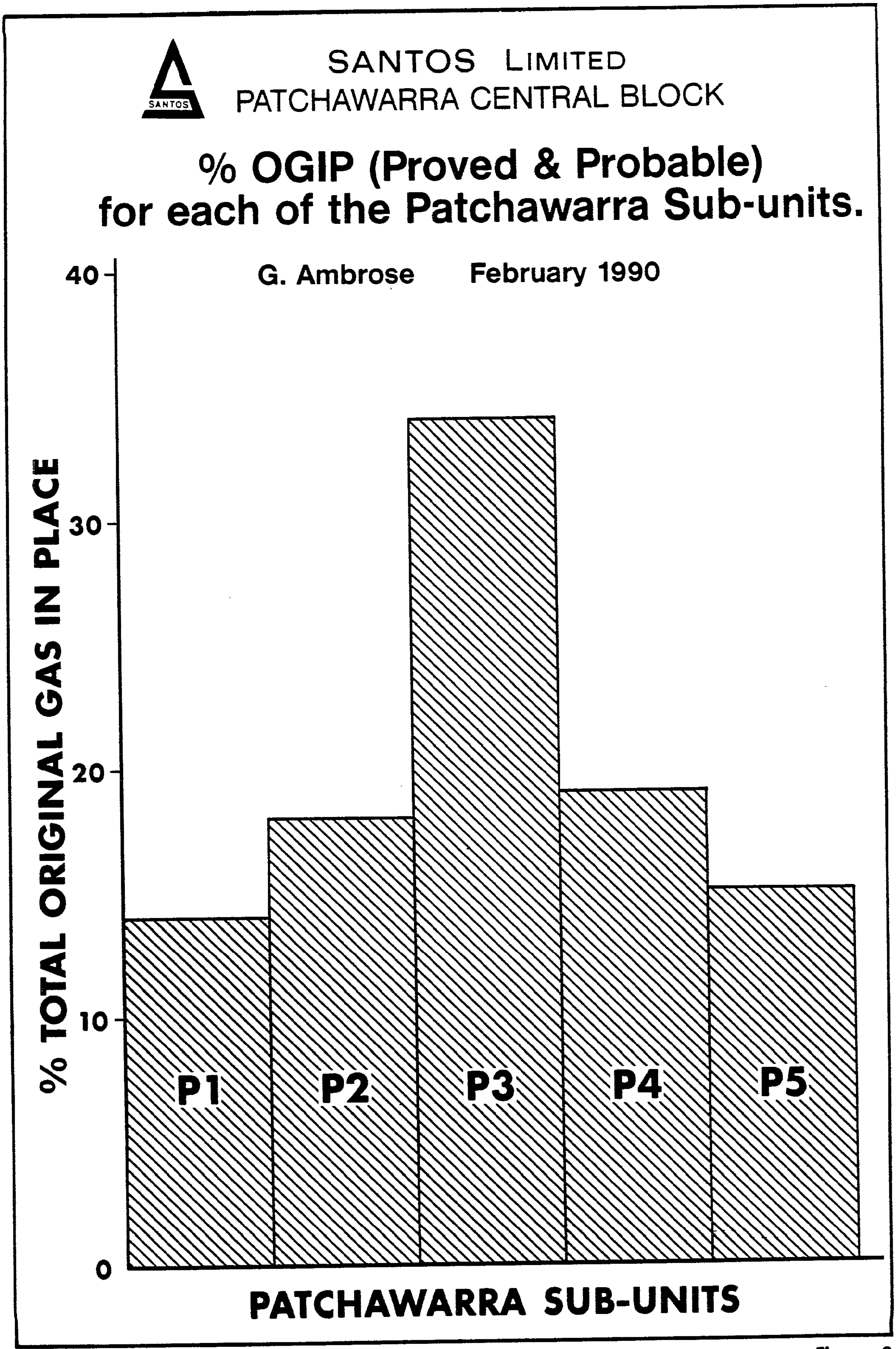

SANTOS
SANTOS LIMITED
PATCHAWARRA CENTRAL BLOCK
% OGIP (Proved & Probable)
for each of the Patchawarra Sub-units.
G. Ambrose February 1990
% TOTAL ORIGINAL GAS IN PLACE
40
30
20
10
0
P1
P2
P3
P4
P5
PATCHAWARRA SUB-UNITS

Figure 3

clearly the highest with 33%. The sequence thickens to the south - southeast from a zero edge on the southwestern flank of the Birdsville Track Ridge (Enclosure 12). A hinge zone trending NE-SW from Titan 1 towards Fly Lake has controlled erosion such that the P3 zero edge is erosional southwest of the hinge and depositional to the northeast. The unit is eroded from the crest of the G.M.I. High but is preserved on the southern extension of this trend where the isopach suggests there was probably little major structural growth. However, even minor growth over this trend may have caused channel systems to bifurcate around the high and concentrate in downflank areas.

Well data indicates the major depocentre is in the Kanowana 1 - Yarowinnie 1 area with the maximum thickness developed in Kanowana 3 (236 ft). Isochron data (SAOGC, 1988) also indicates the unit thins to the north - northeast and a hinge or shelf zone appears to trend northwest - southeast through the Moolion - Coonatie area. In this area the 'Vc' coal is largely absent and Unit P3 is condensed and difficult to resolve.

5.3.1 Palaeogeography

Unit P3 denotes a distinctive fluvial phase following deposition of the 'Vc' Coal (Enclosure 13). Streams were characterised by high width/depth ratio channels usually giving a blocky and sometimes fining upward log signature. The sands are best represented in Kanowana 1 where stacked channel sands 70 ft thick are overlain by a point bar sequence 22 ft thick. Because of the high sand content and depositional style, the basal P3 sand is best modelled as a regional blanket sand. In this fluvial regime the main facies is represented by sand dominated, bed load channels with a high width to depth ratio (>40). There is minor lateral accretion via point bar deposition but bed accretion dominates sediment infill and stream systems are highly avulsive. The high width to depth ratio of the streams and lateral channel migration indicate greater reservoir interconnection than with the meandering stream systems encountered in other units.

The sudden onset of a high energy fluvial regime represents a distinct change in sedimentary style probably caused by one or more of the following factors:

(a) extrabasinal tectonic activity;

(b) a change in erosional base level due to a drop in sea level;

(c) a change in climate.

Overlying the basal fluvial sand sheet are low energy fluvial facies containing a higher percentage of silt, shale and coal. A characteristic feature of this unit is the presence of thick drift coals which probably originated from large floating vegetated mats (SAOGC, 1988).

5.3.2 Reservoir Development

The fluvial sand units within the Unit P3 are the most prolific gas producers in the study which is a function of the high energy environment of deposition and the lateral continuity of the reservoirs. The net and gross sand maps (Enclosures 14 and 15) show extensive reservoir development with a distinct thickening to the southwest which is reflected on the isopach map (Enclosure 12). Reservoir diminution to the northeast is thus attributed to depositional thinning rather than deterioration of net/gross sand ratios as occurs in the axis of the Patchawarra Trough.

The prolific nature of the reservoir is demonstrated by the relatively large number of productive wells and relatively high flow rates (Table 3). Net sand counts are also relatively high compared with other Patchawarra units. The dominant productive facies are massive stacked channel sands and to a lesser degree point bar and crevasse splay reservoirs.

Table 3 Unit P3 - Reservoir Data

Well	Flow (MMCFD)	Sedimentary Facies	Total Net Sand (ft)
Brolga 1*	3.2	stacked channels interbedded silts	29+
Fly Lake 1*	6.1	massive stacked channels	67+
Gooranie 2	0.3	channel sand	24
Kanowana 1	8.5	massive stacked channels	80
Leleptian 1	6.5	massive stacked channels	59
Moorari 1*	9.3	channel sand	10
Mudrangie 1	3.9	massive stacked channels	34
Nulla 1	3.1	channel sand	23
	3.1	point bar-channel	20
Rakoona 1	6.3	channel (point bar) + thin splay	15
Tirrawarra 1*	6.9	stacked u.f. channels	25
Tirrawarra 2*	18.0	channel sequence inc. point bar	18
Tirrawarra 4	1.8	stacked channel sands	40
Tirrawarra 13*	1.73	stacked channel sands	26
Tirrawarra 17	1.7	u.f. channel sand	14
Tirrawarra 22	0.19	lake fill, u.f. channel	9
Tirrawarra 26	0.50	stacked channel sands	50
Tirrawarra 45	1.1	thin splay, channel sands	20
Tirrawarra 46	4.8	stacked channel sands	53
Tirrawarra 51*	2.0	lake fill, u.f. channel	24
Tirrawarra 55	0.79	channel sequence	14
Tirrawarra 56*	0.79	stacked channel sands	31
Tirrawarra 57*	4.7	basal channel, upper distributary mouth bar	27

\+ GWC

* composite test; additional reservoirs included in the test interval.

5.4 Unit P4

This unit shows a similar pattern of deposition to Unit P3. The sequence has a depocentre in the southern portion of the study area, in the vicinity of the Andree - Leleptian Field, where the unit exceeds 250 ft in thickness (Enclosure 16). Isopach and isochron data indicate the unit thins to the north - northeast which was relatively high during deposition. The zero edge, on the flank of the Birdsville Track Ridge, is partly erosional and partly depositional. This is a function of differential erosion across a NE-SW trending hinge zone running from Titan 1 towards Fly Lake.

The unit has been completely eroded from the crest of the G.M.I. Ridge and is partly eroded from the southern extension of this trend where the isopach is 120-150 ft thick. This indicates there was only minor structural growth over this high but it may have been sufficient to deflect major channel systems around the high and into downflank areas.

5.4.1 Palaeogeography

The onset of the deposition of Unit P4 marks a decrease in energy as the fluvial regime evolved from dominantly bedload, high width/depth ratio channels to mixed load, moderate sinuosity channel systems with associated coal and overbank facies; the style of sedimentation is consistent with deposition on a delta plain. Fluvial systems were widespread on the delta plain and probably flowed in from the southwest before discharging sediment into the area of the Nappamerri Trough. It is possible higher energy streams evolved on the western basin margin and flowed down gradient towards the axis of the trough. This sedimentary style has been mapped on seismic by Stanmore and Johnstone (1987) in Patchawarra Southwest and could be extended to the Patchawarra Central flank. However isochron mapping by SAOGC (1988) indicates the unit is less than fifty feet thick adjacent to the flank zero edge although reservoir quality could be enhanced by high sand : shale ratios in this area.

5.4.2 Reservoir Development

The main reservoirs associated with Unit P4 are channel sands, point bars and to a lesser degree crevasse splays (Table 4). Gross and net sand trends (Enclosures 18 and 19) follow the palaeogeography with the highest net sand counts concentrated in the southwest portion of the study area. Generally the best sand development occurs on highs in the central portion of the trough. However, some flank channels have been mapped seismically in Patchawarra Southwest and further seismic - stratigraphic work is required to confirm the extent and viability of these reservoir systems to trap hydrocarbons.

Table 4 Unit P4 - Reservoir Data

Well	Flow (MMCFD)	Sedimentary Facies	Total Net Sand (ft)
Andree 1	2.15	point bar	14
Brolga 2*	8.27	fluvial channel	21
Cooper Ck 1	0.27	splay	12
Fly Lake 1*	6.20	fluvial channel	6
Fly Lake 2#	1.16	fluvial channel	28
Fly Lake 4	9.50	stacked channels	25
Gooranie 1	6.6	fluvial channel	31
Kanowana 2	0.9	fluvial channel	13
Moorari 1*	9.3	thin fluvial channel	7
Moorari 6	0.62	thin fluvial channel	6
Tirrawarra 13	0.39	fluvial channel	4
Tirrawarra 22	0.18	thin splay sands	8
Tirrawarra 26	2.7	fluvial channel	7
Tirrawarra 45	9.6	stacked channel sands	34
Tirrawarra 51*	2.0	thin splay - channel sands	6
Tirrawarra 57*	4.7	thin splay - channel sands	14

* composite test; additional reservoirs included in test interval.

5.5 Unit P5

Unit P5 records the retreat of predominantly subaerial sedimentation ahead of the transgression associated with deposition of the Murteree Shale. The sequence thickens from its NE-SW orientated zero edge along the flank of the Birdsville Track Ridge towards a major depocentre in the south - southeast of the study area; the section reaches a maximum thickness of 280 ft in Coopers Creek 1 (Enclosure 20). From this area the sequence thins progressively to the northeast, the direction from which the Murturee Lake transgressed. Consequently parts of the Murturee Shale are considered to be lateral equivalents of Unit P5. Unit P5 is eroded from the G.M.I. Ridge and hence little can be inferred about the impact of this high on sedimentation. However it is probable that by P5 time the G.M.I. Trend imposed some control on sedimentation via drape and compaction and there may have been some deflection of channels etc. as a result.

5.5.1 Palaeogeography

The palaeogeographic interpretation for the unit is basically in agreement with that proposed by SAOGC (1988). The sequence is generally characterised by upward coarsening log profiles indicative of distributary mouth bars and deltaic infill; these are most commonly developed in the Fly Lake - Brolga and Tirrawarra areas. A distributary channel is inferred in the axial region separating these highs where the greatest differential compaction is likely to have occurred. In a number of wells, particularly in the southern and eastern portions of the study area, upward fining channel sequences occur near the base of the unit and are in turn overlain by upward coarsening deltaic sequences. This typical transgressive sequence was deposited in response to the advance of the Murteree Lake from the northeast and east. As a result most channel development occurs in the southern area; the basal fluvial channel facies does not extend beyond the Fly Lake - Spectre - Gooranie region. To the north and northeast of these wells sedimentation was mainly deltaic and this facies progressively overlapped fluvial sediments deposited to the south. The distributary mouth bar shown on Enclosure 21 is inferred from a seismic anomaly in that area.

5.5.2 Reservoir Development

Gross and net sand development are summarised in Enclosures 22 and 23. The main reservoir facies developed are fluvial channel, distributary mouth bar, distributary channel and crevasse splay. As previously noted fluvial reservoirs are restricted to the southern portion of the study area. Delta front and crevasse splay sands are ubiquitous but these reservoir types become more abundant to the northeast. The net sand map shows a trend of decreasing net sand from south to north reflecting the transition from fluvial to dominantly deltaic facies.

Production from Unit P5 is largely restricted to two fields, Fly Lake and Tirrawarra (Table 5). The dominant reservoir facies are distributary mouth bar and distributary channel. DST flow rates in Fly Lake indicate consistently high quality reservoirs in this Field whereas flow rates in Tirrawarra Field are relatively low by comparison. High quality fluvial reservoirs developed to the south in wells such as Nulla and Welcome Lake are water saturated.

Table 5 Unit P5 - Reservoir Data

Well	Flow (MMCFD)	Sedimentary Facies	Total Net Sand (ft)
Fly Lake 1*	5.8	delta front, distributary channel	29
Fly Lake 1*	6.2	channel	20
Fly Lake 2	1.77	distributary mouth bar	17
Fly Lake 5	4.8	distributary mouth bar, channel	22
Fly Lake 6	10.0	channel	33
Kanowana 1	0.115	distributary channel	31
		distributary channel, crevasse	
Tirrawarra 1	1.01	distributary mouth bar	11
Tirrawarra 4	0.19	distributary mouth bar	3
Tirrawarra 14	4.40	distributary channel	20
Tirrawarra 17	1.56	distributary mouth bar, ? channelised at the top	16
Tirrawarra 45	3.50	distributary channels, thin splays	19
Tirrawarra W. 1	0.48	thick stacked channel sands	32

6. IMPLICATIONS FOR PROSPECTIVITY

Within the study area a number of fields occur on highs within the central trough area (eg. Tirrawarra, Fly Lake). These are largely filled to spill indicating hydrocarbon migration updip into structures on the flank is a strong possibility. The main constraints applying to these and other plays in the area are:

(a) the presence of a viable trapping mechanism; and

(b) the existence of adequate reservoirs.

The main aim of this report has been the generation of reservoir maps to aid the definition and prediction of reservoir trends.

These trends have impacted on the exploration potential of the study area in three categories:

(a) existing leads and prospects;

(b) appraisal and exploration around existing fields; and

(c) stratigraphic plays.

6.1 Leads and Prospects

For existing leads and prospects both the Tirrawarra and Patchawarra have been considered (Enclosure 24) and net and gross sand values are summarised in Table 6. For the Tirrawarra Sandstone plays, only the Patchawarra Central and Merrimelia-Innamincka Blocks have come under consideration. In the relevant portions of Patchawarra Southwest and Patchawarra East Blocks, the Tirrawarra Sandstone is believed to be a poor reservoir. Assessing the reservoir potential of Tirrawarra plays is difficult because in most cases the height of closure is less than the total reservoir thickness. However, by applying newly computed net/gross sand ratios to the prospects' existing gross

Table 6 Leads and Prospects – Sand Summary Sheet
Tirrawarra and Patchawarra

Block	Name	Status	Tirra. Gross Sand	Unit P1 Gross Sand	Unit P2 Gross Sand	Unit P3 Gross Sand	Unit P4 Gross Sand	Unit P5 Gross Sand	Total Patch. Gross Sand	Tirra. Net Sand	Unit P1 Net Sand	Unit P2 Net Sand	Unit P3 Net Sand	Unit P4 Net Sand	Unit P5 Net Sand	Total Patch. Net Sand
Patchawarra Southwest	Lomondy	SL	50	175	20	75	75	90	435	20	90	20	70	95	75	350
	Mulanie	P	60	50	10	15	15	15	105	40	20	5	15	10	5	55
	Nulla West	P	25	125	10	50	60	40	285	5	80	10	40	50	40	220
	Paranta	SL	70	175	20	100	110	100	505	5	50	30	50	65	45	240
	Reglet	P	80	175	40	65	110	65	455	5	50	45	65	70	35	265
	Sharo	SL	55	175	35	100	70	60	440	30	75	30	50	70	55	280
	Stibnite	SL	70	175	35	100	90	65	465	20	70	35	70	90	55	320
Patchawarra East	Dragoon	SL	70	40	20	20	10	20	110	20	10	5	5	5	0	25
	Mort Lake	P	50	30	10	15	10	20	85	20	10	10	5	5	0	30
	Pennie	P	60	50	20	20	10	20	120	20	10	5	5	5	0	25
	Tallerangie	P	125	50	15	25	10	20	120	10	10	0	5	0	0	15
Patchawarra Central	Bunyip	P	80	80	35	60	35	65	275	0	0	0	0	0	5	5
	Chalot	P	55	35	10	10	10	10	75	30	10	5	10	5	0	30
	Crane	P	70	150	40	75	38	90	393	0	5	10	10	10	10	45
	Grey	P	65	65	35	60	30	55	245	0	0	5	10	10	10	35
	Griffon	SL	95	65	25	25	5	20	140	10	10	0	5	0	0	15
	Herald	P	55	175	35	75	55	80	420	40	15	15	25	20	35	110
	Sirlun	SL	50	30	10	15	10	10	75	30	10	5	10	5	0	30
	Stork	P	100	100	35	40	35	35	245	25	10	5	15	5	5	40
	Thyka	P	65	100	15	15	15	10	155	10	40	10	15	10	5	80
	Tirrawarra E	P	120	90	20	50	35	30	225	0	0	0	5	5	0	10
	Yasmin	SL	60	60	10	15	15	20	120	50	25	5	15	10	5	60
Merrimelia/ Innamincka	Cassia	P	140	80	25	55	35	55	250	90	25	10	25	10	0	70
	Cooba	P	140	85	25	60	50	65	285	75	45	5	30	25	0	105
	Coopers Ck UD	P	135	100	25	70	55	70	320	75	25	5	30	30	0	110
	Silva	SL	130	125	25	55	5	45	255	60	25	10	30	10	0	75

hydrocarbon columns, revised reserve estimates have been achieved and these are listed in Table 7. In most cases previously estimated potential reserves have declined as the applied net/gross ratios have decreased. The largest and most attractive Tirrawarra play is Yasmin (0.32 mmbl) in Patchawarra Central Block. The Sirlun and Herald features both have a potential of 0.29 mmbl reserves but closure is weak in both cases. The remaining plays all have a reserve potential of less than 0.2 mmbl. In the Merrimelia - Innamincka Block the Cassia and Cooba prospects with 1.3 and 0.17 mmbl of reserves respectively are the most attractive prospects.

Table 7 Tirrawarra Sandstone: Leads and Prospects - Reserve Summary

Block	Name	Status	Current Net Pay (ft)	Current Reserves (mmbl)	New Net Pay (ft)	New Reserves (mmbl)	Change
Patchawarra Central	Bunyip	P	24	0.24	0	0	-0.24
	Chalot	P	22	0.11	22	0.11	0.00
	Crane	P	24	0.18	0	0	-0.18
	Grey	P	20	0.17	0	0	-0.17
	Griffon	SL	40	0.42	20	0.21	-0.21
	Herald	SL	32	0.38	24	0.29	-0.09
	Sirlun	SL	28	0.29	28	0.29	0.00
	Stork	P	12	0.07	6	0.04	-0.03
	Thyka	P	8	0.04	8	0.04	-0.00
	Tirrawarra E	P	32	0.36	0	0.00	-0.18
	Yasmin	P	64	0.42	48	0.32	-0.10
Merrimelia/ Innamincka	Cassia	P	80	1.3	80	1.3	0.00
	Cooba	P	80	0.23	60	0.17	-0.06
	Coopers Creek UD	P	80	0.17	30	0.06	-0.11
	Silva	P	80	0.31	30	0.12	-0.19
Patchawarra Southwest	Mulanie	P	32	0.49	30	0.46	-0.03

The Patchawarra Formation's gas prospectivity in the study area is summarised in Table 8 which compares previous reserve estimates for existing leads and prospects with revised estimates utilizing the new net sand mapping. Generally this has resulted in an increase in potential gas reserve estimates as a result of increased pay counts. The most attractive plays in Patchawarra East are Pennie and Tallerangie but well data is sparse in this area thereby downgrading estimates of reservoir quality. In Patchawarra Central the best Patchawarra plays occur on the western flank (Yasmin) and to a lesser extent in the Trough area (Thyka and Grey). The remaining prospects generally contain less than 2 BCF of potential reserves. In the MEI Block sand counts are high and the most attractive prospects are Coopers Creek (updip) and Cooba. The plays in the Patchawarra Southwest generally have high net sand counts but lower perceived pay counts have reduced potential reserves. The pay counts used in Patchawarra Southwest are based on the results of Nulla 1 which contained 43 ft of gas pay; the remaining sand was water saturated or tight.

Thus overall, the sand mapping associated with this project has facilitated a review of the prospectivity of Tirrawarra and Patchawarra prospects in the study area. The Tirrawarra prospects, which are restricted to the MEI and Patchawarra Central Blocks, generally have a lower perceived potential due to lower applied net/gross sand ratios. Conversely the perceived potential of most Patchawarra plays has increased as a result of the revised sand mapping and increased net sand counts.

A ranking of the best strong leads/prospects in the Patchawarra Formation in the study area appears in Appendix 1. This is based on six factors, including:

(a) unit P_3 net sand development;
(b) potential sales gas;
(c) integrity of closure;
(d) hydrocarbon charge;
(e) C_{3+} liquid reserves; and
(f) structural setting.

Table 10 lists the top ten prospects in order of merit; the methodology relating to this ranking is outlined in Appendix 1.

Table 8 Patchawarra Formation: Leads and Prospects - Reserve Summary

Block	Name	Status	Current Net Sand (ft)	Current Reserves (BCF)	New Net Sand (ft)	New Reserves (BCF)	Change
Patchawarra East	Dragoon	SL	14	3.5	25 (25)	6.3	+2.8
	Mortlake	SL	14	0.4	30 (30)	0.9	+0.5
	Pennie	P	10	3.6	25 (25)	9.0	+5.4
	Tallerangie	P	27	7.9	15 (15)	4.3	-3.6
Patchawarra Central	Bunyip	P	72	6.4	5 (5)	0.4	-6.0
	Chalot	P	59	4.3	30 (30)	2.2	-2.1
	Crane	P	40	1.9	45 (45)	2.1	+0.2
	Grey	P	32	6.8	35 (35)	7.4	+0.6
	Griffon	SL	28	0.5	15 (15)	0.3	-0.2
	Herald	P	72	7.0	110 (90)	9.0	+2.0
	Sirlun	SL	16	0.9	30 (30)	1.7	+0.8
	Stork	P	12	0.3	40 (40)	1.0	+0.7
	Thyka	P	24	0.9	80 (30)	1.13	+0.2
	Tirrawarra E	P	48	3.4	10 (10)	0.7	-2.7
	Yasmin	P	50	5.7	60 (60)	6.8	+1.1
Merrimelia/ Innamincka	Cassia	P	90	3.0	70 (70)	2.3	-0.7
	Cooba	P	90	4.7	105 (90)	5.5	+0.8
	Coopers Creek(UD)	P	90	2.8	110 (90)	3.4	+0.6
	Silva	SL	90	1.0	75 (75)	0.8	-0.2
Patchawarra Southwest	Lomondy	SL	47	1.7	350 (50)	1.8	+0.1
	Mullanie	P	43	3.7	55 (50)	4.7	+1.0
	Nulla West	P	21	9.3	220 (21)	9.3	0.0
	Paranta	SL	47	4.1	240 (50)	4.4	+0.3
	Shard	SL	47	4.8	280 (50)	5.1	+0.3
	Stibnite	SL	47	2.5	320 (50)	2.7	+0.2

( ) Net Pay

Table 9 Prospects and Leads Summary: Patchawarra and Tirrawarra Gross and Net Sand vs. Sub Sea Depth

Name	Status	Total Patch. Gross Sand (ft)	Total Patch. Net Sand (ft)	'Vc' Subsea (ft)	Total Tirr. Gross Sand (ft)	Total Tirr. Net Sand (ft)	'W' Subsea (ft)
Lomondy	SL	435	350	-8760	50	20	-9230
Mulanie	P	105	55	-8010	60	40	-8420
Nulla West	P	285	220	-8400	25	5	-8820
Paranta	SL	505	240	-9140	70	5	-9860
Reglet	P	455	265	-9460	80	5	-10120
Shard	SL	440	280	-9050	55	30	-9860
Stibnite	SL	465	320	-9100	70	20	-9860
Dragoon	SL	110	25	-9420	70	20	-9730
Mort L.	P	85	30	-8900	50	20	-9200
Pennie	P	120	25	-9240	60	20	-9550
Tallerangie	P	120	15	-9520	125	10	-9820
Bunyip	P	275	5	-9339	80	0	-9827
Chalot	P	75	30	-8274	55	30	-8558
Crane	P	393	45	-9020	70	0	-9180
Grey	P	245	35	-9227	65	0	-9846
Griffon	SL	140	15	-10022	95	10	-10113
Herald	P	420	110	-9098	55	40	-9505
Sirlun	SL	75	30	-7955	50	30	-8252
Stork	P	245	40	-9360	100	25	-9835
Thyka	P	155	80	-9401	65	10	-9850
Tirrawarra East	P	225	10	-9215	120	0	-9658
Yasmin	SL	120	60	-8471	60	50	-8622
Cassia	P	250	70	-8865	140	90	-9470
Cooba	P	285	105	-9290	140	75	-9870
Coopers Creek UD	P	320	110	-9300	135	75	-9885
Silva	SL	255	75	-9306	130	60	-9860

Table 10 Prospect Ranking - Central Patchawarra Trough

Prospect	Status	Block	Sales Gas	Comments	Ranking
Yasmin	P	PC	6.8	Awaiting 1990 seismic	1
Cooba	P	MEI	5.5	Possible tight reservoir	2
Grey	P	PC	7.4	Possible tight reservoir	3
Cassia*	P	MEI	2.3	Fault seal required	4
Pennie	P	PE	9.0	Distant from facilities	5
Coopers Creek U.D.	P	MEI	3.4	Structurally weak	6
Tallerangie	P	PE	4.3	Distant from facilities	7
Mulanie	P	PSW	4.7	? More seismic required	8
Thyka	P	PC	1.1	Possible tight reservoir	9
Tirrawarra East	P	PC	0.7	Small reserves	10

* Denotes fault play - hence high risk.

6.2 Existing Fields

The potential for addressing possible reserves associated with the Patchawarra Fm. in existing fields and an assessment of other downdip potential occurs below:

Tirrawarra Field: In this field there is 25 BCF possible OGIP within 14 reservoirs. The gas lies in a thin halo around the edge of the field and currently only one appraisal well is being considered for drilling; this is Tirrawarra Southwest located on the southwest margin of the field. Additional potential occurs to the south in the Gooranie area where detailed mapping indicates an area between the Tirrawarra and Gooranie Fields which appears to lie above possible LKG's. Further work is required to determine viable sand development in this area which has been plagued by tight reservoirs. Results to date indicate crestal locations are most likely to encounter viable reservoirs.

In terms of downflank traps the Patchawarra isochron thickens considerably from the Tirrawarra High into the main trough. Obviously, the main constraints are the definition of a trap (updip pinchout) and the deterioration of reservoir quality with depth.

Fly Lake - Brogla: This field contains 49.9 BCF possible OGIP in 12 sands with most of this lying in a halo around the edge of the field. The most attractive reservoirs to address for possible gas are the 85-9, 86-7 and 91-0 sands and there is a possibility of 1 - 2 appraisal wells in this area. Further work (seismic) is required to address downflank plays where the Patchawarra thickens off the crest of the structure. The main constraints are trap definition and reservoir development.

Moorari - Woolkina: This field contains 9.1 BCF possible OGIP in 5 Patchawarra sands. The small volume of possible OGIP precludes any appraisal drilling at this time, although a location northwest of Moorari 7 could be considered; the well would address possible gas in the 91-3 and the 91-6 sands (Unit P3). In terms of downflank plays the 'Vc'-'W' isochron (Units P2, P1) thickens downflank and has some potential provided trap and reservoir are assured. Reservoir development is a serious constraint considering the relatively poor Patchawarra sand development over the Moorari - Woolkina complex (total net sand varies from 0' to 42').

Kudrieke - Mitchie: This area contains 8.2 BCF of possible gas, but low deliverability and poor economics preclude an appraisal well. About 5.0 BCF of potential OGIP occurs towards the Mitchie structure where there was some intersected Patchawarra log pay. Future work should address possible sand buildups (as reflected by the well data) above the current LKG. Reservoir constraints preclude exploration further downdip.

Coonatie Field: The Patchawarra in this field contains 53.7 BCF possible OGIP in 6 sands. Sand development is poor and deliverability is low, both factors militating against any appraisal drilling. However, the Coonatie structure is extremely robust with associated downflank thickening and further work is required to assess the downflank stratigraphic potential.

<u>Andree - Leleptian</u>: This field contains 37.3 BCF of possible OGIP in 13 sands. No further drilling is planned to address this gas since it occurs in a thin halo around the edge of the field. Downflank thickening in the 'Vc'-'W' interval provides the best opportunity for possible stratigraphic plays.

<u>Pelican - Massy - Merrimelia</u>: The Pelican - Massy - Merrimelia gas accumulation lies within the greater closure of stratigraphically trapped gas and oil sands proven over the southwestern nose of the Merrimelia structure. Stratigraphic pinchout or erosional unconformity underlying basal Toolachee shales act as the updip seal for these sands. Further work, including seismic stratigraphy, is required to evaluate sand trends on the nose in order to address possible and potential reserves. At this stage, a well between the Pelican and Massy Fields is being promoted as a Tirrawarra development well which will prove up 5 - 10 BCFSG in the Patchawarra Formation.

<u>Narie</u>: This field occurs on the southwestern extension of the Merrimelia nose and contains 5.1 BCF of possible OGIP distributed in a thin halo around the edge of the field. Consequently, there is no plan to address these possible reserves and any additional downdip stratigraphic potential is minimal.

<u>Mudrangie</u>: This field contains 3.5 BCF possible OGIP in the 94-2 sand in Mudrangie 1. No appraisal locations exist within the current GIP limits, although there may be some downflank stratigraphic possibilities which warrant further work.

<u>Kanowana</u>: This field contains 52 BCF possible OGIP. About 35 BCF of this occurs in basal Patchawarra reservoirs which may be tested through casing. No appraisal drilling is planned at this stage.

Overall net sand counts are very high over this field and the possibility of downflank stratigraphic plays should be investigated.

Lake MacMillan: This field contains 4.3 BCF possible OGIP distributed in a small halo around the edge of the field, thus militating against any appraisal drilling. The poor reservoir quality of the Patchawarra in this area also downgrades the possibility of downflank stratigraphic plays.

Nulla: The field contains 8.2 BCF possible OGIP which exists in three sands in a halo around the edge of the field. Production testing of Nulla 1 indicated the radius of investigation exceeded the mapped 2P OGIP limit and seismic-stratigraphic work has defined a stratigraphic play immediately west of the Nulla structure named Nulla West. A total of 26.5 BCF potential GIP is mapped in two Unit P3 sands, but further work is required to refine the play.

6.3 Stratigraphic Plays

One of the aims of this study has been to delineate which portions of the study area most deserve further work in developing stratigraphic plays within the Patchawarra Formation. The main applicable traps are:

(a) structural-stratigraphic pinchout edges with a preserved updip depositional margin;

(b) structural-stratigraphic pinchout edges with an eroded updip margin;

(c) within channel stratigraphic traps draped over plunging antiforms;

(d) within channel traps;

(e) updip sealing of reservoir sandstones against faults.

Play types (a) and (b) are most likely to form along the northwestern edge of the trough and several have been mapped at the Patchawarra level in this area. Further encouragement for exploration in this area comes from the recent results of Callabonna 1 which contains 130+ ft of net sand in the section below the 'Vc' coal. This report however, has concentrated on the central portions of the trough, in particular reviewing play types around the major fields. A number of the structures under review show marked structural growth during Patchawarra time and this could have controlled sedimentation to some degree with some channel systems bifurcating around the highs. The structures which exhibit most growth are Tirrawarra, Fly Lake - Brogla, Moorari - Woolkina, Coonatie, Kudrieke and Andree - Leleptian. The two obvious constraints in addressing downflank plays are the definition of a trap and the prediction of reservoir quality sand. For example, because of the style of sedimentation in the interval 'Vc'-'W' (mainly deltaic), downflank isochron thickening in this interval is not as attractive for reservoir development as thickening in the 'V_2'-'Vc' interval which denotes a major fluvial phase. The most common downflank traps are likely to be channels draped over noses and pinchout edges with three-way dip closure. In addition, truncation plays on the southerly plunging Merrimelia High are attractive targets. Overall those areas exhibiting high net sand counts combined with downflank thickening (structural growth) are primary targets for stratigraphic plays (Enclosure 25). Hence, the southern portion of the study area is favoured because of high net sand contents over structures in that area indicating a higher chance of porous sand buildups downdip. To the north total net sand contents decrease and although many of the structures record structural growth the possibility of downdip porous sand development is remote (Enclosure 25).

7. RECOMMENDATIONS

(1) The main result of this report has been the compilation of net and gross sand maps for the Tirrawarra Sandstone and Patchawarra Formation. It is recommended these be utilised to refine the selection of suitable drilling locations in future exploration and help define stratigraphic plays in the study area. Additional work should be directed at refining porosity and 'Vsh' cut-offs since in some instances the standard cut-offs adopted in this report appear to be optimistic. While the cut-offs are valid for a field development situation slightly more conservative criteria may be applicable for exploration wells.

(2) The prospect ranking outlined for Patchawarra gas prospects in Appendix 1, and summarised on page 34, establishes priorities for the 1990-91 gas exploration programme (see below). Of the prospects outlined in Table 10, only Yasmin, Cooba, Grey, Pennie and Tallerangie could be considered for drilling at this time and the quality of the remaining prospects is poor. In terms of appraisal drilling the main possibilities occur on the Merrimelia nose between the Pelican and Massy Fields (Pelican 6), in the Moorari Field northwest of Moorari #7 (Moorari #8) and possibly 1 - 2 wells on the Fly Lake-Brolga complex. In addition Tirrawarra Southwest, which is located just beyond the southwest margin of the Tirrawarra Field, will be considered for drilling in 1990. A generalised drilling schedule for these gas exploration/ appraisal wells is outlined below:

Quarter	1990	1991
1		Tallerangie 1
2	Pelican 6	Pennie 1
3	Cooba/Yasmin 1	Fly Lake 8
4	Grey 1/Tirrawarra Southwest	Moorari 8

It is apparent that if the 1990 programme is completed as proposed, then from 1991 onwards there will be a shortfall of drillable Patchawarra gas prospects which could not be offset by appraisal wells. Although this ranking does not review all of the gas potential in the study area, the Patchawarra Formation is by far the main contributor and the sharp decline in the quality of prospects is of concern. The situation can be partially addressed by the remapping of existing leads and prospects (see (4) below) and the detailing of appropriate strong leads.

(3) It is recommended further detailed stratigraphic mapping be carried out in those areas highlighted for their stratigraphic potential (eg. Fly Lake, Merrimelia nose, Andree - Leleptian). As an adjunct to this work three lines of high resolution seismic are planned over the Tirrawarra Field. It is planned that the increased vertical and horizontal resolution will allow calibration of commercial reservoir development with seismic over key portions of the Field. Expansion of the study to adjacent areas of Patchawarra Trough, combined with the geological modelling, found herein, should allow prediction of potential reservoir trends and stratigraphic traps.

(4) A number of leads and prospects highlighted in this report require remapping. In Patchawarra Central these are Herald, Sirlun, Thyka and Griffon. In Patchawarra East, Dragoon and Mortlake require mapping while in Patchawarra Southwest the Lamondy, Mullanie, Nulla West, Paranta, Shard and Stibnite features all require remapping.

(5) Further seismic-stratigraphic mapping is required west of the Fly Lake - Brolga Field to decide on the presence or absence of a major meander belt in this area (Patchawarra Unit P1) with attendant stratigraphic plays, particularly on the western side of the high.

(6) Further work should be directed at determining porosity trends in the upper Tirrawarra Sandstone (Unit T3) which is the critical reservoir unit in most of the remaining Tirrawarra plays where height of closure is generally much less than reservoir thickness. Documentation of net/gross sand ratios in the upper Tirrawarra will give a far more accurate estimate of expected net pay than is currently the case.

(7) Additional study of depth/porosity relationships for the Patchawarra is required. Because Patchawarra porosity development is very much facies dependent any depth versus porosity relationship must allow for this. To attain a meaningful depth/porosity relationship porosity data should be compiled for similar facies with comparable 'Vsh' values.

(8) Future exploration in the area should take account of the fact that downflank deterioration of reservoir quality in many fields is probably at least in part due to the inhibition of diagenesis due to the presence of hydrocarbons. This preserved porosity model has been applied to exploration in the Nappamerri Trough (S. Taylor pers. comm.) and is equally applicable to the central portions of the Patchawarra Trough. The two main aspects of the model are that:

(a) the crestal portion of any particular hydrocarbon accumulation should have the best preserved reservoir quality;

(b) those structures displaying the earliest and strongest structural growth (eg. as indicated by a 'C'-'P' isochron) are the most attractive targets for preserved porosity in this geological setting.

Table 11 Stratigraphic Tops - Patchawarra and Tirrawarra

WELL	KB	P5	P4	P3	P2	P1	TIRRA	MERRI
ANDREE 1	113	8965	9154	9348	9485	9736	10130	10218
ANDREE 2	155	9055	9247	9469	9560	9810	10221	10312
BALMINGA 1	144	9600	9747	9828	9950	10006	10421	10557
BROLGA 1	128	8858	8976	9026	9062	9238	9573	9644
BROLGA 2	111	8858	8964	9025	9114	9266	9592	9665
COONATIE 1	150	9764	? 9791	?	? 9840	9898	10144	10304
COONATIE 2	173	9544	?	?	?	9635	9822	9907
COONATIE 3	162	9850	9920	9940	9974	10078	10338	10419
COOPR CK 1	121	8859	9140	9342	9479	9662	10080	10238
DELIN 1	146	9810	9874	9891	9968	10092	10400	10514
FLY LAKE 1	115	8557	8799	8845	8953	9066	9332	9436
FLY LAKE 2	132	8769	8914	8997	9096	9250	9530	9600
FLY LAKE 3	122	8720	8965	9036	9153	9285	9582	9678
FLY LAKE 4	113	8717	8828	8893	8980	9134	9408	9475
FLY LAKE 5	114	8642	8868	8919	9022	9168	9457	9532
FLY LAKE 6	115	8620	8828	8886	9011	9117	9377	9460
FLY LAKE 7	118	8642	8866	8923	9028	9168	9457	9528
GOORANIE 1	131	8810	9040	9157	9266	9483	9918	10082
GOORANIE 2	131	8818	9058	9186	9260	9446	9888	10028
GOORANIE 3	181	8838	9096	9192	9334	9570	9968	10168
KANOWANA 1	117	8793	9030	9210	9398	9578	10035	10142
KANOWANA 2	151	8855	9089	9286	9444	9624	10080	10183
KANOWANA 3	138	8848	9050	9248	9484	9642	10093	10229
KUDRIEKE 1	133	9581	9645	9669	9708	9888	10108	10210
KUDRIEKE 2	149	9485	9502	9532	9560	9658	9849	9951
LAKE MAC 1	147	9720	9762	9807	9823	9915	10222	10302
LAKE MAC 2	140	9708	9740	9800	? 9818	9934	10240	10348
LELEPTIN 1	108	8870	9048	9313	9460	9672	10051	10180
LELEPTIN 2	114	8956	9139	9390	9507	9744	10133	10219
MASSY 1	135	ERODED	7855	?	7943	8038	8469	8656
MERRIMEL 1	132	ERODED	7963	?	7970	8092	8484	8608
MINGANA 1	118	8822	8948	9024	9110	9264	9550	9638
MINKIE 1	147	PERMIAN ABSENT						
MITCHIE 1	148	9471	9490	9520	9549	9670	9808	9914
MOOLION 1	140	9363	9400	9427	9476	9593	9696	9824
MOORARI 1	142	8962	9084	9137	9183	9280	9550	9640
MOORARI 2	135	9317	9425	9484	9566	9684	10032	10110
MOORARI 3	174	8923	8994	9048	9086	9141	9390	9444
MOORARI 4	163	8962	9013	9060	9124	9178	9437	9480
MOORARI 5	155	8962	9012	9067	9122	9192	9428	9492
MOORARI 6	150	9135	9189	9246	9307	9379	9660	9720
MOORARI 7	166	9049	9117	9169	9226	9286	9556	9636
MUDRANG 1	147	9212	9372	9414	9560	9698	10107	10164
MUDRANG 2	155	9206	9385	9447	9550	9742	10205	10378
NARIE 1	133	ERODED	8071	8178	8326	8457	8828	8990
NARIE 2	133	ERODED	8120	8270	8444	8588	8999	9147
NULLA 1	102	7936	8092	8288	8386	8477	8830	8907
PIRRAMTA 1	158	PATCHAWARRA ABSENT					7870	7942
PELICAN 1	133	ERODED	7920	7986	8140	8247	8652	8870
PELICAN 2	134	ERODED	7896	7980	8172	8306	8607	8807
PELICAN 3	129	ERODED	8007	8012	8132	8298	8726	9008
PELICAN 4	134	ERODED	8064	8110	8272	8401	8940	9116
QUARTPOT 1	164	9143	9216	9270	9342	9460	9764	9860
RAKOONA 1	121	9050	9238	9320	9396	9569	9964	10082

Table 11 Continued

WELL	KB	P5	P4	P3	P2	P1	TIRRA	MERRI
REGOLITH 1	96	8285	8472	8662	8830	8934	9317	9396
SPECTRE 1	125	9091	9354	9489	9600	9798	10190	10294
TIRRAW 1	128	8722	8884	8972	9039	9198	9554	9696
TIRRAW 3	130	8949	9087	9161	9235	9379	9704	9808
TIRRAW 5	129	8883	9092	9180	9244	9448	9896	10022
TIRRAW 6	127	8905	9038	9136	9180	9328	9666	9756
TIRRAW 7	130	8962	9150	9229	9340	9474	8902	10036
TIRRAW 10	128	8978	9144	9224	9296	9423	9781	9916
TIRRAW 13	184	8759	8908	8990	9073	9223	9480	9544
TIRRAW 17	139	8782	8958	9044	9091	9275	9646	9767
TIRRAW 19	143	8823	8964	9044	9111	9280	9654	9762
TIRRAW 22	139	8860	9003	9085	9149	9301	9636	9742
TIRRAW 26	139	8836	8980	9074	9159	9284	9648	9768
TIRRAW 36	118	8872	9082	9160	9277	9440	9846	9900
TIRRAW 42	142	8791	8976	9069	9169	9396	9806	9950
TIRRAW 43	205	8824	9006	9104	9194	9397	9814	9939
TIRRAW 45	131	8825	9016	9094	9197	9353	9734	9874
TIRRAW 55	120	8862	9051	9162	9246	9457	9823	9952
TIRRAW 56	130	8856	9000	9081	9166	9304	9648	9782
TIRR WST 1	122	8897	9098	9186	9280	9478	9878	9980
TOONMAN 1	137	9575	8601	9630	9689	9793	10019	10118
VARANUS 1	126	8932	9150	9324	9419	9639	10050	10182
VARANUS 2	126	8921	9150	9338	9464	9632	10058	10194
WELCM LK 1	94	8174	8348	8588	8726	8818	9206	9286
WOOLKINA 1	134	9200	9302	9364	9414	9501	9786	9884
WOOLKINA 2	132	9244	9318	9385	9452	9560	9903	9984
YAROWINN 1	111	8735	8986	9216	9391	9597	10053	10127

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APPENDIX 1

PATCHAWARRA FORMATION
PROSPECT AND STRONG LEAD RANKING
CENTRAL PATCHAWARRA TROUGH

Prospect and Strong Lead Ranking - Central Patchawarra Trough

In light of the results of this study, a general review of Patchawarra strong leads and prospects was undertaken. Prospects and strong leads have been assessed in six categories with a maximum of 10 points to be scored in each. To achieve a final ranking the point scores in the various assessment categories have been weighted according to their perceived importance. This is outlined in Table 1:

Table 1 Lead and Prospect Ranking

Category	Allocated Scoring	Weighting Factor
1. Unit P3 Net Sand (ft)	0-10 (2), 10-20 (7), 20+ (10)	0.30
2. Potential Sales Gas (BCF)	<1 (1), 1-3 (3), 3-6 (6), 6-10 (10)	0.25
3. Integrity of Closure	weak (0), fair (5), good (10)	0.20
4. Hydrocarbon Charge	weak (0), fair (5), good (10)	0.10
5. C_{3+} Liquids (mmbl)	0-0.5 (2), 0.5-1 (7), >1 (10)	0.10
6. Structural Setting	flank (5), trough (5-10)	0.05

Note: ( ) indicates point score

The final rankings for the relevant leads and prospects are outlined in Tables 2 and 3 and are derived by:

1. multiplying the score in each assessment category by the weighting factor; and

2. summing this number for each of the categories.

This prospect ranking is based on the Patchawarra Formation gas-liquids potential, although prospects with additional targets have been highlighted. The six assessment categories include a number of variables which have been documented and these are summarised below:

1. Unit P3 Net Sand Development: this unit is by far the most productive in the study area in terms of gas reserves and production potential.

2. Potential Sales Gas: includes assessment of area, net pay, porosity, hydrocarbon saturation, FVF, recovery factor and shrinkage. In most cases, the structures are presumed to be 80% full.

3. Integrity of Closure: includes an assessment of the risk of the structure not being closed, including consideration of the amplitude of the closure and the age and density of the seismic grid.

4. Hydrocarbon Charge: hydrocarbon charge is generally not a problem except on the outer portion of the flank area, eg. Nulla #1.

5. C_{3+} Liquids Reserves: this relates to the prospects potential gas reserves and their liquids richness.

6. Structural Setting: this category reflects the fact that prospects on the flanks of the Merrimelia High and in certain parts of the Patchawarra Trough are favoured compared with those in the central portions of the trough and on the outer flank.

In terms of the most highly ranked prospects (Table 2) Yasmin and Cooba (Patchawarra Central and MEI respectively) rank one and two and both are included in the proposed 1990 Drilling Programme. The Grey prospect (Patchawarra Central) ranks number three and is currently being promoted for drilling. The Cassia (MEI) and Pennie (Patchawarra East) prospects rank number four and five respectively and one or both may be drilled as part of an accelerated gas programme later this year. There is a sharp fall off in the quality of the remaining prospects, for a number of differing reasons, and this is reflected by the low weighted point scores.

Consequently, in Patchawarra Central further work on Mulanie and Herald is required to determine their exact status (with regard to remapping, reprocessing and possibly more seismic). The leads and prospects in Patchawarra Southwest are currently being remapped and further seismic may be warranted. In MEI further work is required to mature the Cassia fault play, which appears to have a weak seal (Merrimelia) in the hanging wall. The viability of Coopers Creek updip and Silva await the results of Cooba #1. The viability of the Pennie and Tallerangie prospects in Patchawarra East are probably very much dependent on the economics of a gas trunkline to one of the established fields.

A ranking of strong leads occurs in Table 3 and from this the most promising features appear to be Paranta, Shard and Reglet (Patchawarra Southwest). All of these leads will be remapped within the next few months after which consideration for additional seismic and or reprocessing will be given.

Table 2 Prospect Ranking (Study Area)

Ranking Factor	Block	P_3 Res. Net Sand x 0.30	Potential Sales Gas x 0.25	Trap Integrity x 0.20	Hydrocarbon Charge x 0.10	C_{3+} Reserves x 0.10	Structural Setting x 0.05	Weighted Point Score	Relative Ranking
Yasmin[1]	P.C.	7	10	10	10	7	5	8.6	1
Cooba[1]	MEI	10	6	10	10	7	5	8.5	2
Grey	P.C.	2	10	10	10	10	10	7.6	3
Cassia[1]	MEI	10	3	5	10	7	10	7.0	4
Pennie[2]	P.E.	2	10	10	10	2	5	6.6	5
Coopers Creek U.D.	MEI	10	3	5	10	2	5	6.2	6
Tallerangie[2]	P.E.	2	6	10	10	7	5	6.1	7
Mulanie[1]	P.S.W.	7	6	5	5	7	5	6.1	8
Thyka[1]	P.C.	7	3	5	10	2	5	5.3	9
Tirrawarra East	P.C.	7	1	5	10	2	5	4.8	10
Stork[1]	P.C.	7	3	0	10	2	5	4.3	11
Crane	P.C.	7	3	0	10	2	5	4.3	12
Bunyip	P.C.	0	1	10	10	2	5	3.7	13
Chalot[1]	P.C.	7	3	0	5	2	5	3.8	14

1 Additional Tirrawarra Sandstone Potential
2 Additional Toolachee Formation Potential

Table 3 Strong Lead Ranking (Study Area)

Ranking Factor	Block	P_3 Res. Net Sand x 0.30	Potential Sales Gas x 0.25	Trap Integrity x 0.20	Hydrocarbon Charge x 0.10	C_{3+} Reserves x 0.10	Structural Setting x 0.05	Weighted Point Score	Relative Ranking
Paranta	P.S.W.	10	6	5	5	2	5	6.5	1
Shard	P.S.W.	10	6	0	10	7	5	6.5	2
Reglet	P.S.W.	10	3	5	10	2	5	6.2	3
Silva[1]	MEI	10	1	5	10	2	5	5.7	4
Stibnite	P.S.W.	10	3	0	10	2	5	5.2	5
Lamondy	P.S.W.	10	3	0	5	2	5	4.7	6
Dragoon[2]	P.E.	2	6	0	10	7	5	4.1	7
Sirlun[1]	P.C.	7	3	0	5	2	5	3.8	8
Mort Lake[2]	P.E.	2	1	5	10	2	5	3.3	9
Griffon[1]	P.C.	2	1	0	10	2	5	2.3	10

1 Additional Tirrawarra Sandstone Potential
2 Additional Toolachee Formation Potential

SANTOS LIMITED

S.A. EXPLORATION

VOLUME 2 of 2

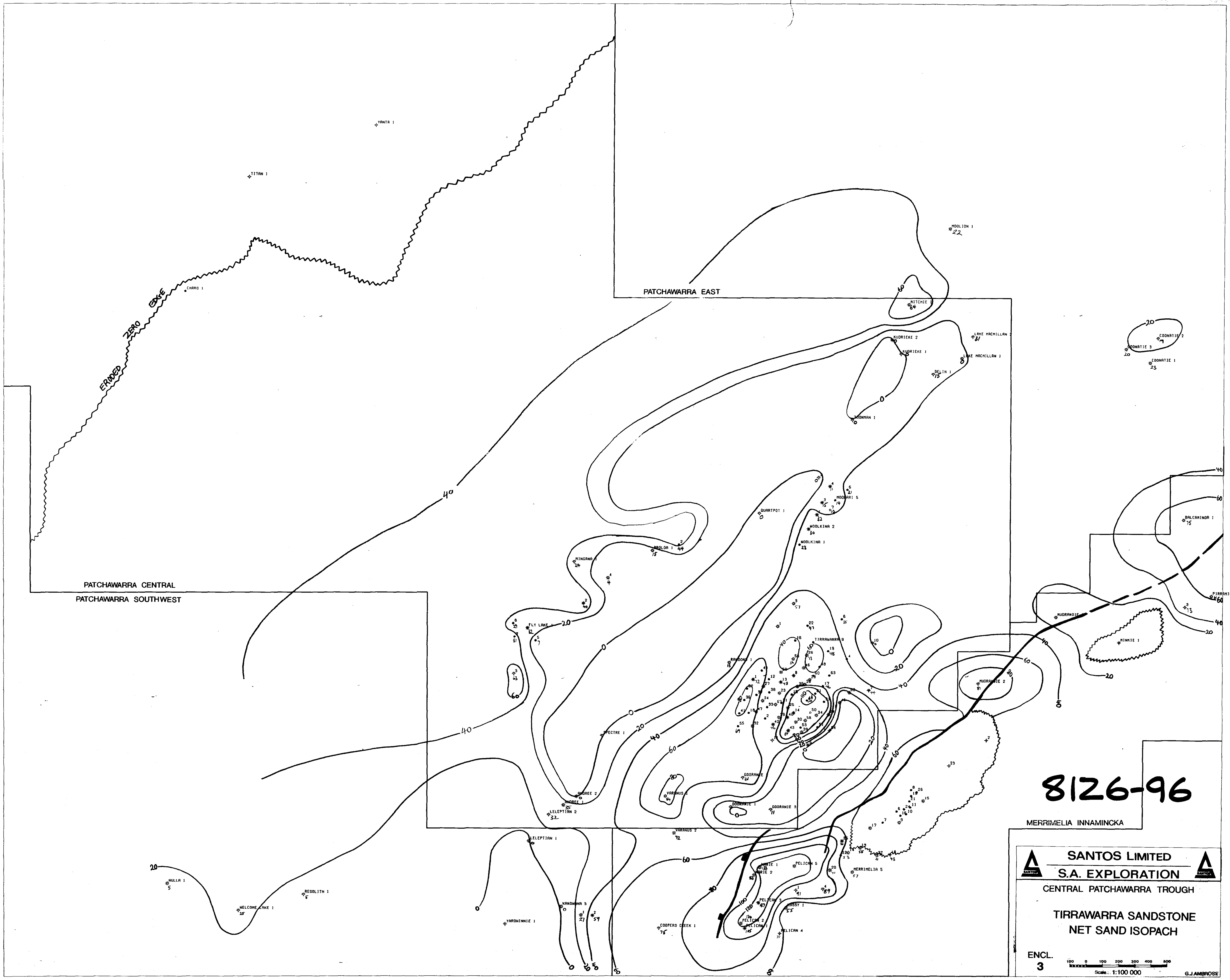
RESERVOIR DEVELOPMENT OF THE TIRRAWARRA SANDSTONE AND PATCHAWARRA FORMATION IN THE CENTRAL PATCHAWARRA TROUGH

PATCHAWARRA CENTRAL BLOCK
P.E.L. 5 & 6, S.A.

G.J.AMBROSE
MARCH 1990


139 37
27 17
140 23
27 50
ERODED ZERO EDGE
PATCHAWARRA EAST
PATCHAWARRA CENTRAL
PATCHAWARRA SOUTHWEST
MERRIMELIA INNAMINCKA
8126-94
SANTOS LIMITED
S.A. EXPLORATION
CENTRAL PATCHAWARRA TROUGH
TIRRAWARRA SANDSTONE
FORMATION ISOPACH
ENCL.
1
Scale : 1:100 000
G.J.AMBROSE
PATCEN 052

139 37
140 23
27 17
27 50
PATCHAWARRA EAST
PATCHAWARRA CENTRAL
PATCHAWARRA SOUTHWEST
ERODED EDGE
EROSIONAL EDGE
MERRIMELIA INNAMINCKA
8126-95
SANTOS LIMITED
S.A. EXPLORATION
CENTRAL PATCHAWARRA TROUGH
TIRRAWARRA SANDSTONE
GROSS SAND ISOPACH
ENCL.
2
Scale : 1:100 000
G.J.AMBROSE
PATCEN 053



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S.A. EXPLORATION

CENTRAL PATCHAWARRA TROUGH

TIRRAWARRA SANDSTONE NET SAND ISOPACH

ENCL. 3

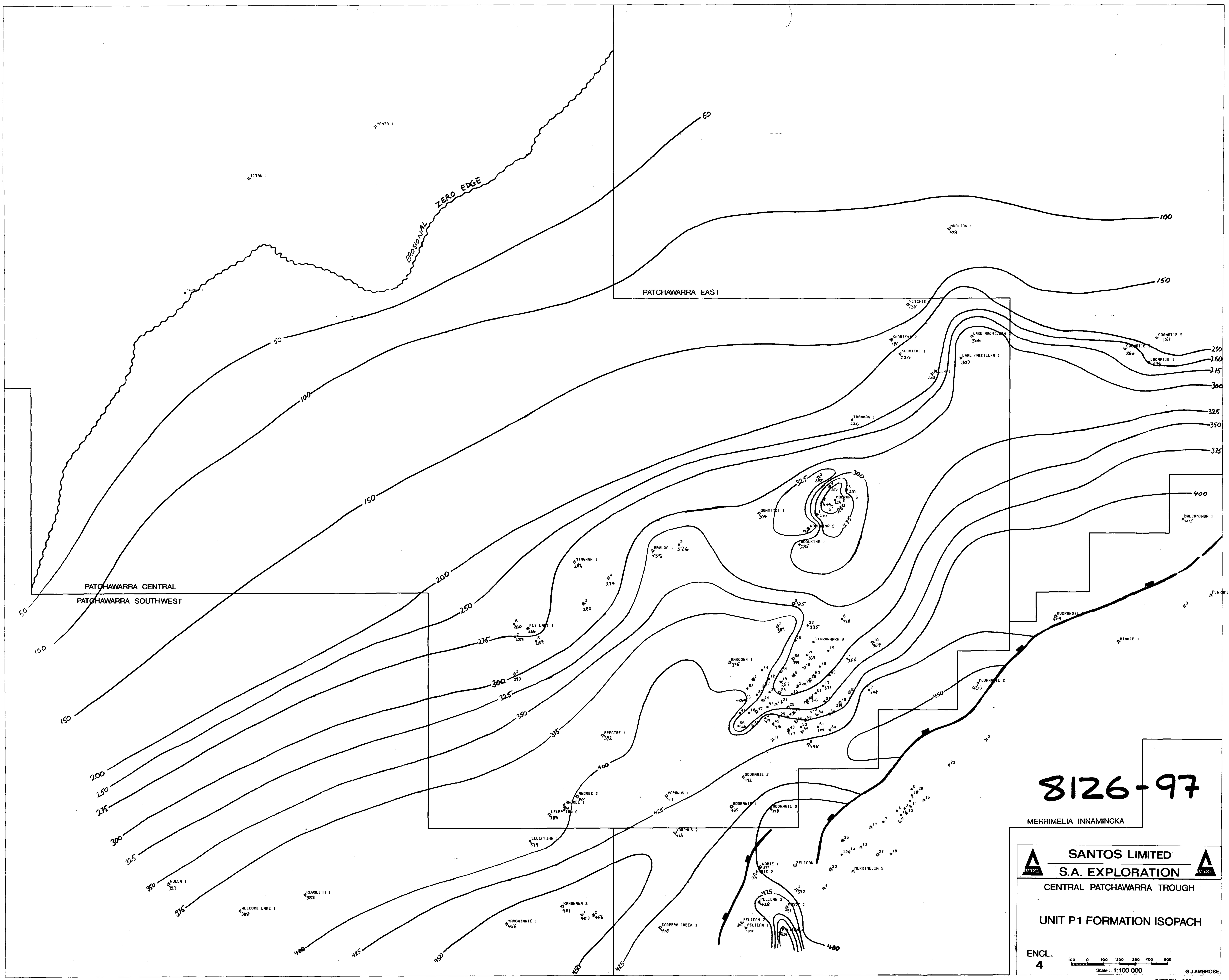
Scale: 1:100 000

G.J.AMBROSE

PATCEN 054

139 37 — 140 23

27 17



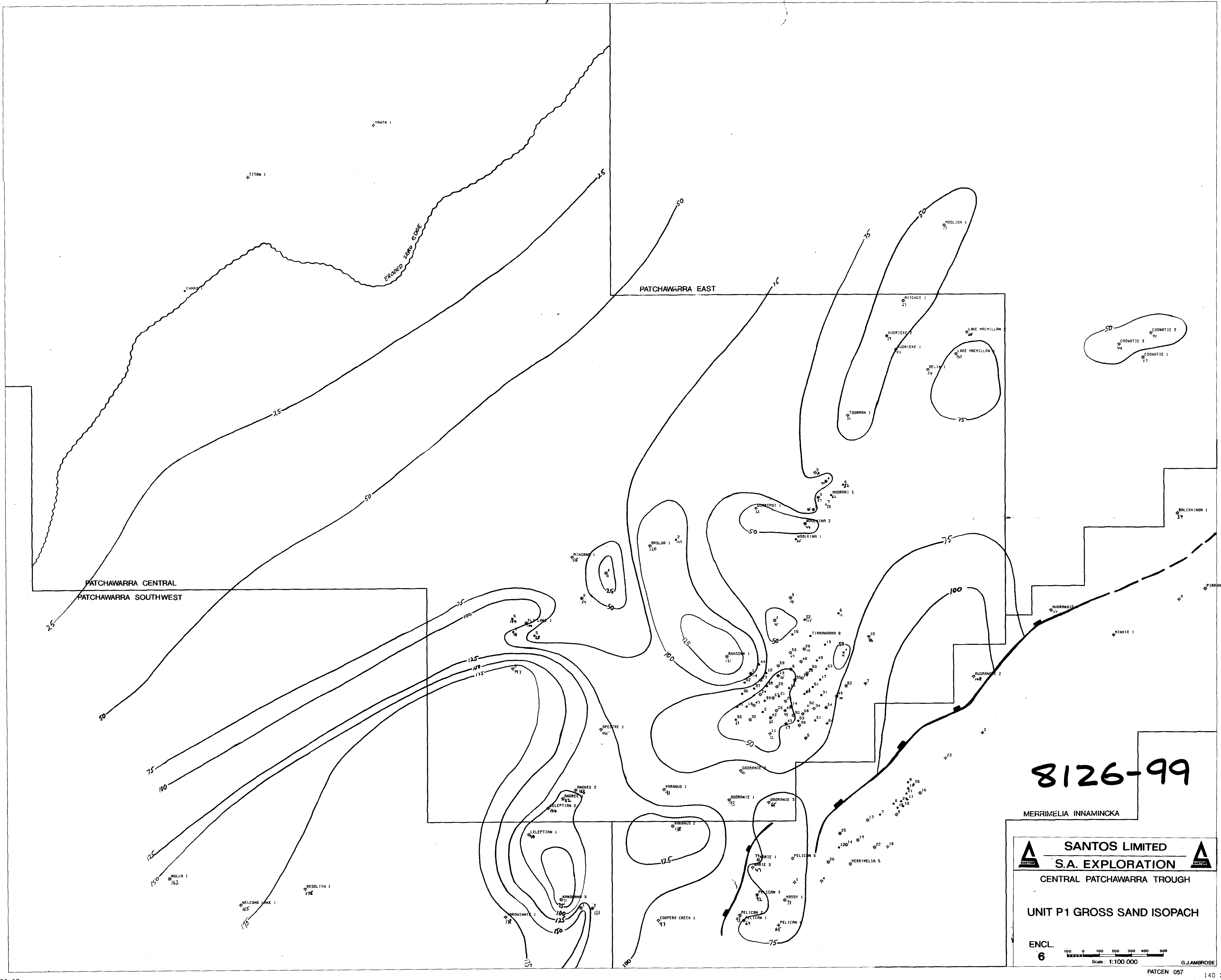
27 50

139 37

PATCEN 055

140 23

139 37
27 17
140 23
27 50
27 5
YANTA 1
TITAN 1
CHARD 1
ERODED ZERO EDGE
PATCHAWARRA EAST
MOOLION 1
MITCHIE 1
KUDRIEKE 2
KUDRIEKE 1
LAKE MACMILLAN 2
LAKE MACMILLAN 1
DELIN 1
COONATIE 2
COONATIE 3
COONATIE 1
TOONMAN 1
SECONDARY CHANNELS FEEDING FROM THE N.W.
QUARTPOT 1
WOOLKINA 2
WOOLKINA 1
BROLGA 1
MINGANA 1
BALCAMINDA 1
PATCHAWARRA CENTRAL
PATCHAWARRA SOUTHWEST
MIDDLE DELTA PLAIN
area of lake, swamp deposits, plus meandering channels and crevasse splays.
CREVASSE SPLAY DEVELOPMENT
FLY LAKE 1
MUDRANGIE 1
PIRRAMINTA 1
TIRRAWARRA 9
RAKOONA 1
MINKIE 1
LOWER DELTA PLAIN
Interdistributary lake-swamp; distributary channels and thin splays
MUDRANGIE 2
SPECTRE 1
MAIN FLUVIAL CHANNEL ZONE
8126-98
GOORANIE 2
ANDREE 2
ANDREE 1
LELEPTIAN 2
VARANUS 1
GOORANIE 1
GOORANIE 3
MERRIMELIA INNAMINCKA
VARANUS 2
LELEPTIAN 1
CREVASSE SPLAY DEVELOPMENT
NARIE 1
NARIE 2
PELICAN 5
MERRIMELIA 5
NULLA 1
REGOLITH 1
WELCOME LAKE 1
PELICAN 3
MASSY 1
KANOWANA 3
YARROWANIE 1
PELICAN 2
PELICAN 1
COOPERS CREEK 1
PELICAN 4
SANTOS LIMITED
S.A. EXPLORATION
CENTRAL PATCHAWARRA TROUGH
UNIT P1 PALAEOGEOGRAPHY
ENCL.
5
Scale : 1:100 000
G.J.AMBROSE
PATCEN 056



SANTOS LIMITED
S.A. EXPLORATION
CENTRAL PATCHAWARRA TROUGH

UNIT P1 GROSS SAND ISOPACH

ENCL. 6

Scale : 1:100 000

G.J.AMBROSE

PATCEN 057

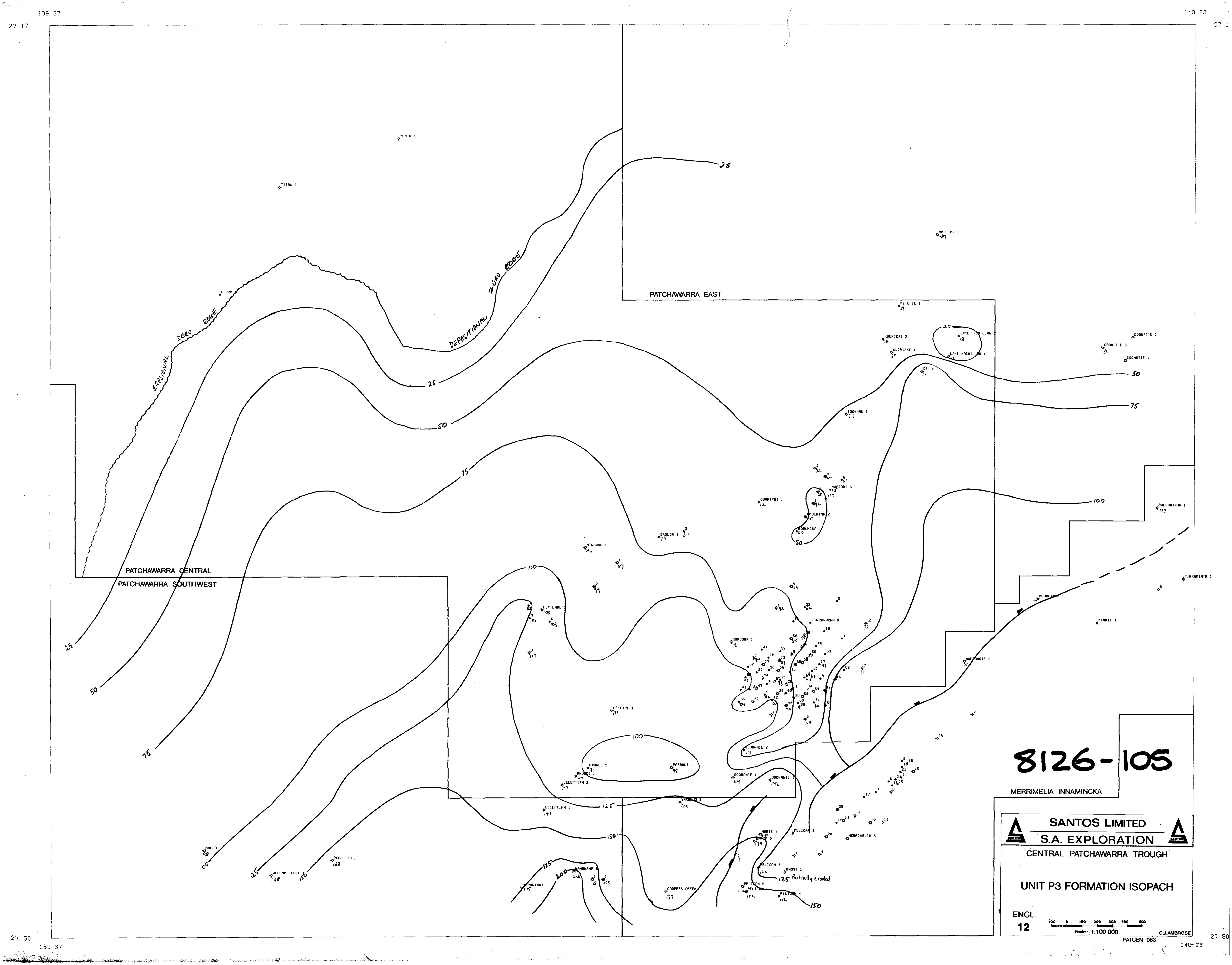
139 37
140 23
27 17
27 50
ERODED ZERO EDGE
PATCHAWARRA EAST
PATCHAWARRA CENTRAL
PATCHAWARRA SOUTHWEST
YANTA 1
TITAN 1
CHARO 1
MOOLION 1
RITCHIE 1
KUDRIEKE 2
KUDRIEKE 1
LAKE MACMILLAN 2
LAKE MACMILLAN 1
DELIN 1
COONATIE 2
COONATIE 3
COONATIE 1
TOONMAN 1
MOORARI 5
QUARTPOT 1
WOOLKINA 2
WOOLKINA 1
BROLGA 1
MINGANA 1
FLY LAKE 1
TIRRAWARRA 3
KOOKOONA 1
SPECTRE 1
BALCAMINGA 1
MUDRANGIE 1
MINKIE 1
PIRRAMINTA 1
MUDRANGIE 2
GOORANIE 2
GOORANIE 1
GOORANIE 3
VARANUS 1
VARANUS 2
ANDREE 2
ANDREE 1
LELEPTIAN 2
LELEPTIAN 1
NULLA 1
WELCOME LAKE 1
REGOLITH 1
TARRAWANNIE 1
KADWANNA 3
COOPERS CREEK 1
NARIE 1
NARIE 2
PELICAN 5
PELICAN 3
PELICAN 2
PELICAN 1
PELICAN 4
MASSY 1
MERRIMELIA 5
8126-100
MERRIMELIA INNAMINCKA
SANTOS LIMITED
S.A. EXPLORATION
CENTRAL PATCHAWARRA TROUGH
UNIT P1 NET SAND ISOPACH
ENCL.
7
Scale : 1:100 000
G.J.AMBROSE
PATCEN 058

139 37
140 23
27 17
27 50
EROSIONAL ZERO EDGE
PATCHAWARRA EAST
PATCHAWARRA CENTRAL
PATCHAWARRA SOUTHWEST
MERRIMELIA INNAMINCKA
8126-101
SANTOS LIMITED
S.A. EXPLORATION
CENTRAL PATCHAWARRA TROUGH
UNIT P2 FORMATION ISOPACH
ENCL.
8
Scale : 1:100 000
G.J.AMBROSE
PATCEN Q59

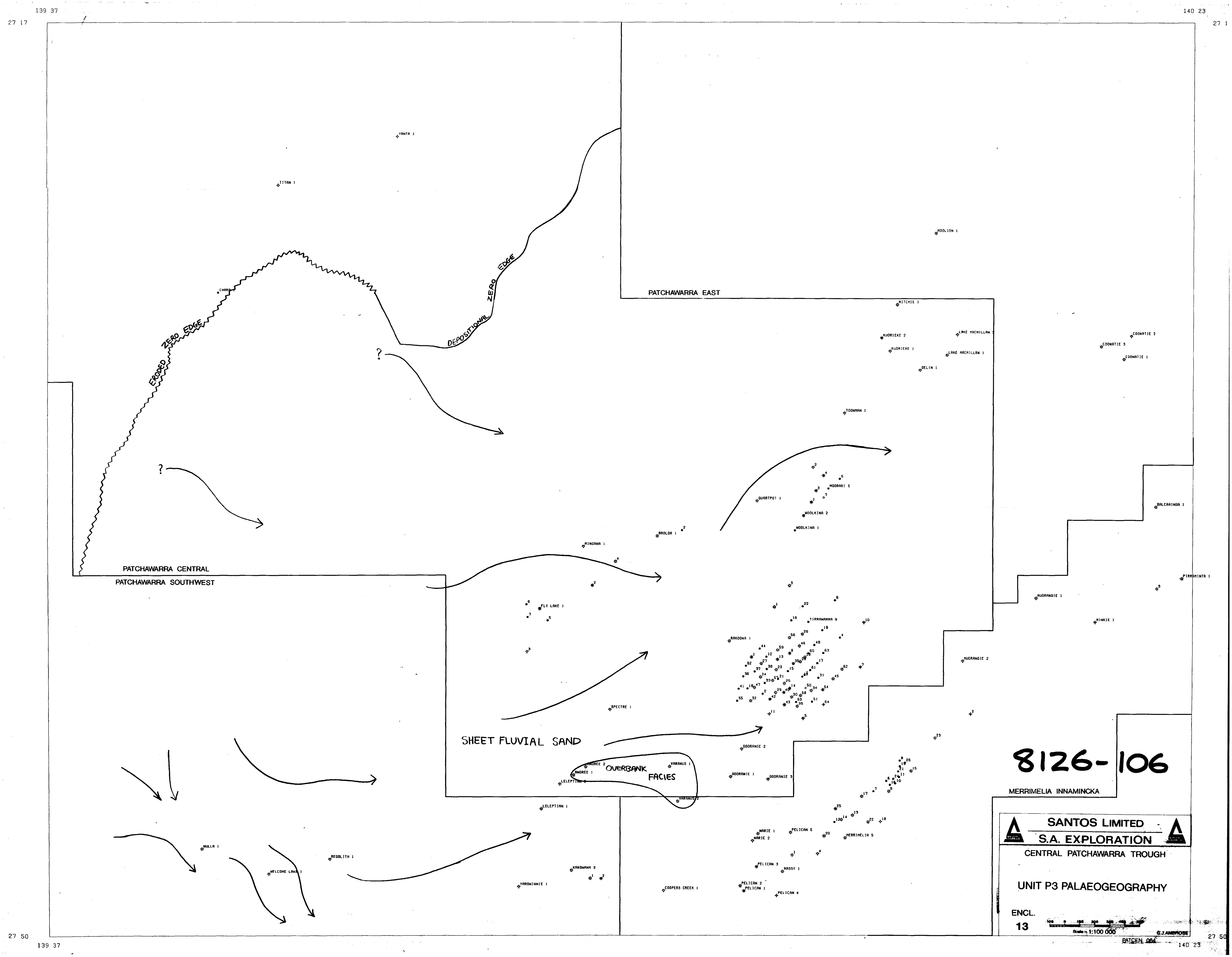
139 37
27 17
140 23
ERODED ZERO EDGE
PATCHAWARRA EAST
PATCHAWARRA CENTRAL
PATCHAWARRA SOUTHWEST
MERRIMELIA INNAMINCKA
?
MEANDER BELT ZONE
OVERBANK FACIES Inc. COAL SWAMPS
OVERBANK FACIES Inc COAL SWAMPS
OVERBANK (inc. SPLAY)
MEANDER BELT ZONE
OVERBANK (inc. SPLAY)
OVERBANK FACIES Inc. COAL SWAMPS
CHANNEL
YANTA 1
TITAN 1
CHARO 1
MOOLION 1
KITCHIE 1
TOONMAN 1
MOORARI 5
QUARTPOT 1
BROLGA 1
MINGANA 1
FLY LAKE 1
TIRRAWARRA 9
SPECTRE 1
GOORANIE 2
VARANUS 1
ANDREE 2
ANDREE 1
LELEPTIAN 2
LELEPTIAN 1
VARANUS 2
MERRIMELIA 5
PELICAN 5
PELICAN 3
PELICAN 4
KASSY 1
COOPERS CREEK 1
YAROWINNIE 1
REGOLITH 1
WELCOME LAKE 1
MULLA 1
COONATIE 2
COONATIE 3
COONATIE 1
BALCANINGA 1
PIRRAMINTA 1
MUDRANGIE 1
MUDRANGIE 2
MINKIE 1
8126-102
SANTOS LIMITED
S.A. EXPLORATION
CENTRAL PATCHAWARRA TROUGH
UNIT P2 PALAEOGEOGRAPHY
ENCL. 9
Scale 1:100 000
PATCEN 060
27 50
139 37
140 23


139 37
27 17
140 23
27 50
ERODED ZERO EDGE
PATCHAWARRA EAST
PATCHAWARRA CENTRAL
PATCHAWARRA SOUTHWEST
MERRIMELIA INNAMINCKA
YANTA 1
TITAN 1
CHARO 1
MOOLION 1
MITCHIE 1
LAKE MACMILLAN 2
LAKE MACMILLAN 1
COONATIE 2
COONATIE 1
TOONMAN 1
MOORARI 5
QUARTPOT 1
WOOLKINA 2
WOOLKINA 1
BALCAMINOA 1
MINGANA 1
PIRRAMINTA 1
MUDRANGIE 1
MINKIE 1
TIRRAWARRA 9
RAKOONA 1
MUDRANGIE 2
SPECTRE 1
DOORANIE 2
VARANUS 1
DOORANIE 1
DOORANIE 3
VARANUS 2
LEPTIAN 1
NARIE 1
NARIE 2
PELICAN 5
PELICAN 3
PELICAN 2
PELICAN 1
PELICAN 4
MASSY 1
MERRIMELIA 5
NULLA 1
WELCOME LAKE 1
REGOLITH 1
YAROWINNIE 1
COOPERS CREEK 1
8126-103
SANTOS LIMITED
S.A. EXPLORATION
CENTRAL PATCHAWARRA TROUGH
UNIT P2 GROSS SAND ISOPACH
ENCL.
10
Scale: 1:100 000
G.J.AMBROSE
PATCEN 061

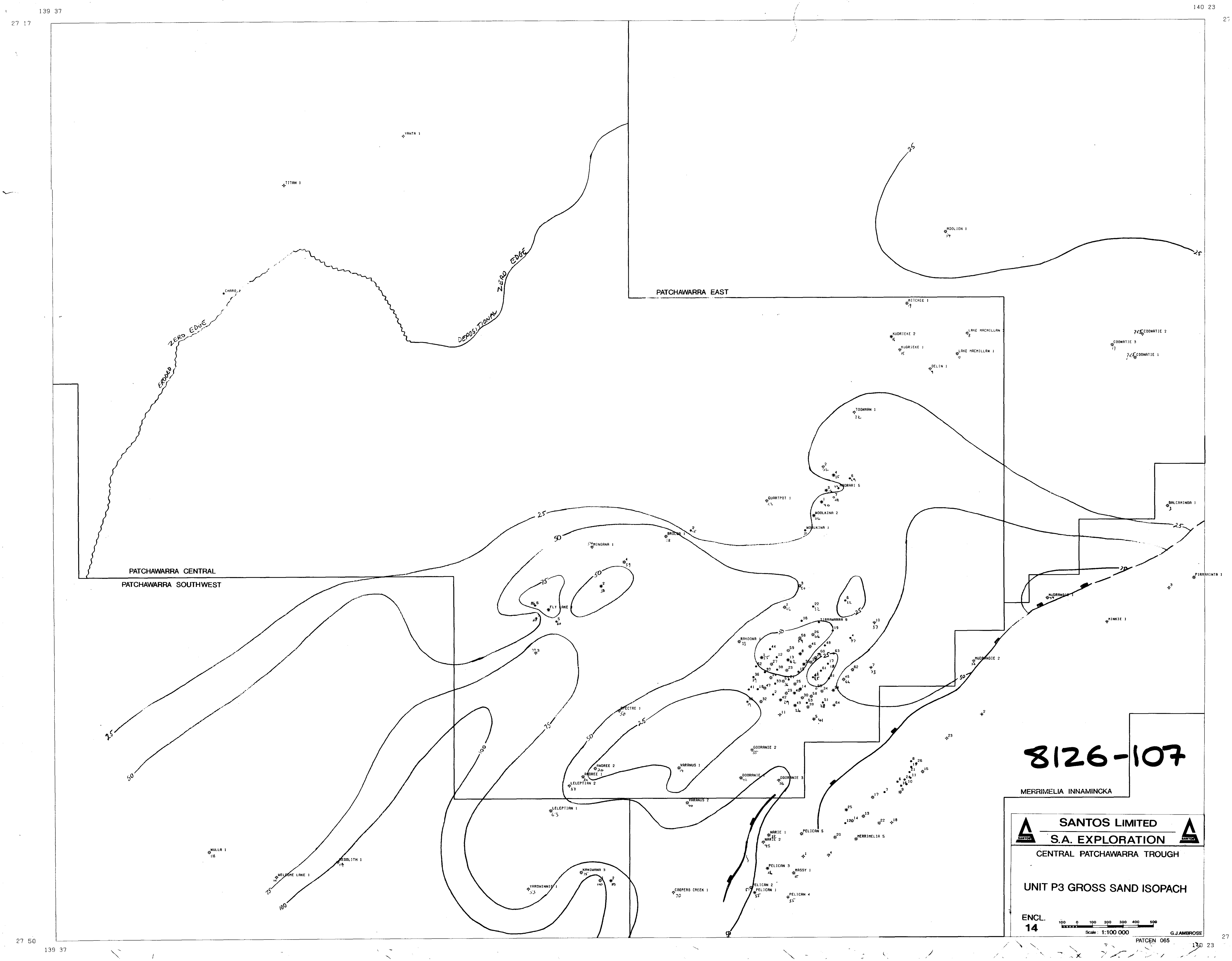

139 37
27 17
140 23
27 50
ERODED ZERO EDGE
PATCHAWARRA EAST
PATCHAWARRA CENTRAL
PATCHAWARRA SOUTHWEST
MERRIMELIA INNAMINCKA
TIRRAWARRA 9
SPECTRE 1
FLY LAKE 1
MERRIMELIA 5
COOPERS CREEK 1
8126-104
SANTOS LIMITED
S.A. EXPLORATION
CENTRAL PATCHAWARRA TROUGH
UNIT P2 NET SAND ISOPACH
ENCL.
11
PATCEN 082



PATCHAWARRA EAST
PATCHAWARRA CENTRAL
PATCHAWARRA SOUTHWEST
MERRIMELIA INNAMINCKA
EROSIONAL ZERO EDGE
DEPOSITIONAL ZERO EDGE
Partially eroded
8126-105
SANTOS LIMITED
S.A. EXPLORATION
CENTRAL PATCHAWARRA TROUGH
UNIT P3 FORMATION ISOPACH
ENCL.
12
Scale: 1:100 000
G.J.AMBROSE
PATCEN 063



139 37
27 17
140 23
27 1
ERODED ZERO EDGE
DEPOSITIONAL ZERO EDGE
?
?
PATCHAWARRA EAST
PATCHAWARRA CENTRAL
PATCHAWARRA SOUTHWEST
SHEET FLUVIAL SAND
OVERBANK FACIES
MERRIMELIA INNAMINCKA
8126-106
SANTOS LIMITED
S.A. EXPLORATION
CENTRAL PATCHAWARRA TROUGH
UNIT P3 PALAEOGEOGRAPHY
ENCL.
13
Scale 1:100 000
PATCEN 004
27 50
139 37
27 50
140 23



SANTOS LIMITED

S.A. EXPLORATION

CENTRAL PATCHAWARRA TROUGH

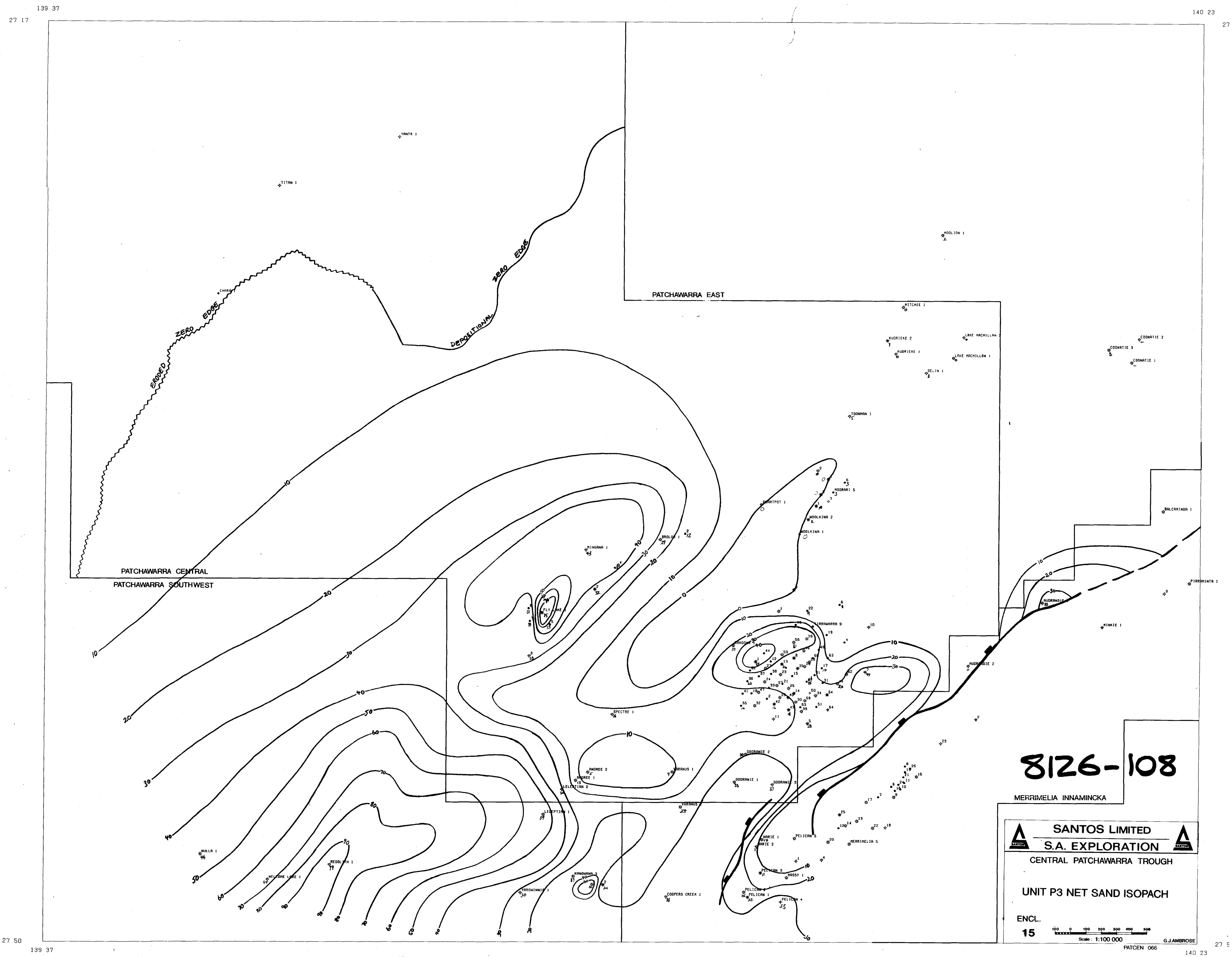
UNIT P3 GROSS SAND ISOPACH

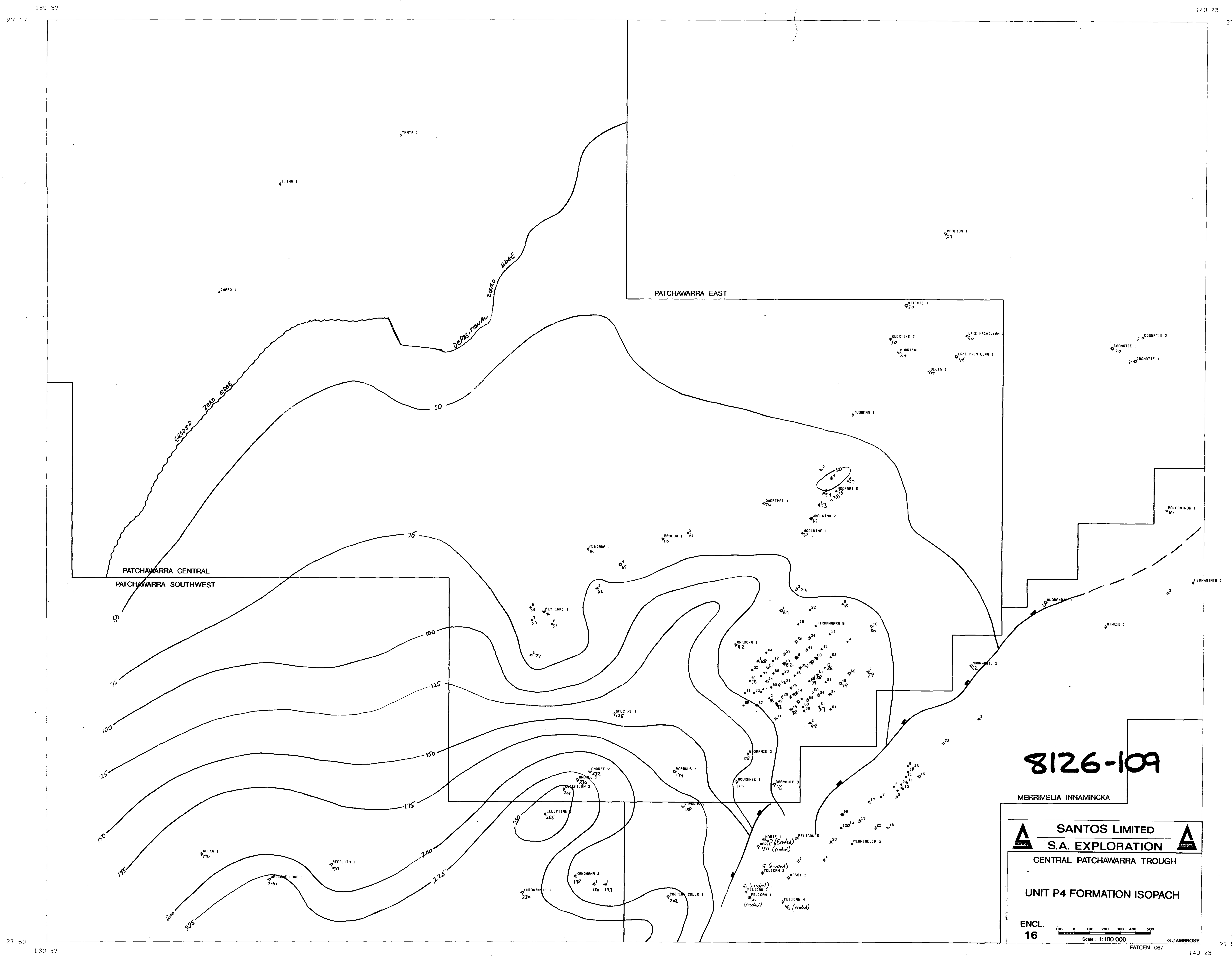
ENCL. 14

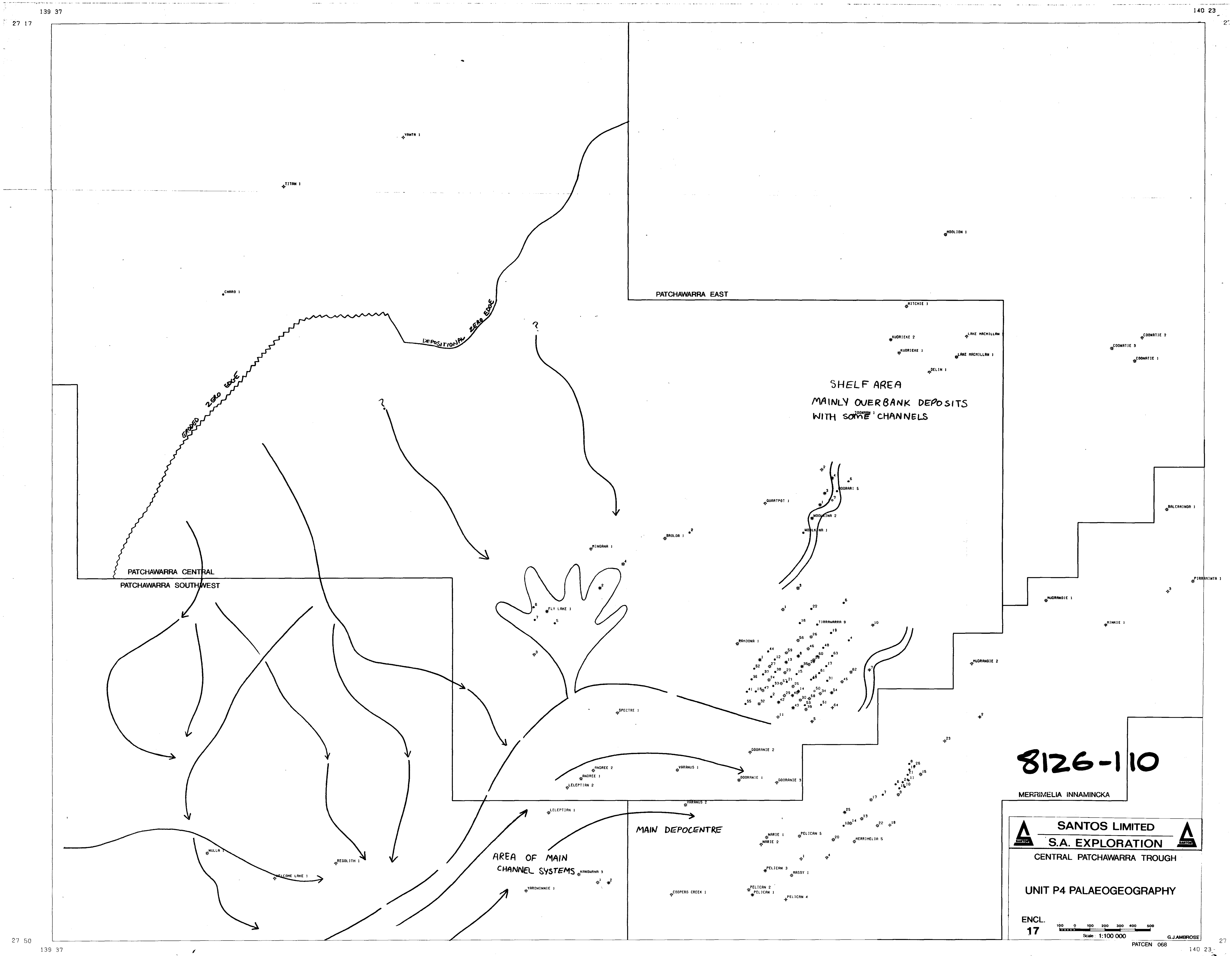
Scale : 1:100 000

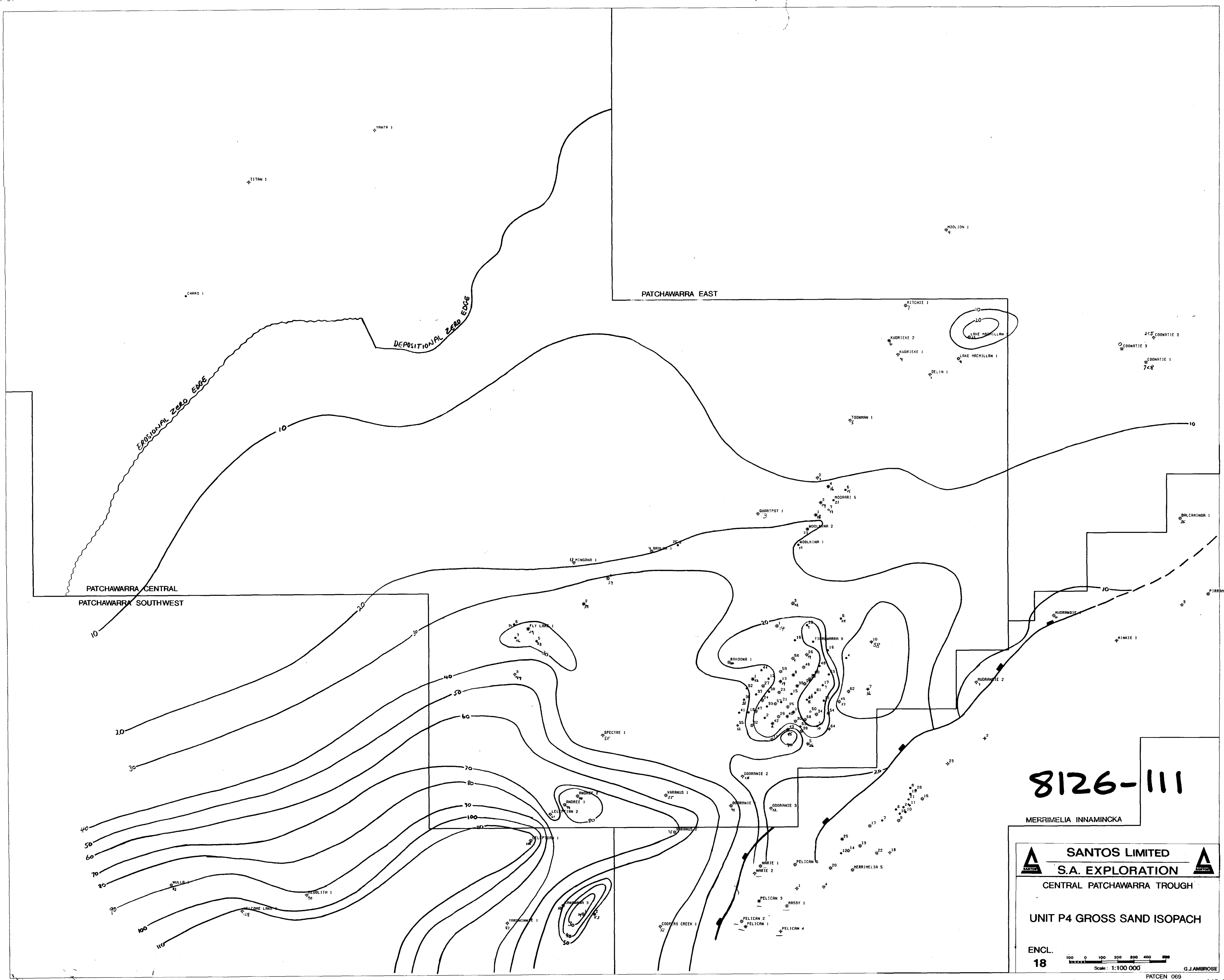
G.J.AMBROSE

PATCEN 065

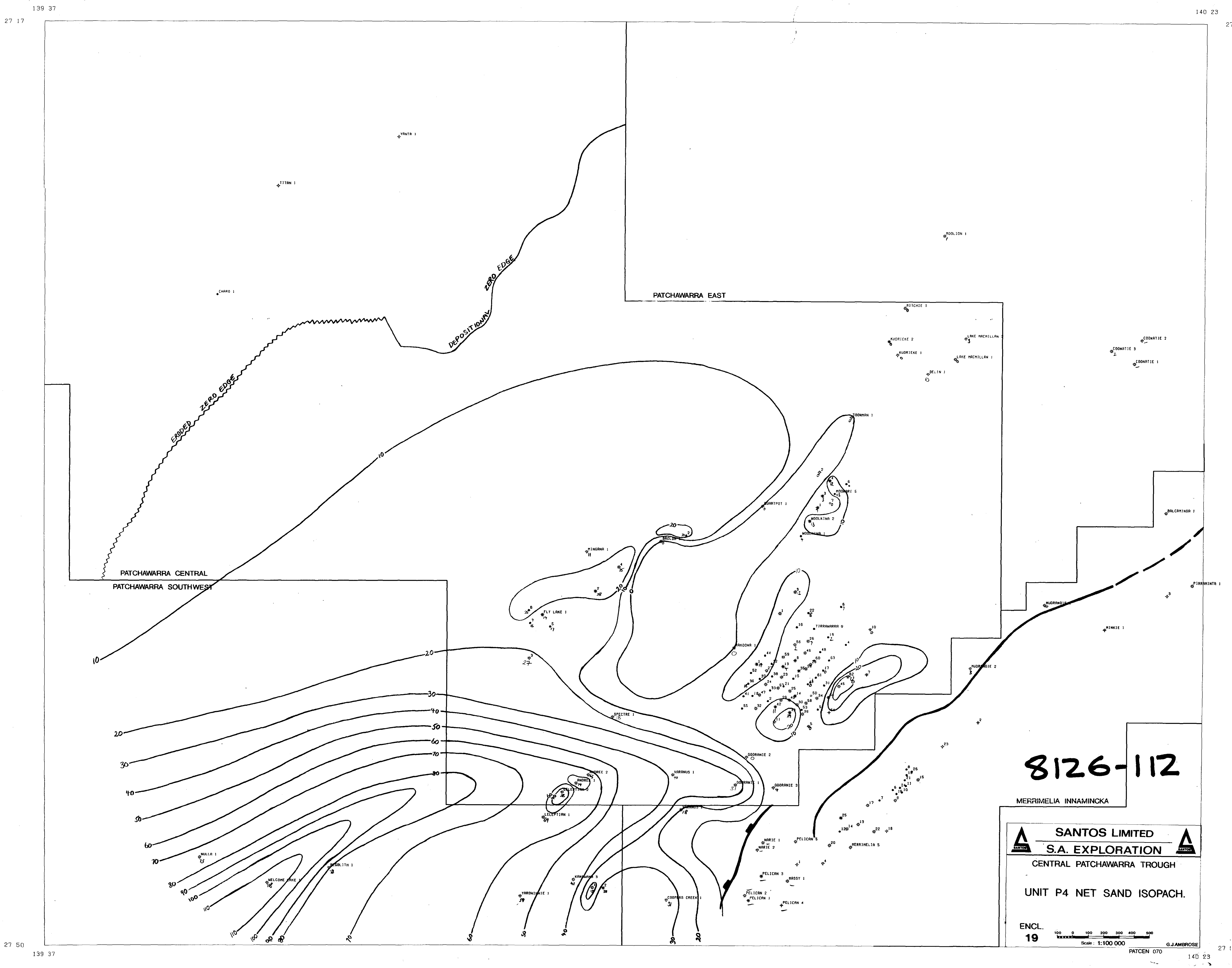

139 37
27 17
140 23
27
27 50
139 37
140 23
ERODED ZERO EDGE
DEPOSITIONAL ZERO EDGE
PATCHAWARRA EAST
PATCHAWARRA CENTRAL
PATCHAWARRA SOUTHWEST
YANTA 1
TITAN 1
MOOLION 1
MITCHIE 1
KUDRIEKE 2
KUDRIEKE 1
LAKE MACMILLAN 2
LAKE MACMILLAN 1
DELIN 1
COONATIE 2
COONATIE 3
COONATIE 1
TOONMAN 1
MOORARI 5
WOOLKINA 2
WOOLKINA 1
BALCANINOA 1
MINGANA 1
BROLGA 1
FLY LAKE
TIRRAWARRA 9
SPECTRE 1
GOORANIE 2
GOORANIE 1
ANDREE 2
ANDREE 1
LELEPTIAN 2
LELEPTIAN 1
YARRANUS
NULLA 1
WELLCOME LAKE 1
REGOLITH 1
KANOWANA 3
YARROWINNIE 1
COOPERS CREEK 1
PELICAN 5
PELICAN 3
PELICAN 1
PELICAN 4
MASSY 1
MERRIMELIA 5
MUDRANGIE 2
MINKIE 1
PIRRAMINTA 1
8126-108
MERRIMELIA INNAMINCKA
SANTOS LIMITED
S.A. EXPLORATION
CENTRAL PATCHAWARRA TROUGH
UNIT P3 NET SAND ISOPACH
ENCL.
15
Scale: 1:100 000
G.J.AMBROSE
PATCEN 066


139 37
140 23
27 17
27 50
PATCHAWARRA EAST
PATCHAWARRA CENTRAL
PATCHAWARRA SOUTHWEST
MERRIMELIA INNAMINCKA
ERODED ZERO EDGE
DEPOSITIONAL ZERO EDGE
50
75
100
125
150
175
200
225
250
8126-109
SANTOS LIMITED
S.A. EXPLORATION
CENTRAL PATCHAWARRA TROUGH
UNIT P4 FORMATION ISOPACH
ENCL.
16
Scale : 1:100 000
G.J.AMBROSE
PATCEN 067

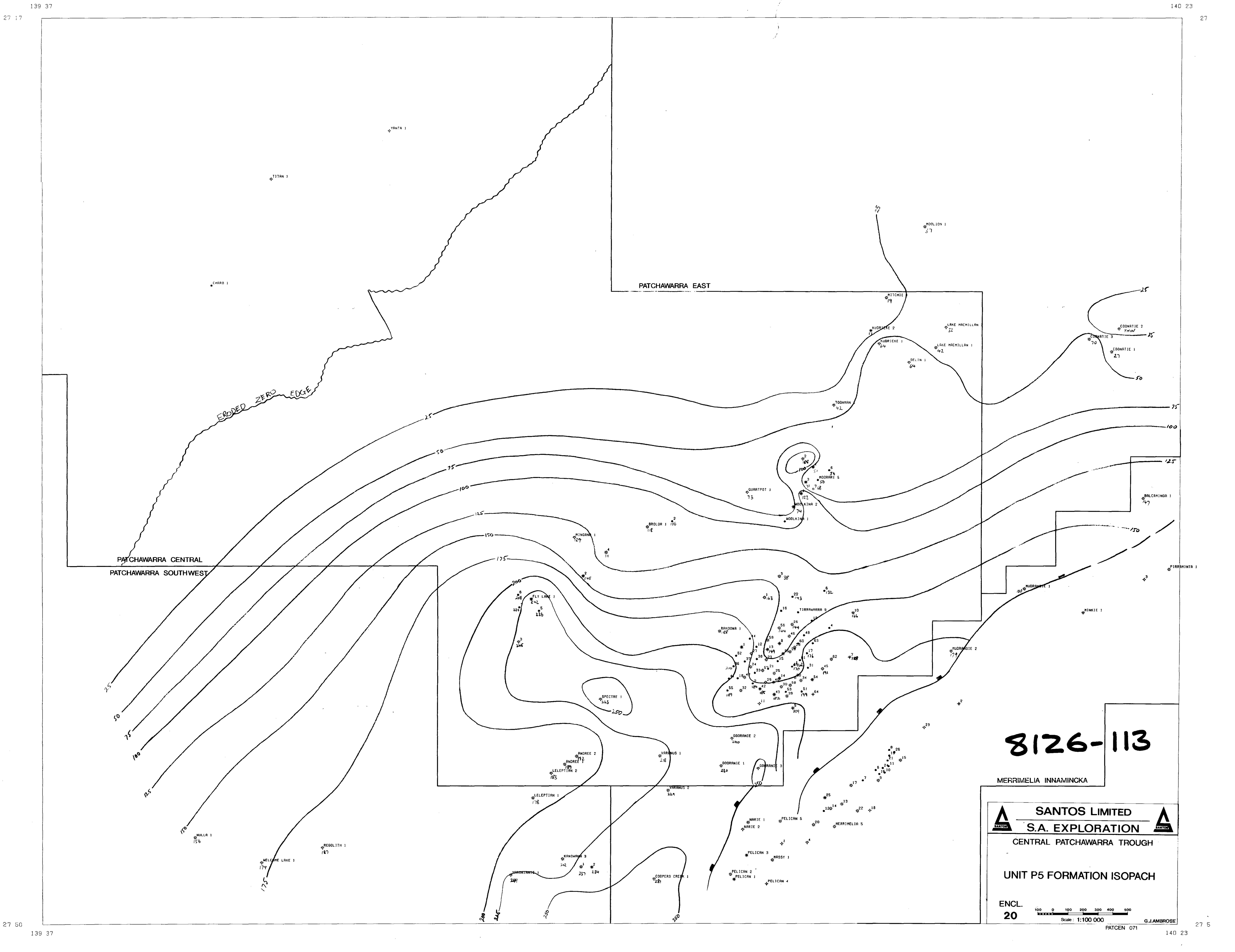

139 37
140 23
27 17
27 50
PATCHAWARRA EAST
PATCHAWARRA CENTRAL
PATCHAWARRA SOUTHWEST
MERRIMELIA INNAMINCKA
ERODED ZERO EDGE
DEPOSITIONAL ZERO EDGE
SHELF AREA
MAINLY OVERBANK DEPOSITS
WITH SOME CHANNELS
MAIN DEPOCENTRE
AREA OF MAIN
CHANNEL SYSTEMS
8126-1 10
SANTOS LIMITED
S.A. EXPLORATION
CENTRAL PATCHAWARRA TROUGH
UNIT P4 PALAEOGEOGRAPHY
ENCL.
17
Scale 1:100 000
G.J.AMBROSE
PATCEN 068



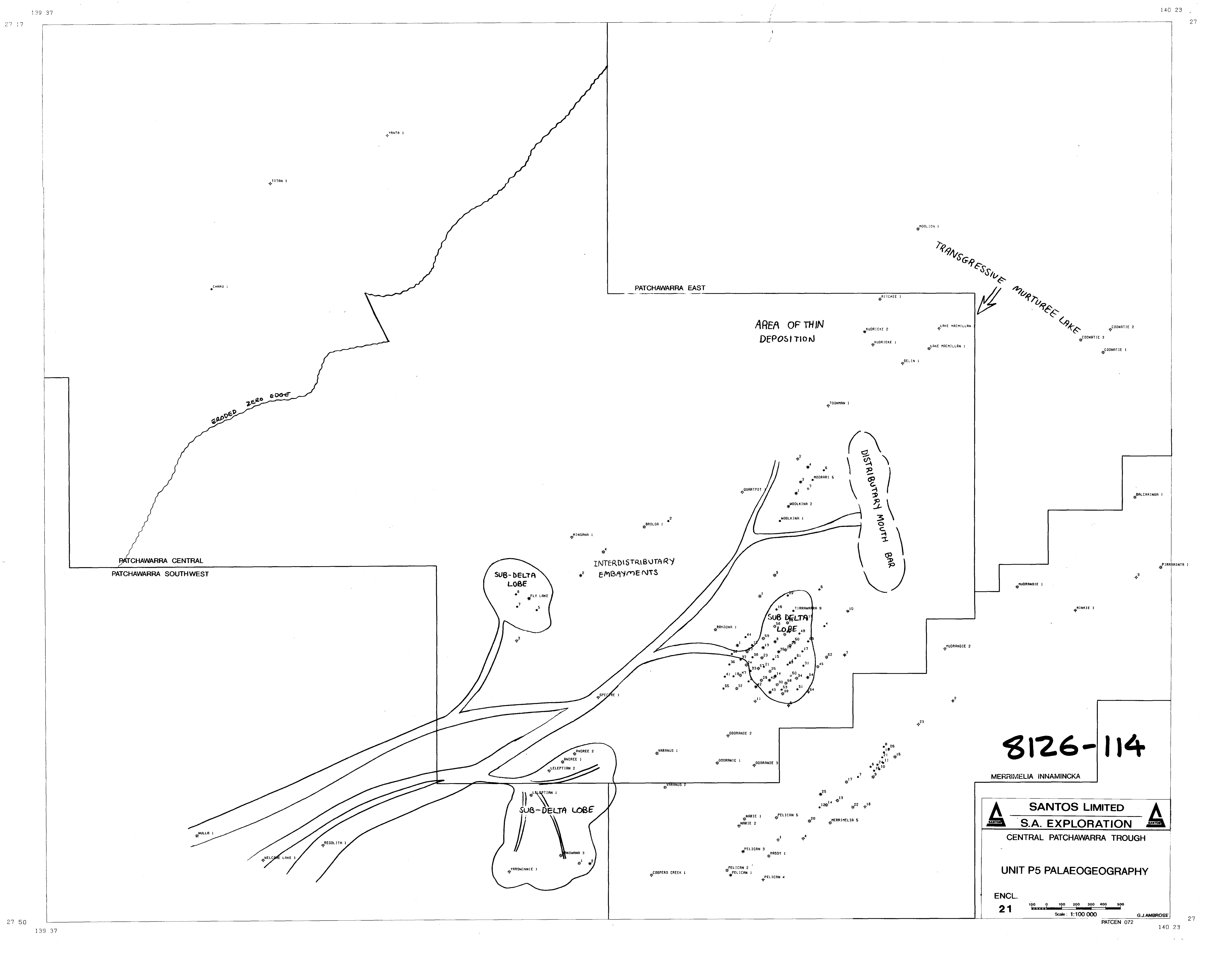
SANTOS LIMITED
S.A. EXPLORATION
CENTRAL PATCHAWARRA TROUGH
UNIT P4 GROSS SAND ISOPACH
ENCL.
18
Scale: 1:100 000
G.J.AMBROSE
PATCEN 069
8126-111
PATCHAWARRA EAST
PATCHAWARRA CENTRAL
PATCHAWARRA SOUTHWEST
MERRIMELIA INNAMINCKA
EROSIONAL ZERO EDGE
DEPOSITIONAL ZERO EDGE
139 37
140 23
27 17
27 50



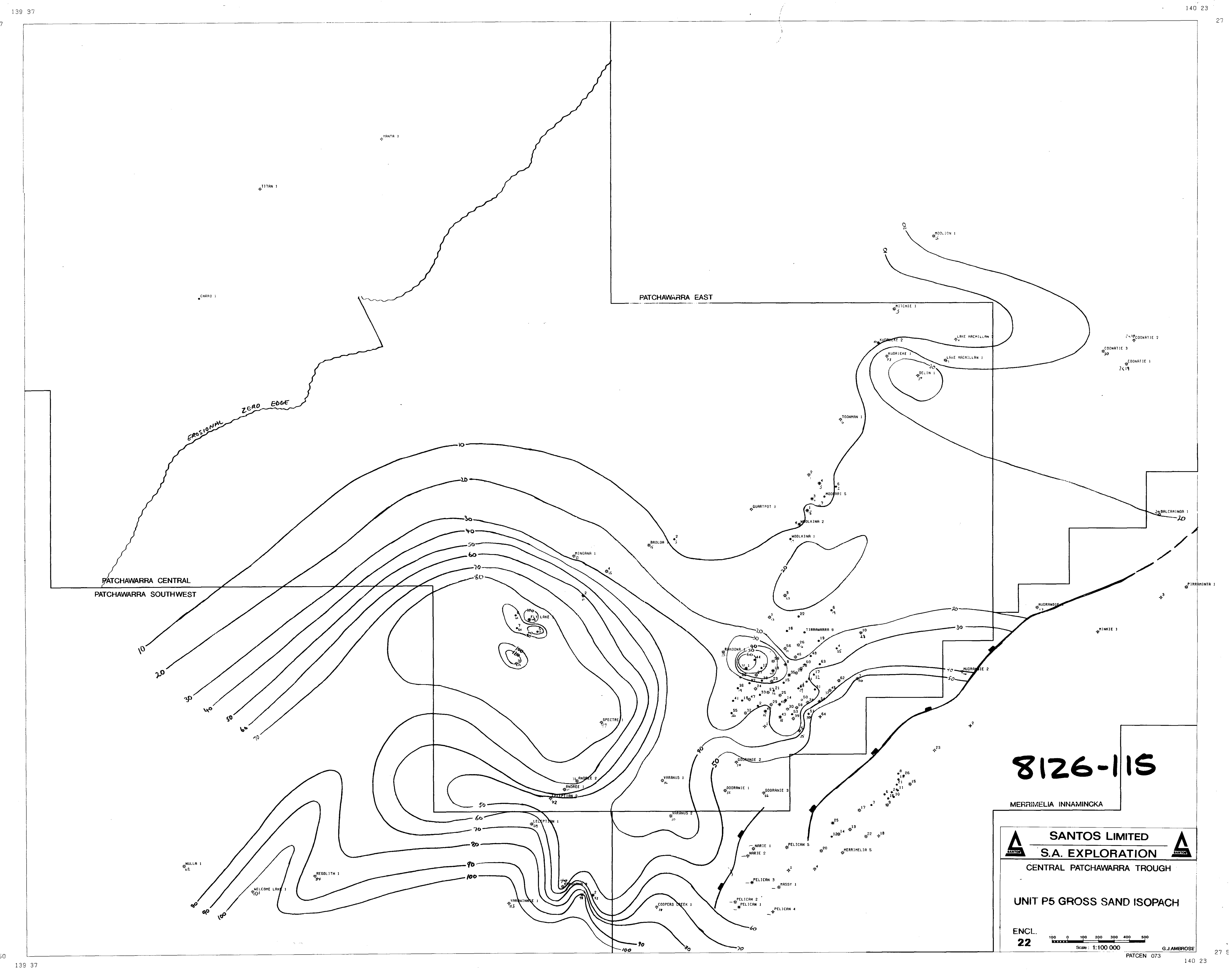
8126-112
SANTOS LIMITED
S.A. EXPLORATION
CENTRAL PATCHAWARRA TROUGH
UNIT P4 NET SAND ISOPACH.
ENCL. 19
Scale 1:100 000
G.J.AMBROSE
PATCEN 070
PATCHAWARRA EAST
PATCHAWARRA CENTRAL
PATCHAWARRA SOUTHWEST
MERRIMELIA INNAMINCKA
ERODED ZERO EDGE
DEPOSITIONAL ZERO EDGE
139 37
140 23
27 17
27 50



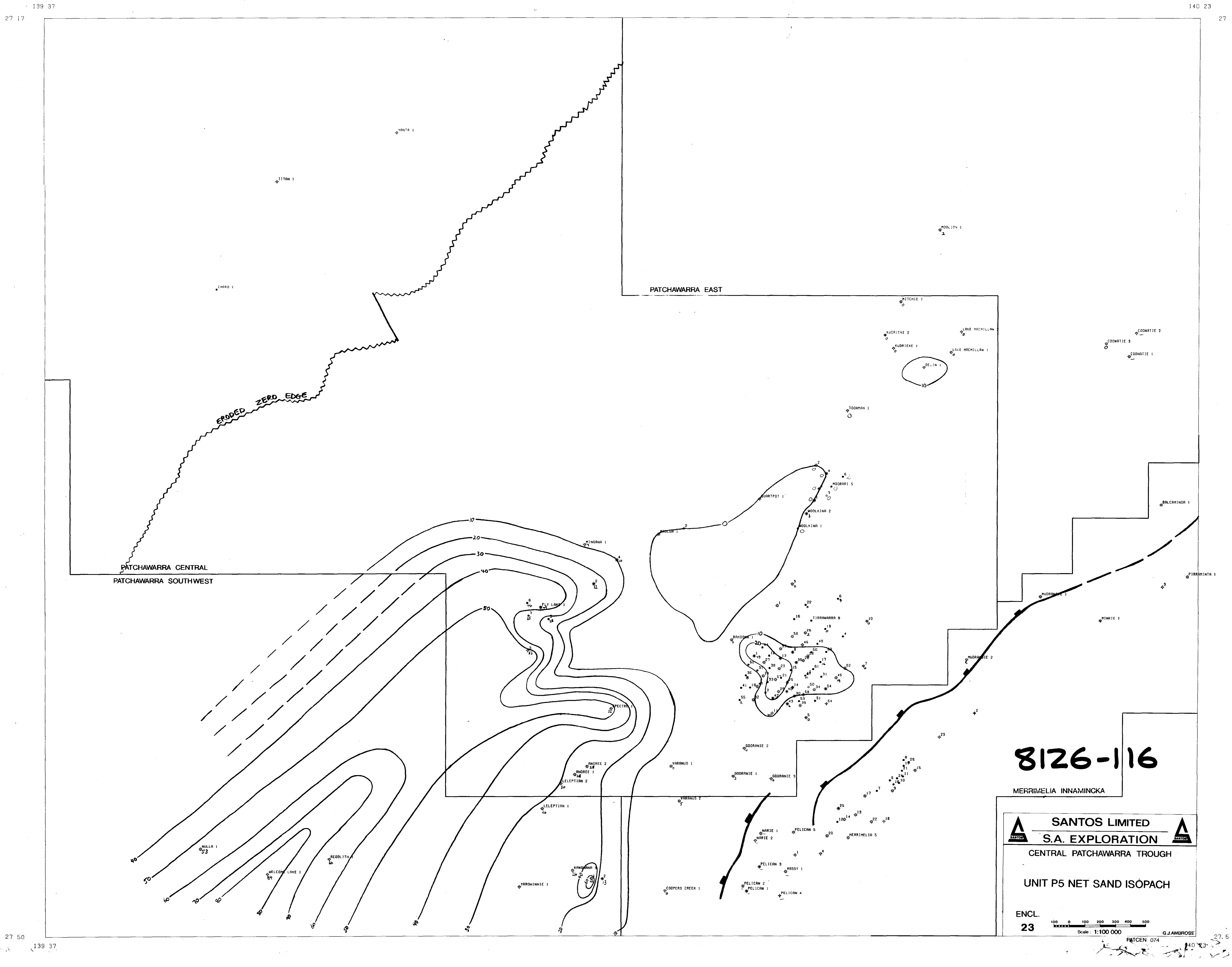
139 37
140 23
27 17
27
27 50
27 5
ERODED ZERO EDGE
PATCHAWARRA EAST
PATCHAWARRA CENTRAL
PATCHAWARRA SOUTHWEST
MERRIMELIA INNAMINCKA
8126-113
SANTOS LIMITED
S.A. EXPLORATION
CENTRAL PATCHAWARRA TROUGH
UNIT P5 FORMATION ISOPACH
ENCL.
20
Scale: 1:100 000
G.J.AMBROSE
PATCEN 071

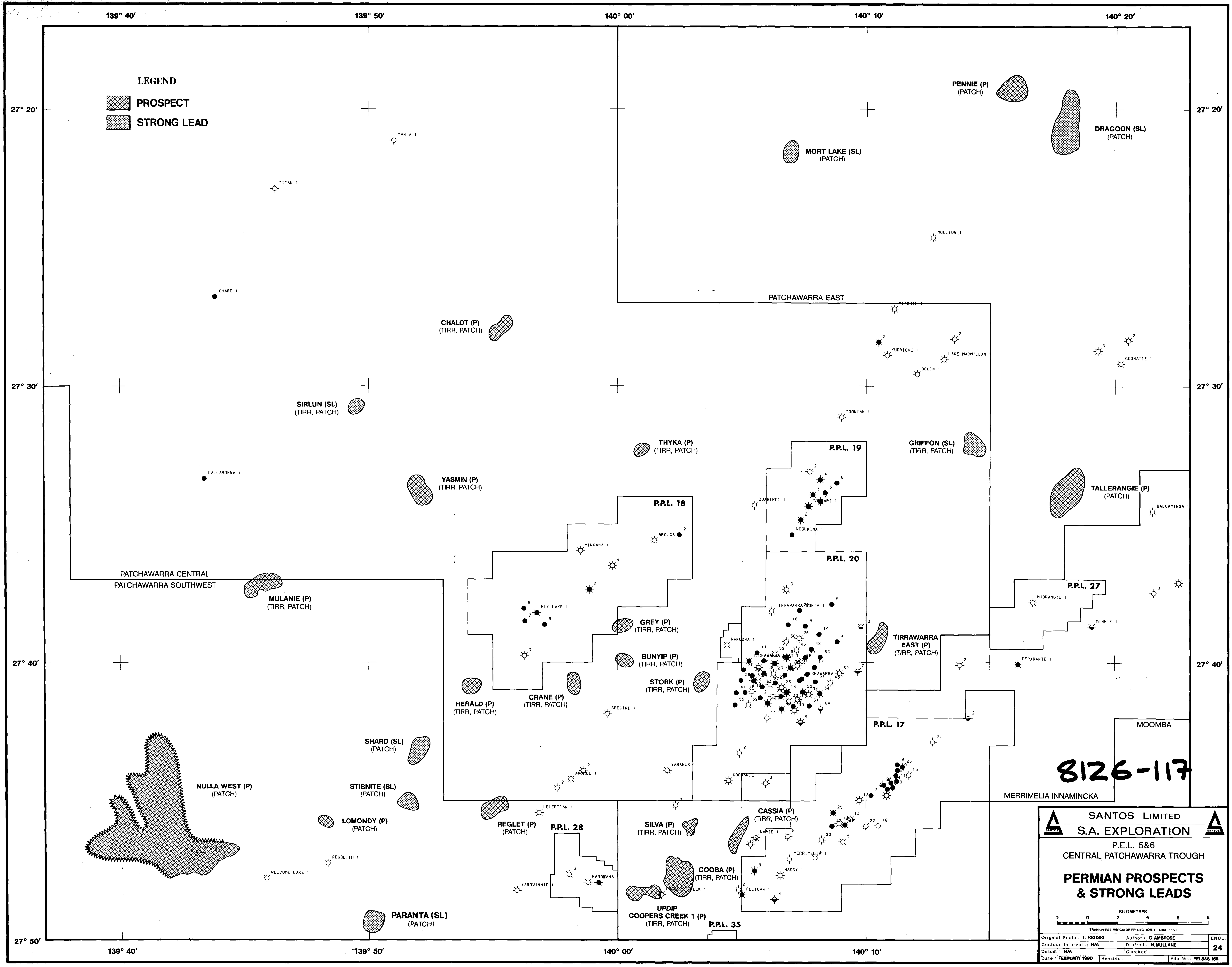


139 37
27 17
140 23
27
ERODED ZERO EDGE
PATCHAWARRA EAST
TRANSGRESSIVE MURTUREE LAKE
AREA OF THIN DEPOSITION
DISTRIBUTARY MOUTH BAR
INTERDISTRIBUTARY EMBAYMENTS
PATCHAWARRA CENTRAL
PATCHAWARRA SOUTHWEST
SUB-DELTA LOBE
SUB DELTA LOBE
SUB-DELTA LOBE
8126-114
MERRIMELIA INNAMINCKA
SANTOS LIMITED
S.A. EXPLORATION
CENTRAL PATCHAWARRA TROUGH
UNIT P5 PALAEOGEOGRAPHY
ENCL.
21
Scale : 1:100 000
G.J.AMBROSE
PATCEN 072
27 50
139 37
140 23

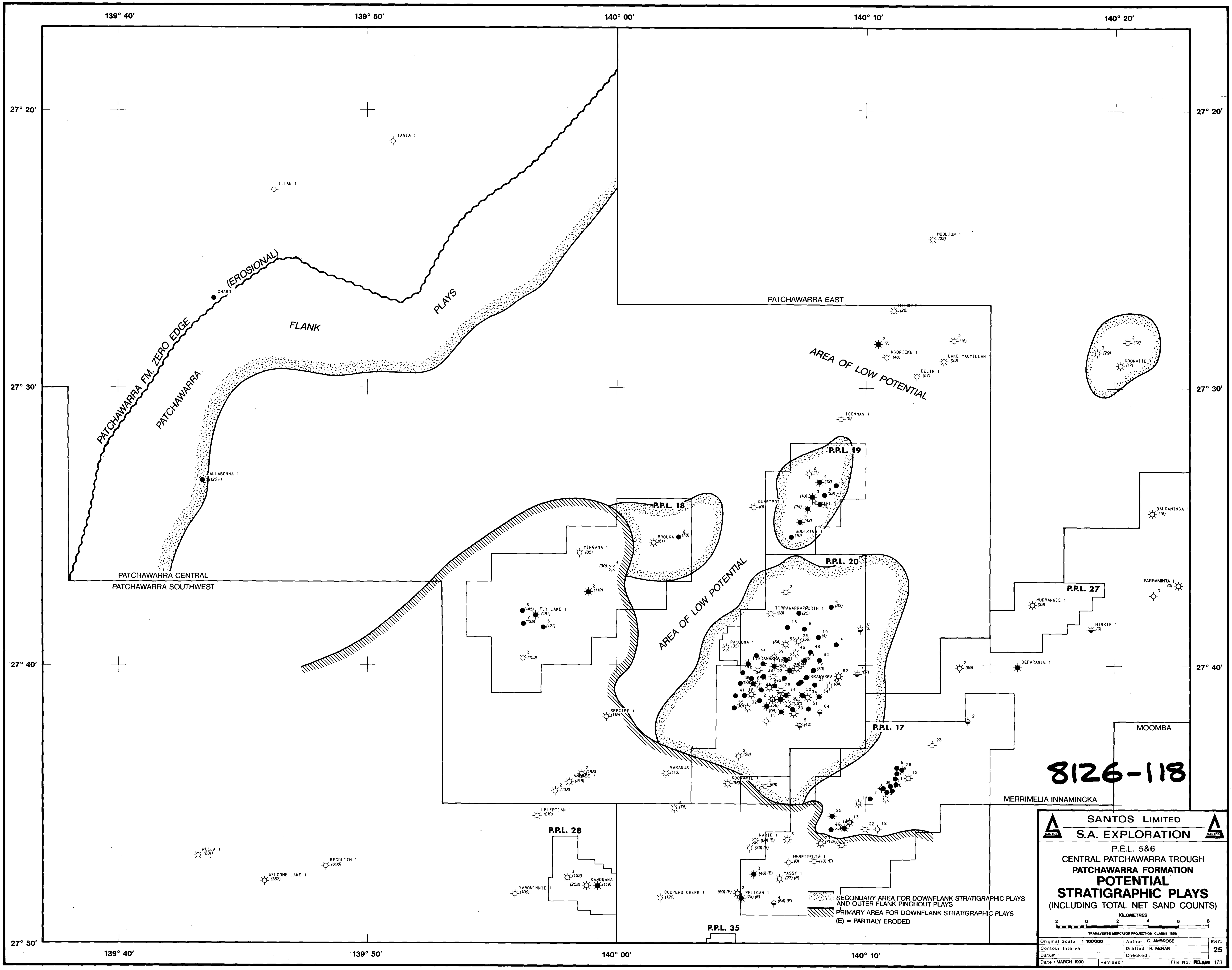


8126-115
PATCHAWARRA EAST
PATCHAWARRA CENTRAL
PATCHAWARRA SOUTHWEST
MERRIMELIA INNAMINCKA
EROSIONAL ZERO EDGE
SANTOS LIMITED
S.A. EXPLORATION
CENTRAL PATCHAWARRA TROUGH
UNIT P5 GROSS SAND ISOPACH
ENCL. 22
Scale: 1:100 000
G.J.AMBROSE
PATCEN 073


139 37
140 23
27 17
27
27 50
27 5
ERODED ZERO EDGE
PATCHAWARRA EAST
PATCHAWARRA CENTRAL
PATCHAWARRA SOUTHWEST
MERRIMELIA INNAMINCKA
8126-116
SANTOS LIMITED
S.A. EXPLORATION
CENTRAL PATCHAWARRA TROUGH
UNIT P5 NET SAND ISOPACH
ENCL.
23
Scale : 1:100 000
G.J.AMBROSE
PATCEN 074

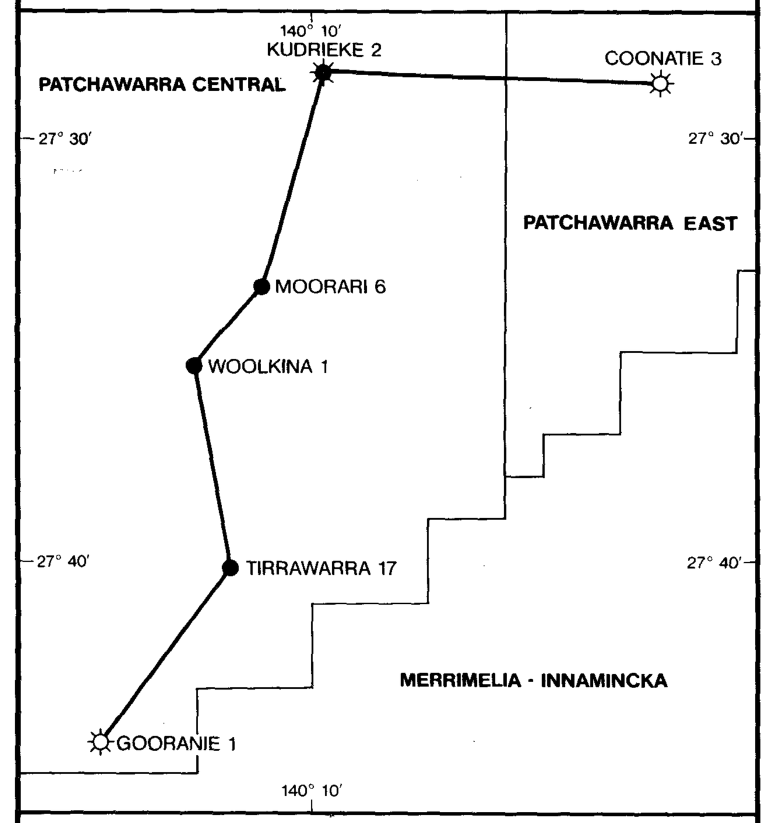


LEGEND
PROSPECT
STRONG LEAD
139° 40'
139° 50'
140° 00'
140° 10'
140° 20'
27° 20'
27° 30'
27° 40'
27° 50'
PENNIE (P) (PATCH)
DRAGOON (SL) (PATCH)
MORT LAKE (SL) (PATCH)
YANTA 1
TITAN 1
MOOLION 1
CHARO 1
PATCHAWARRA EAST
CHALOT (P) (TIRR, PATCH)
KUDRIEKE 1
LAKE MACMILLAN 1
DELIN 1
COONATIE 1
SIRLUN (SL) (TIRR, PATCH)
TOONMAN 1
THYKA (P) (TIRR, PATCH)
P.P.L. 19
GRIFFON (SL) (TIRR, PATCH)
CALLABONNA 1
YASMIN (P) (TIRR, PATCH)
QUARTPOT 1
WOOLKINA 1
TALLERANGIE (P) (PATCH)
BALCAMINGA 1
P.P.L. 18
BROLGA
MINGANA 1
P.P.L. 20
P.P.L. 27
PATCHAWARRA CENTRAL
PATCHAWARRA SOUTHWEST
MULANIE (P) (TIRR, PATCH)
MUDRANGIE 1
FLY LAKE 1
TIRRAWARRA NORTH 1
MINKIE 1
GREY (P) (TIRR, PATCH)
RAKOONA 1
TIRRAWARRA EAST (P) (TIRR, PATCH)
BUNYIP (P) (TIRR, PATCH)
DEPARANIE 1
STORK (P) (TIRR, PATCH)
HERALD (P) (TIRR, PATCH)
CRANE (P) (TIRR, PATCH)
SPECTRE 1
P.P.L. 17
MOOMBA
SHARD (SL) (PATCH)
VARANUS 1
COORANIE 1
8126-117
NULLA WEST (P) (PATCH)
STIBNITE (SL) (PATCH)
MERRIMELIA INNAMINCKA
LOMONDY (P) (PATCH)
REGLET (P) (PATCH)
LELEPTIAN 1
P.P.L. 28
SILVA (P) (TIRR, PATCH)
CASSIA (P) (TIRR, PATCH)
REGOLITH 1
WELCOME LAKE 1
YAROWINNIE 1
KANOWANA
COOBA (P) (TIRR, PATCH)
MERRIMELIA 1
MASSY 1
PELICAN 1
UPDIP COOPERS CREEK 1 (P) (TIRR, PATCH)
PARANTA (SL) (PATCH)
P.P.L. 35
SANTOS LIMITED
S.A. EXPLORATION
P.E.L. 5&6
CENTRAL PATCHAWARRA TROUGH
PERMIAN PROSPECTS & STRONG LEADS
KILOMETRES
2 0 2 4 6 8
TRANSVERSE MERCATOR PROJECTION, CLARKE 1858
Original Scale : 1: 100 000
Contour Interval : N/A
Datum : N/A
Date : FEBRUARY 1990
Author : G. AMBROSE
Drafted : N. MULLANE
Checked :
Revised :
ENCL. 24
File No.: PEL5&6 185



139° 40'
139° 50'
140° 00'
140° 10'
140° 20'
27° 20'
27° 30'
27° 40'
27° 50'
PATCHAWARRA FM. ZERO EDGE (EROSIONAL)
PATCHAWARRA FLANK PLAYS
AREA OF LOW POTENTIAL
PATCHAWARRA EAST
PATCHAWARRA CENTRAL
PATCHAWARRA SOUTHWEST
P.P.L. 17
P.P.L. 18
P.P.L. 19
P.P.L. 20
P.P.L. 27
P.P.L. 28
P.P.L. 35
MOOMBA
MERRIMELIA INNAMINCKA
8126-118
SANTOS LIMITED
S.A. EXPLORATION
P.E.L. 5&6
CENTRAL PATCHAWARRA TROUGH
PATCHAWARRA FORMATION
POTENTIAL
STRATIGRAPHIC PLAYS
(INCLUDING TOTAL NET SAND COUNTS)
SECONDARY AREA FOR DOWNFLANK STRATIGRAPHIC PLAYS AND OUTER FLANK PINCHOUT PLAYS
PRIMARY AREA FOR DOWNFLANK STRATIGRAPHIC PLAYS
(E) = PARTIALY ERODED
KILOMETRES
TRANSVERSE MERCATOR PROJECTION, CLARKE 1858
Original Scale : 1:100000
Contour Interval :
Datum :
Date : MARCH 1990
Author : G. AMBROSE
Drafted : R. McNAB
Checked :
Revised :
ENCL. 25

LINE OF SECTION



SANTOS LIMITED

S.A. EXPLORATION

P.E.L. 5&6

PATCHAWARRA CENTRAL BLOCK

STRATIGRAPHIC CROSS SECTION

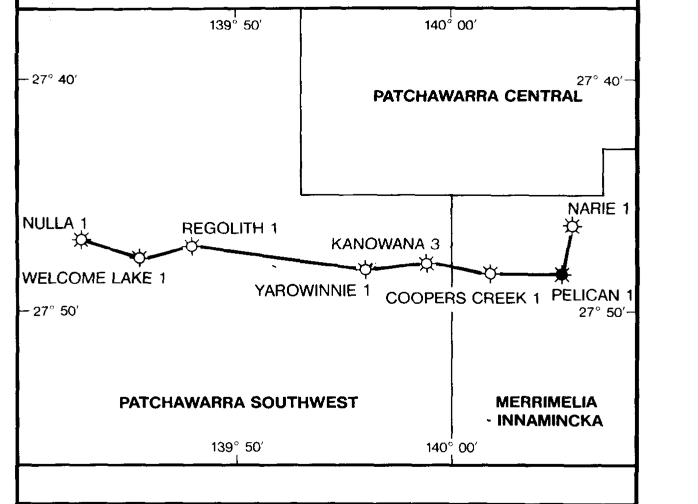
GOORANIE 1 - COONATIE 3

TRANSVERSE MERCATOR PROJECTION , CLARKE 1858

Original Scale : 1 : 1200	Author : G. AMBROSE	ENCL. 26
Contour Interval :	Drafted : J. R. BRUSE	
Datum : TOP TOOLACHEE	Checked :	
Date : MARCH, 1990	Revised :	File No.: PATCEN 041

8126-119

LINE OF SECTION



SANTOS LIMITED

S.A. EXPLORATION

P.E.L. 5&6

PATCHAWARRA SOUTHWEST

STRATIGRAPHIC CROSS SECTION

NULLA 1 - NARIE 1

TRANSVERSE MERCATOR PROJECTION, CLARKE 1858

Original Scale : 1 : 1200	Author : G. AMBROSE	ENCL. 27
Contour Interval :	Drafted : J. R. BRUSE	
Datum : TOP TOOLACHEE	Checked :	
Date : MARCH, 1990 / Revised :	File No.: PATSWT 027	

8126-120