OPEN FILE

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

Rept.Bk.No. 80/128

TOODLA NO. 1
WELL COMPLETION REPORT

REPORT NO. 3 of the
EROMANGA BASIN STUDY GROUP.

GEOLOGICAL SURVEY

by

M. GRIFFITHS

(Fossil Fuels Section)

D.M. No. 288/79

CONTENTS Page

APPENDICES

TABLES PLAN NO.

FIGURES

CONTENTS continued.

f

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

Rept.Bk.No. 80/128
DME No. 288/79

TOODLA NO. 1
WELL COMPLETION REPORT
REPORT NO. 3 OF THE EROMANGA BASIN STUDY GROUP

ABSTRACT

The South Australian Department of Mines and Energy (SADME) Toodla No. 1 well was drilled near the southwestern margin of the Eromanga or Great Artesian Basin, about 20 km east-northeast of Mount Dutton at the northern end of the Peake and Denison Ranges. The prime objective of the well was to core a complete section through the Mesozoic sequence in an area with little previous hydrocarbon exploration. A secondary objective was to identify and core underlying ?Permian (or older) sedimentary rocks.

The well was abandoned at a total depth of 353 m, having continuously cored 192 m of flat-lying Mesozoic shales and sandstones from the lower part of the Eromanga Basin sequence. These sediments were underlain unconformably by 11+ m of slightly metamorphosed siltstones and shales (?Ordovician). Core recoveries were good (91%) in the shaley sections but very poor (7%) in the basal Mesozoic artesian aquifer sands.

As a result of core losses an accurate assessment of the potential reservoir rocks is not possible, but organic geochemical studies of the overlying Bulldog Shale indicate that marginal source-rock potential and moderate oil-shale potential in Cretaceous shales of this type may be developed deeper in the basin. The well partly delineated a western limit to the prospective Permian deposition in the Pedirka Basin, and the identification of a prominent seismic reflector beneath the "C-Horizon" as an ?Ordovician economic basement will assist in the future correlation of seismic data within the region.

INTRODUCTION

In early 1979 SADME formed the Eromanga Basin Study Group within the Fossil Fuels section. The Study Group effort was aimed at a comprehensive assessment of the petroleum potential of that basin.

The principal initial task of the Study Group was a re-assessment of large amounts of oil-company subsurface information to prepare an all-inclusive data base from core, cuttings and petrophysical logs. Ultimately the Group's main aim was the construction of appropriate structure contour, isochore and lithofacies maps and the creation of paleogeographic and depositional models from this data base, with additional control to come from new stratigraphic wells and surface mapping.

Toodla No. 1 represents the first stratigraphic well drilled as part of the study. The well was designed to test a complete Mesozoic sequence near the southwestern margin of the basin, and to identify and evaluate the pre-Mesozoic sequence.

WELL HISTORY

General Well Data

Well Name and Number:

South Australian Department of Mines and Energy,
TOODLA NO. 1.
SADME Bore No. 6042000SW00020

Location:

Latitude	27°43'47"	South
Longitude	135°50'55"	East

The drill-site was 18 km ENE of Mount Dutton Railway Siding, 0.5 km SE of a point midway between SADME seismic shotpoints DK6 and DK7.

Access:

Access to the site was gained by a track (SADME seismic line DK) from Mount Dutton Railway Siding.

Map Reference:

1: 250 000 OODNADATTA
1: 100 000 Algebuckina (6042)

Pastoral Lease:

Mr. R. Napier,
Pamatta Pty. Ltd.,
Allandale,
via Oodnadatta, S.A., 5734.

Details of Petroleum Tenement:

Petroleum Exploration Licences Nos 5 and 6.

Tenement Holder:

Delhi Petroleum Pty. Ltd. and Santos Ltd.

Elevation:

Ground	96.7 m above sea level
Kelly Bushing	1.0 m above ground level

Total Depth:

353 m below ground level.

Date Drilling Commenced:

13th September 1979

Date Drilling Completed:

9th November 1979

Actual Drilling Time to T.D.:

26 days

Date Well Completed:

15th November 1979.

Status:

Plugged and abandoned.

Well Costs:

$68,042.79 to 31/5/80;
$192.76 per metre drilled.

Drilling Data

Name and Address of Operator:

South Australian Department of Mines and Energy Drilling and Mechanical Branch, Dalgleish Street, Thebarton, S.A., 5031.

Drilling Rig Particulars:

Make	Failing 1500
Type	Rotary Drill
Rated Capacity	457.2 m with 75.7 mm (2-63/64") O.D. drill pipe.
Motor	Cummins diesel
Power Rating	138 kW at 1800 r.p.m.

Mast:

Make	Failing 1500
Type	Open front
Rated Capacity	10,909 kg

Pumps (2):

Make	Gardner-Denver
Type	FGFXG
Size	12.7 x 15.2 cm
Motor	Cummins diesel
Power Rating	31.7 kW

Hole Size:

187.3 mm (7-3/8") to 150 m
75.7 mm (2-63/64") to 353 m
Reamed 127 mm (5") from 150 m to 353 m

Casing and Cementing Details:

Size	Grade	Depth
127 mm (5" I.D.)	NB steel pipe	0-150 m

The casing annulus was cemented between 150 m and the surface using a slurry composed of 60 sacks of cement mixed into 466 gallons of water, displaced from within the hole by 426 gallons of water.

Bit Record

No. Bits Used	Size	Type	Make
1 (drilling from 0-150 m)	187.3 mm (7-3/8")	3 cone roller bit	Varel V2
5 (coring from 150-344.45 m) (and from 347.5-353 m)	NQ 75.7 mm (2-63/64")	multi-step diamond-set core bits	Mindrill
2 (reaming from 150-344.45 m) (and from 347.5-353 m)	NQ 75.7 mm (2-63/64")	diamond-set reamer shells	Mindrill
1 (reaming from 150-344.45 m) (drilling from 344.45-347.5 m, and reaming from 347.5-353 m).	127 mm (5")	3-cone roller bit	Varel V2

Drilling Fluids Used:

Only non-oil-based drilling fluids were used uphole, to obtain samples suitable for source-rock analysis; and only water was used to core from 150 m to 353 m (T.D.).

Surface to 150 m	Rotary drilling. Baroid Aquagel High Yield Bentonite: 25 kg per 200 gallons water - 5 sacks used.
150 m - 353 m	NQ coring. Straight water - no additives.

The thread lubricant used for pipe and tool joints and the core barrel bearings was a non-contaminating mixture of molybdenum disulphide, red lead and glycerine.

Water Supply:

Water for drilling fluid and camp use was obtained from Watson Bore, situated approximately 3 km north-east of the drill-site. This artesian bore flows water with a salinity of 2507 ppm at a recorded rate of 2300 m^3/day (21,300 gph).

Formation Sampling

Ditch Cuttings:

One sample was collected and retained for every 2 m interval of rotary drilling between the surface and 150 m. Washed samples were examined and described with the aid of a binocular microscope. The samples also were examined under ultra-violet light for any fluorescence indicative of hydrocarbons.

Coring:

Continuous coring commenced at 150 m and continued to the total depth of 353 m. (Core size NQ - (1-7/8" diam.). Core recoveries averaged 67% overall but dropped to only 7% in the Algebuckina Sandstone due to inadequate mud systems and equipment.

Water Sampling:

Two water samples were collected while drilling the artesian section of the well; one 2-litre sample was taken at 285 m where the aquifer was first encountered, and another at 307 m depth near the zone of greatest flow (in excess of 20,000 gph). Analyses are contained in Appendix IV.

Storage of samples and cores:

All ditch samples and cores are permanently stored at the Core Library of the South Australian Department of Mines and Energy, Conyngham Street, Glenside, S.A. 5065.

Petrophysical Logging

All well logging was carried out using the South Australian Department of Mines and Energy Failing Logmaster unit (914 m model).

Log	Depth (m)	Date
Gamma-Ray	from 0 to 352	24-10-79
Neutron-Neutron	" "	"
Caliper	" "	"
Density	" "	"
Resistivity (16" Normal)	" "	"
Resistivity (64" Normal)	" "	"
Resistivity (6 ft. Lateral)	" "	"
SP (Self-Potential)	" "	"
PR (Point Resistivity)	" "	"

No measurements of bit penetration rate or downhole temperature were taken, nor were any well velocity or deviation surveys run.

Well Completion

The casing string consisted of 150 m of 125 mm (5" I.D.) steel pipe installed from the surface. The annulus between this casing and the 187.3 mm (7-3/8") surface hole was cemented with 60 sacks of cement in 466 gallons of water. Upon completion of drilling and logging a cement plug was set from 71 m to T.D. (353 m) using 105 sacks of cement to make up 805 gallons of slurry, with a second plug set from the surface to 6 m depth using 20 sacks of cement mixed into 258 gallons of water. These two plugs were required to shut off the artesian aquifer, which commenced flowing at 285 m, far below the bottom of the casing, the final water discharge rate measuring in excess of 20,000 gph (91.0 kl/hr) at a shut-in pressure of 19 psi.

GEOLOGY

Regional Setting

Toodla No. 1 is located near the southwestern margin of the Eromanga Basin (Fig. 1). To the east lies the Lake Eyre depression and to the west the Peake and Denison Ranges. These ranges topographically express an uplifted block of Adelaidean to early Proterozoic basement (part of the Muloorinna Ridge), which in areas bordering the ranges is covered by onlapping Mesozoic sediments of the Eromanga Basin. The Muloorinna Ridge divides the Permian Pedirka Basin to the northeast from the Permian Arckaringa Basin to the southwest.

Surface topography around the wellsite consists of a gently undulating, gibber-strewn and creek-dissected tableland which rises sharply northward to form an elevated plateau, and descends gradually southward to arid sandy plains crossed by numerous ephemeral streams flowing east towards Lake Eyre.

Previous Exploration

Toodla No. 1 is the first stratigraphic well drilled on the southwestern margin of the Eromanga Basin since SADME Coongra No. 1 was completed in March 1978 (Fig. 2). Coongra No. 1, like Toodla No. 1, was intended to serve a three-fold purpose:

(i) to establish the Mesozoic stratigraphy over portions of the Muloorinna Ridge;

(ii) to search for possible extensions of Permian sediments across the Muloorinna Ridge; and

(iii) lastly but most importantly to assess the hydrocarbon potential of both Mesozoic and ?Permian sediments.

Unfortunately the mechanical history of both wells proved to be similar: Coongra was abandoned before reaching its target depth due to insuperable drilling difficulties, and achieved none of its proposed objectives. Thus SADME Toodla No. 1 with its marginally better drilling success represents the most valuable recent addition to our knowledge of the geology and hydrocarbon potential in the vicinity of the Muloorinna Ridge.

The nearest known significant oil show (Wiltshire, 1978) occurs in the Poolowanna Formation (Lower Jurassic) in Poolowanna No. 1, approximately 250 km northeast of Toodla No.1. With the exception of the Officer Basin oil show (Cambrian) in SADME Byilkaoora No. 1, some 220 km to the west, other hydrocarbon shows in this region are restricted to Mokari No. 1 (a weak gas flow from Lower Jurassic sediments) and Purni No. 1 (mild Permian water fluorescence). Locations of other deep oil exploration wells and shallow SADME wells in the general area are shown on Figure 2, and their formation tops are listed in Table 2. Overall well coverage is sparse, and the hydrocarbon potential of the area still largely unknown.

Reasons for Drilling

The primary objective of Toodla No. 1 was to fully penetrate the Mesozoic section, a consideration which restricted the choice of drillsites to the margin of the basin due to the limited drilling capacity (about 800 m) of the Department's rigs. A site for the well was selected in the region of Mount Toodla on the OODNADATTA 1: 250 000 sheet because this area satisfied a number of Eromanga Basin Project exploration aims:

(i) correlation of outcropping sediments of the type section of the western Eromanga Basin, in the nearby Mount Dutton and Algebuckina Hill areas, with those in the basin margin subsurface;

(ii) correlation of a basin margin sequence with the deeper basin sequence; and

(iii) because the Mesozoic sediments were considered suitable for continuous coring, a full assessment could be made of their hydrocarbon reservoir, cap rock and source rock potential; besides which

(iv) the well would permit the correlation of existing reflection seismic data with the subsurface section, and arising from this,

(v) a well drilled to "basement" at Toodla could determine the existence of presumed Permian sediments in the area and evaluate their hydrocarbon potential.

This last reason was decisive in the selection of the Toodla wellsite since limited evidence from an earlier SADME reflection seismic survey in the area (line DK of Figure 3) suggested the existence of a small infrabasin beneath the Eromanga Basin sequence with reflection velocities similar to those measured in Permian sediments of the Cooper Basin (see time cross-section and velocity data, Fig. 4).

Accordingly, the Toodla No. 1 well originally was sited 15 km northeast of Mount Dutton Railway Siding at shotpoint No. 5 on the DK seismic line. Subsequently, upon field inspection of the area before the commencement of drilling, the well position was shifted slightly to a new site near shotpoint No. 7 on that line, for logistic convenience. The proposed depth of the well was 700 m or prior "basement". The predicted sequence of lithologies is listed below (and also summarised on Fig. 5):

0-200 m	Oodnadatta Formation - grey, fossiliferous, argillaceous siltstone and shale with minor beds of limestone and calcareous sandstone including the Mount Alexander Sandstone Member (60-105 m), the Coorikiana Member (180-200 m) and possibly the Wooldridge Limestone Member (depth of occurrence unknown but presumed to lie somewhere between the above two members).

	Details of all three members are as follows:- Mount Alexander Sandstone Member - fine, glauconitic sandstone with thin ferruginous beds; Coorikiana Member - greenish grey fine to medium sandstone with minor grey shales and possible thin lenses of pebbly sandstone; Wooldridge Limestone Member - greenish, sandy siltstone and shale with minor grey, silty concretionary limestone, including some cone-in-cone limestone. Contains ammonite fauna.
200-380 m	Bulldog Shale - grey, silty, carbonaceous shale and siltstone with occasional concretions of hard limestone.
380-400 m	Cadna-owie Formation - interbedded sandstone, siltstones and shales with common coarse to pebbly, partly siliceous sandstone and possible boulder lenses.
400-425 m	Algebuckina Sandstone - white to pale brown, medium-grained to conglomeratic sandstone, possibly partly silicified.
425-690 m	Permian? - grey shales, siltstones and sandstones perhaps containing coal, similar to the Purni Formation sediments of the Pedirka Basin or the Mount Toondina Beds of the Arckaringa Basin.
690-700 m	"Basement" - metamorphic rocks, perhaps quartz mica schists or quartzites.

Results of Drilling

Mesozoic formation tops in Toodla No. 1 were encountered from 100 m to 116 m higher than prognosed (Fig. 5). The well spudded into Recent and Tertiary alluvial sands and gravels. The topmost Mesozoic unit, the Oodnadatta Formation, was intersected at 8 m depth and was 108.5 m thinner than expected. The Mount Alexander Sandstone and Coorikiana members of the Oodnadatta Formation were included in this general thinning of the highest Mesozoic beds, being respectively 42 and 8 m thinner than anticipated; possibly part of the Mount Alexander Sandstone Member may be missing at Toodla along with the upper portion of Oodnadatta Formation shale. By contrast, the Bulldog Shale and Cadna-owie Formation thicknesses at Toodla proved to be almost exactly the same as pre-drilling estimates (Fig. 5). The Algebuckina Sandstone was unexpectedly thick in the well (cf. Fig. 6): 58 m compared with the prognosed 25 m.

Lithologies throughout the Mesozoic section of the well were much as prognosed. A few exceptions occurred:

(i) the lack of any thin ferruginous beds in the Mount Alexander Sandstone Member;

(ii) the lack of identifiable Wooldridge Limestone Member in the Oodnadatta Formation; and

(iii) the generally fine-grained nature of most of the arenaceous units, which at Toodla contain only rare traces of the coarse conglomeratic horizons encountered elsewhere in the Oodnadatta region.

No sediments of Permian age were intersected in Toodla No. 1; these were prognosed as coal-bearing sands and conglomerates or glacial diamictites similar in appearance to the Purni or Crown Point formations of the Pedirka Basin to the north and northeast. Instead the Algebuckina Sandstone was underlain unconformably by a slightly metamorphosed and barren quartzitic "basement". Only nine metres of this was cored before total

TABLE 1

SUMMARY OF STRATIGRAPHIC SEQUENCE:

TOODLA No. 1

AGE	FORMATION	SUBSURFACE DEPTH (m) (to top)	SUBSEA ELEVATION (m) (to top)	THICKNESS (m)
Tertiary - Recent	Eyre Formation ?Macumba Sandstone Member	0	+96.7	8
Albian	Oodnadatta Fmn.	8	+88.7	91.5
Albian	Mount Alexander Sandstone Member	(15)	(+81.7)	(3)
Albian	Coorikiana Member	(87.5)	(+9.2)	(12)
Albian - Aptian	Bulldog Shale	99.5	-2.8	164.5
Aptian - - Neocomian	Cadna-owie Fmn.	264	-167.3	20
Neocomian	Algebuckina Sandstone	284	-187.3	58
pre-Mesozoic	Un-named; low-grade metamorphic rocks	342	-245.3	11+
TOTAL DEPTH		353	-256.3	

depth (353 m) was reached, due to drilling problems; its minimum age is assumed to be ?Ordovician by analogy with "basement" rocks intersected in wells to the north on the Muloorinna Ridge and in the western Pedirka Basin.

The average core recovery over the entire 203 m of continuous coring at Toodla was 81%, but it is important to note that core recovery from the artesian aquifer within the Algebuckina Sandstone at the base of the Mesozoic was very much lower, averaging only 7%, due largely to inadequate drilling equipment (since improved). Because of these severe core losses an accurate assessment of the petroleum potential of the reservoir rocks is not possible, although some indirect conclusions can still be drawn as outlined in Section 4 of this report. Since the well passed directly from a Mesozoic sequence into pre-Permian rocks, it provides an improved definition of the western limit of the prospective Permian Pedirka Basin. Furthermore, it clearly shows that the deep seismic reflector beneath the local "C-Horizon" represents economic "basement" for hydrocarbon accumulation in the Muloorinna Ridge region.

Stratigraphy

The stratigraphic sequence penetrated in Toodla No. 1 is summarized in Table 1. Lithologic correlations between Toodla No. 1 and other wells drilled on the Muloorinna Ridge are shown on a geological cross-section in Figure 7. The nomenclature of the Mesozoic rock units found in this portion of the Eromanga Basin follows that used on the OODNADATTA 1:250 000 geological sheet, which in turn derives from Freytag (1966). Formation names and ages assigned to these rock units comply with those introduced by Wopfner et al. (1970).

Depths to formation tops have been selected on the basis of combined lithological and petrophysical data. All drilling depths were measured from the top of the kelly bushing and have since been corrected to a ground-level datum, relative to which the petrophysical logs were later run. A comparison of the anticipated section and the actual section is shown in Figure 5.

Generalized descriptions of lithologies and environments of deposition of the formations in Toodla No. 1 are given below in descending stratigraphic order, while more detailed descriptions of the cuttings and core are given in Appendices I and II respectively. The significant well data are summarized on the composite well log in Enclosure 1, and are recorded in a moderately extended form on standard large-format "fact sheets" in Enclosures 2 (cuttings data) and 3 (core data). In addition Enclosure 3 includes a pictorial Selley Log designed to augment the conventional core-logging sheets.

Eyre Formation (Tertiary-Recent) Depth Interval 0-8 m

Tertiary to Recent sediments at the Toodla wellsite consist of a 2 m thick weathered surface section of rudaceous gypsite sediments overlying partly unconsolidated calcareous sandstones and siltstones to a depth of 8 m. This lithology closely resembles that of the Lower Tertiary Macumba Sandstone Member of the Eyre Formation, which forms the nearby prominent hills of Mount Toodla and Mount Harvey; it is likely that surface deposits at the wellsite constitute piedmont outwash from these hills. In particular the ferruginized silcrete clasts occurring at the surface are characteristic of the Macumba Sandstone Member (Freytag et al., 1967). These clasts consist mainly of silcreted grey and white sandstone and yellow or red-spotted white jasper, with minor ironstone, tabular crystalline gypsum, and calcreted clayey siltstone. From the petrophysical data shown on the composite well log (Encl. 1) the arenaceous nature of these surface sediments is represented by an overall slight decrease in the gamma-ray log counts over the interval 0 to 8 m depth, relative to the higher average natural radioactivity reading obtained from the underlying Oodnadatta Formation shales. The gamma-ray response is coupled to a slightly enhanced neutron-log count for this interval compared with that derived from the underlying shales.

Oodnadatta Formation (Albian) Depth Interval 8-99.5 m

The Oodnadatta Formation is primarily a silty shale or argillaceous siltstone unit with minor interbedded silty and sandy carbonate bands. It has significant fossil, glauconite and carbonaceous components, and traces of secondary silicification (flint and jasper veins) are also present at rare intervals. The sediments are predominantly light to dark grey with a variable but minor content of brown to blackish interstitial organic matter. Occasional paler areas of light brown to pale cream denote concentrations of claystone or carbonate. As far as can be determined from the cuttings samples, the gross bedding in the formation is typically highly disturbed and irregular, with fine sands, silts and clays often intimately associated, although the persistence of an equigranular, homogeneous cuttings fraction suggests that very thin, discrete individual layers of glauconitic sand and laminated claystone are probably also common.

Freytag (1966) recognised three thin but distinct mappable horizons within the Oodnadatta Formation in the Oodnadatta area:

(i) near the top of the formation is the Mount Alexander Sandstone Member, a widespread arenaceous unit that has been intersected in most wells;

(ii) near the middle of the formation lies the Wooldridge Limestone Member, a calcareous sandy siltstone with limestone concretions containing ammonites;

(iii) the basal portion consists of the Coorikiana Member, a laterally persistent, richly glauconitic, lithic and calcareous sandstone. The following discussion centres around the identification of these beds in Toodla No. 1.

From a comparison of limited creek bed exposures adjacent to the Toodla No. 1 wellsite with the Oodnadatta Formation type section at the same topographic level (at Mount Arthur on the OODNADATTA 1:250 000 sheet, some 25 km northeast of Toodla), it has been possible to identify the Mount Alexander Sandstone Member with a fair degree of certainty at a depth of 15 to 18 m in Toodla No. 1. This lithological pick is supported by petrophysical data from the well, where the gamma-ray log (Encl. 1) shows abruptly decreased values between 15 and 18 m. Cuttings reveal that the Mount Alexander Sandstone Member at Toodla consists of moderately calcareous, silty to very fine glauconitic and slightly arkosic quartz sand, yellow-brown, sub-rounded and well-sorted, occurring over a distinct three-metre interval. The gamma-ray log trace indicates that the sandstone bed has a gradational base and sharp top characteristic of a high-energy, transgressive longshore bar environment, the fairly common dark greenish-black rounded glauconite grains implying marine depositional conditions. In addition, Mount Alexander Sandstone outcrops near the well site exhibit a characteristic olive-brown to buff grey, flaggy weathering surface which can easily be differentiated from the contiguous whitish-grey soft and crumbly shales.

By definition the Wooldrige Limestone Member contains the best-developed of the numerous thin and hard concretionary limestone bodies which occur throughout the Oodnadatta Formation.

At its 7.5 m thick type section 15 km northwest of Oodnadatta it is further distinguished by a high celestite content and by abundant ammonite fossils (Freytag, 1966). This member has been tentatively correlated with the widespread radioactive Toolebuc Formation found at depth in the Eromanga Basin. The Wooldridge Limestone Member does not appear to have been intersected in Toodla No. 1, although the gamma-ray log count over the interval 77-80 m shows a sharp increase which may represent a lensoidal phosphatic limestone body near the drill-hole but not intersected by it. The apparent lack of lithological variation over the above interval is inconsistent with the recorded gamma-ray log response, which clearly differs significantly from that obtained in the surrounding shales. Another more explicable petrophysical log anomaly occurs higher in the Oodnadatta Formation, where a well-defined peak in the neutron log trace between 45.6 and 46.8 m depth lies adjacent to the thickest and most silicified "hard-bar" developed within the shales. Here the corresponding gamma-ray curve shows only a marginal decrease in intensity. A visual inspection of the drill cuttings from this interval reveals a uniform tightness within the "hard-bar", a feature also reflected in the slight positive anomaly recorded on the formation density log at this depth, in contrast to an otherwise uniformly lower response from the unsilicified shale (cf. Encl. 4).

The Coorikiana Member has been picked with some certainty in the basal 12 m of the Oodnadatta Formation. It has a characteristic lithology of fine-grained, silty to shaley, richly glauconitic sandstone, calcareous in part, olive-green to fawn-brown, cross-bedded and moderately well-sorted with subordinate dark grey clay-shale laminations. The depth interval 87.5 to 99.5 m over which it occurs is most easily discerned on the gamma-ray log. Here the downward trace initially shows a relatively sharp contact with the overlying shales, then a significantly lower count rate due to the sandy nature of the unit, and finally a gradational contact with the underlying Bulldog Shale extending over some metres. Such a well defined clean sandy break in a shallow marine depositional environment could correspond to a longshore bar similar to that previously mentioned for the Mount Alexander Sandstone Member.

Bulldog Shale (Albian-Aptian)　　Depth Interval 99.5-264 m

The Bulldog Shale, which conformably underlies the Coorikiana Member of the Oodnadatta Formation, is a shallow marine shale formation resembling the Oodnadatta Formation in many respects. Its two most notable features are a high content of both shelly fossils and carbonaceous matter, in addition to lesser pyritic, glauconitic and calcareous components. The lithologies are mainly grey to dark grey silty shales which grade downwards into siltstones. There are also minor bands of sand and carbonate. The sand is usually of fine to medium grainsize, glauconitic and slightly carbonaceous, with minor fossil fragments (mostly mollusc shells) and pyrite nodules (see Appendix I for cuttings descriptions from the interval 136-138 m and Appendix II for core descriptions from the intervals 166.5-180 m and 193-208 m). The carbonates are bluish-grey, dense, fine-grained and silty concretionary bodies which are frequently fossiliferous and often exhibit "cone-in-cone" type structures (see Appendix II for core descriptions from the intervals 150-152 m and 169-171 m). These highly porous carbonate bands normally tend to show up rather well on the neutron log trace (cf. the composite well log), owing to their greater pore-water content relative to that of the surrounding compacted shales. The neutron log peaks are sometimes very clearly defined by the carbonate bands (e.g. as at 170 and 203 m depth), and where possible their position has been used to correct the cumulative discrepancies (up to 2 m) found between the logger's depths and driller's depths for core recovered in Toodla No. 1.

The Bulldog Shale was identified in the well between 99.5 and 264 m depth, based on preliminary palynological evidence (W.K. Harris, pers. comm.) and on lithological evidence. The intervening thickness of 164.5 m is less than the maximum recorded thickness of 241 m in the Oodnadatta Town Bore No. 2 (Thornton, R.B. 74/178), so it would seem that the unit is thinning in the vicinity of Toodla No. 1, possibly due to onlap onto the Peake and Denison inlier at nearby Mount Dutton.

On the basis of its gross lithology and types of sedimentary structures the Bulldog Shale in Toodla No. 1 can be divided into two informal sub-units. The upper sub-unit, which extends from 99.5 to 166.5 m, is characterized by a sequence of pale grey, relatively well-sorted and fairly regularly interlaminated argillaceous shales and siltstones containing a moderate amount of glauconite and pyrite plus abundant well-preserved lignitic and shelly fossils. The bedding throughout this sub-unit consists of undisturbed, subhorizontal even laminations and thin interbeds up to 3 cms thick with common ripple cross-laminations clearly visible in the cleaner glauconitic siltstones.

By comparison, the lower sub-unit consists of distinctive very dark grey to black shale, with numerous contrasting very clean wispy white siltstone lenticles dispersed irregularly throughout, but becoming increasingly common near the base of the sub-unit. The general gamma-ray log signature of the shales in this lower sub-unit is considerably more muted in intensity than that originating from the more argillaceous upper Bulldog shales, allowing for the uniform attenuation effect on natural radiation caused by the steel casing inserted through most of the upper sub-unit (cf. the composite well log for this formation interval). The reason for the pronounced blackish colour of the shales is their unusually rich carbonaceous matrix, the total organic carbon content of the rock increasing almost monotonically from less than 1% up to 2% with increasing depth (cf. Appendix V). In addition, the shales of the lower sub-unit are considerably more bioturbated than those in the upper sub-unit. As a result the originally regular layering has largely become highly disturbed. Some soft self-sediment compaction features have also been preserved in the form of flame structures and load casts. Most of the deformed and convoluted bedding has been generated by intense burrowing, resulting in sand, glauconite and pyrite-filled tubes cutting across and being truncated by sedimentary depositional surfaces. Evidence suggesting an intertidal environment is provided by the frequent alternation of beds representing relatively vigorous deposition with beds representing more quiescent conditions, e.g. ripple cross-laminations, graded bedding within siltstone layers, and beds of claystone and argillaceous siltstone draped over scoured and eroded silty and sandy lenses which occasionally contain micro- to meso-scale tabular and trough cross-beds, perhaps of tidal channel origin (see sheet 1 of Enclosure 3 and also the core descriptions in Appendix II for the depth interval 166.5 to 264 m).

Near the base of the Bulldog Shale, below 240 m, the sandy bands gradually coarsen and become less glauconitic, while trace terrigenous constituents such as quartz and feldspar granules, coarse mica flakes, carbonized timber fragments and possible pyritic root casts begin to occur, thereby indicating an increasing proximity to a non-marine sediment source, e.g. a river mouth. At the same depth there also first appear rare heavy mineral and kaolin fragments. A pyritic claystone at the lower boundary of the formation has been partially oxidised through subaerial exposure.

<u>Cadna-owie Formation</u> (Aptian-Neocomian) <u>Depth Interval</u> 264-284 m

The Cadna-owie Formation consists mainly of interbedded quartz siltstones and very fine to fine-grained sandstones with minor shales and claystones. Several noticeably coarser sandy to granular and occasionally pebbly layers also occur (cf. Appendix II for core descriptions from this interval). These gritty layers often form the basal portion of upward fining sedimentation cycles extending over about 50 cm (as depicted in the Selley Log on sheet 2 of Enclosure 3). Sorting in individual layers is better here than in the overlying formations but on the whole the rock texture is decidedly less mature with abundant sub-angular to angular medium to coarse quartz grains. The Cadna-owie Formation beds also tend to be more indurated than the overlying shales, with some siltstone bands having a hard carbonate cement in addition to the generally weak to moderately firm siliceous cement binding the majority of clastic grains. The matrix material is usually silty but with an increasing proportion of kaolin towards the base of the formation. Trace constituents include black carbonaceous plant material, pyrite peloids, and coarse mica flakes and feldspar grains, some combined with quartz as rock fragments. In the uppermost parts of the formation there are small admixtures of glauconite grains. Some signs of bioturbation such as disturbed laminations and tubular coarse sand intrusion occur in the finer-grained upper

4 m of the Cadna-owie Formation, although most of these layers are thinly bedded and ripple cross-laminated with little evidence of faunal activity or post-depositional sediment deformation.

The lower 24 m of Bulldog Shale together with the uppermost 4 m of Cadna-owie Formation are considered to represent a transition from a marine to a marginal marine environment of deposition in Toodla No. 1. The remainder of the Cadna-owie Formation below 268 m differs from the uppermost portion and may represent wholly non-marine sedimentation. In particular the lower coarse kaolinitic sands are in part strongly cross-bedded, with scoured and erosional basal contacts appearing for the first time, although this feature on its own is not a specific indicator of any particular environment of deposition.

Lithologies recorded in the Cadna-owie Formation elsewhere indicate intermittent episodes of marine influence throughout the sequence. According to Wopfner et al. (1970), the variety of rock types in this stratigraphic interval represents shallow marginal marine and several specialised marginal and brackish environments. The same authors recorded sporadic occurrences of calcite ooids throughout the Cadna-owie Formation at its type section near Big Cadna-owie Spring, 55 km south-southwest of Mt. Dutton. No calcareous ooids were recognised in the Cadna-owie Formation at Toodla No. 1. However, chamosite ooids were found in the upper part of the Algebuckina Sandstone at Toodla No. 1 and a similar occurrence of chamosite ooids was previously recorded in the basal Cadna-owie Formation at Oodnadatta Town Bore No. 2 (Thornton, 1974).

Since these wells are 52 km apart and since chamosite ooids have not previously been recorded in outcrop, no attempt is made to correlate the subsurface sequence on this basis at the present time.

The geophysical log response of the Cadna-owie Formation is significantly different from that produced by the overlying beds. The top of the formation at 264 m is characterized by fairly abrupt changes in amplitude of the logs relative to that obtained from the overlying Bulldog Shale. The gamma-ray log shows sharply decreased values consistent with a loss of shaliness and/or mica content, while the neutron log gives moderately enhanced readings indicative of an increase in water-filled porosity (cf. the composite well log). However, the only lithological changes discernible in the core at this depth are an increase in the pebble content of the coarsest sandy layers and the gradual disappearance of glauconite from the weakly bioturbated uppermost sediments (see Appendix II). The remaining logs in the suite run at Toodla, namely density, SP and resistivity, are practically useless for any type of log evaluation except perhaps the most basic qualitative kind, owing to their lack of calibration, extremely low sensitivity and poor resolution (for confirmation of this see Enclosure 4). Nevertheless, the transition from the overlying massive shales to the Cadna-owie Formation does show up as a change in electric log amplitude, particularly on the resistivity logs, which increase markedly from a near zero reading in the Bulldog Shale to a moderately high level within the more arenaceous Cadna-owie beds, with the exception of some slightly porous ?sand layers below 268 m, where saline pore waters partly lower the average formation resistivity. This effect seems to diminish towards the base of the formation.

<u>Algebuckina Sandstone</u> (Upper Jurassic) <u>Depth Interval</u> 284-342 m

The Algebuckina Sandstone is the principal artesian aquifer of the Mesozoic Eromanga Basin sequence, often yielding flows in excess of a million gallons a day (180 kl/hr). Only a portion of the cored artesian section penetrated in Toodla No. 1 was recovered successfully because the downhole drilling equipment could not circulate muds of sufficient weight to control hole conditions and prevent a major influx of formation waters. This problem proved insurmountable so a decision was made to continue coring through the artesian section despite the unbridled flow of water. The inevitable consequences were large-scale washouts of the hole and low core recoveries (average 7%) which diminished with depth in the aquifer. Such core pieces as were obtained were spaced at fairly regular intervals throughout the aquifer and are probably only representative of the more indurated lithologies. However, BHP West Lake Eyre No. 2 (WLE-2), a mineral exploration well with a basement objective drilled after Toodla No. 1 and 80 km to the southeast in a similar basin margin position, was able to provide additional knowledge of the nature of the Jurassic-basement contact. The first core cut in this well recovered intact a portion of the weathered basement and about 9.5 metres of the overlying Algebuckina Sandstone.

The Algebuckina Sandstone recovered at Toodla No. 1 consists in its upper parts of very coarse and relatively clean but noticeably kaolinitic sands which are quite strikingly white in colour, with moderately to very well-sorted subangular to sub-rounded quartz grains. Near the top of this upper sub-unit, from 287 to 290 m, the sands show traces of siliceous cementation which are reflected on the well logs by below-average neutron readings and sharply peaked density values (see Enclosure 4 for these logs). Below this slightly indurated part of the formation the sands are predominantly poorly consolidated, with excellent visually estimated porosities (up to 30%) and permeabilities. The overall cleanliness of these sands, even throughout the broad zones of total core loss, is clearly evident from the low magnitudes of the gamma-ray trace on the composite well log (Enclosure 1).

Chamosite ooids occurring at 290.7 m constitute about 25% of a thin band of quartz sandstone which is greenish-white in colour. Petrographic investigations of this ferruginous oolitic material (Appendix III) show that the ooids commonly range in diameter from 0.25 to 0.50 mm and that some have quartz grain cores or have incorporated small quartz grains during growth. The rock matrix is possibly siderite; it is a coarse-grained, unstained, inefficient carbonate cement with crystal sizes of about 0.1 to 0.2 mm. Chamositic ooids of the type found in Toodla have recently been described in detail from an occurrence in northeastern Colombia (James and van Houten, 1979), wherein they were loosely assigned a fluvio-deltaic origin associated with a waning detrital input and probable minor transgression. Within Australia, in addition to the Toodla occurrence, chamositic ooids have recently been recorded from rocks of similar lithology but belonging to a slightly older Lower Jurassic regressive phase in the Surat Basin of Queensland (Porter, 1979).

Measured formation resistivities over most of the Algebuckina Sandstone are much lower than those obtained from the more argillaceous and poorly sorted coarse basal sands of the overlying Cadna-owie Formation, suggesting that the Algebuckina Sandstone at Toodla No. 1 may be almost saturated with weakly saline groundwater, assuming that this water occupies a volumetrically significant proportion of the rock. Two samples of the artesian groundwater obtained from 285 and 307 m depth in the well were submitted for salinity and dissolved hydrocarbon analysis (see Appendix IV), but the resulting concentration figures were low and did not indicate any hydrocarbon accumulations within the potential Algebuckina Sandstone reservoir unit in the immediate vicinity of Toodla.

The most prominent sedimentary structures in the middle to upper Algebuckina Sandstone are persistent massive trough cross-beds, with subordinate tabular cross-beds and wavy, current-laminated beds with minor cut-and-fill structures. These well-developed structures form repeated upward-fining cycles over intervals varying from 5 to 150 cm. Typically these cycles grade upwards from gritty or granular sands to silty or very fine sands occasionally capped by thin claystone bands. Micaceous streaks and carbonaceous laminae are common, the latter becoming lignitic or coalified in places. Pebble horizons occur sporadically in the upper sand beds, becoming increasingly frequent with depth and often containing traces of feldspar crystals, metamorphic rock fragments and clasts of blue quartz.

The basal portion of the Algebuckina Sandstone is largely missing in the core from Toodla No. 1 but has been cored in BHP West Lake Eyre No. 2 well (the WLE-2 well location is shown on Fig. 2). From studies of both the Toodla No. 1 and WLE-2 cores it appears that the major difference between the mid-upper and basal Algebuckina Sandstone sub-units is the increasing degree of induration (silicification) of the latter going downwards to the base of the formation, although a few unconsolidated sandy horizons still occur. Besides this a pronounced change takes place in the overall grainsize distribution with increasing depth in both wells. A much finer-grained fraction predominates in the lower part of the sequence, mostly in the form of immature clayey fine to very fine sands, siltstones and mudstones. These beds still contain significant amounts of mica and carbonaceous matter with minor rootlet horizons, but the kaolin content of the basal sands has decreased significantly compared with that in the sands above. The bedding structures have also diminished in size, and near the formation base consist mostly of very small-scale cycles of cross-bedding, current erosion and sediment slumping, etc. The only coarse-grained deposits are a few isolated gritty to granular feldspathic sandstone lenses and bands dispersed through the now much less massive and more closely interlayered sands and shales.

A basal conglomerate, one to two metres in thickness, comprises the Algebuckina Sandstone portion immediately overlying the pre-Mesozoic unconformity. This conglomerate is typically dark brown in colour due to a high degree of secondary ferruginization, with strongly pervasive interstitial vein hematite and disseminated magnetite. In Toodla No. 1 the few conglomerate clasts recovered from this stratigraphic level all consist of quartzite, whereas in the West Lake Eyre No. 2 well, although the larger rounded clastic fragments are composed of quartzite, there is a preponderance of smaller, more angular chloritic schist and gneiss fragments derived from the underlying basement rocks of the Precambrian "Peake Series" (Wopfner et al., (1970) after Reyner, 1955). The conglomerate matrix lithology in both wells is identical to that of the immediately overlying beds, namely, slightly kaolinitic siltstones and well-sorted, angular fine sands separated by abundant black carbonaceous and highly micaceous laminae.

The log signature of the basal Algebuckina Sandstone subunit in Toodla No. 1 is not very different from that of the overlying more massive and less-indurated sequence, except perhaps for a slightly muted neutron-log intensity reflecting decreased porosity. However, the caving of the drillhole walls throughout this aquifer interval renders impossible any direct interpretation of the log readings in terms of precise lithologies in such large zones of no core recovery (for a confirmation of the extent of hole erosion within this formation refer to the caliper log in Enclosure 4).

Pre-Mesozoic "Basement" (Ordovician?) Depth Interval 342-353(+)m

The pre-Mesozoic rocks at Toodla No. 1 are separated from the basal conglomerate of the Algebuckina Sandstone by an abrupt but irregular erosion surface. This surface is underlain by an uneven but at least 1 metre thick weathered zone characterized by numerous kaolinized joints and fractures, some of which contain quartzitic pebbles and finer sediments derived from the overlying conglomerate. This post erosional contamination implies the existence of open fissures at the time of resumption of deposition.

The fresh "basement" rock lying beneath and projecting into the weathered zone consists of dark grey silty claystones and pale grey, argillaceous to very fine-grained sandy siltstones thinly interlaminated with a massive, blue-grey, predominantly fine-grained and slightly pyritic sandstone which appears quartzitic. This sandstone consists mostly of subangular to sub-rounded quartz grains which are more indurated than any seen previously, having visible minor siliceous overgrowths. Petrographic studies (Appendix III, samples 109 and 110) indicate only limited recrystallisation, at least in the two rock specimens examined, possibly because most of the available intergranular pore space in the sandstone has been filled by a primary brown interstitial clay. This suggests that the partial induration seen in the "basement" core is a low-grade diagenetic effect, with the compaction of the rock resulting in incipient pressure solution of the quartz. Additional evidence of compaction is provided by microstylolites in the more argillaceous portions of this core (again see samples 109 and 110 as above).

These features support the idea that diagenesis, rather than metamorphic processes, has affected the pre-Mesozoic rocks at Toodla. Such mildly altered sediments contrast markedly with the "basement" rocks from West Lake Eyre No. 2 well, which consist of highly metamorphosed pelitic schists and gneisses with affinities to the Precambrian rocks in the adjacent Peake and Denison basement inlier.

Another pertinent feature of the "basement" rocks is that in both Toodla No. 1 and West Lake Eyre No. 2 they show similar bedding dips (15-25^{o}) in contrast to the overlying essentially horizontal bedding of the Eromanga sequence. These similar dips could indicate that the Toodla No. 1 "basement" rocks are appreciably older than the Mesozoic and have been equally affected by the same pre-Jurassic regional tectonic movements that tilted the metamorphosed basement in WLE-2.

Williams (1975) determined an Ordovician <u>metamorphic</u> age for steeply dipping basement rocks intersected in FPC(A)-Delhi-Santos Poonarunna No. 1 and Mokari No. 1, beneath the Pedirka Basin. Williams considered that these rocks lithologically resembled outcropping Proterozoic strata in northern South Australia. P.M. Austin (SADME, personal communication, November 1979) has suggested that the "basement quartzites" in Toodla No. 1 strongly resemble Ordovician lithologies in the Amadeus Basin, notably the Stairway Sandstone. This tends to confirm earlier age estimates of similar shallow-dipping quartzitic "basement" units in other wells of the region (e.g. Thornton (1974), for Oodnadatta Town Bore No. 2, Wopfner (1970) for Santos Oodnadatta No. 1 well, and Jacque (1966) for the French Petroleum Company (Australia) Mount Crispe No. 1 in the adjoining western Pedirka Basin). However, it should be emphasized that the true age of the "basement" at Toodla has not yet been resolved by palaeontological or geochronological techniques and is tentatively regarded herein as Ordovician.

History of Deposition

The history of deposition at Toodla No. 1 is essentially similar to that previously described for the exploration wells drilled in the vicinity of Oodnadatta township (e.g. Thornton (1974), Oodnadatta Town Bore No. 2 well completion report). The lack of Permian sediments in Toodla No. 1 tends to confirm earlier indications (Devine and Youngs, 1973) that the Paleozoic Arckaringa and Pedirka Basins are not connected in the region between Oodnadatta and the northern Peake and Denison Ranges. Presumably this localized absence can be attributed either to early Paleozoic crustal movements in the area which served to elevate the Muloorinna Ridge, preventing Permian deposition, or to post-Paleozoic (?Triassic) uplift and subsequent erosion.

Block-faulting associated with the uplift of the Peake and Denison Ranges may also have affected the nearby Mesozoic sediments to some degree, although the major uplift is of Tertiary age (Wopfner, 1964). Movement on the Mount Dutton fault may have influenced the thicknesses of the various Mesozoic units encountered in Toodla No. 1.

The Upper Jurassic Algebuckina Sandstone, which unconformably overlies weathered (?)Ordovician quartzites, is believed to have been deposited in an active floodplain environment, most probably in meandering river channels, because of the presence of typical channel-floor conglomerates in association with an abundance of relatively fine but mature cross-bedded sandstones. By contrast the typical deposits of braided stream systems are considerably coarser-grained throughout, and often lack the large-scale, upward-fining, cross-bedded depositional cycles of the kind found in the Algebuckina

Sandstone core from Toodla. Possible subordinate lacustrine or overbank deposits are interbedded with the fluviatile facies in the lower part of this formation, as indicated by the prominence of shales, siltstones and mudstones that lack well-developed current bedding structures. However, the major process active throughout the interval (bearing in mind the low core recovery) appears to be one of widespread fluviatile sedimentation culminating in vigorous, high energy depositional conditions exemplified by the macro-cross beds developed in the uppermost part of the unit. The lower boundary of the Algebuckina Sandstone is clearly marked by a basal boulder conglomerate overlying the stable, weathered "basement" quartzite, while the top of the unit is defined by a grainsize change to the siltstones and very fine sandstones of the Cadna-owie Formation.

The Cadna-owie Formation is interpreted as having been deposited in an environment transitional between the fluviatile Algebuckina Sandstone and the initially marginal to predominantly marine environment of the Bulldog Shale. The lower boundary of the Cadna-owie Formation at its type section is marked by a transgressive disconformity representing the onset of the lower Cretaceous marine transgression.

The Bulldog Shale in Toodla No. 1 conformably overlies the Cadna-owie Formation and represents an initially marginal environment. The bulk of the Bulldog Shale and the overlying Oodnadatta Formation are marine. These formations exhibit similar, uniform lithologies and log responses and can only be subdivided on the basis of thin sheet sands and lenticular limestones. The more prominent marker beds in the Oodnadatta Shale may correlate with the Mount Alexander Sandstone, Wooldridge Limestone and Coorikiana members recognised elsewhere in the subsurface and in outcrop (see Fig. 7).

35

The thin surface veneer of Cainozoic sediments found at Toodla No. 1 represents the result of a terrestrial deposition and weathering regime that returned to the Oodnadatta region following marine regression during the middle Cretaceous. The isolated mesas of the dissected tableland lying to the north of the Toodla wellsite are often covered with a silcrete capping formed by deep subaerial weathering on the Tertiary land surface. Since then a prolonged period of erosion has resulted in a generally flat landscape covered with unconsolidated alluvial outwash sediments which include those masking the bedrock outcrop at the Toodla wellsite. Further north and east, large areas of Pleistocene aeolian sands form the long, parallel dunes of the Simpson Desert.

SIGNIFICANCE TO THE OCCURRENCE OF PETROLEUM

In Toodla No. 1 the overall hydrocarbon potential of the rocks encountered was lower than expected. This was mainly due to the absence of possibly prospective Permian rocks which were expected to occur beneath the zone of artesian water flow. In addition, the strong artesian water flow from the basal Mesozoic sands during drilling removed most of the aquifer matrix materials as well as possible signs of interstitial hydrocarbons from this next most prospective section. Accordingly one might conclude that an equivalent flow within the undisturbed aquifer would undoubtedly have kept it flushed and thus prevented any significant accumulation of petroleum there. The results of the geochemical analyses performed on fresh samples of the artesian water bear out this conclusion by showing that the groundwater reservoir's salinity and dissolved hydrocarbon concentration are far below prospective levels.

In terms of physical characteristics, though, the reservoir quality of the Algebuckina Sandstone in particular is excellent,

36

and seems to be consistently developed over a thickness of 58 m instead of the anticipated 25 m. A reliable assessment of reservoir quality in this formation was severely limited by large core losses but it can reasonably be assumed that the lost core had better poro-perm characteristics than the recovered, presumably more indurated material. By contrast, the reservoir potential of the remainder of the Mesozoic sequence in Toodla was found to be minimal, with all arenaceous intervals higher in the section than the Algebuckina Sandstone being thinner than anticipated and having poor reservoir characteristics. In fact, no hydrocarbon shows were detected from fluoroscope inspection of the core over the entire cored interval. However, these results do not exclude the possibility of hydrocarbon entrapment occurring elsewhere on the basin margins within post-Algebuckina sand units. In this regard the Cadna-owie Formation is particularly prospective, being a transitional unit with some source-rock potential and having gross lithological similarity to the Algebuckina Sandstone. As a consequence, lenticular sands with good porosity and permeability developed at higher levels within it would be effectively isolated from the underlying artesian water flow and so might constitute a better stratigraphic trap. Similarly the Coorikiana and Mount Alexander Sandstone members of the Oodnadatta Formation could possess good reservoir potential away from Toodla in deeper portions of the basin, perhaps to an even greater degree than the cleanest Cadna-owie beds, since by comparison they are often better sorted, thicker yet highly discontinuous clean sand bodies isolated within a very thick shale sequence.

The lower part of this latter sequence, the Bulldog Shale, was tested in the Toodla core for its source-rock potential. The results indicated that the total organic carbon (TOC) content of the shale was less than the accepted threshold value for the generation of hydrocarbons in significant quantity, since it only varied from less than 1 up to 2%, although interestingly in an almost monotonic fashion, with increasing depth in the formation. However, this consistent upward trend in the shale TOC with depth may augur the existence of more suitably organic-rich, high-ranking petroleum source-rocks at a stratigraphically equivalent much deeper level in the basin, where hopefully both the source-beds and the adjacent reservoir beds may be correspondingly more extensive and better-developed. Recent source-rock studies of the Bulldog Shale in Toodla No. 1 (Steveson, 1980, p. 2-4) include the discovery therein of alginite-"B", a known algal crude-oil precursor. Such specific geochemical information will help to upgrade the hydrocarbon exploration potential of the southwestern portion of the Eromanga Basin.

ACKNOWLEDGEMENTS

The advice and assistance of T.R. Watts, P.M. Austin, G.J. Ambrose and D.I. Gravestock in compiling this report is gratefully acknowledged.

MG:GU

M. GRIFFITHS

256

REFERENCES

Devine, S.B. and Youngs, B.C. (1973). Stratigraphic Problems and Proposed Drilling North of Oodnadatta. SADME unpublished report RB 73/25.

Freytag, I.B. (1966). Proposed Rock Units for Marine Lower Cretaceous Sediments in the Oodnadatta Region of the Great Artesian Basin. Geol. Surv. South Aust. Quart. Geol. Notes v. 18, p. 3-7.

__________., Heath, G.R. and Wopfner, H. (1967). Oodnadatta 1: 250 000 Geological Map Sheet. S.A. Geol. Atlas Series No. SG 53-15.

Hess, A. (1957?). Santos Oodnadatta No. 1 well completion report, in: Geosurveys of Aust. unpublished report, SADME closed file Env. 260 (SR 11/5/3A).

Jacque, M. (1966a). Mount Crispe No. 1 well completion report. SADME open file Env. 626 - unpublished.

__________. (1966b). Mokari No. 1 well completion report. SADME open file Env. 640 - unpublished.

James, H.E. Jr. and Van Houten, F.B. (1979). Miocene goethitic and chamositic oolites, northeastern Colombia. Sedimentology v. 26, p. 125-133.

Magnier, P. (1964a). Witcherrie No. 1 well completion report. SADME open file Env. 349 - unpublished.

__________. (1964b). Purni No. 1 well completion report. SADME open file Env. 352 - unpublished.

Northcott, I.W. (1980). Coongra No. 1 well completion report. SADME unpublished report RB 80/54.

Porter, C.R. (1979). Fluvio-deltaic deposition in Lower Jurassic sediments of the Surat Basin, Queensland. The APEA Journal, 1979. p. 37-49.

39

Reyner, M.L. (1955). The Geology of the Peake and Denison Region. Geol. Surv. South. Aust. Rept of Inv. No. 6, p. 23.

Steveson, B.G. (1980). Description of organic material in polished sections of the core from Toodla No. 1. AMDEL project 1/1/238, Progress Report No. 35. SADME closed file envelope 3344 (SR 28/1/57).

Williams, G.E. (1975). Northern extent of the Delamerian Orogeny. Search v. 6 (10), p. 435-436.

Wiltshire, M.J. (1978). Poolowanna No. 1 well completion report. SADME closed file Env. 3170.

Wopfner, H. (1964). Permian-Jurassic History of the Western Great Artesian Basin. Trans. Roy. Soc. South Aust. v. 88, p. 117-128.

__________. (1957). Unpublished report to Santos Ltd., cited in:

__________., Freytag, I.B. and Heath, G.R. (1970). Basal Jurassic-Cretaceous Rocks of the Western Great Artesian Basin, South Australia: Stratigraphy and Environment. A.A.P.G. Bull., v. 54, p. 383-416.

Youngs, B.C. (1973). The Geology of the Pedirka Basin. SADME unpublished report RB 73/92.

APPENDIX I

CUTTINGS DESCRIPTIONS

DITCH CUTTINGS DESCRIPTIONS

All the 2-metre cuttings samples were examined wet, under a binocular microscope, normally with 30x magnification. Colours were described for the wet sample. Grainsize determination was from the Wentworth scale; roundness from Power's, and degree of sorting and textural maturity according to Folk.

Depth (m)	Percentage	Constituents	Description
0-2	100%	SAND	Quartz, brownish to grey, poorly sorted, sub-mature, mostly occurring as a silcreted pebble and cobble talus at the surface, then grading to an orange-brown, highly silicified but sometimes also weakly calcareous, fine to very fine-grained, ferruginous sandstone at depth.
	Minor		Rudaceous jasper, ironstone and cherty material.
	Trace		Crystalline selenite, clear, tabular to fibrous.
2-4	100%	SANDSTONE	Quartz, yellow-brown, fine to very fine-grained, angular to sub-rounded, poorly sorted, but now becoming more calcareous and less siliceous, with;
	Minor		Kunkar-type hard limey sandstone, white, nodular.
	Trace		Accessory lithic fragments & selenite as above.
4-6	100%	SANDSTONE	As above; now much less silicified than either of the above samples, but still slightly calcareous.
	Minor		Selenite as above.
	Trace		Kunkarised sandstone nodules.
6-8	100%	SANDSTONE	As above; now appears to have lost almost all trace of silicification, but is still slightly calcareous. However, kunkar-type nodules are now lacking.
	Trace		Selenite as above.
8-10	30%	SANDSTONE	As above;
	30%	SILT	Quartz, light grey-brown; slightly micaceous & calcareous.
	40%	CLAY	Predominantly unindurated; light grey, soft and sticky.
	Trace		Selenite as above.

Depth (m)	Percentage	Constituents	Description
10-12	10%	SANDSTONE	As above; may be cavings.
	50%	SILTSTONE	grey-brown, carbonaceous, well-consolidated.
	40%	MUDSTONE	dark grey, clayey, slightly calcareous.
12-14	95%	SILTSTONE	As above.
	5%	MUDSTONE	As above.
14-16	60%	SANDSTONE	Quartz, greenish-brown, very fine-grained, subrounded & well-sorted; moderately glauconitic with dark greenish-black rounded glauconite grains; weakly calcareous.
	25%	SILTSTONE	As above.
	15%	MUDSTONE	As above, grading to a creamy to yellow-brown coloured clay, moderately calcareous.
16-18	90%	SANDSTONE	As above, but now more calcareous and glauconitic (quartz-glauconite ratio approx. 50-50). Also minor arkosic sand, yellow-brown, silty to very fine-grained.
	10%	SILTSTONE	As above.
18-20	15%	SANDSTONE	As above, becoming less glauconitic.
	70%	SILTSTONE	As above, grey-brown, carbonaceous.
	15%	MUDSTONE	As above, also becoming carbonaceous.
20-22	95%	SILTSTONE	As above, but slightly more lignitic. Also the first appearance here of a significant amount of framboidal pyrite nodules about 2-3 mm in diameter
	5%	MUDSTONE	As above, now becoming a light grey-brown colour and not so clayey, but is still fairly calcareous.
22-24	25%	SANDSTONE	Quartz, light grey to white, very fine-grained, sub-rounded and well-sorted with traces of brown & black lignitic plant fibres.
	60%	SILTSTONE	As above, brownish-grey but with less carbonaceous material than before, and now entirely lacking pyrite.
	15%	MUDSTONE	As above, pale grey-brown and fairly argillaceous but now also non-calcareous, with a decreasing silt content.

43

Depth (m)	Percentage	Constituents	Description
24-26	30%	SANDSTONE	As above, sand now very clean and white.
	65%	SILTSTONE	As above, becoming quite dense and hard (shaley) with only traces of organic matter (less than 1 mm diam. plant fragments).
	5%	CLAYSTONE	Grey, compact and laminated clay.
26-28	10%	SANDSTONE	Quartz sand as above, but now becoming dirtier with interstitial silt and clay.
	85%	SILTSTONE	Very argillaceous (about 50%), soft and greasy, mottled greenish-grey and poorly consolidated siltstone with trace black organic matter spots.
	5%	CLAYSTONE	Dark greenish-grey, soft & greasy pure clay blebs in the above sandstone.
28-30	10%	SANDSTONE	As above.
	85%	SILTSTONE	As above, perhaps with less interstitial clay, but now with some significant framboidal pyrite once again (approx. 5-10% of sample).
	5%	CLAYSTONE	As above, occurring in sandstone lenses.
30-32	10%	SANDSTONE	As above.
	85%	SILTSTONE	As above, dark grey to grey-green shaley siltstone; no pyrite.
	5%	CLAYSTONE	As above, interlaminated with sandstones and siltstones, and interstitial in siltstones.
32-34	10%	SANDSTONE	As above.
	85%	SILTSTONE	As above, now a fairly clean shale with only minor interstitial clay. No pyrite.
	5%	CLAYSTONE	Interlaminated thin stringers in shale.
34-36	10%	SANDSTONE	As above.
	85%	SILTSTONE	As above, but becoming argillaceous once again.
	5%	CLAYSTONE	As above, but colour has altered to a light grey-brown.
36-38	10%	SANDSTONE	As above.
	85%	SILTSTONE	As above, but softer with more clay.
	5%	CLAYSTONE	As above.
38-40	10%	SANDSTONE	As above.
	85%	SILTSTONE	Soft grey-green very clayey silt-shale.
	5%	CLAYSTONE	As above.

Depth (m)	Percentage	Constituents	Description
40-42	10%	SANDSTONE	As above.
	85%	SILTSTONE	As above but much less argillaceous, and still non-calcareous and non-pyritic.
	5%	CLAYSTONE	As above.
42-44	15%	SANDSTONE	As above.
	80%	SILTSTONE	As above.
	5%	CLAYSTONE	As above.
44-46	15%	SANDSTONE	As above.
	80%	SILTSTONE	As above, but becoming more argillaceous.
	5%	CLAYSTONE	As above.
46-48	10%	SANDSTONE	As above.
	85%	SILTSTONE	As above, but becoming increasingly hard from around 46.5 m. At 47 m the sample was a very indurated, dark greenish-grey siliceous shale, comprising about 10% pale green flinty bounds & veins 0.5 to 2.5 mm thick plus minor chips of pinkish to bright red jasperoidal material. Near 48 m the shale was slightly softer but still fairly siliceous.
	5%	CLAYSTONE	As above.

Depth (m)	Percentage	Constituents	Description
48-50	10%	SANDSTONE	As above.
	85%	SILTSTONE	Back to the soft grey-green argillaceous silt-shale as found above the hard bar at 46.5-47.5 m.
	5%	CLAYSTONE	As above.
50-52	20%	SANDSTONE	As above, except that the sand is now becoming cleaner in parts. This interval is notable for the first appearance of relatively abundant coarse shell fragments dispersed throughout the entire lithology.
	75%	SILTSTONE	As above but perhaps less argillaceous.
	5%	CLAYSTONE	As above.
52-54	20%	SANDSTONE	As above, fossiliferous throughout.
	75%	SILTSTONE	As above, but with still less interstitial clay, plus yet another trace of hard green flinty banding and red jasper flakes in what is now becoming a fairly hard and also fairly calcareous shale.
	5%	MUDSTONE	Light grey-brown and non-calcareous.
54-56	20%	SANDSTONE	As above, with trace very fine glauconite.
	75%	SILTSTONE	Predominantly calcareous shale with minor interstitial clay.
	5%	MUDSTONE	As above.
56-58	20%	SANDSTONE	As above, now becoming increasingly glauconitic.
	75%	SILTSTONE	As above, but becoming more argillaceous and glauconitic, the glauconite being present as amorphous fine sand-sized dark green lumps (fecal pellets?) making up approx. 20% of the shale. Minor shell fragments are evident too.
	5%	MUDSTONE	As above.
58-60	20%	SANDSTONE	As above, but with less shelly material.
	55%	SILTSTONE	As above, with an increasing clay content.
	25%	MUDSTONE	As above.

Depth (m)	Percentage	Constituents	Description
60-62	20%	SANDSTONE	As above, but shell content is increasing again.
	55%	SILTSTONE	As above, but becoming harder again around 61 m, where there is another flinty, siliceous pale green band the same as before. The shale now also contains a trace of pyrite as well as an increasing quantity of glauconite lumps (now approx. 35% of sample) and large shell fragments (about 10% of sample). In addition two new materials have appeared in this interval; a few quite large brown-black woody lignitic fragments, and several orange to yellow-brown columnar, lath-like aggregates of transparent sparry calcite crystals radiating in overgrowth fashion from thin central fibres of what might be seagrass or similar plant remains of marine origin.
	25%	MUDSTONE	As above.
62-64	20%	SANDSTONE	As above.
	60%	SILTSTONE	As above, but now lacking pyrite, calcite overgrowths and siliceous material. Shell fragments still plentiful (up to 5% of sample).
	20%	MUDSTONE	As above, becoming darker with increasing content of finely divided carbonaceous matter.
64-66	30%	SANDSTONE	Quartz, very fine to fine-grained, slightly more winnowed than before, with a preferential enrichment of glauconite lumps in this coarser fraction compared with the shale, some lumps being quite large (up to 5 mm diam.).
	55%	SILTSTONE	As above, except that shale is now less glauconitic and more pyritic.
	15%	MUDSTONE	Grey to dark grey, interlaminated with shales.
66-68	25%	SANDSTONE	Moderately winnowed as above, but lacking any glauconite.
	60%	SILTSTONE	As above, but the shale is now becoming more lignitic and pyritic at the expense of glauconite. It is also becoming slightly siliceous and hard again in places, as evidenced by traces of pale green flint-banded shale cuttings.
	15%	MUDSTONE	As above.

Depth (m)	Percentage	Constituents	Description
68-70	10%	SANDSTONE	As above.
	70%	SILTSTONE	As above, but lacking pyrite and flint.
	20%	MUDSTONE	As above.
70-72	20%	SANDSTONE	As above.
	65%	SILTSTONE	As above, but lacking siliceous veining and pyrite, now replaced by minor shell fragments and a re-occurrence of the calcite overgrowths of seagrass fibres.
	15%	MUDSTONE	As above.
72-74	10%	SANDSTONE	As above.
	70%	SILTSTONE	As above, slightly lignitic and also glauconitic once again, with signif. calcite overgrowth crystals throughout. No pyrite or shell fragments.
	20%	MUDSTONE	As above.
74-76	30%	SANDSTONE	As above.
	60%	SILTSTONE	As above, but now without any calcite crystals.
	10%	MUDSTONE	As above.
76-78	10%	SANDSTONE	As above.
	70%	SILTSTONE	As above, but with less glauconite (only trace amounts visible now).
	20%	MUDSTONE	As above.
78-80	10%	SANDSTONE	As above.
	70%	SILTSTONE	As above, the shale now becoming more lignitic and glauconitic with minor calcite overgrowth crystals and pyrite framboids. No shell fragments still.
	20%	MUDSTONE	As above.
80-82	10%	SANDSTONE	As above, interbedded layers and lenses in a predominantly shale lithology.
	70%	SILTSTONE	As above, except that now for the first time some of the shale cuttings have minor thin dark grey calcite veins in them.
	20%	MUDSTONE	As above.
82-84	10%	SANDSTONE	As above.
	70%	SILTSTONE	As above, with an increasing amount of crystalline calcite, both transparent colourless to grey sparry vein-filling material and also the former common orange-brown radiating overgrowth aggregates.

Depth (m)	Percentage	Constituents	Description
	20%	MUDSTONE	As above.
84-86	10%	SANDSTONE	As above; relatively glauconite - rich.
	70%	SILTSTONE	As above; gradually becoming a very lignitic (approx. 25% of sample) and slightly glauconitic (about 10%) but still non-calcareous shale, with however about 10% dark grey veining through it. Minor pyrite and calcite crystal overgrowths, plus a trace amount of shell fragments.
	20%	MUDSTONE	As above.
86-88	10%	SANDSTONE	As above.
	70%	SILTSTONE	As above; clayey shale matrix is now becoming quite calcareous
	20%	MUDSTONE	As above.
88-90	50%	SANDSTONE	As above but with considerably more glauconite (approx. 30%) in occasional well-winnowed very fine sandstone; predominant sand lithology is dirtier and only poorly sorted.
	40%	SILTSTONE	As above; shale is now only fairly lignitic (about 15% of sample) with a significant amount (greater than 20%) of very green glauconite, mostly segregated and concentrated as lenses and layers of rounded fecal-type pellets; there is also a fair amount of pyrite (more than 5%) closely associated with lignite fragments.
	10%	MUDSTONE	As above; but becoming calcareous and paler in colour.
	Minor		Shell fragments and calcite overgrowth crystals.
90-92	60%	SANDSTONE	As above but now with extremely glauconitic very fine-grained non - calcareous clean sand beds (approx. 60% glauconite pellets).
	35%	SILTSTONE	Pale grey-white and non-calcareous; otherwise as above.
	5%	MUDSTONE	Fairly calcareous, brownish-grey silty claystone to argillaceous siltstone with minor lignite.
	Trace		Pyrite, calcite overgrowth crystals and shells.

Depth (m)	Percentage	Constituents	Description
92-94	65%	SANDSTONE	As above except that sample is now even more glauconitic than before (approx. 65-75%) with a significant amount of fine sand entering the sequence in association with the coarsest glauconite zones.
	20%	SILTSTONE	Lignitic shale as above, now slightly calcareous and becoming more clay-ric and less silty.
	15%	CLAYSTONE	First appearance here of a distinct creamy-white calcareous claystone
	Minor		Calcite overgrowth crystals.
	Trace		Pyrite and shell fragments.
94-96	65%	SANDSTONE	As above, with the glauconite concentrated mostly into very fine sandy interbeds in the clay-shale.
	20%	SILTSTONE	As above.
	15%	CLAYSTONE	As above.
96-98	65%	SANDSTONE	As above.
	25-30%	SILTSTONE	As above.
	10-5%	CLAYSTONE	As above, but now with less clay of the type described above.
98-100	60%	SANDSTONE	As above, still with abundant (about 50%) very glauconitic very fine sand.
	40%	SILTSTONE	As above, but now predominantly a non-calcareous grey clay-shale, with some minor thin harder calcareous patches in it at around 98.5 m.
	Minor		Very calcareous brown lignitic material.
100-102	30%	SANDSTONE	As above, but gradually becoming less glauconitic (down to about 35%).
	55-60%	SILTSTONE	As above, with an increase in the amount of shell fragments, lignite and calcite crystals.
	15-10%	MUDSTONE	As above 92 metres, but containing traces of the former creamy-white calcareous claystone.
102-104	25%	SANDSTONE	As above, but less glauconitic.
	55%	SILTSTONE	As above, with abundant shell fragments but only trace lignite. No calcite overgrowth crystals or pyrite.
	20%	MUDSTONE	As above, but with none of the former claystone.

Depth (m)	Percentage	Consituents	Description
104-106	25%	SANDSTONE	As above.
	55%	SILTSTONE	As above.
	20%	MUDSTONE	As above, but now with a minor reappearance of the creamy-white calcareous claystone.
106-108	15%	SANDSTONE	As above.
	65%	SILTSTONE	Shale as above, but with no lignite and only trace shell fragments.
	20%	MUDSTONE	As above, but with only trace claystone.
108-110	10%	SANDSTONE	As above.
	60%	SILTSTONE	As above.
	30%	MUDSTONE	Grey, laminated unfossiliferous mudstone.
110-112	20%	SANDSTONE	As above, slightly glauconitic and lignitic.
	65%	SILTSTONE	As above, but trace lignite has replaced the shell fragments as an accessory constituent. Becoming harder and siliceous around 111-111.5 metres.
	15%	MUDSTONE	As above, no claystone.
112-114	25%	SANDSTONE	As above, becoming more glauconitic (about 5%).
	65%	SILTSTONE	As above, with minor lignite and trace shells and calcite overgrowth crystals.
	10%	MUDSTONE	As above, but with minor creamy-white claystone.
114-116	30%	SANDSTONE	As above.
	50%	SILTSTONE	As above.
	20%	MUDSTONE	As above.
116-118	10%	SANDSTONE	As above, very fine-grained, sand : glauconite ratio approx. 50:50.
	70%	SILTSTONE	As above, continuing moderately glauconitic but with much more lignite (approx. 10-15% of sample), the lignite being associated with about 10% creamy-white calcareous claystone. In general the shale is of the fossiliferous non-calcareous type, but is gradually becoming less argillaceous and coarsening slightly to silt-shale.
	20%	MUDSTONE	As above, but with pale claystone now comprising nearly half this grainsize fraction.
	Trace		Shell fragments and calcite crystals.

Depth (m)	Percentage	Constituents	Description
118-120	10%	SANDSTONE	As above, now with only trace glauconite.
	70%	SILTSTONE	As above, but with less lignite (approx. 10%) and only trace glauconite, shells and calcite crystals.
	20%	MUDSTONE.	As above, but with only minor claystone.
120-122	10%	SANDSTONE	As above.
	70%	SILTSTONE	Shale as above, now much more lignitic again (approx. 20% of sample), brown, silty and very calcareous. The lignite is associated with about 10% non-calcareous whitish claystone. Pyrite has also re-appeare in the shale, plus a first appearance of minor bright yellow calcite vein-filling material.
	20%	MUDSTONE	As above.
	Trace		Calcite overgrowth crystals and shells
122-124	10%	SANDSTONE	As above.
	75%	SILTSTONE	As above, but with less lignite and no yellow calcite veins. Struck flinty hard-bar at 123.75 metres.
	15%	MUDSTONE	As above.
124-126	10%	SANDSTONE	As above.
	75%	SILTSTONE	As above, with about 15% lignite in a now very slightly calcareous silt-shale. Minor glauconite and bright yellow vein calcite. Trace calcite overgrowth crystals. No shells.
	15%	MUDSTONE	As above.
126-128	10%	SANDSTONE	As above.
	70%	SILTSTONE	As above, with trace glauconite, pyrite, lignite and claystone.
	20%	MUDSTONE	As above.
128-130	10%	SANDSTONE	As above.
	70%	SILTSTONE	As above.
	20%	MUDSTONE	As above.
130-132	10%	SANDSTONE	As above.
	70%	SILTSTONE	As above.
	20%	MUDSTONE	As above.

Depth (m)	Percentage	Constituents	Description
132-134	80%	SILTSTONE	As above, non-calcareous silt-shale with traces of lignite and whitish claystone. No visible glauconite. Minor calcite overgrowth crystals
	20%	MUDSTONE	As above.
134-136	90%	SILTSTONE	As above.
	10%	MUDSTONE	As above.
136-138	70%	SANDSTONE	Quartz, very fine to fine-grained, sub-rounded and moderately glauconitic
	20%	SILTSTONE.	Hard, dark grey, non-calcareous and unfossiliferous shale containing some minor pink to light creamy-brown jasper or chalcedony fragments. Trace lignite and shells. No pyrite.
	10%	CLAYSTONE	Significant amounts of creamy-white claystone.
138-140	10%	SANDSTONE	As above, slightly glauconitic.
	70%	SILTSTONE	As above, the shale is still quite har and dark grey, and is becoming slightly glauconitic again. It contains several rather big shell fragments and a significant number of the pipe-clay coloured claystone fragments, but practically none of the lignite with which it is normally associated.
	20%	MUDSTONE	As above, 136 metres.
140-142	20%	SANDSTONE	As above, becoming more glauconitic (approx. 15%).
	60%	SILTSTONE	As above, but with much more glauconite and also calcite as crystal overgrowths and vein material. Minor pyrite, lignite, claystone and shells.
	20%	MUDSTONE	As above.
142-144	10%	SANDSTONE	As above.
	60%	SILTSTONE	As above, but lacking the pyrite and calcitic vein material.
	20%	MUDSTONE	As above.
144-146	15%	SANDSTONE	As above, but less glauconitic now (about 10% of sample).
	75%	SILTSTONE	As above, but with more claystone, lignite and shell fragments.
	10%	MUDSTONE	As above.

Depth (m)	Percentage	Constituents	Description
146-148	80%	SILTSTONE	As above, but now a fairly pyritic (finely disseminated) non-calcareous shale with approx. 10-15% lignite plus minor claystone, shell fragments and orange-brown columnar calcite overgrowth crystals. In addition there is also a significant amount of pale greenish-white calcitic vein filling material. Only traces of glauconite are visible.
	20%	MUDSTONE	As above.
148-150	80%	SILTSTONE	As above, but the shell fragments and glauconite are now missing.
	20%	MUDSTONE	As above.

APPENDIX II

CORE DESCRIPTIONS

55

MF 40

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

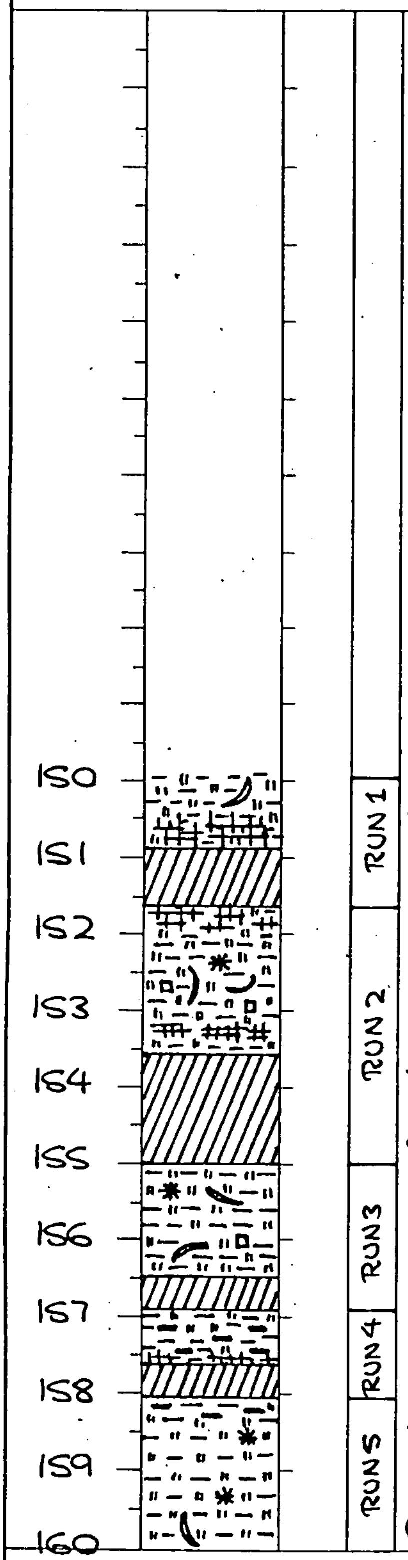
CORE AND CUTTINGS DESCRIPTION

WELL TOODLA # 1.
LOCATION 18 km ENE of Mt. Dutton railway siding.
LAT. 27°43'46"S.
LONG. 135°50'55"E.
ELEVATION GR. 96·66 m. DATUM M.S.L.
R.T. 97·66 m.

CORE NO. Continuous after 150m.
DEPTH 150-160m.
DATE DRILLED 20-9-79 to 25-9-79
RECOVERY 7·80m 78 %
FORMATION Oodnadatta Fm.

DEPTH (METRES)	GRAPHIC LOG	DRILL TIME MINS	RECOVERY LOG	DESCRIPTION

[Rotary drilled section between surface and 150m depth, with ditch cuttings only.]



Light grey, slightly marly interbedded fine siltstones + shales containing shell fragments and finely disseminated pyrite.

Cone-in-cone limestone, partly replacing minor highly calc. shale. The calcite forms a fenestral fabric of reticulated veins and replacement moulds of large seashells. The veins consist of greenish-yellow to brownish-green calcite and are up to 5mm thick near the base of the layer.

Finely interlayered, slightly calc. siltstones + shales as above. Clay-shale now predominates, giving the rock an overall dark grey colour. There is more pyrite in this interval than before, both as finely dissem. crystals and also as large framboidal aggregates (up to 1cm in diam.) The coarser siltstone layers and lenses are also rich in glauconite, plus minor shell fragments and brownish-orange calcite overgrowth crystals (after seagrass fibres?).

Sedimentary structures visible in the core include worm burrows, small-scale deformed bedding with flame and slump structures, and several load casts.

Another two cone-in-cone limestone bands occur at 153·3-153·43m and 157·6-157·7m depth. The matrix in these bands is shale as above, but most of the rock is composed of whitish-grey sparry calcite.

Two carbonaceous shale beds occur at 157·1-157·6m and 158·1-158·35m. The shale is a very lustrous blackish-grey and partly coalified.

Finely interlaminated siltstones and shales as above.
(No U-V fluorescence in the core up to 160m.)

BIT TYPE Diamond NQ coring. LOGGED BY M.GRIFFITHS
TIME – START 1041 Hrs on 20-9-79
FINISH 1200 Hrs on 25-9-79 DATE 25-9-79

FOSSIL FUELS SECTION

SHEET 1 OF

DRG. NO. S

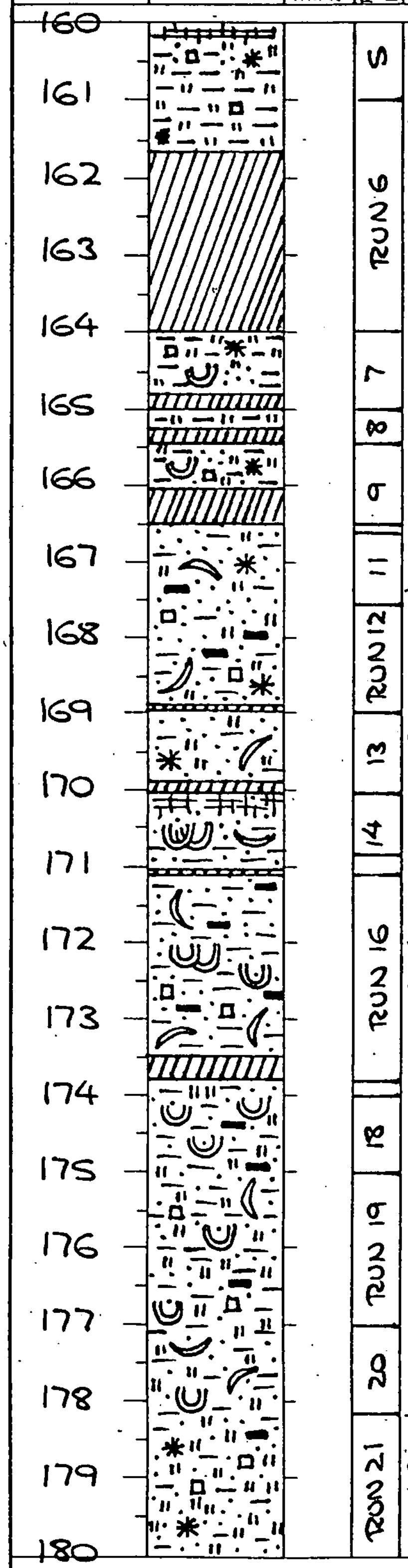
DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

CORE AND CUTTINGS DESCRIPTION

WELL TOODLA #1
LOCATION 18 km ENE of Mt. Dutton railway siding.
LAT. 27° 43' 47" S.
LONG. 135° 50' 55" E.
ELEVATION GR. 96·66 m. DATUM M.S.L.
R.T. 97·66 m

CORE NO. Continuous coring after 150m.
DEPTH 160-180 m.
DATE DRILLED 25-9-79 to 1-10-79.
RECOVERY 16·11 m 80·5%
FORMATION Oodnadatta Fmn.

DEPTH (METRES) | GRAPHIC LOG | DRILL TIME MINS | RECOVERY LOG | DESCRIPTION



From 160 to 166·5m a fairly pyritic non-calc. shale is finely interbedded with slightly glauconitic non-calc. siltstones. At 160·2m the core is cross-cut by a vein of coarsely crystalline calcite. The shale is dark grey and moderately carbonaceous, besides containing occasional pyrite nodules up to 1cm. in diameter (<5%). The siltstone is rarely sandy (f.g. sand) and is predominantly rich in glauconite, which gives it a grey-green colour. Over the interval 164·47-166·50m the shale laminations are disrupted in places by sand blebs and stringers suggestive of burrowing by marine organisms.

From 166·5m onwards the unit becomes much sandier, with the sand/silt fraction often coarsening up to medium sand grainsize. The colour of the shale also darkens to quite a blackish-grey, and similarly the siltstone layers darken from a light greenish-grey to a blackish green-grey. A lot more evidence of bioturbation appears; it is rare to find a discrete sediment layer continuing across the entire width of the core. The glauconite lumps increase in size to med. sand. g.s., and pyrite nodules become much more abundant (10-15%), often occurring intercalated with a light grey-brown clay. Macrofossil fragments are still common; mostly white to yellow-grey pelecypod shells. Orange-brown calcite overgrowth crystals on seaglass fibres are also present in trace amounts.
At 170·8-171·15m a band of sparry calcitic shale (~75% calcite) occurs, predom. white c̄ dk. blackish-grey shale intraclasts, + minor pyrite. From 171·15 to 171·35m a less calcitic sequence (only minor veining) of finely interlayered lt. grey siltstones & grey shales occurs, now becoming less sandy & glauconitic and finer in grainsize.
Extremely bioturbated, organic-rich and sandy siltstones with lesser very carbonaceous dark shales lie between 171·35 and 175·0m depth. Many bedding structures are visible in the convoluted finer sediments, while well-developed micro- to meso-scale ripple cross-beds are seen outlined by glauconitic and carbonaceous material in the sandy layers. There is abundant evidence of intense burrowing activity. Shell fragments and pyrite nodules are present in moderate amounts.
The core becomes sandier again after 172·9m (from 60-80% v.fine light grey qtz. sand), but its glauconite and finely divided organic matter content is now diminishing to only a trace.

BIT TYPE Diamond NQ coring. LOGGED BY M. GRIFFITHS.
TIME – START 1200 Hrs on 25-9-79
FINISH 1550 Hrs on 1-10-79 DATE 1-10-79

FOSSIL FUELS SECTION

SHEET 2 OF DRG. NO. S

MF 40

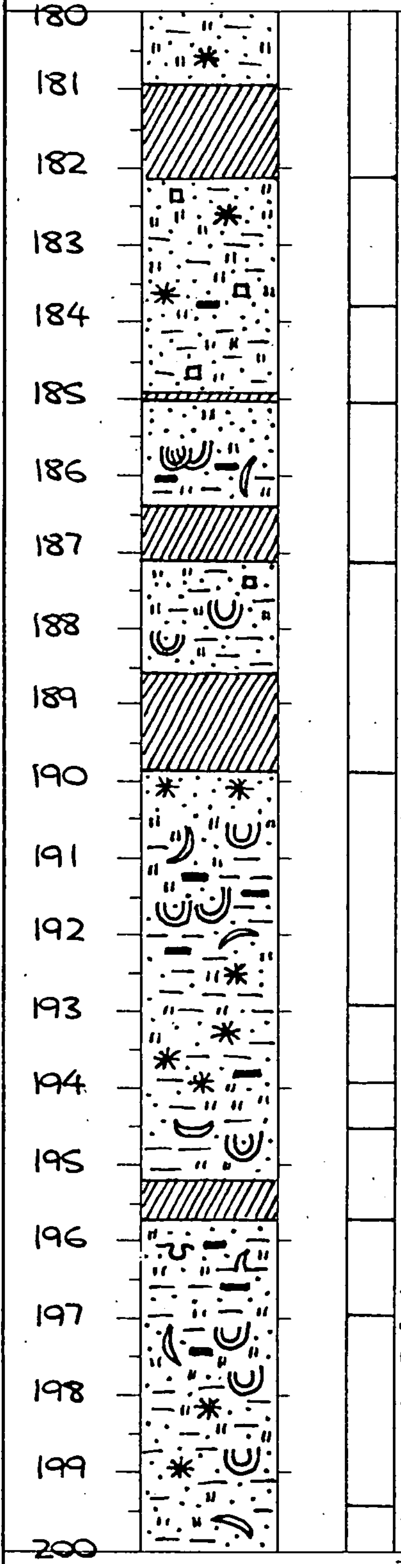
DEPARTMENT OF MINES AND ENERGY — SOUTH AUSTRALIA

CORE AND CUTTINGS DESCRIPTION

WELL TOODLA #1
LOCATION 18 km ENE of Mt. Dutton railway siding.
LAT. 27° 43' 47" S.
LONG. 135° 50' 55" E.
ELEVATION GR. 96·66 m DATUM M.S.L.
R.T. 97·66 m

CORE NO. Continuous coring after 150 m.
DEPTH 180-200 m.
DATE DRILLED 1-10-79 to 4-10-79.
RECOVERY 15.75 m 79 %
FORMATION Oodnadatta Fm.

DEPTH (METRES) | GRAPHIC LOG | DRILL TIME MINS | RECOVERY LOG | DESCRIPTION



A more muddy siltstone layer occurs over the interval 17 -178 m, similar to that seen between 171·15 & 171·35 m.

From 178 to 185 m depth the lithology becomes much sandier again (~80% v.f. sand) as above, but now contains sand layers up to 10cm thick instead of only 1-2 cm thick as previously. The intervals 178·0-178·3 m and 179·0 -179·6 m are much less bioturbated than elsewhere, with good bedding continuity. Some of these beds contain patches of fine to med. qtz sand which are relatively glauconite-rich. Pyrite nodules are more evenly spread over the whole sandy interval and and are more abundant than the glauconite (5-10%).

Between 185·0 & 185·3 m there is a very well-layered portion of the above sandy bed; the sand is very fine-grained, fairly clean & ~90% of core. This portion grades back into a fairly bioturbated section of interlayered sand and silty dark grey shale. The clay content of the shale beds increases to ~60-70% around 186 m, then they become sandier again towards 190 m. Significant amounts of whitish-yellow shell fragme up to 3-4 cm. long are scattered through the section below 185 m, but the pyrite content has decreased to only a trace. Glauconite too is found only as traces in the sand layers, except for the interval 189·0-189·2 where it is quite abundant (~50% of sand as med. sand sized lumps).

Bioturbated clayey & silty sand A'A to 195 m, but lacking as much pyrite as the preceding section below 175 m. The sand is perhaps slightly more organic-rich and clayey than before, with a v. glauc-rich zone between 193·6 & 193·8 m depth (55-75% glauc.), becoming more concentrated towards the base. Minor shell fragments & trace lignitic material can be seen.

195 - 197·1 m interval has thinly (~0·5 mm) interbedded but well-layered v.f. lt. grey slightly org. sands (~40% of core; micro X-bedded) and thicker dk. grey org.-rich shales (~60%). Rare glauc., no pyrite & only trace shelly materia V. slight bioturbation in places - mostly bedding is disrupted by soft-sedimen deformation structures (load casts, flame structs etc.)

197·1 -199·8 m. Slightly more sandy interval (up to 50% of core). Sediment is well-bioturbated but now also much more glauconitic in places c̄ med sand size amorphous lumps commonly assoc. c̄ minor v. clean sand layers & lenses, but not every one of them. Signif. shelly material also re-appears, but pyrite seems to be absent. Hardly any good bedding is visible in this section; the sediments are greatly disturbed by burrowing.

From 199·8-200 m the lithology changes back into a fairly well-layered undisturbed sequence as above (195-197 m), with minor burrows & small shell The v.f. sand layers are slightly glauconitic, but lack pyrite.

*(No U.V. fluorescence visible in the core down to 200 m depth.)

BIT TYPE Tungsten carbide NQ coring LOGGED BY M. GRIFFITHS
TIME — START 1605 Hrs on 1-10-79
FINISH 0945 Hrs on 4-10-79 DATE 4-10-79

FOSSIL FUELS SECTION

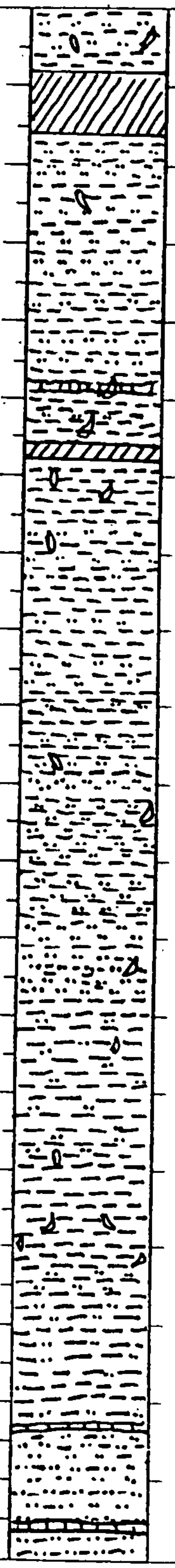
SHEET 3 OF
DRG. NO. S

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

CORE AND CUTTINGS DESCRIPTION

WELL Toodla ※ I
LOCATION
LAT.
LONG.
ELEVATION GR.
R.T.
DATUM
CORE NO.
DEPTH
DATE DRILLED
RECOVERY m
FORMATION

DEPTH (METRES) | GRAPHIC LOG | DRILL TIME MINS | RECOVERY LOG | DESCRIPTION



200
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
217
218
219
220

Interlaminated dk.gy. claystone and pl. gy. siltstone; wispy lenticular lams. and siltstone has small cross-lamination and flame structures and load casts; shells, bioturbation, glauconite. 70% clay, 30% silt.

AA except claystone 80%, siltstone 20%

Cross-laminated siltstone
Mainly claystone with some cross-lam., wispy siltstone (up to 4cm thick) but usually small lenticles; bioturbation, minor shells, glauconite.
AA. Mainly dk claystone with pale grey silt – fine s.s. (up to 5cm) – these are cross-laminated with erosive bases; pyrite, glauconite (as specks about silt size; pyrite is finely disseminated or in aggregates up to 10mm.
AA. but with flame structures and flaser bedding very common.
Also rip up pellets of dk shale in fine siltstone. Thin Lsst (25cm), calcite vein + large shells.
massive gy claystone; shells, minor siltstone.
Massive gy pyritic claystone, scattered shell fragments + mica flecks.
A.A. but with wispy pl. gy siltstone laminations (up 2cm); shells, pyrite.
Mainly dk gy claystone; shells plus bioturbation at 207.8
Minor pyritic siltstone lams. (20%) – mica flecks, glauconite.
A.A. Mainly claystone, minor siltstone; bioturbated, very glauconitic.
20% wispy laminated glauconitic, micaceous, ? pyritic siltstone, 80% dk claystone
AA
50% siltstone, 50% claystone; pyritic, glauconite, ? bioturbated.

70% glauconitic, pyritic silt, 30% claystone.
Clayey siltstone (212.35–212.6) – v. glauconitic
silty claystone; wispy slumped lams.; bioturbation (U burrows)

Massive claystone (fractured); conchoidal fracture.

Minor wispy laminations of siltstone but mainly claystone
Massive silty claystone (silt 40%) – glauconite.
plus minor wispy siltstone lams.
thin calcareous siltstone (? Lsst)
Clayey glauconitic siltstone – fine s.s.; black carbonaceous flecks.
thin gy Lsst. (10cm)
clayey siltstone – glauconite

BIT TYPE
TIME – START
FINISH
LOGGED BY G. Ambrose
DATE

PETROLEUM GEOLOGY SECTION

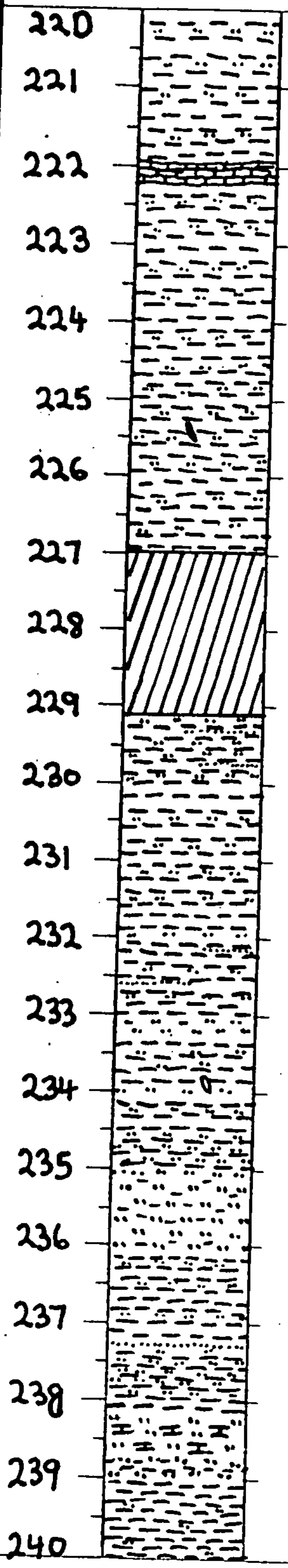
SHEET OF
DRG. NO S

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

CORE AND CUTTINGS DESCRIPTION

WELL Toodla ※ I
LOCATION
LAT.
LONG.
ELEVATION GR.
R.T.
DATUM
CORE NO.
DEPTH
DATE DRILLED
RECOVERY m
FORMATION

DEPTH (METRES)	GRAPHIC LOG	DRILL TIME MINS	RECOVERY LOG	DESCRIPTION



Mainly dk grey claystone with thin wispy, pl. grey siltstone lams; flame structures load casts, evidence of penecontemporaneous reworking, disrupted lams (?bioturbation) glauconite, especially in the wispy siltstones.

Dk gy argillaceous Lsst; calcite veins.

Mainly dk grey carbanaceous claystone as above; subordinate pl grey siltstone lams (often glauconitic, pyritic); cross lamination and flame structures common. Most siltstone lams very thin (<1cm) and usually lenticular; very minor v.f.g sand. Average 70% shale 30% silt.

Claystone is pyritic

Shell fragments at 265.65

As above
Some black lamination in cross-laminated siltstone component. Also a little v.f.g sand in siltstone layers.

Essentially as above: dk grey carb. claystone; pl gy, sometimes glauconitic siltstone (≈20-30%); much biotubation in Interval 230-231., pyritic throughout.

Small amount of fine carbonaceous (plant) matter in siltstone laminae

As above but 80-90% claystone, ≈10% siltstone; rare lenticles of v.f.g. s.s.

40% cross-lam siltstone 60% claystone from 233 – 233.25. Carbanaceous (plant) frags 70% claystone, 30% pyritic, glauconitic claystone – strong bioturbated. shells at 234.

As above but 70% claystone 30% siltstone. Laminae highly disturbed and broken up (bioturbated); minor x lams.

Mainly glauconitic pl gy siltstone, minor wispy shale intervals; strongly bioturbated in places.

Dk gy carbonaceous claystone 70%; 30% pale gy glauconitic siltstone in wispy lams up to 2cm thick; some x lams + bioturbation.

Glauconitic, silty, pyritic claystone; highly bioturbated + minor fine qtz sand. From 237.3 – 273.8 50% silt, 50% clay; cross lams + bioturbation + v. glauconitic + pyrite

Calcareous siltstone with calcite veins.

50% silt, 50% claystone; slumping (microfaults), bioturbation, x lams, ?worm burrow filled with v. f.g. qtz sand. Siltstone glauconitic, pyrite throughout.
90% claystone; 10% glauconitic siltstone, siltstones sometimes have eroded bases and graded tops.

BIT TYPE
TIME – START
FINISH
LOGGED BY G. Ambrose
DATE

PETROLEUM GEOLOGY SECTION

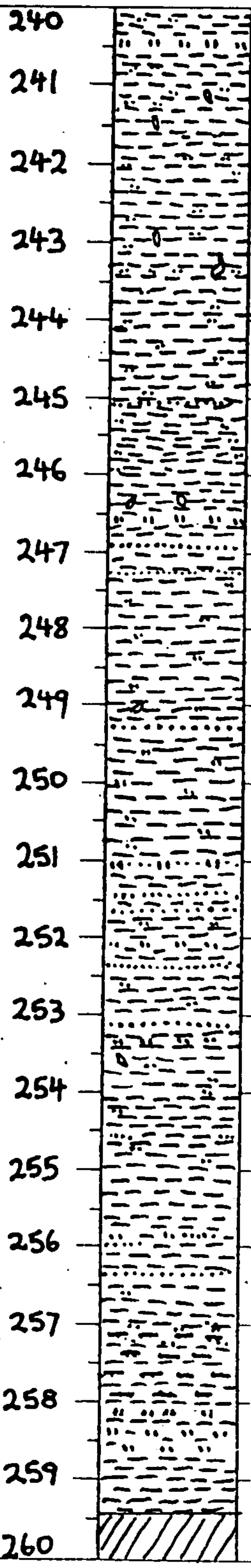
SHEET OF
DRG. NO S

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

CORE AND CUTTINGS DESCRIPTION

WELL Toodla ※ I
LOCATION
LAT.
LONG.
ELEVATION GR.
R.T.
DATUM
CORE NO.
DEPTH
DATE DRILLED
RECOVERY m
FORMATION

DEPTH (METRES) | GRAPHIC LOG | DRILL TIME MINS | RECOVERY LOG | DESCRIPTION



90% dk grey, pyritic, carbonaceous claystone; minor wispy siltstone lenticles
240·4 – 240·5 is a silty interval

very small shells at 241·05 and 241·10 in wispy siltstone intervals, scattered pyrite nodules, large shells at 241·4; Minor bioturbation with some burrows filled with siltstone and fine s.s. At 242 carbonaceous plant frags, coorse mica flakes and pyritic tubular stuctures (? roots). Silt is ? Kaolinitic

a.a. many pyritic tubules (? roots)
shell at 243

more silty (20%) and bioturbated at 243·4; minor cross lams

Mainly claystone (90%), wispy siltstone (10%); pyrite ? kaolin, horizontal tubules.

lamination of fine-medium qtz sand at 245·08.
a.a.

Mainly claystone; v. minor siltstone. Shells at 246·5

v.fine silty s.s.; pyrite, glauconite, shells, ? Kaolin
Shells in silty s.s. at 247·25
Shale becomes paler (to pl gy) in colour at 247·5; pyritic tubules (horizontal and vertical), subhorizontal bedding 247·7-247·8.

95% dk gy claystone, 5% pl gy siltstone; small shells at 248·9; minor fine qtz sand

Fine-medium grained, argillaceous qtz s.s. (249·4 – 249·42)

as above

1cm fine sandy siltstone (fine-med. qtz sand)

mainly claystone; minor siltstone and fine s.s., rare qtz granules.
cross-laminated siltstone

claystone + minor cross-laminated siltstone (glauconite), some carb. frags
Shells at 253·42.

fine-medium qtz sand filling tubules (? burrows) at 254·6
95% claystone, only minor silt.

minor siltstone, fine sandstone
v.f.g silty s.s.; glauconite, pyrite
claystone becoming a paler grey colour.; minor glauconitic silty s.s. with rare pebbles, pyritic tubular structures.
50% claystone; 50% glauconitic siltstone and s.s. from 257→257·1 + fine s.s.
Solid massive grey claystone with many pyritic tubules.

clayey glauconitic siltstone

BIT TYPE
TIME – START
FINISH
LOGGED BY G. Ambrose
DATE

PETROLEUM GEOLOGY SECTION

SHEET OF
DRG. NO. S

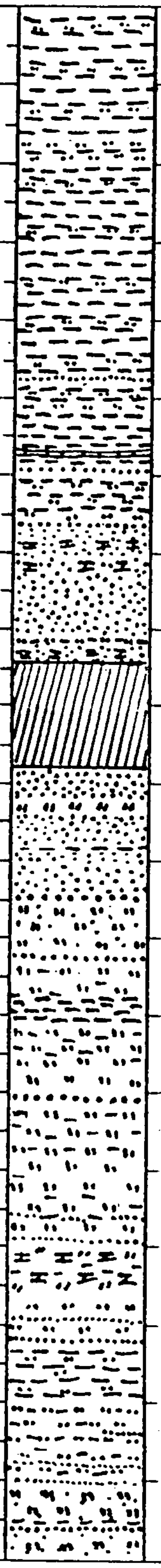
DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

CORE AND CUTTINGS DESCRIPTION

WELL Toodla ※I
LOCATION
LAT.
LONG.
ELEVATION GR.
R.T.
DATUM
CORE NO.
DEPTH
DATE DRILLED
RECOVERY m %
FORMATION

DEPTH (METRES)	GRAPHIC LOG	DRILL TIME MINS	RECOVERY LOG	DESCRIPTION

260
261
262
263
264
265
266
267
268
269
270
271
272
273
274
275
276
277
278
279
280



Dk gy – black carbonaceous claystone ; pyritic with specks of plant material ; minor (10-15%) interlaminated micaceous, ? glauconitic, pl. gy. siltstone ; wispy irregular laminations (5mm thick) often showing irregular basal contact with claystone (eg flame structures) but flat tops.

Cross-laminated siltstone (50%) with carbonaceous lams ; 50% claystone.

Mainly claystone (90%) with minor interlaminated siltstone as above ; highly pyritic and some pyrite is weathered to iron oxide.

AA but 70% dark grey claystone ; 30% pyritic, glauconitic, micaceous siltstone – fine sandstone containing cross-lams., wispy lenticles ; some silt lams are very glauconitic and have sharp bases and graded tops ; bioturbation at 263·5m

From 264·7-264·8 have cross-lam. fine s.s., pyritic, glauconitic + minor med.-coarse qtz gns.

Claystone A.A. (90%), pl gy pyritic siltstone (10%) ; calcite 265·25—265·45.

Slightly calcareous shale and cone in cone limestone.

V.f-g qtz sandstone-siltstone ; ? kaolin, glauconite, pyrite.

Interlaminated gy shale (paler than above) and pl. gy silt - fine s.s. (qtz), wispy lams, glauconite, biotubation. Gritty, v.f.g qtz s.s. 266·75 - 266·8 m.

266·75 -268 mainly well-sorted, v. f. g. qtz sandstone ; sometimes cemented by calcite and sometimes argillaceous ; scattered med., coarse, v. coarse angular qtz gns + 1 pebble of pegmatite at 267·8 ; minor plant material and bioturbation minor intercalation of pyritic silty claystone

V. f.g argillaceous qtz s.s. calcitic in part with kaolin veins and thin shale partings quite hard and massive. 270·15 - 270·25 v. hard gy-brown siltstone with irregular upper and lower contacts + veins of kaolin.

v. f.g - f.g, argillaceous qtz sandstone ; cross-lams, pyrite, kaolinitic, rare qtz granules, black carbonaceous specks ; v. c. pebbly s.s. 271·4-271·5 - marks the base of upward fining cycle.

Sandy siltstone - black carbonaceous specks, disturbed lamination.

2cm thick kaolinitic, medium sandstone.

Cross lam. clayey, pyritic siltstone with minor fine sand. + qtz granules, micaceous massive pyritic silty claystone ; much plant matter

Cross-lam clayey siltstone ; pyritic, micaceous + black carbonaceous matter, bioturbated, a few thin intervals of fine and medium s.s., coarse ss at 274.1

Minor (<1cm) gritty coarse s.s. in mainly lam. siltstones AA.

Hard calc. siltstone, pyritic, plant matter, x lams. + minor claystone

Non calc clayey siltstone, minor fine s.s. (rare coarse sand), plant matter.

50% fine-medium qtz sand (Kaolinitic), 50% clayey siltstone.

Carbonaceous, pyritic silty claystone and clayey siltstone ; wispy lams + minor x lams ; minor lenses of white Kaolinitic s.s. (v.f.g).

Cross-lam. clayey siltstone ; carbonaceous, pyrite ; 10-15% v.f.g kaolinitic s.s.

A.A. but v.f.g. kaolinitic siltstone increases to 40%.

Sandy siltstone occasionally clayey ; pyritic, crosslams, coarse kaolinitic quartz s.s. with erosive base at 279·68

BIT TYPE
TIME – START
FINISH

LOGGED BY. G. Ambrose

DATE

PETROLEUM GEOLOGY SECTION

SHEET OF

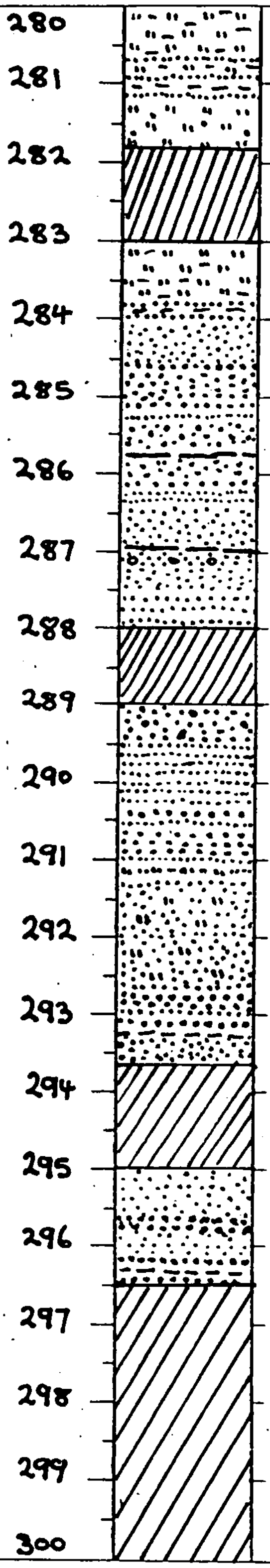
DRG NO S

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

CORE AND CUTTINGS DESCRIPTION

WELL Toodla # I
LOCATION
LAT.
LONG.
ELEVATION GR.
R.T.
DATUM
CORE NO.
DEPTH
DATE DRILLED
RECOVERY m %
FORMATION

DEPTH (METRES)	GRAPHIC LOG	DRILL TIME MINS	RECOVERY LOG	DESCRIPTION



Clayey siltstone with wispy dk shale lams; pyritic, caboraceous, x lams.
Minor gritty, kaolinitic s.s. lams.

Sandy siltstone; scattered coarse qtz gns (sub ang.); cross-lams, mica, kaolin
minor shale at 281.63.

Clayey sandy siltotone; cross-lams 2-3cm high, black carbonaceous laminae + ? bioturbation; scattered fine-medium-coarse qtz sand.
Interlaminated coarse, gritty, kaolinitic s.s. and xlam silty claystone.
v.f.g. sandstone; silty clayey (? kaolin).
med.-coarse g. s.s. 284.5-248.6; kaolinitic, minor v. coarse s.s. Main water flow begins in this aquifer. s.s is largely clean. * sub ang.-sub. rounded.
fine-med. s.s.; minor shale. Upward fining cycle over 50mm
coarse gritty s.s.; feldspar (trace) crystal; minor qtz cement, kaolin.
285.63 – 285.65 hard, dk gy, f.g. silt; slightly calc. ? silicified.
f-m.g. well sorted clean s.s.
a.a. but gritty sandstone intervals; lignitic lam. at one point.
V. hard ? silic grey clayey siltstone, underlain by thin pebbly coarse s.s.
v. hardy silty f.g. s.s. – ? silicified but acid leaves yellow stain; blue qtz granules.
med. s.s. – scattered granules; minor carbonaceous laminae.

Poorly sorted med - coarse - f.g. s.s. (minor granules); clean, friable.
Well-sorted f.g-m.g. clean s.s.
a.a. but minor coarse qtz sand and granules

med.g - c.g. s.s.; some granules + many rounded dk gns (med. sand size)? oolites
fine silt - s.s. – carbonaceous laminae.
Silty v.f.g. s.s.; micaceous kaolinitic + minor carbonaceous laminae.

med: coarse gritty s.s.; dark gy ? carbonaceous. See some carbonaceous frag
silty claystone with minor fine sand.
mainly f.g. s.s. with wispy coal laminae at 293.35.

Massive, mainly f.g. qtz s.s.; minor med.-coarse qtz + a few granules; mostly clean but sometimes has a clayey matrix; wavy bedding, x lams, ? slumps; micaceous + carbonaceous streaks. Gritty interval 295.6 – 295.88.
Alternating gritty s.s. and silty shale lams., upward fining cycle over 3cms

BIT TYPE
TIME – START
FINISH
LOGGED BY G. Ambrose
DATE

PETROLEUM GEOLOGY SECTION

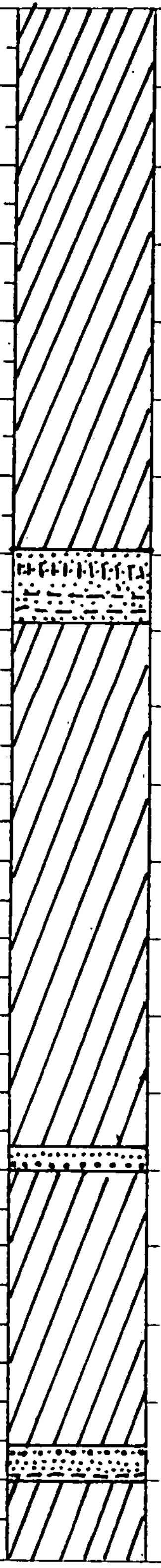
SHEET OF
DRG. NO. S

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA

CORE AND CUTTINGS DESCRIPTION

WELL Toodla ✲ I
LOCATION
LAT.
LONG.
ELEVATION GR.
R.T.
DATUM

CORE NO.
DEPTH
DATE DRILLED
RECOVERY m
FORMATION

DEPTH (METRES)	GRAPHIC LOG	DRILL TIME MINS	RECOVERY LOG	DESCRIPTION
300				
301				
302				
303				
304				
305				
306				
307				Dk gy, clayey v.f.g. silty s.s. ; minor sub angular med-coarse qtz sand grains. v. hard, silicic fine s.s. (pyritic) - ? boulder v.f.g. silty micaceous sandstone carbonaceous in part ; dark carbonaceous laminae (cross-lams), scattered coarse qtz gns and minor ? kaolin cement.
308				
309				
310				
311				
312				
313				
314				
315				v. well sorted f.g. - v.f.g. qtz s.s., minor clay (? kaolin) matrix. Coarse - v. coase clayey s.s., minor sub-ang. to ang. qtz granules - ? kaolin matrix
316				
317				
318				
319				v. coarse qtz s.s., minor qtz granules (sub.ang.) and r.f.'s ; clay (? kaolin matrix) + v.f.g sand (interstitial) f.g. - m.g. s.s., scattered qtz grit, clay (? kaolin) hard, pale grey, claystone 318.99 - 319.
320				

BIT TYPE
TIME - START
FINISH

LOGGED BY G. Ambrose
DATE

PETROLEUM GEOLOGY SECTION

SHEET OF
DEG. NO. S

64

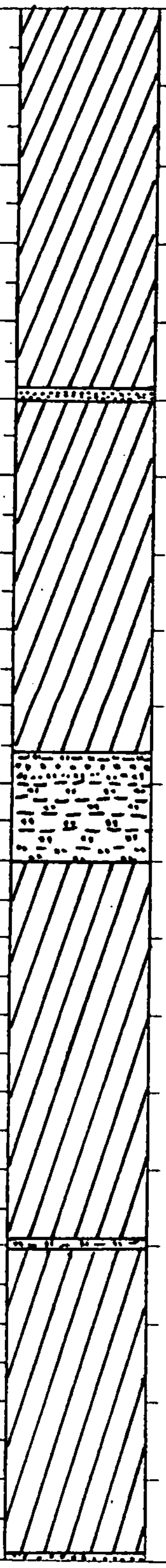
DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

CORE AND CUTTINGS DESCRIPTION

WELL Toodla # I
LOCATION
LAT.
LONG.
ELEVATION GR.
R.T.
DATUM

CORE NO.
DEPTH
DATE DRILLED
RECOVERY m %
FORMATION

GRAPHIC LOG



DEPTH (METRES)	DRILL TIME MINS	RECOVERY LOG	DESCRIPTION
320			
321			
322			
323			
324			
325			F.g., well sorted white qtz s.s. – interstitial clay (? kaolin)
326			
327			
328			
329			70% black clayey siltstone (black carb. specks), 30% pl gy, micaceous, sandy (v.f.g.) siltstone (cross lamin). grit band at 329.7
330			a.a. but 50% clayey siltstone, 50% sandy siltstone. a.a. but 90% pl gy sandy siltstone, 10% black wispy ~~b~~ clayey laminae.
331			
332			
333			
334			
335			
336			pl. gy, clayey siltstone, mica + minor black carb. specks; one v.f.g. qtz s.s. lamination.
337			
338			
339			
340			V. hard silicicified v.f.g qtz s.s – minor interstitial Kaolin.

BIT TYPE
TIME – START
FINISH

LOGGED BY G. Ambrose

DATE

PETROLEUM GEOLOGY SECTION

SHEET OF

DEG. NO. S

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

CORE AND CUTTINGS DESCRIPTION

WELL Toodla * I

LOCATION

LAT.

LONG.

ELEVATION GR.

R.T.

DATUM

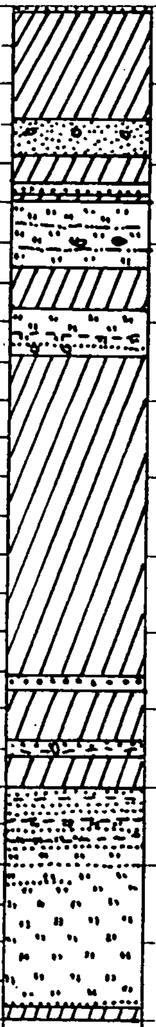
CORE NO.

DEPTH

DATE DRILLED

RECOVERY m

FORMATION

DEPTH (METRES)	GRAPHIC LOG	DRILL TIME MINS	RECOVERY LOG	DESCRIPTION
340				Hard, f.g-v.f.g., well-sorted white s.s. (qtz cement + minor ? kaolin)
341				Hard grey f.g.-v.f.g. qtz s.s. - qtz cement + minor kaolin; minor black carbonaceous laminae; qtz pebbles at 341.50.
342				v. hard glassy quartzite (? boulder) Interlaminated dk gy silty claystone (35%) and pl.gy, v.f.g. sandy siltstone (70%); siltstone is quartzitic in part (i.e. recrystallised) + white flecks, beds are jointed and have about 15° dip. Quartzite cobble at 342.92; White mineral (? Kaolin) in joints
343				
344				a.a. but a few more black silty claystone laminations; sediments slightly recrystallised beds dipping 15-20°; minor blue-grey silty quartzitic s.s.; qtz + qtzite pebbles at 344.4 beds are jointed and infilling joints is white clay (? Kaolin); at 344.45 are x lams,
345				
346				
347				
348				qtz grit with interstitial pyrite; quartzite fragment (? boulder); minor dk grey claystone (? contamination) with med-c.g sand; minor f.g. qtzite with interlams of black clayey silt.
349				gy qtzite + qtz pebbles; minor blacks lams of fine clayey siltstone; jointed (? Kaolin)
350				F.g. pl.gy quartzitic s.s. (is dk blue-grey colour in places) + minor lams of dk.gy clayey siltstone :- jointed; minor pyritic s.s.; beds have 15° dip. minor pyritic siltstone (brecciated in part and invaded by ? Kaolin).
351				pl-gy siltstone (laminated, jointed); minor med s.s. lams (pyritic) - ? dip 25°
352				grey jointed siltstone ∝ 20° dip.
353				f.g. quartzitic s.s.
354				
355				
356				
357				
358				
359				
360				

BIT TYPE

TIME – START

FINISH

LOGGED BY G. Ambrose.

DATE

PETROLEUM GEOLOGY SECTION

SHEET OF

DRG. NO. S

APPENDIX III

PETROGRAPHIC DESCRIPTIONS

The Australian
Development
Laboratories

amdel

Street, Frewville,
h Australia 5063
delaide 79 1662
Telex AA 82520

ease address all
rrespondence to
x 114 Eastwood
SA 5063
In reply quote:

31 January 1980

GS 1/2/0
Your ref: 12.06.0536

Director-General,
Department of Mines & Energy,
EASTWOOD.

Attention: G. Ambrose

REPORT GS 2153/80

YOUR REFERENCE: Application of 2 November 1979

MATERIAL: 17 rocks

LOCALITY: Toodla No. 1

IDENTIFICATION: 6042 RS 94-110

DATE RECEIVED: 5 December 1979

WORK REQUIRED: MA1.3

Investigation and Report by: Dr Brian Steveson

Manager, Geological Services Division: Dr Keith J. Henley

Keith Henley

for Norton Jackson,
Managing Director.

meo/23

nt: Osman Place
Thebarton S.A.
ephone 43 8053
aboratory: Perth

PETROGRAPHY OF SAMPLES FROM TOODLA NO. 1

Sample: RS 94; TS42555

Location: Toodla No. 1; 218.37 m

Rock Name:
Argillaceous glauconitic sandstone

Hand Specimen:
This is a grey rock which is slightly friable. The cut surface of the hand specimen shows a very indefinite foliation at right angles to the core length and in places there are discontinuous beds containing quartz grains up to 1 mm in size.

Thin Section:
The thin section contains about 1 centimeter of the stratigraphic section and there are considerable differences in the lithology from place to place so that it is not possible to give an overall mineralogical composition of the sample. All the beds contain a fairly abundant matrix of partly kaolinitic material and within this there is fine sand or silt-grade material consisting of quartz and glauconite and it is likely that the latter mineral comprises about 10% of the rock overall. The most distinctive lithology in the thin section is similar to that described immediately above but also containing quartz grains which have an average size of about 0.6 mm. This probably represents sand material washed into the otherwise glauconitic siltstone probably during a period of particularly strong current activity.

In the bulk of the rock there is an abundant matrix which is brown in plane polarized light and rather dark between crossed nicols, and it seems most likely that this is a kaolinitic matrix. It is notably homogeneous throughout the whole area of the thin section and it generally shows a weak bulk extinction indicating some parallel alignment of the kaolinite flakes. Within this are silt-grade to very fine sand-grade grains of quartz and glauconite. These two minerals occur in about equal abundance and both form equant grains. Those of quartz (and minor feldspar) tend to be rather angular in shape but the glauconite grains are notably well rounded and some have rather characteristic drying cracks. Minor detrital components in the rock are small amounts of fine-grained muscovite and a few grains of rather angular ?zircon. There is a gradation from this silt-grade material into rocks in which the quartz has an average size of 0.1 to 0.2 mm and finally to the lithology containing quartz and feldspar grains which are more than 0.4 mm in size. In this bed the coarse sand-grade material comprises about 40% of the rock and the remainder is finer-grained and similar to the bulk of the sample. Some of the large grains are extremely well rounded and probably represent recycled quartz and feldspar grains. There is one large feldspar grain which consists of rather sericitized plagioclase but there are smaller grains of both plagioclase and potassium feldspar.

This rock is a marine silt or very fine sand characterized by the abundance of glauconite and a ?kaolinitic matrix. In one place there has been an incursion of sandy material with which has been introduced a population of well-rounded coarse sand grains mainly of quartz but also containing plagioclase.

Sample: RS 95; TS42556

Location: Toodla No. 1; 265.65 m

Rock Name:
Cone-in-cone limestone

Hand Specimen:
This is a grey, compact rock and it shows a very characteristic cone-in-cone structure. This can be particularly seen near the thin end of the hand specimen where there are angular rings round the cones.

Thin Section:
The sample consists very largely of calcite which has a fibrous or plumose structure such as characterizes these cone-in-cone phenomena. The thin section also contains cross sections of the annular ring structures as little wedge-shaped features arranged along lines which converge and diverge in accordance with the cone structure. The small wedges contain what appears to be argillaceous material with small amounts of detrital, very fine-grained, quartz.

In places in the thin section the structure is more contorted and the cone-in-cone less clear and here the calcite tends to be intergrown with small amounts of silt-grade quartz. The quartz grains are generally equant and some are unusually well-rounded for grains in this size range. Elsewhere, quartz is intergrown with dark ferruginous material which is probably iron-stained clay, as well as opaque goethite or possibly hematite. These patches of what may be described as calcareous siltstone comprise only a small proportion of the section and the rock is completely dominated by the fibrous calcite. As characterizes cone-in-cone structures the fibres are generally oriented at right angles to the overall bedding in the sample, i.e. parallel to the cone length.

There is some controversy about the origin of cone-in-cone structures but they seem to characterize thin beds of limestone in otherwise shaly sequences and it is thought that pressure is in some way involved in the formation of these structures.

Sample: RS 96; TS42557

Location: Toodla No. 1; 266.75 m

Rock Name:
Argillaceous sandstone

Hand Specimen:
This rock is similar in many respects to that from 218.37 m in that it is a grey, slightly friable sandstone. There is bedding at an angle of about 80° to the core length and this is defined by slight variations in colour.

Thin Section:
An optical estimate of the constituents gives the following:

	%
Quartz	70
Feldspar	5
Glauconite	5
Heavy minerals	Trace
Chlorite	Trace
Clay	20

This is a fairly homogeneous sandstone consisting in most places in the thin section of isolated quartz and feldspar grains in an abundant clay matrix.

In some areas of the thin section there is evidence of a bimodal grain size distribution and there are grains which have an average size of about 0.25 mm which occur with more abundant material which has an average grain size of about 0.08 mm. The bulk of the rock can, in fact, be described as a very fine-grained sandstone with this coarser-grained material in patches. The larger grains consist of quartz and minor feldspar and are generally moderately to well rounded. The feldspar is uncommonly fresh and cross-hatch twinning is well displayed by several microcline crystals. Throughout the whole of the rock there is fairly abundant silt-grade or very fine sand-grade material consisting of quartz and feldspar in similar proportions to those in the coarser grain size population. The smaller grains have a tendency to be somewhat more angular in shape but this is commonly a feature of silt grains. Minor detrital-type components consist principally of the heavy minerals tourmaline and zircon. These grains belong entirely to the finer grain size population although one tourmaline grain 0.1 mm in length was observed.

The grains occur in an abundant matrix which is brown in plane polarized light and rather dark between crossed nicols. The material is somewhat heterogeneous and it is possible that a small amount of the clay may have been derived from original lithic fragments. In general, the clay apparently has a random orientation and there appears to have been no compaction of the rock with pressure being exerted on the clay matrix. In a few places also, there are elongate patches of clay free from detrital quartz and these probably represent shale fragments incorporated in the siltstone.

Glauconite was tentatively identified in several places where it occurs as rather dull green, rounded clasts up to 0.1 mm in diameter. Some of these clasts show what are interpreted as shrinkage and drying cracks and these serve to confirm the identification of this mineral.

This is a marine sandstone containing a diversity of detrital material particularly in terms of the grain size. There is a population of sparse, sand-grade grains amongst widely dispersed coarse silt or very fine sand material. It is also possible that the rock contains a small amount of elongate clasts of shaly material.

Sample: RS97; TS42558

Location: Toodla No. 1 267.68 m

Rock Name:
Friable argillaceous sandstone

Hand Specimen:
This is a grey friable rock which is massive. There are a few reflectant flakes of mica but otherwise the material consists of crumbly grey ?quartz and clay.

Thin Section:
An optical estimate of the constituents gives the following :

	%
Quartz	80-85
Clay	10
Feldspar	3-5
Opaques & Semi-opaques	3
Heavy minerals	1

This is a cleaner and generally better sorted sandstone than others described above and it contains only about 10% of clay. The detrital quartz and feldspar clearly form a rigid framework.

Overall, the detrital grains of quartz and feldspar are fairly well sorted about the average size of 0.15 mm; however, there are some grains as much as 0.06 mm in size and some of these are rather characteristically and tabular feldspar grains. The feldspar is fresh and both microcline and plagioclase can be identified in the thin section. Larger grains are commonly subangular in shape but many of the grains about the mean size and smaller tend to be distinctly angular. The grains are in contact at tangential contact points and there is no evidence of any modification of the detrital material after deposition. Minor detrital components consist of heavy minerals of which tourmaline, zircon and traces of muscovite can be identified. There are also some opaque detrital grains as well as dispersed opaque and semi-opaque limonitic material.

The latter generally occurs as a stain on the intergranular clay matrix. This material in many places occurs simply as a coating on the grains and as an infilling of small intergranular spaces not more than 0.05 mm in size. In a few places in the thin section, however, there are relatively large patches of clay free from any detrital material. Some of these patches are about 0.5 mm in size but some are elongate and several millimetres in length. It is not clear whether these were originally shale clasts or whether original detrital material may have been dissolved away. It seems most likely that these patches of clay simply represent accumulations of fine-grained clay with the sediment, and the rock has undergone virtually no compaction and the clay aggregates have therefore survived.

This is a much cleaner sandstone than others described above and it shows fairly good sorting although there is evidence of the sparse, notably coarse grain size population.

Sample RS98: TS42559

Location: Toodla No. 1 270.07 m

Rock name:
Dolomitic sandstone

Hand Specimen:
A massive and compact fine-grained grey rock. There is some evidence of bedding at right angles to the core length but this is very indistinct. Sample is notably more compact than the friable rocks described above.

Thin Section:
An optical estimate of the constituents gives the following :

	%
Quartz	60-65
Dolomite	30
Feldspar	3
Clay	2
Opaques & semi-opaques	2
Heavy minerals	Trace
Muscovite	Trace

This is a well sorted sandstone efficiently cemented by fine-grained ?dolomite. The carbonate mineral does not stain with alizarin red-S nor does it appear to have an exceptionally high refractive index and therefore the material is assumed to be dolomite.

The detrital grains are equant and anhedral in shape and most are angular to subangular. The average grain size is approximately 0.15 mm. There are a few exceptionally large grains, particularly one elongate grain of chalcedony which is 1 mm in length. Feldspar is fresh and most of the grains appear to be cross-hatch twinned microcline. These grains of feldspar have a similar size and shape to quartz. Heavy minerals are represented by tourmaline and zircon and by a few subround grains of opaques.

The detrital components have been cemented by dolomite which forms a contiguous network throughout the whole of the thin section. Individual dolomite crystals are difficult to discern but appear to be of the order of 0.03 mm in size. Some detrital grains appear to have been partly corroded by the dolomite although it seems unlikely that this would have been a very marked process since the grains appear to form a fairly rigid framework. In places where it appears that the grains might well have been in tangential contact there tends to be a narrow zone of dolomite about 0.02 mm in width. In some places the dolomite occurs in cross-cutting fracture zones which cut individual quartz grains.

The relatively small proportion of quartz given in the list of minerals above refers to the bulk of the rock where the quartz occurs as small patches enclosed in the dolomite, presumably representing the intergranular phase subsequently almost entirely replaced by the dolomite. In one part of the thin section,however, there is considerably more clay intergrown with the dolomite and in places these two minerals form rather large aggregates where the quartz is not present as a framework. To this extent, therefore, this part of the rock is rather similar to RS 97.
The clay in other samples has, in this rock, (RS 98) simply been largely replaced by authigenic dolomite.

Little can be said about the origin of this sample since original matrix material has been almost entirely replaced by an authigenic component. The sample appears to have been a medium-grained, well-sorted sandstone, possible with of the order of 20-25% of clay matrix. Dolomite has now virtually completely replaced the latter.

Sample: RS 99; TS42560

Location: Toodla No. 1; 270.14 m.

Rock Name:
Dolomitic sandstone and dolomitized shale

Hand Specimen:
This is a grey to buff coloured rock which is extremely compact and appears to be very fine-grained. There is a central, discontinuous bed of slightly darker material but other than this the sample appears to be homogeneous.

Thin Section:
The sedimentary structures in the sample can be seen when the thin section is viewed macroscopically. Darker brown material is dolomitized claystone or shale and there is lighter dolomitic sandstone. The latter appears to have formed some kind of sedimentary intrusion and penetrated into adjacent dolomitized shale. The sandstone body which cuts across the bedding is about 3 mm in width and 1 cm in length.

The darker brown lithology which comprises the bulk of the thin section is a dolomitized shale. It has a fine-grained speckled brown appearance in plane polarized light and is rather dark between crossed nicols. The bulk of the material consists of clay more or less obscured by fine-grained dolomite. The two minerals are intergrown on a scale of less than 0.05 mm. Within this material there are minor amounts of quartz and traces of mica. The rock is notably massive and homogeneous.

The dolomitic sandstone is very similar to the rock described immediately above where it forms part of a bed at one end of the thin section. The material consists of about 70-80% of quartz and feldspar with fairly clear, fine-grained dolomite forming virtually the whole of the intergranular space. There is a sharp boundary between this and the adjacent dolomitized shale. The intruded pile of dolomitic sandstone is similar in composition to the bed of dolomitized sandstone and it is likely that the material has, in fact, been intruded upwards, possibly due to variations in overburden pressures in the shale.

The sample consists principally of a dolomitized and, possibly ferruginized, shale grading in places into a silty shale. There are also minor beds of dolomitic sandstone similar to RS 98. The most interesting feature in the thin section is the presence of an intrusion of the sandstone apparently upwards into the shale. In one place where there is a massive overlying bed of shale this may have a discordant contact with the underlying shale and sandstone.

Sample: RS 100; TS42561

Location: Toodla No. 1; 270.24 m.

Rock Name:
Dolomitic argillaceous sandstone

Hand Specimen:
This is a grey to buff-coloured, fine-grained rock which is notably massive and compact. There are a few small, irregular patches of darker material which possibly consist wholly of carbonate.

Thin Section:
An optical estimate of the constituents gives the following:

	%
Quartz	75
Dolomite	15
Clay	10
Feldspar	1-2
Heavy minerals	Trace

For the most part, this is a homogeneous and massive sandstone but in one part of the thin section the material is a dolomitized shale similar to that in sample RS 99. The proportions given above refer to the sandstone.

Detrital quartz and feldspar are equant but angular grains which appear to have been partly corroded by the authigenic dolomite. This is shown particularly by the fact that there is a considerable range of roundness from rare grains which are subround in outline to the majority of the grains which are distinctly angular. Feldspar is generally microcline and it is completely fresh. As far as can be determined, the grains form a rigid framework. Between these grains is an aggregate of dolomite and rather indeterminate clay material. The dolomite forms a fine-grained granular mosaic of micritic material in which the average crystal size is probably less than 0.02 mm, although this is rather difficult to tell with any precision. In most places the dolomite is by no means compact and there are spaces between the crystals. Some of these spaces are voids but others are clay material which is brown in plane polarized light and dark between crossed nicols. Others are patches of kaolinite in which individual flakes can be seen. It appears likely that much of the more indistinct fine-grained clay is a remnant of the original argillaceous matrix and the rare pockets of kaolinite may well be authigenic material which preceded the deposition of dolomite.

The sample contains dispersed opaque and semi-opaque material, most of which is probably derived from partly altered original opaque detrital grains. There are rare grains of tourmaline and zircon, also.

At one end of the thin section there is a dark, dolomitized shale with rare sand-grade quartz fragments. The material is very similar to that in sample RS 99.

Sample: RS 101; TS42562

Location: Toodla No. 1; 277.78 m.

Rock Name:
Silty mudstone

Hand Specimen:
This is a friable, grey rock which is aphanitic. On one of the cut surfaces there is a paler bleb oriented at right angles to the core length but this is the only evidence of any inhomogeneity in the sample.

Thin Section:
An optical estimate of the constituents gives the following:

	%
Clay	65
Quartz	20
Opaques & semi-opaques	5
Muscovite	5
Biotite/chlorite	2
Feldspar	2

This is a homogeneous silty and sandy mudstone and it contrasts strongly with the dolomitic rocks described immediately above.

The bulk of the sample consists of a turbid, fine-grained material which is brown in plane polarized light and largely dark between crossed nicols. The material is clearly a fine-grained clay of some kind. Within this, some birefringent wisps can be seen and there is a complete gradation up to fairly well-defined flakes of muscovite/sericite of the order of 0.02 mm in length. Larger flakes of both biotite and chlorite are clearly of detrital origin and not part of the bulk of the argillaceous material in the rock. Where birefringent flakes and wisps can be seen they have a common orientation of the long axes, defining the bedding in the rock.

Detrital grains of quartz and feldspar are widely dispersed throughout the sample and in no way form any kind of framework. The thin section contains exceptional grains up to 0.8 mm in size but most of the quartz and feldspar is present as angular grains less than 0.1 mm in diameter. The grains are invariably angular but equant in shape. Feldspar is not abundant and only a few grains were specifically identified. In places there are clay aggregates which appear to have textures pseudomorphing the cleavage in a pre-existing mineral and these may well represent pseudomorphs after original feldspar.

This is a typical silty mudstone consisting very largely of fine-grained clay material with widely scattered silty quartz and feldspar.

Sample: RS 102; TS42563

Location: Toodla No. 1; 285.65 m.

Rock Name:
Mudstone with sandstone beds

Hand Specimen:
The core sample consists principally of an aphanitic grey rock which is hard and compact. Within this are grey, rather friable, sandstone beds ranging in thickness from about 1 mm to more than 5 mm. The sandstones are subparallel to each other and approximately at right angles to the length of the core.

Thin Section:
An optical estimate of the constituents gives the following:

	%
Clay	70
Carbonate	15
Quartz	10
Feldspar	1-2
Opaques & semi-opaques	1
Kaolinite	1

This is a rather complex rock consisting principally of a calcareous mudstone within which are rather heterogeneous sandstone bands. The mineral proportions given above are, in effect, an average for the stratigraphic section intersected in the thin section.

The bulk of the rock consists of a mudstone which is a dark brown in plane polarized light and almost completely black under crossed nicols. The material presumably consists very largely of clay, although direct petrographic evidence for this really cannot be seen. Within the dark material there are brown patches which are commonly not more than about 0.05 mm in size and these consist of fine-grained carbonate. These patches comprise about 10% of the mudstone and are widely scattered as a random speckling of the clay.

The sandstone beds vary from a few scattered fragments in beds not more than 1 mm in thickness and not continuous through the width of the thin section, to the well-defined units up to about 5 mm in thickness. Detrital material consists of quartz and feldspar but there is an extremely wide grain size range of such material even within individual sandstones and quartz grains range, for example, from 0.2 mm to 1.5 mm in size. The larger grains tend to be subround to subangular in shape but the smaller ones are commonly somewhat angular. Feldspar is fresh but some grains show what appears to be fracturing or alteration along specific irregular planes. The quartz and feldspar in the sandstone rarely form a rigid framework but the grains are widely separated by clay material similar to that in the bulk of the rock. Also present, however, is relatively clear but fine-grained carbonate which fills some of the intergranular spaces, and there are patches of relatively coarse-grained kaolinite which is presumably of authigenic origin. In one or two of the sandstone beds there are aggregates of sand-grade quartz with authigenic kaolinite and carbonate which are of the order of 1 mm in size and these form subround aggregates which may, themselves, be detrital fragments. It appears, therefore, that the sandstones may, to a large extent, be coarse sand in which the detrital material consists both of large individual crystals and also of sandstone fragments. These sort of textures can only be seen in a few places and the overall impression given is of a rather ill-sorted sandstone bed.

As the description indicates, the sandstones are rather heterogeneous and difficult to interpret. They are cemented principally by clay material similar to that in the bulk of the section, but there is also a significant amount of authigenic kaolinite and carbonate. The sands are essentially ill-sorted and presumably represent some kind of material deposited rather quickly from fast-flowing currents which probably interrupted the otherwise quiescent conditions under which the bulk of the clay was deposited.

Sample: RS 103; TS42564

Location: Toodla No. 1; 290.7 m

Rock Name:
Chamositic sandstone

Hand Specimen:
This is a massive, friable rock which is a dark green colour. The rock is clearly some kind of medium-grained, ill-cemented sandstone.

Thin Section:
An optical estimate of the constituents gives the following:

	%
Quartz	60
Ferruginous oolites	25
Siderite	15
Heavy minerals	Trace
Feldspar	Trace

The sample contains detrital grains of quartz and of a material which is green in plane polarized light and completely dark between crossed nicols. The material does not appear to be phosphatic and hence it is assumed to be some kind of poorly crystalline chamositic material. The pellets of this show a concentric structure and are clearly oolitic.

The quartz grains show generally excellent rounding and good to moderate sorting. The largest grains in the thin section are about 1 mm in size and the average size of the grains is about 0.3 mm. Feldspar is present in trace amounts only and only one or two fresh grains of microcline were identified. The ferruginous oolites commonly have a diameter of about 0.5 mm, ranging in a few instances down to 0.3 mm. The oolites are variously green and brown and show fairly well defined concentric textures. Some have cores of small quartz grains and others appear to have incorporated quartz grains during their growth.

The sample is only poorly cemented by fairly coarse-grained, unstained carbonate which is almost certainly siderite. The carbonate crystals are commonly about 0.1-0.2 mm in size and, although in places they occupy all of the intergranular space, elsewhere there are pores in the rock and it is clear that the siderite is not an efficient cement. One or two grains show a thin skin of ferruginous material (this may well be chamosite), but there are no other cementing materials apart from this and the siderite.

Heavy minerals are represented by a few small grains of rather broken zircon.

The sandstone is probably some kind of marine sand deposited in a shallow shelf environment.

Sample: RS 104; TS42565

Location: Toodla No. 1; 307.34 m.

Rock Name:
Micaceous siltstone

Hand Specimen:
This is a fine-grained grey rock with a laminar foliation. Individual beds, which have different colours, are of the order of 1-8 mm in thickness and are aligned at right angles to the core length.

Thin Section:
An optical estimate of the constituents gives the following:

	%
Quartz	65
Clay	15-20
Opaques & semi-opaques	5-10
Mica and chlorite	10
Feldspar	1
Heavy minerals	Trace

This is a thinly bedded and somewhat heterogeneous rock and the mineral proportions given above are an overall average for the material intersected in the thin section. The rock is essentially a siltstone with some beds which are rich in opaque material and others which contain relatively large amounts of mica and chlorite.

Detrital grains of quartz and feldspar have been well sorted but most are angular and equant in shape. The average grain size is approximately 0.06 mm. Feldspar is not common and only a few grains were specifically identified. These were potassium feldspar but it is possible that the rock also contains a small amount of plagioclase. Some of the mica is clearly detrital material and some beds contain as much as 10% of oriented flakes of muscovite, some of which are as much as 0.3 mm in length. Elsewhere, muscovite is much less common. It is not clear whether chlorite is a detrital mineral or part of the clay matrix of the sample. In one or two fields of view there is a relatively large amount of rather indeterminate grey material which has been described as chlorite. Relatively large aggregates could well be of detrital origin and some of these are as much as 0.15 mm in length. Elsewhere the chlorite is not well defined and effectively becomes part of the clay matrix of the rock. The latter varies considerably from place to place, both in its appearance and in the overall proportion. It is generally more or less brown or turbid in plane polarized light and dark between crossed nicols, ranging in places to more birefringent aggregates of illitic or sericitic material. The heterogeneity of the clay may indicate that some is derived from original argillaceous detrital fragments but there is little evidence of pseudomorphs of these. Some patches of clay are green and birefringent and these may well be small patches of detrital glauconite. There are no subspericular aggregates of transported glauconite such as characterizes sandier rocks.

The opaque material generally forms elongate lenses and rather ragged blebs, some of which could well be carbonaceous. Lenses are not more than about 0.3 mm in length and most are very thin.

This is a somewhat heterogeneous rock but it is, overall, a rather clayey siltstone with bands which are variously micaceous and others probably carbonaceous.

Sample: RS 105; TS42566

Location: Toodla No. 1; 318.95 m.

Rock Name:
Porous sandstone

Hand Specimen:
This is a pale grey, massive rock which is distinctly friable. As far as can be determined, the sample has an even, medium-grained texture.

Thin Section:
An optical estimate of the constituents gives the following:

	%
Quartz	70
Clay	15
Pores	10-15
Feldspar	1-2
Mica	1
Opaques	Trace

Pores have been listed in the mineral proportions given above since they appear to be an integral part of the rock. The sample is a poorly cemented sandstone containing a rather variably distributed brown clay matrix.

The detrital grains are equant and angular to sub-angular in shape and there is evidence of good to excellent sorting in most places. There are rare large grains of the order of 0.5 mm in size but the average grain size is about 0.15-0.2 mm and few grains are less than 0.07 mm in diameter. Quartz is by far the most abundant detrital material and there are only small amounts of feldspar, muscovite and opaques. The feldspar grains are distinctly altered and some can barely be distinguished from the clay matrix.

The latter occurs between most of the quartz grains but does not always fill the whole of the intergranular space and there are pores occasionally up to 1 mm in size. The clay is homogeneous and appears to be a genuine clay matrix. It is a fairly distinctive yellow colour in plane polarized light but it is completely dark between crossed nicols and it seems most likely that it represents some kind of kaolinitic material. The quartz has sharp contacts against it and does not appear to have reacted with the clay during the diagenesis of the rock.

This is an immature, argillaceous sandstone showing no evidence of any kind of authigenic activity whatsoever. It is not possible to determine from the thin section whether the sandstone is of marine or non-marine origin or information of any kind concerning the environment of deposition.

Sample: RS 106; TS42567

Location:
Toodla No. 1; 330.6 m.

Rock Name:
Argillaceous sandstone

Hand Specimen:
This is a grey sandstone which is laminated and fairly compact. The cut vertical section shows dark laminae generally less than 1 mm in size which have an overall orientation at right angles to the core length. The laminae do, however, vary somewhat in orientation and there are places where they join together or separate into different lamellae.

Thin Section:
An optical estimate of the constituents gives the following:

	%
Quartz	55-75
Clay	10-30
Opaques	10-15
Mica	3
Feldspar	1
Heavy minerals	Trace

The range of proportions given for the quartz and clay are included to show the extent to which the two minerals vary from place to place in the thin section. The apparent homogeneity of the hand specimen when viewed macroscopically is not so clear in thin section and there tend to be more irregular variations in the proportions of clay and quartz. The detrital quartz is, however, invariably in the silt-grade size range and the grains are angular to subround in shape and generally show moderate to good sorting. The average grain size is about 0.07 mm. Both plagioclase and microcline were identified amongst the feldspars and both appear to be fairly fresh and unweathered.

The clay material in the rock is distinctly heterogeneous and it is thought than in some of the more argillaceous lithologies a considerable amount of the clay may have been derived from small lithic fragments. There are birefringent aggregates of sericitic material which occur adjacent to weakly birefringent, possibly authigenic, kaolinite. Some of the coarser-grained aggregates of kaolinite may well have been derived from complete alteration of original feldspar grains. Some apparently oriented aggregates of kaolinite are as much as 0.1 mm in overall size. The clay does not provide a very efficient cement and the rock is somewhat friable. In other parts of the thin section the clay material is obscured by semi-opaque ferruginous oxide or hydroxide material. In some fields if view virtually the whole of the intergranular space is more or less orange or red-brown and such material is probably either wholly limonite or a fine-grained intergrowth of limonite and clay. These parts of the rock appear to be more compact and better cemented.

The sample is a very fine-grained sandstone or coarse siltstone cemented by a rather variable clay matrix which, in places, may well have been derived from the degradation of original lithic fragments.

In places the clay is stained by limonitic material. The darker irregular bands which can be seen in the hand specimen occur in the thin section as elongate areas generally rich in both clay and laminae of opaque material which may well be carbonaceous. These bands are by no means as well defined in the thin section as they appear to be in the hand specimen.

Sample: RS 107; TS42568

Location: Toodla No. 1; 336.0 m.

Rock Name:
Argillaceous siltstone

Hand Specimen:
This is a grey to buff-coloured rock which has a fine-grained, almost aphanitic texture. There is a central, relatively sandy band which is pale in colour but the remainder has a laminar foliation and appears to be dark and relatively fine-grained.

Thin Section:
An optical estimate of the constituents gives the following:

	%
Quartz	70
Clay	15
Opaques & semi-opaques	10
Mica	3
Feldspar	1
Heavy minerals	Trace

Quartz grains are fairly well sorted but most are angular in shape. The average grain size is about 0.06 mm. For the most part the quartz forms a rigid framework and clay occurs in angular intergranular spaces and as a film on the surfaces of the grains. Most of the clay in the rock is more or less yellow or brown in plane polarized light ranging towards material which is stained by limonite/goethite and is darker. Under crossed nicols the clay is also completely dark and it is likely that much of it is kaolinite. The clay is fairly homogeneous and is probably an original argillaceous matrix. The rock contains subparallel narrow bands about 0.3 mm in width characterized by the abundance of ferruginous material. These bands also contain rather more varied and abundant clay possibly derived from lithic fragments. Some of the narrow elongate lenses of opaques in this part of the rock may well be carbonaceous.

Minor components of the rock are a few somewhat altered grains of feldspar and traces of heavy minerals, including somewhat tabular crystals of tourmaline. Detrital muscovite is widespread in the thin section and the flakes have a rather indefinite, subparallel orientation. Some mica flakes are of the order of 0.2 mm in length but many are much smaller than this.

The sample is a typical laminated argillaceous siltstone which shows no unusual characteristics.

Sample: RS 108; TS42569

Location: Toodla No. 1; 340.0 m.

Rock Name:
Quartz sandstone

Hand Specimen:
This is a massive and compact, pale grey sandstone with a grey to white, speckled appearance. The sample shows a few widely distributed pores.

Thin Section:
An optical estimate of the constituents gives the following:

	%
Quartz	90
Clay	10
Feldspar	1
Opaques	Trace
Tourmaline	Trace

This is a compact quartz sandstone which has been lithified by pressure solution effects including the dissolution of quartz and its re-precipitation in original pore spaces. There are equant patches of clay, also.

Quartz is present as an interlocked, granular mosaic with an average crystal size of about 0.25 mm. Within individual crystals there are trails of clay or dark ferruginous material which define the shape of original detrital grains, and it is clear that these were originally fairly well rounded and well sorted. Not all the crystals show these rings and hence some of the crystals may well be entirely of secondary origin. Feldspar is present in only a few places in the thin section where it forms rather altered grains with essentially tabular shapes but rounded vertices. Tourmaline is also unusually well rounded and is probably recycled sedimentary material. The grains are pleochroic in shades of green and blue and at least one of the crystals in the section has a completely circular outline.

Clay occurs as well defined patches within the virtually monomineralic mosaic of granular quartz. The clay is an orange colour and the patches are generally 0.2-0.4 mm in size. They are completely dark between crossed nicols and probably consist of kaolinite-like material rather than illite or sericite. Presumably the clay represents original matrix since it is fairly homogeneous.

The sample is, therefore, a fairly pure quartz sandstone with has been lithified essentially by the solution and re-deposition of quartz. Much of the rock now consists of an interlocked granular aggregate of quartz and there are only small amounts of clay in specific patches. The excellent lithification of the rock serves to distinguish it from many of those described above.

Sample: RS 109; TS42570

Location: Toodla No. 1; 343.0 m.

Rock Name:
Argillaceous sandstone

Hand Specimen:
This is a massive and compact, grey to green sandstone with thin dark bands commonly spaced several millimetres apart. These bands define a laminar bedding at right angles to the core length.

Thin Section:
An optical estimate of the constituents gives the following:

	%
Quartz	85
Clay	10
Feldspar	5
Tourmaline	1
Opaques and semi-opaques	1

This is a well lithified sandstone consisting principally of quartz and brown to granular clay. The sample is homogeneous and massive, apart from a series of bands of dark microstylolitic material.

The quartz grains have an average size of approximately 0.1 mm and they show excellent sorting. Most of the grains are subangular to subround in shape, although there are a few fairly well rounded grains, also. The grain contacts are commonly of the tangential variety, ranging to a few long and even concavo-convex boundaries in places. Quartz overgrowths cannot be seen but these have probably been inhibited by the amount of clay in the rock. Feldspar grains are generally similar to those of quartz, varying from completely rounded types to some tabular grains with slightly rounded vertices. Both microcline and plagioclase are apparently completely fresh.

As a result of solution of the quartz the amount of intergranular space appears to have been reduced and the rock contains only about 10% of clay. This material does, however, occur everywhere in the rock and even in long grain contacts there is commonly a thin seam of brownish clay. Under crossed nicols the clay is completely dark and it appears to be a fine-grained homogeneous material probably derived from a genuine argillaceous matrix.

Transecting the thin section there is a multiple band of dark material which, in places, is concentrated into a microstylolitic zone of opaque material. On either side of this there is dark, iron-stained argillaceous material surrounding somewhat finer-grained quartz. The whole material probably represents a somewhat argillaceous silty band within the sandstone and this has been a locus for pressure solution and the development of the microstylolitic feature.

The rock contains a relatively large amount of tourmaline present as fairly well rounded grains showing pleochroism from almost colourless to a deep yellow-brown shade.

This is a fairly mature or sub-mature sandstone characterized by the excellent sorting and moderate rounding of the grains. It is likely that there was a considerable amount of clay but the proportion has probably been slightly reduced during diagenesis and the removal of some of the quartz as a result of pressure solution. The effects of compaction are also shown by the development of microstylolites.

Sample: RS 110; TS42571

Location: Toodla No. 1; 351.5 m.

Rock Name:
Siltstone with sandy bands

Hand Specimen:
The sample is a massive and fairly compact grey rock with a moderately well defined parallel laminar bedding. On the cut surfaces there are buff-coloured granular patches up to about 7 mm in length.

Thin Section:
The thin section contains at least two discrete lithologies and these will be described in turn.

The bulk of the rock consists of a thinly banded argillaceous siltstone ranging towards a shale. In the silty beds there is of the order of 50% of detrital quartz which forms angular, fairly well sorted grains having an average size of approximately 0.05 mm. Detrital mica is also present in such rocks. The intergranular material in the siltier beds is fairly clear in plane polarized light and completely dark between crossed nicols. It is not dissimilar to the intergranular material in sample RS 109. Between these siltier beds there are altogether darker lithologies consisting very largely of clays which are more or less iron-stained. Within this rather dense and dark aggregate can be seen small oriented flakes of muscovite and rare silt-grade quartz grains. These two lithologies alternate on a scale of approximately 1 mm and form well defined laminar beds over most of the thin section. In one place, however, there is a somewhat irregular cross-cutting feature which appears to have disturbed the bedding somewhat. When the thin section is viewed macroscopically this feature appears almost to be some kind of siltstone which has been mobilized under differential compaction and penetrated through the alternation of siltstone and shale beds.

In one place in the thin section there is a rather unusual sandstone lithology which appears to rest on an unconformity in the alternating sequence described immediately above. The sandstone is of the order of 1-3 mm in thickness and it contains well rounded and well sorted quartz grains having an average size of about 0.25 mm. These do not, however, form any kind of rigid framework and are separated by silty material similar to the siltstone described above. The relative proportions of sand-grade grains and the silty matrix vary considerably and it seems likely that the sandstone bed is discontinuous and there was deposition of the sandy material irregularly over the sediment's surface and that the scattered sand-grade grains were then swamped by the deposition of more silty material. The presence of this sand presumably indicates periods of brief influx of stronger currents than were responsible for the even deposition of alternating siltstone and shale. After the sediments were partly covered and not yet lithified there has clearly been some differential compaction resulting in the mobilization of the siltstone in a few places and soft silty material has penetrated upwards through the sequence.

APPENDIX IV

WATER ANALYSES

SOUTH AUSTRALIAN DEPARTMENT OF MINES AND ENERGY

WATER SAMPLE ANALYSIS ADVICE

---

(1)

Bore Reference TOODLA #1

Analysis No. W 4370/79

Hundred Out of

Section.

Sample collected by G. AMBROSE

Date 13/10/79

Depth sample taken 285 m

Name Ambrose

Address c/o FOSSIL FUELS
SECTION

Dept. Mines Results

Conductivity 4350 uS at 25°C

to AMDEL for analysis 12/11/79

Salinity 2545 mg/l

AMDEL NO. 2324/80

pH 7.2

Remarks

Sent on to AMDEL for dissolved hydrocarbon analysis

Unit No. 20

Bore Folder No. 6042

---

(2)

Bore Reference TOODLA #1

Analysis No. W 4369/79

Hundred out of

Section

Sample collected by G. AMBROSE

Date 15/10/79

Depth sample taken 307 m

Name Ambrose

Address c/- FOSSIL FUELS
SECTION

Dept. Mines Results

Conductivity 4350 us at 25°C

to AMDEL for analysis 12/11/7

Salinity 2545 mg/l

AMDEL NO. 2324/80

pH 7.7

Remarks

Sent on to AMDEL for dissolved hydrocarbon analysis

Unit No. 20

Bore Folder No. 6042

The Australian Mineral Development Laboratories
Flemington Street, Frewville,
South Australia 5063
Phone Adelaide 79 1662
Telex AA 82520

Please address all correspondence to
P.O. Box 114 Eastwood
SA 5063
In reply quote:

amdel

NATA CERTIFICATE

AC 1/4/0 - 2324/80

13 December 1979.

REPORT COMPLETE

The Director General,
Dept. of Mines & Energy,
P.O. Box 151,
EASTWOOD S.A. 5063

REPORT AC 2324/80

SADME TOODLA NO. 1. - DISSOLVED HYDROCARBON ANALYSIS.

YOUR REFERENCE: Application dated 12 November 1979. 12.06.0601.

IDENTIFICATION: Sample Mark W4369/79, W4370/79.

DATE RECEIVED: 13 November 1979.

ANALYSIS
mg/1

SAMPLE MARK	GREASE + OIL
W4369 /79	<15
W4370 /79	<15
METHOD: Q9	

NOTE: The total sample was extracted, once, with 25ml of carbon tetra chloride. The organic extract was compared to a 2% paraffin in carbon tetra chloride. Read on IR over the range 3350/cm to 2500/cm.

Enquiries quoting AC 2324/80 to the Manager please

D. K. Rowley
Manager
Analytical Chemistry Division

for Norton Jackson
Managing Director

dg

APPENDIX V
SOURCE ROCK ANALYSES

95

The Australian
Mineral Development
Laboratories

amdel

ington Street, Frewville,
South Australia 5063
phone Adelaide 79 1662
Telex AA 82520

Please address all
correspondence to
P.O. Box 114 Eastwood
SA 5063

21 February 1980

In reply quote: GS 1/1/238 (B3112/80)

Your Ref: 11.06.323

Director-General,
Department of Mines & Energy,
PO Box 151,
EASTWOOD, SA 5063.

Attention: Dr D.M. McKirdy

SOURCE ROCK STUDIES -
COOPER BASIN

PROGRESS REPORT NO. 32

Investigation and Report by: Harold Sears

Manager, Geological Services Division: Dr Keith J. Henley

Keith Henley

for Norton Jackson
Managing Director

jd

TOTAL ORGANIC CARBON - TOODLA NO. 1

Total organic carbon analyses were performed on 24 samples of drill core from Toodla No. 1 in accordance with the client's application of 11 December 1979.

The results are as follows:

Applicant's No.	Total Organic Carbon (%)	Depth (m)
A3326/79	0.85	151.7-151.83
A3327/79	0.82	157.42-157.59
A3328/79	0.91	160.0-160.5
A3329/79	0.94	165.1-165.95
A3330/79	0.77	170.35-170.95
A3331/79	1.08	179.0-179.28
A3332/79	1.06	183.1-183.35
A3333/79	0.96	186.47-186.73
A3334/79	0.97	194.47-194.78
A3335/79	1.10	195.55-195.80
A3336/79	0.71	203.0-203.3
A3337/79	1.00	209.0-209.35
A3338/79	1.10	214.7-215.0
A3339/79	0.90	217.33-217.60
A3340/79	1.20	222.8-223.0
A3341/79	1.12	225.16-225.46
A3342/79	1.09	230.62-230.92
A3343/79	1.39	236.12-236.38
A3344/79	1.46	241.04-241.37
A3345/79	1.44	246.46-246.80
A3346/79	1.29	254.65-255.0
A3347/79	1.85	258.85-259.40
A3348/79	1.63	260.14-260.43
A3349/79	1.99	265.28-266.0

	ARCKARINGA SUB-BASIN AREA							
TOP OF STRATIGRAPHIC UNITS / WELL NAME AND NUMBER	MANYA NO.1	MARLA NO.1	LAMBINA NO.1	MOUNT WILLOUGHBY NO.1	MOUNT FURNER NO.1	WEEDINA NO.1	COOTANOORINA NO.1	MOUNT TOONDINA NO.2
Tertiary to Recent sediments.	+241(Sfce)	+285(Sfce)	+298·4(Sfce)			+96·62(Sfce)	+106·07(Sfce)	
Oodnadatta Fmn.								
Mt. Alexander Sandstone Member.								
Toolebuc Wooldridge } Limestone Mmbr.								
Coorikiana Mmbr.								
Bulldog Shale		+283	+292·3	+240·49(Sfce)	+131·37(Sfce)		+104·0	
Cadna-owie Fmn.	+209	+232	+139·6	+139·91	+70·41	+90·52 ?	-6·71	+105·76(Sfce)
Algebuckina Sandstone	+143·5		+85·65	+96·01	+26·21		-36·27	+60·04
Poolowanna Beds ? Peera-Peera Beds ?								
a. Purni Fmn. b. Mt. Toondina Fmn. } equivalents.			(b) +39·32	(b) +40·85	(b) -1·22	(b) +30·17	(b) -81·38	
Stuart Range Fmn.			-3·35	-52·12	-391·06	-462·08	-410·57	
c. Crown Point Fmn. d. Boorthanna Fmn. } equivalents.	(d) +119	(d) +211 ?	(d) -135·94				(d) -671·17	
e. Idracowra Sandstone f. Cootanoorina Fmn. } equivalents	+95 ?	+201·5 ?		(f) -383·13		(f) -560·53	(f) -785·47	
Middle to Lower Devonian.						-629·72		
Silurian.								
Ordovician						-1512·42		
Cambrian.								
Proterozoic.					-417·88			
TOTAL DEPTH	+89·74	+178·92	-145·69	-399·28	-423·67	-152·4	-842·16	+12·8

	MULOORINNA RIDGE AREA							
TOP OF STRATIGRAPHIC UNITS / WELL NAME AND NUMBER	COONGRA NO.1	YARDINNA NO.1	SANTOS OODNADATTA NO.1	OODNADATTA TOWN BORE NO. 2	TOODLA NO. 1	OUTCROP SECTION-ALGEBUCKINA HILL	WEST LAKE EYRE NO.2	WEST LAKE EYRE NO.1
Tertiary to Recent sediments.	+292·0(Sfce)	+146·0(Sfce)	+128·32(Sfce)	+120·81(Sfce)	+96·66(Sfce)		+54·2(Sfce)	+8·06(Sfce)
Oodnadatta Fmn.		+145·39	+121·61	+112·81	+88·66			
Mt. Alexander Sandstone Member.				+381	+81·66			
Toolebuc Wooldridge } Limestone Mmbr.								
Coorikiana Mmbr.		+53·95	+0·30		+9·16			
Bulldog Shale	+283·0	+45·42	-11·89	-28·19	-2·84		+50·2	+4·06
Cadna-owie Fmn.	+209·7		-178·61	-269·19	-167·34	+94·81	-97·8	-141·94
Algebuckina Sandstone			-209·0	-294·69	-187·34	+74·37	-112·8	-264·94
Poolowanna Beds ? Peera-Peera Beds ?								
a. Purni Fmn. b. Mt. Toondina Fmn. } equivalents.								
Stuart Range Fmn.								
c. Crown Point Fmn. d. Boorthanna Fmn. } equivalents.								
e. Idracowra Sandstone f. Cootanoorina Fmn. } equivalents								
Middle to Lower Devonian.								
Silurian.								
Ordovician			-265·78	-313·19	-245·34			
Cambrian.								
Proterozoic.						+56·08	-121·4	
TOTAL DEPTH	+91·3	-10·06	-274·62	-318·67	-256·34		-154·70	-270·94

	PEDIRKA SUB-BASIN AREA				
TOP OF STRATIGRAPHIC UNITS / WELL NAME AND NUMBER	F.P.C.(A) MOUNT CRISPE NO.1	F.P.C.(A) WITCHERRIE NO.1	F.P.C.(A) PURNI NO.1	F.P.C.(A) MOKARI NO.1	DELHI-SANTOS MACUMBA NO.1
Tertiary to Recent sediments.	+127·41(Sfce)	+81·99(Sfce)	+72·85(Sfce)	+64·00(Sfce)	+41·15(Sfce)
Oodnadatta Fmn.	+118·27	+66·75	-402·63		-654·71
Mt. Alexander Sandstone Member.					
Toolebuc Wooldridge } Limestone Mmbr.					-1108·86
Coorikiana Mmbr.					
Bulldog Shale	+81·69	-38·71	-710·49	-913·49	-1137·51
Cadna-owie Fmn.	-57·30	-195·38	-907·99	-1128·38	-1382·27
Algebuckina Sandstone	-85·34	-234·09	-951·28	-1176·23	-1436·52
Poolowanna Beds ? Peera-Peera Beds ?					-2147·31 -2249·73
a. Purni Fmn. b. Mt. Toondina Fmn. } equivalents.			-1343·86 (a)	-1739·20 (a)	-2406·09 (a)
Stuart Range Fmn.					
c. Crown Point Fmn. d. Boorthanna Fmn. } equivalents.	-319·12 (c)	-472·44 (c)	-1624·89 (c)	-2088·80 (c)	-2481·37 (c)
e. Idracowra Sandstone f. Cootanoorina Fmn. } equivalents					
Middle to Lower Devonian.		-573·33			-2522·22
Silurian.					
Ordovician	-338·32	-1087·83		-2190·00	
Cambrian.	-650·44				
Proterozoic.			-1713·28		
TOTAL DEPTH	-1593·79	-1381·96	-1807·16	-2321·67	-2575·86

+218·0 Depth in metres from sea level.
For locations of wells see plan S15136

Table 2

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

TOODLA NO. 1 WELL COMPLETION REPORT
SOUTHWESTERN EROMANGA BASIN
EXPLORATION WELL FORMATION TOPS, TO T.D.

COMPILED M.G.
C D O DATE 16·3·81
DRAWN S.R.
SCALE
DATE 6/10/80
CHECKED
PLAN NUMBER 80-693

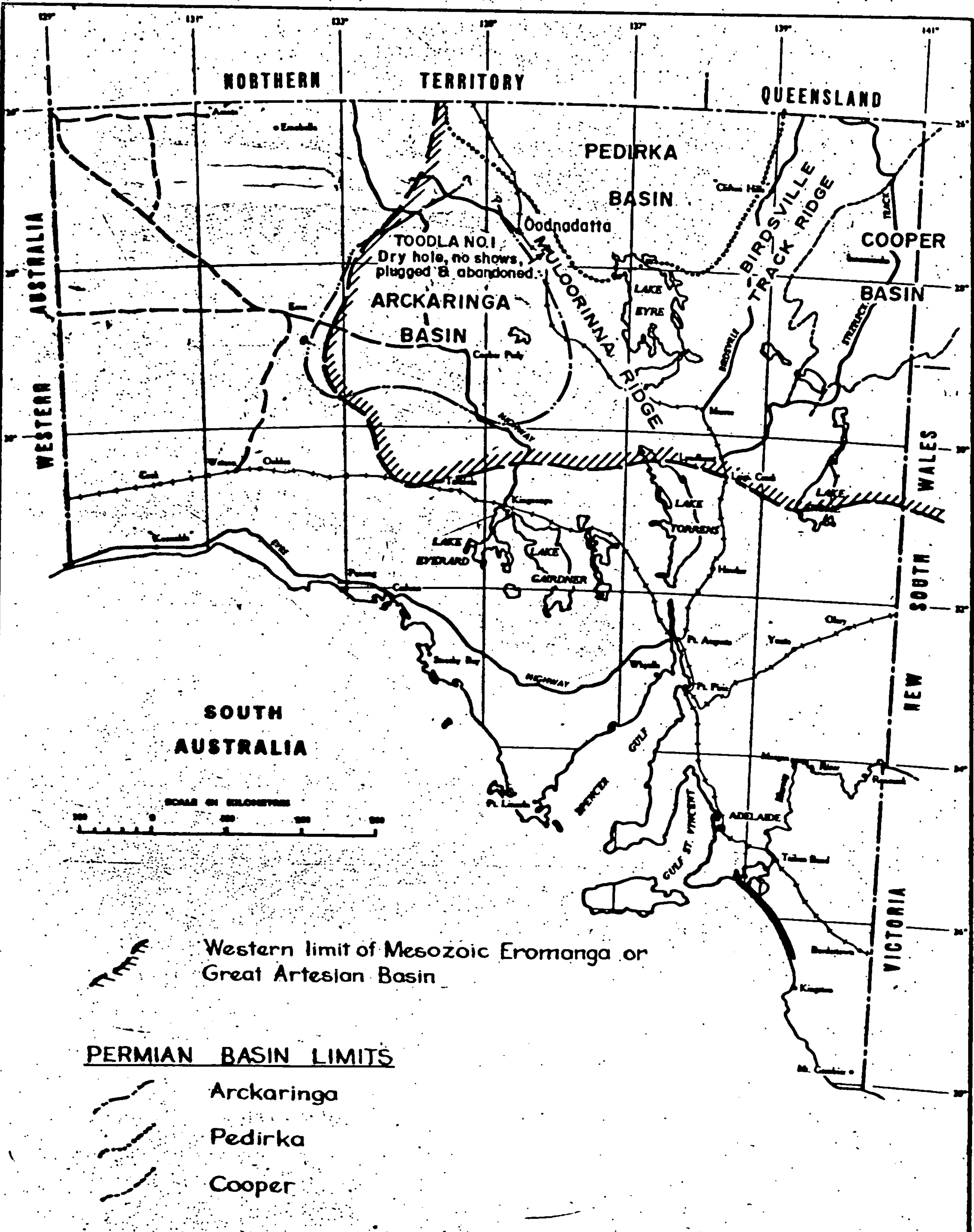


Fig. 1

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

TOODLA NO.1 WELL COMPLETION REPORT

GENERAL LOCALITY PLAN &
APPROXIMATE BASIN LIMITS

COMPILED M.C.	C.D.O. 16·3·81 DATE
DRAWN S.R.	SCALE 1:7500 000
DATE 27/10/80	PLAN NUMBER
CHECKED	S15190

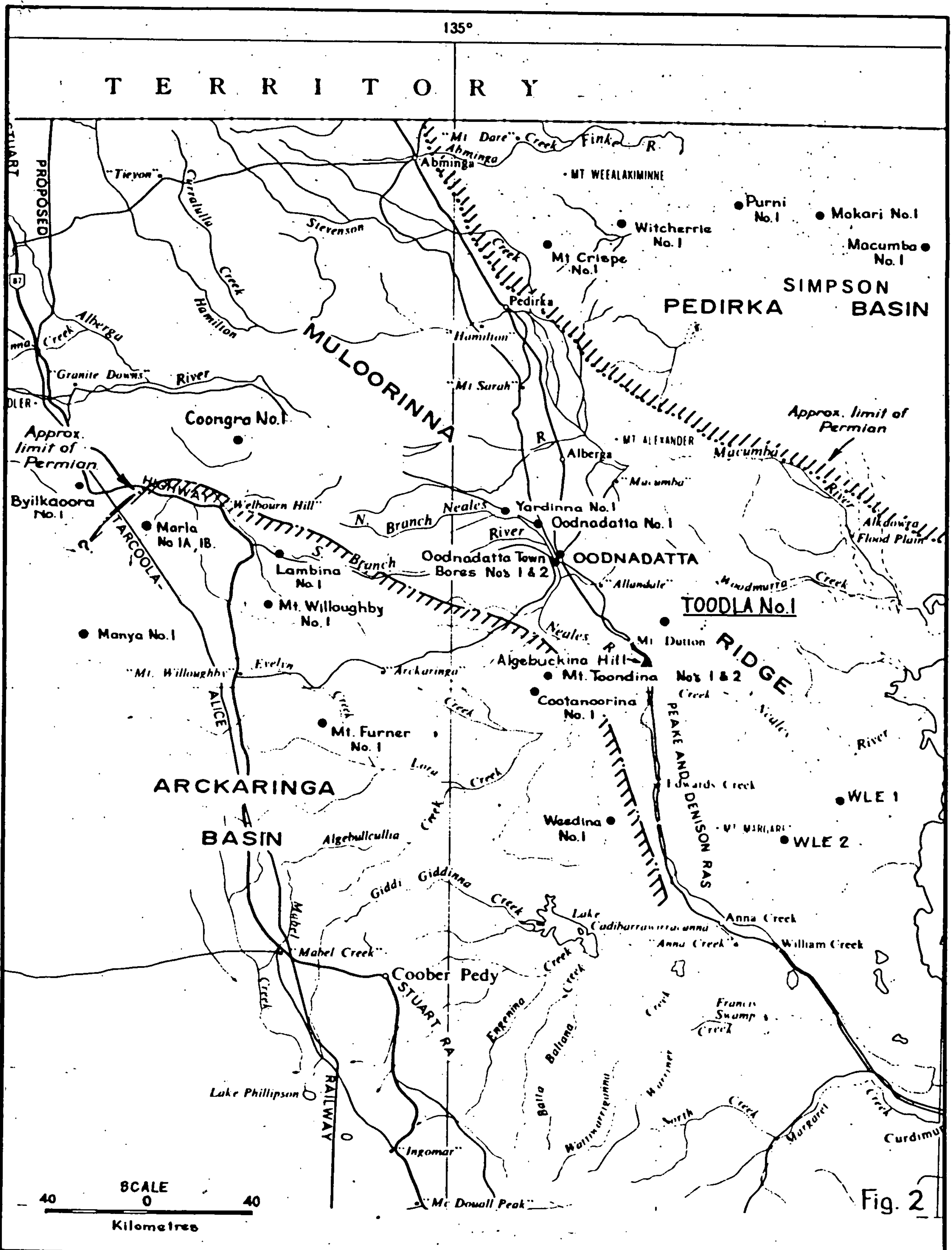


Fig. 2

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

COMPILED M.Griffiths
DRN S.R. CKD:
16-3-81 B

TOODLA NO.1 WELL COMPLETION REPORT
LOCATION OF STRATIGRAPHIC & PETROLEUM EXPLORATION WELLS

SCALE: 1 : 2,000,000
DATE: Oct. 1980
PLAN NUMBER
S15136

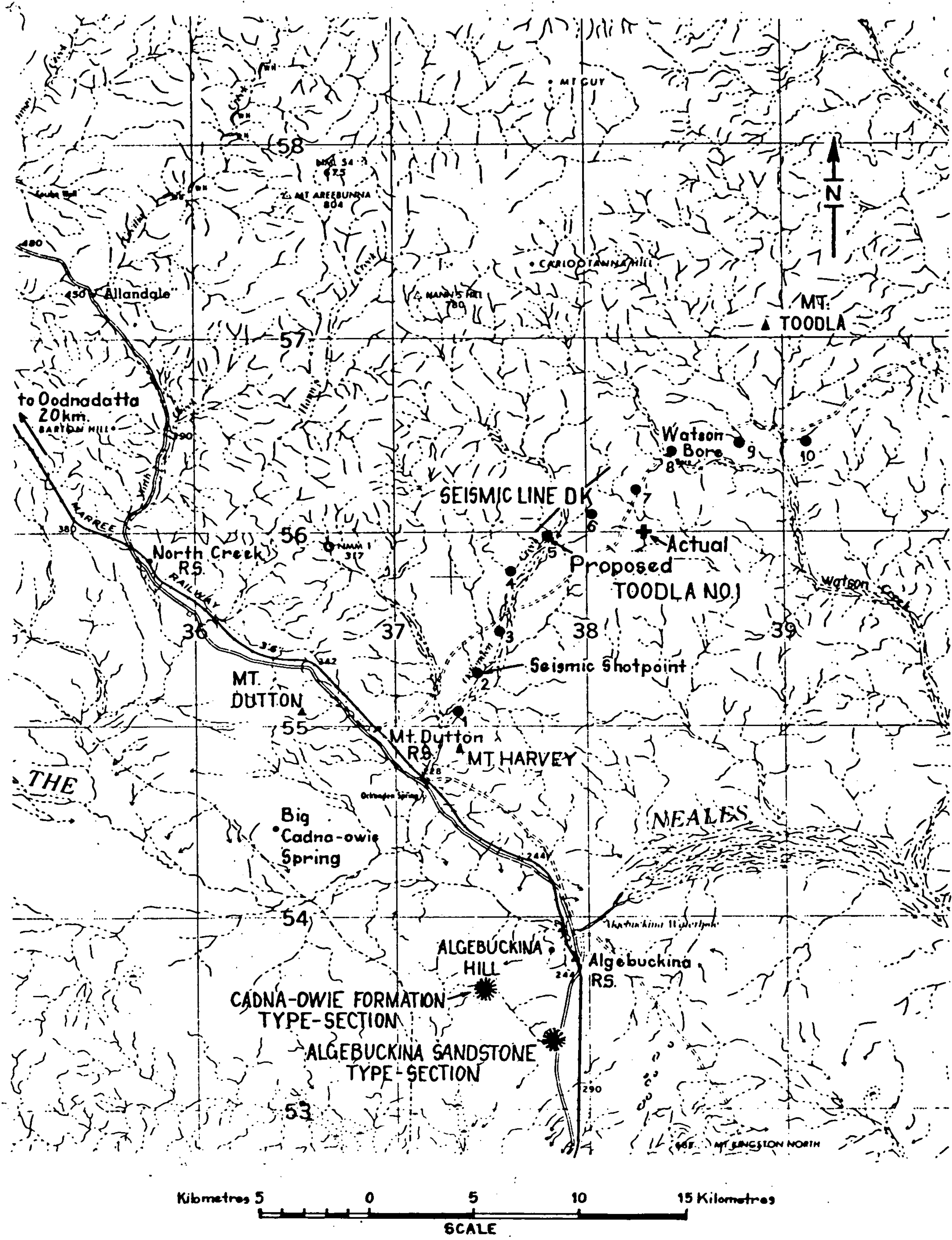


Fig. 3

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

TOODLA NO. 1 WELL COMPLETION REPORT

SEISMIC LINE DK
SHOTPOINT LOCATION PLAN

COMPILED O.J. W.B.

DRAWN G.R.

DATE 2/10/80

CHECKED

16·3·81
C.D.O. DATE

SCALE 1:250000

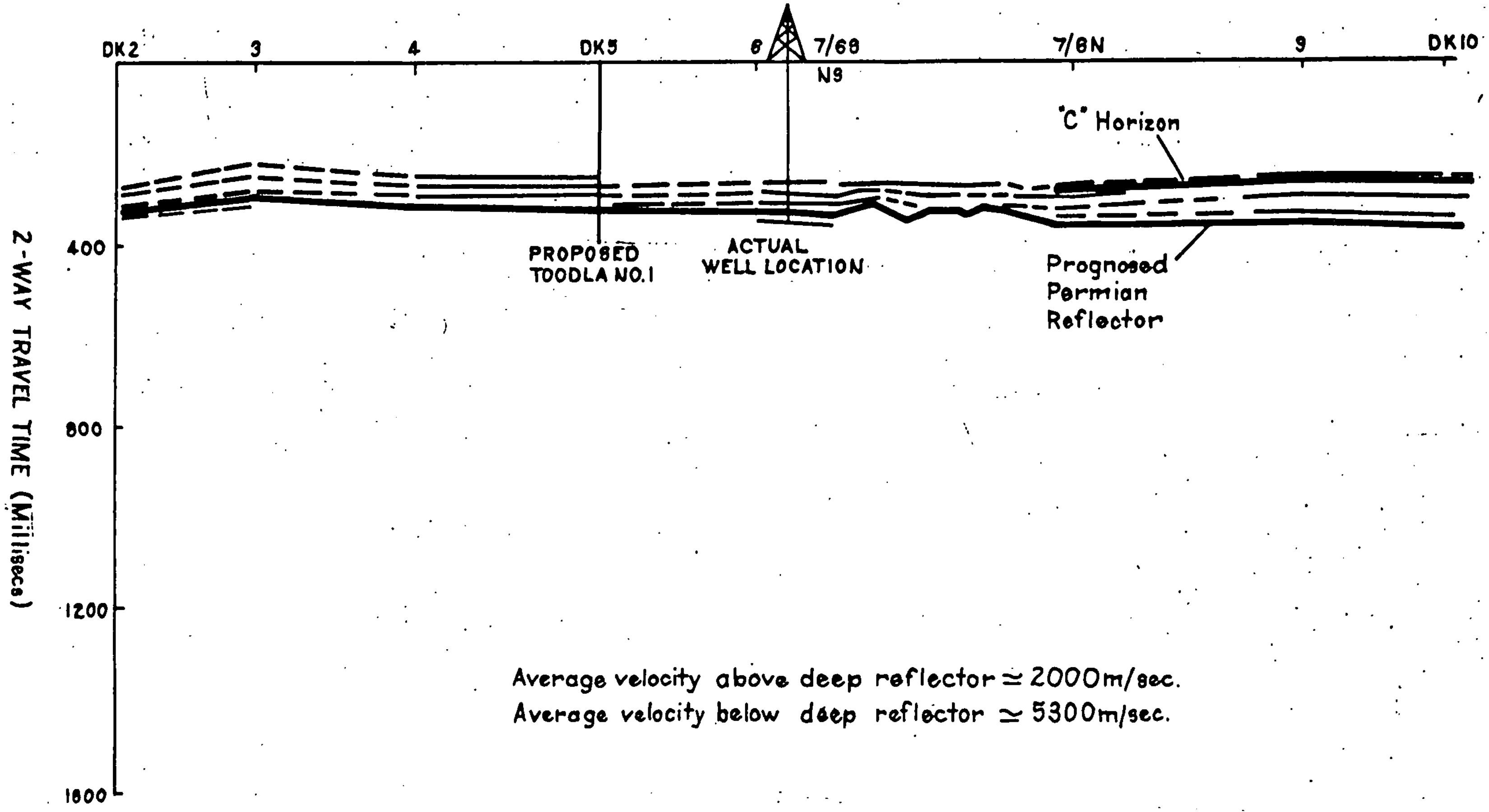
PLAN NUMBER
S15137

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

TOODLA NO. 1 WELL COMPLETION REPORT
SEISMIC LINE DK
REFLECTION TIME CROSS-SECTION

COMPILED O.J. W.B.	C.D.O. 16.3.81 DATE
DRAWN S.R.	SCALE AS SHOWN
DATE 1/10/80	PLAN NUMBER
CHECKED	S15138

Fig. 4



Average velocity above deep reflector ≃ 2000m/sec.
Average velocity below deep reflector ≃ 5300m/sec.

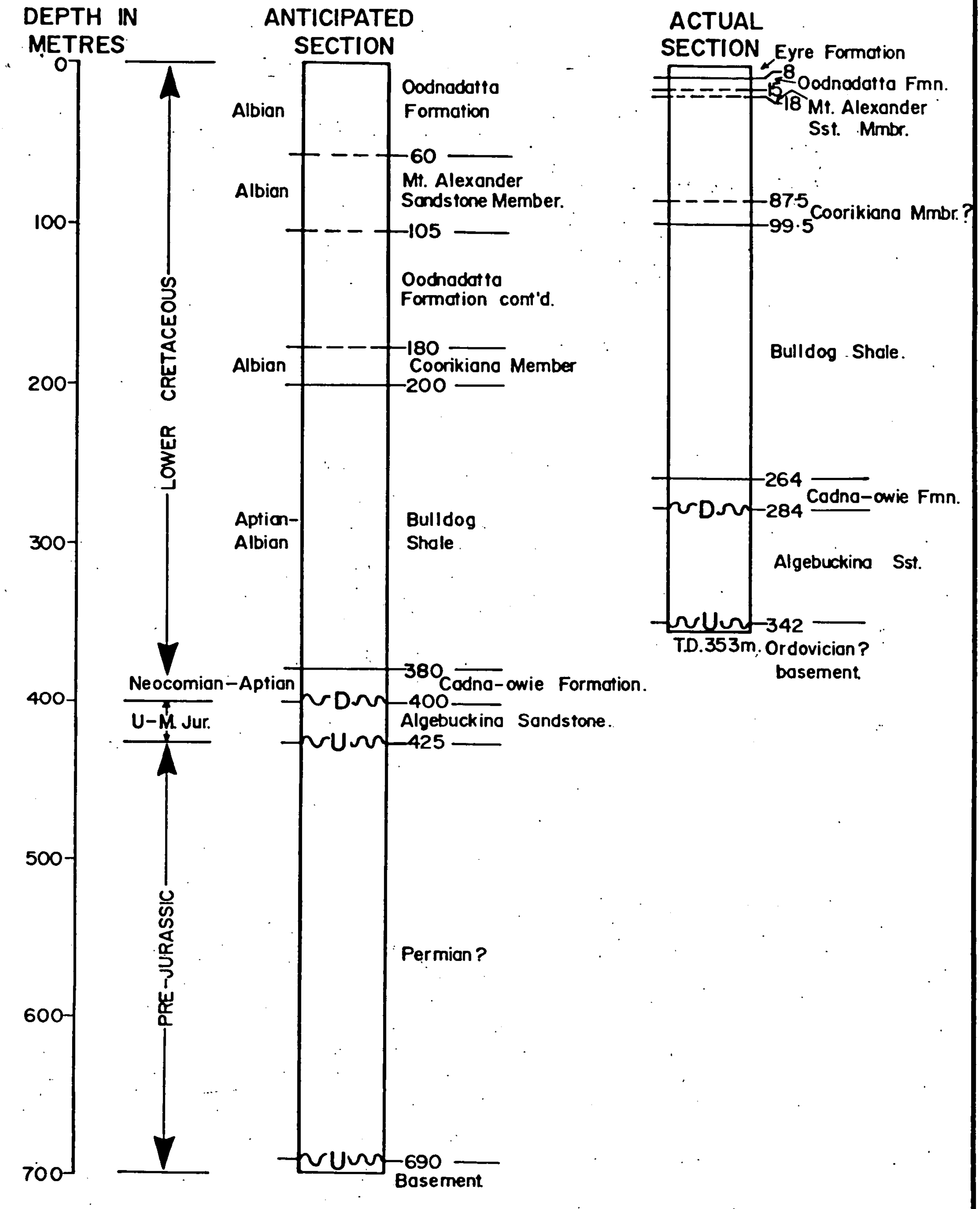
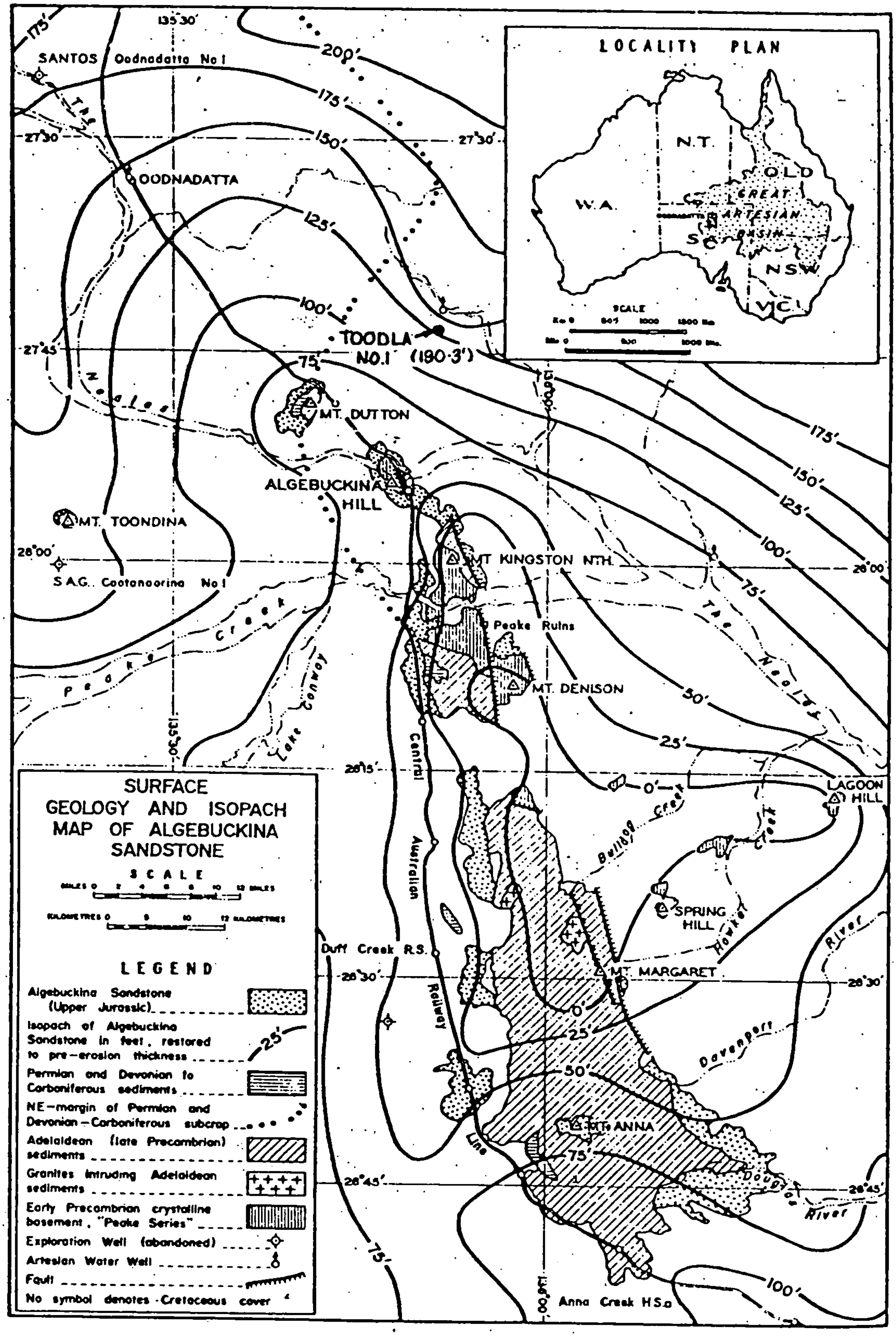


FIG. 5

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

TOODLA NO. 1 WELL COMPLETION REPORT
COMPARISON OF ANTICIPATED AND ACTUAL SECTIONS

COMPILED M.G.	C.D.O.	DATE 16·3·81
DRAWN S.R.	SCALE	
DATE 10/4/80	PLAN NUMBER S14758	
CHECKED		



The Algebuckina Sandstone isopach map shown above was compiled prior to 1970 from outcrop and well data, supplemented by the results of reflection and refraction seismic surveys carried out by the Geological Survey of South Australia.

After Wopfner et.al. (1970), A.A.P.G. Bull. 54, p.383-416, (Fig.1)

Fig. 6

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

TOODLA NO. 1 WELL COMPLETION REPORT

SURFACE GEOLOGY AND ISOPACH MAP OF ALGEBUCKINA SANDSTONE

COMPILED M.B.
DRAWN S.R.
DATE 17/10/80
CHECKED
16·3·81
CDO DATE
SCALE As shown
PLAN NUMBER
S15150

FIG.7

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

TOODLA NO.1 WELL COMPLETION REPORT

CORRELATION SECTION

COMPILED M.G.
DRAWN S.R.
DATE 21/5/80
CHECKED
B 16·3·81
C.D.O. DATE
SCALE Ver. 1:500 000
Hor. 1:2000
PLAN NUMBER
80–305

DEPARTMENT OF MINES AND ENERGY—SOUTH AUSTRALIA

TOODLA NO. 1

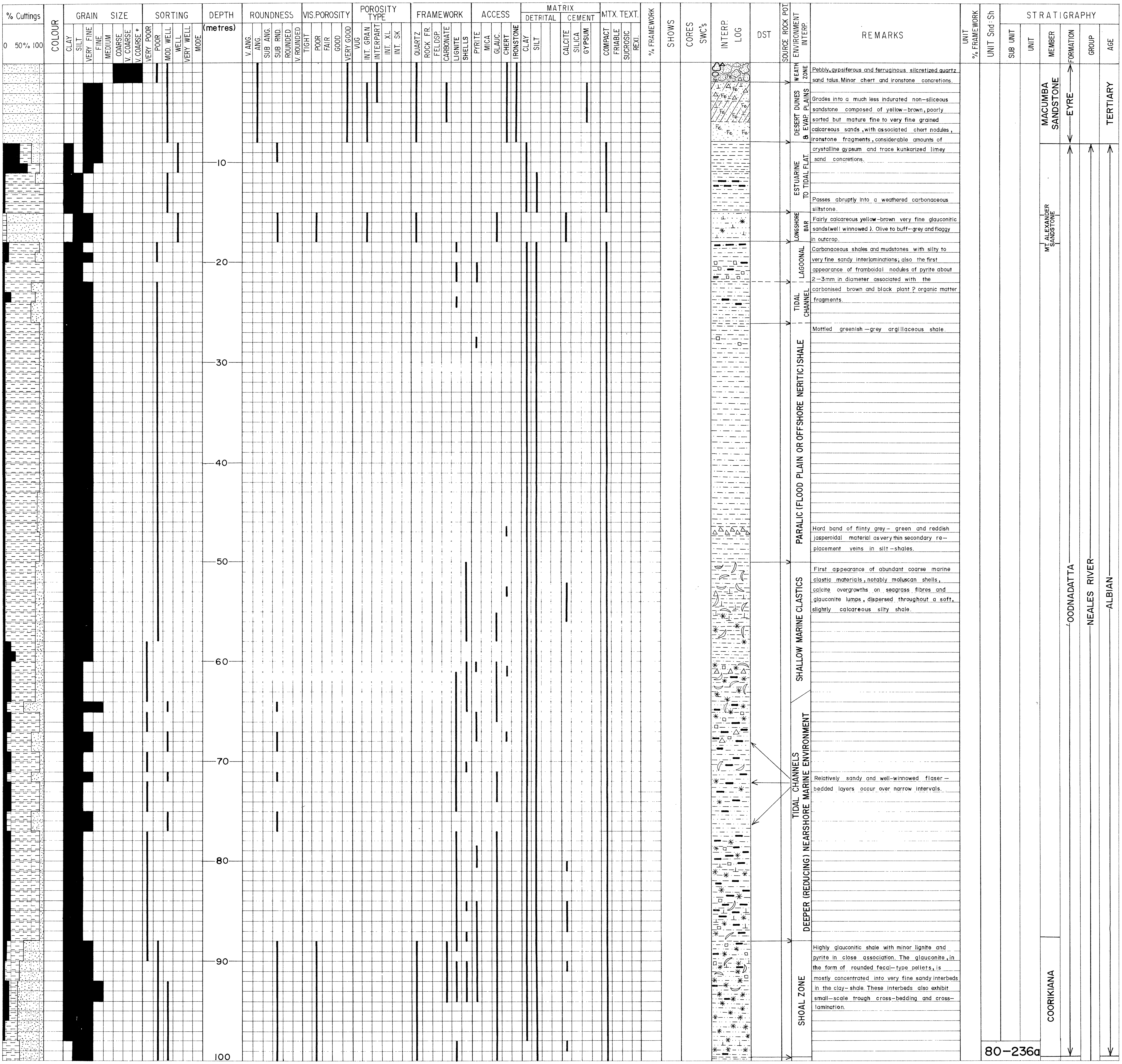
COMPOSITE WELL LOG.

MF 78

DEPARTMENT OF MINES AND ENERGY-SOUTH AUSTRALIA

CLASTIC LITHOFACIES DATA SHEET (A) DRILL CUTTINGS

WELL COMPANY / NAME / NO. TOODLA No 1 KB 1metre GEI. 96·65metres LOGGER / DATE M. GRIFFITHS DEPTH FROM SURFACE TO 100 metres



Pebbly, gypsiferous and ferruginous silcretized quartz sand talus. Minor chert and ironstone concretions.

Grades into a much less indurated non–siliceous sandstone composed of yellow–brown, poorly sorted but mature fine to very fine grained calcareous sands, with associated chert nodules, ironstone fragments, considerable amounts of crystalline gypsum and trace kunkarized limey sand concretions.

Passes abruptly into a weathered carbonaceous siltstone.

Fairly calcareous yellow–brown very fine glauconitic sands (well winnowed). Olive to buff–grey and flaggy in outcrop.

Carbonaceous shales and mudstones with silty to very fine sandy interlaminations; also the first appearance of framboidal nodules of pyrite about 2–3mm in diameter associated with the carbonised brown and black plant ? organic matter fragments.

Mottled greenish – grey argillaceous shale.

Hard band of flinty grey – green and reddish jasperoidal material as very thin secondary replacement veins in silt – shales.

First appearance of abundant coarse marine clastic materials, notably molluscan shells, calcite overgrowths on seagrass fibres and glauconite lumps, dispersed throughout a soft, slightly calcareous silty shale.

Relatively sandy and well–winnowed flaser–bedded layers occur over narrow intervals.

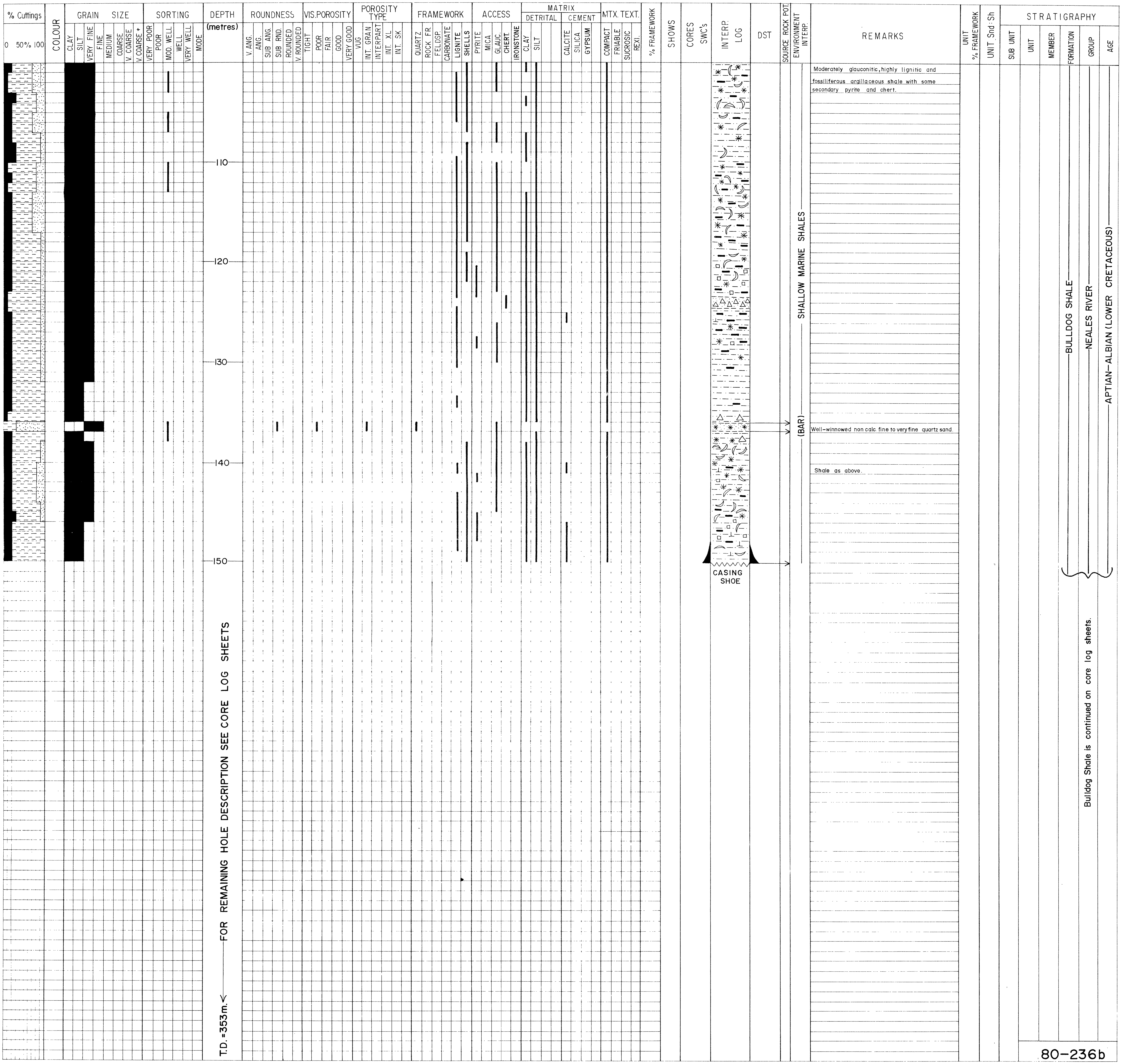
Highly glauconitic shale with minor lignite and pyrite in close association. The glauconite, in the form of rounded fecal–type pellets, is mostly concentrated into very fine sandy interbeds in the clay–shale. These interbeds also exhibit small–scale trough cross–bedding and cross–lamination.

DEPARTMENT OF MINES AND ENERGY-SOUTH AUSTRALIA

MF 78

CLASTIC LITHOFACIES DATA SHEET (A) DRILL CUTTINGS

WELL COMPANY/NAME/NO. TOODLA No 1 KB SURFACE GEI. LOGGER/DATE M. GRIFFITHS DEPTH FROM 100 TO 150 metres



Moderately glauconitic, highly lignitic and fossiliferous argillaceous shale with some secondary pyrite and chert.

Well-winnowed non calc. fine to very fine quartz sand.

Shale as above.

T.D. = 353m. ← FOR REMAINING HOLE DESCRIPTION SEE CORE LOG SHEETS

Bulldog Shale is continued on core log sheets.

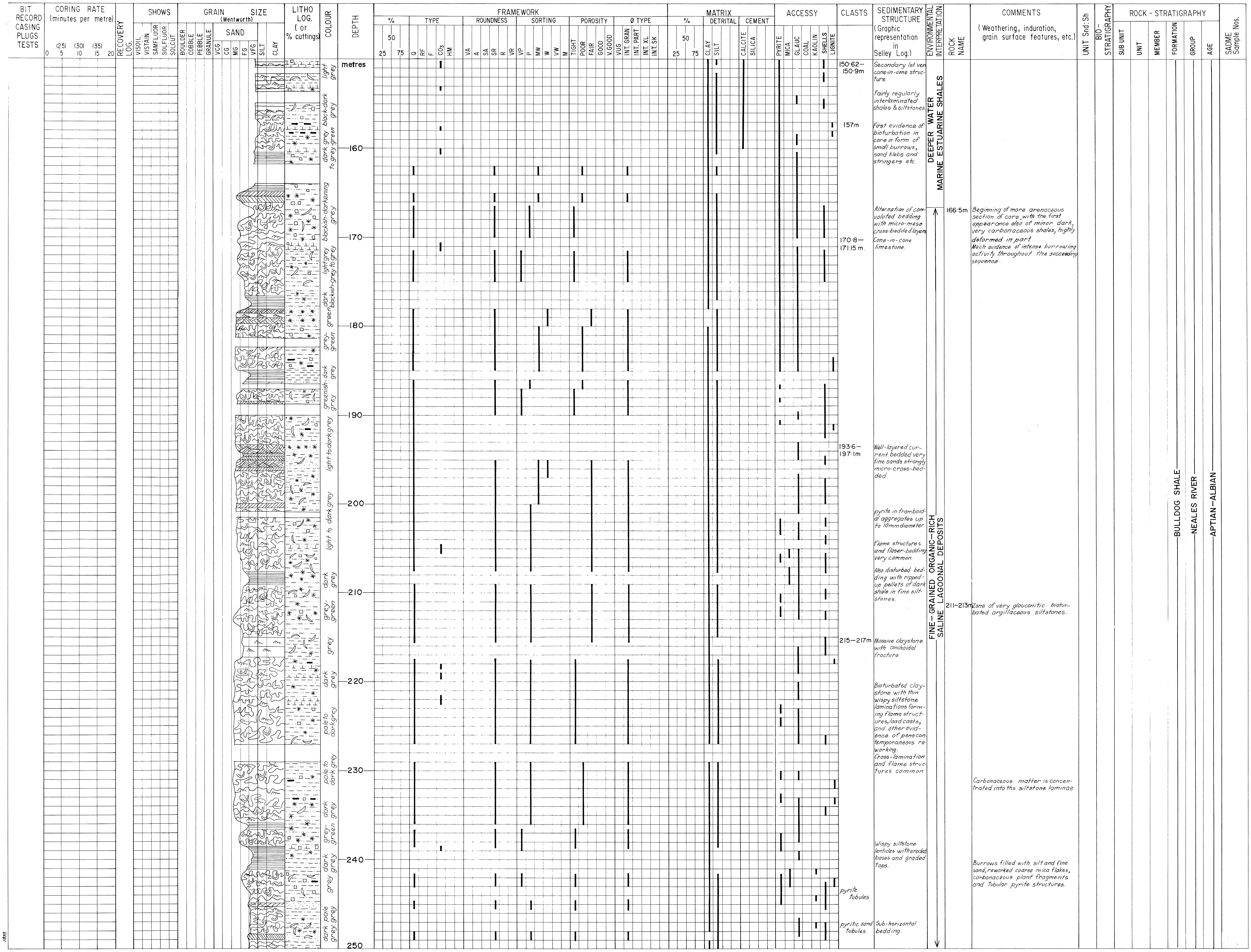
80-236b

DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA

CORE LOG (metric)

WELL NAME / NO. TOODLA No1
LAT. 27°43'47"S
I-MILE SHEET ALGEBUCKINA
LOGGER/DATE M. GRIFFITHS
K.B. SURFACE
SPUD DATE 13/9/79
T.D. (DRILLER) 353 metres

PROJECT EROMANGA BASIN STUDY
LONG. 135°50'55"E
4-MILE SHEET OODNADATTA
DEPTH INTERVAL 150—250 metres
GROUND EL. 96·66mASL
COMPLETION DATE 9/11/79
T.D. (LOGGER) 353 metres



150·62—150·9m — *Secondary lst. vein cone-in-cone structure.*

Fairly regularly interlaminated shales & siltstones.

157m — *First evidence of bioturbation in core in form of small burrows, sand blebs and stringers etc.*

Alternation of convoluted bedding with micro-meso cross-bedded layers

166·5m — *Beginning of more arenaceous section of core, with the first appearance also of minor dark, very carbonaceous shales, highly deformed in part.*
Much evidence of intense burrowing activity throughout the succeeding sequence.

170·8—171·15 m. — *Cone-in-cone limestone.*

193·6—197·1m — *Well-layered current bedded very fine sands strongly micro-cross-bedded.*

pyrite in framboidal aggregates up to 10mm diameter.

Flame structures and flaser-bedding very common.

Also disturbed bedding with ripped-up pellets of dark shale in fine siltstones.

211–213m — *Zone of very glauconitic bioturbated argillaceous siltstones.*

215—217m — *Massive claystone with conchoidal fracture.*

Bioturbated claystone with thin wispy siltstone laminations forming flame structures, load casts, and other evidence of penecontemporaneous reworking.
Cross-lamination and flame structures common.

Carbonaceous matter is concentrated into the siltstone laminae.

Wispy siltstone lenticles with eroded bases and graded tops.

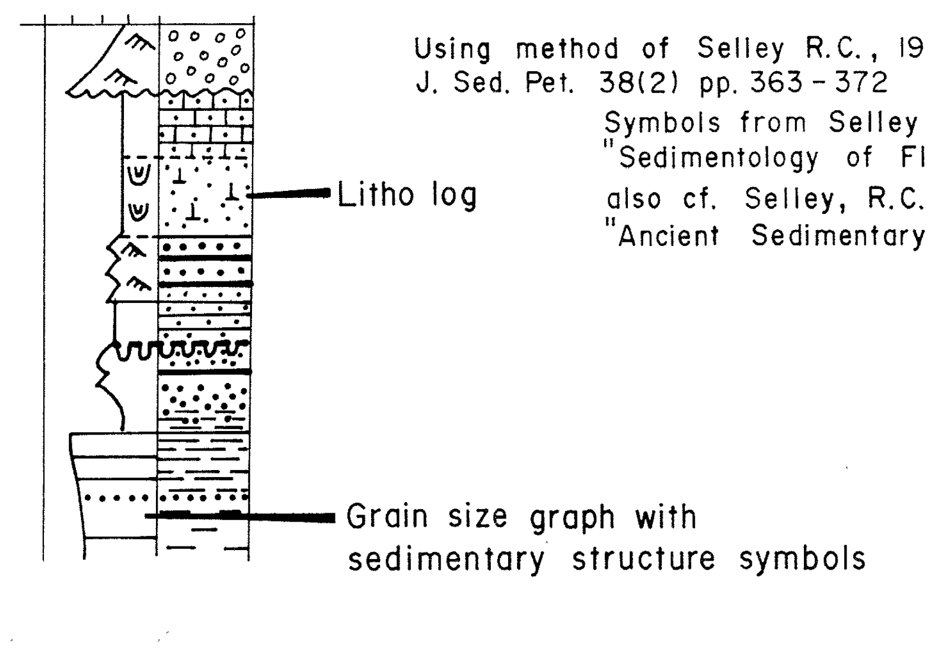
Burrows filled with silt and fine sand, reworked coarse mica flakes, carbonaceous plant fragments and tubular pyrite structures.

pyrite tubules

pyritic sand tubules — *Sub-horizontal bedding.*

80--237a

REFERENCE FOR GRAIN SIZE AND LITHO LOG.



Using method of Selley R.C., 1968
J. Sed. Pet. 38(2) pp. 363 - 372
Symbols from Selley or Bouma A.H., 1962
"Sedimentology of Flysch Deposits" (Elsevier)
also cf. Selley, R.C. (1978)
"Ancient Sedimentary Environments" (2nd ed.) (Chapman & Hall)

Colour: use the G.S.A. Rock Colour Chart based on the Munsell System.

Sedimentary Structures: use column for written details, place symbol in grain size column.

Framework Type: Q = quartz RF = rock fragments F = feldspar CO_3 = carbonate HM = heavy minerals.

Roundness: using Power's scale.
V.A. = very angular A = angular S.A. = sub - angular S.R. = sub - rounded R = rounded V.R. = very rounded

Sorting: based on Folk, R. (1968) "Petrology of Sedimentary Rocks." (Hemphill's) pp. 103-105
V.P. = very poor P = poor M.W. = moderately well W = well sorted V.W. = very well sorted M = modal sorting

Porosity Type: state whether pores are interconnected or not.

SHEET NO. 1 OF 2

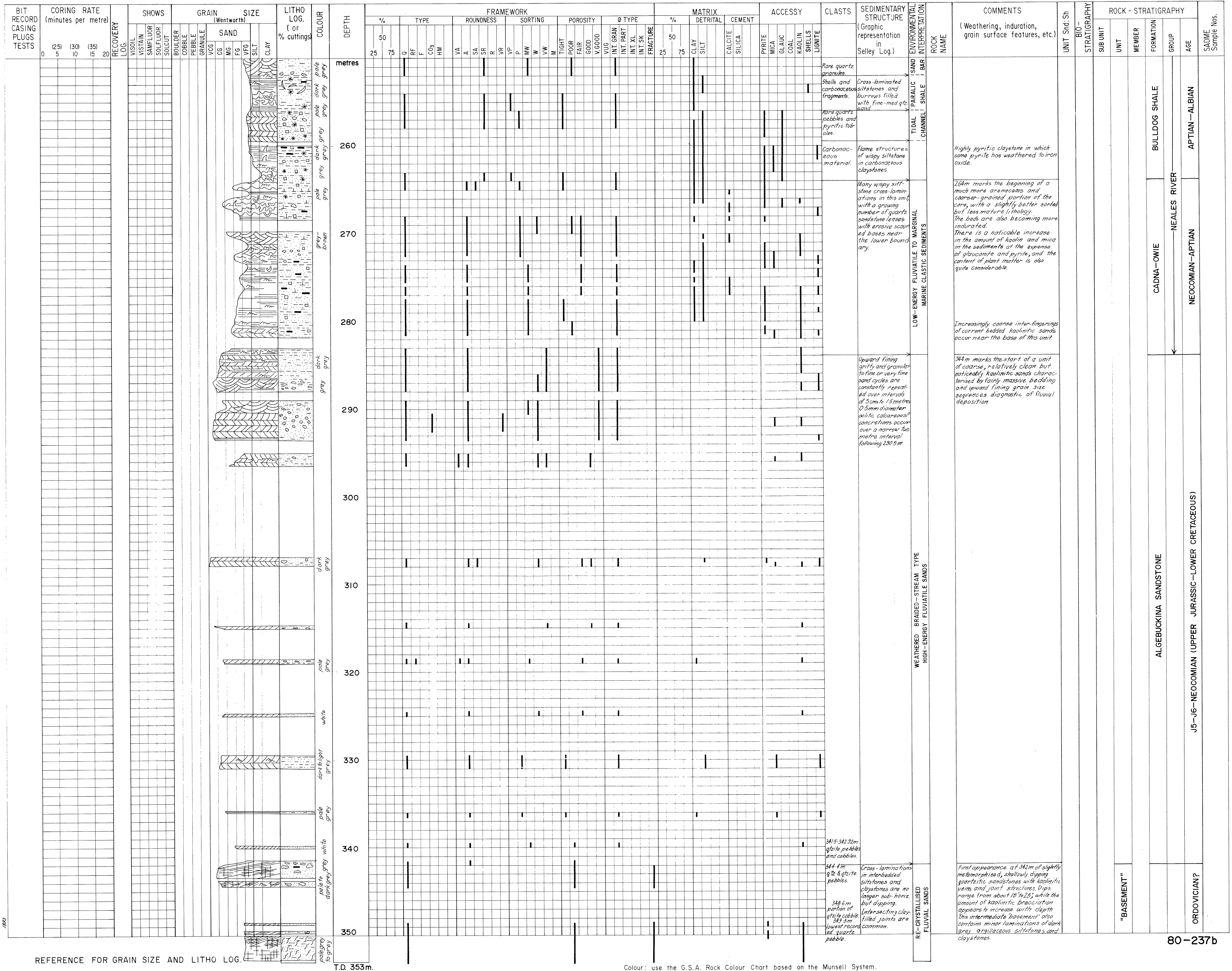
DEPARTMENT OF MINES AND ENERGY - SOUTH AUSTRALIA

MF 93

CORE LOG (metric)

WELL NAME / NO. TOODLA No 1
LAT. 27°43'47"S
1-MILE SHEET ALGEBUCKINA
LOGGER/DATE M.GRIFFITHS
K.B. SURFACE
SPUD DATE 13/9/79
T.D. (DRILLER) 353metres

PROJECT EROMANGA BASIN STUDY
LONG. 135°50'55"E
4-MILE SHEET OODNADATTA
DEPTH INTERVAL 250—353 metres
GROUND EL. 96·66m AGL
COMPLETION DATE 9/11/79
T.D. (LOGGER) 353metres



Rare quartz granules.

Shells and carbonaceous fragments.

Cross-laminated siltstones and burrows filled with fine-med. qtz. sand.

Rare quartz pebbles and pyritic tubules.

Carbonaceous material.

Flame structures of wispy siltstone in carbonaceous claystones.

Highly pyritic claystone in which some pyrite has weathered to iron oxide.

Many wispy siltstone cross-laminations in this unit, with a growing number of quartz sandstone lenses with erosive scoured bases near the lower boundary.

264m marks the beginning of a much more arenaceous and coarser-grained portion of the core, with a slightly better sorted but less mature lithology.
The beds are also becoming more indurated.
There is a noticable increase in the amount of kaolin and mica in the sediments at the expense of glauconite and pyrite, and the content of plant matter is also quite considerable.

Increasingly coarse inter-fingerings of current bedded kaolinitic sands occur near the base of this unit.

Upward fining gritty and granular to fine or very fine sand cycles are constantly repeated over intervals of 5cms to 1·5 metres. 0·5mm diameter oolitic calcareous? concretions occur over a narrow two metre interval following 290·5m.

344m marks the start of a unit of coarse, relatively clean but noticeably kaolinitic sands characterised by fairly massive bedding and upward fining grain size sequences diagnostic of fluvial deposition.

341·5-342·92m qtzite pebbles and cobbles.

344·4m qtz & qtzite pebbles.

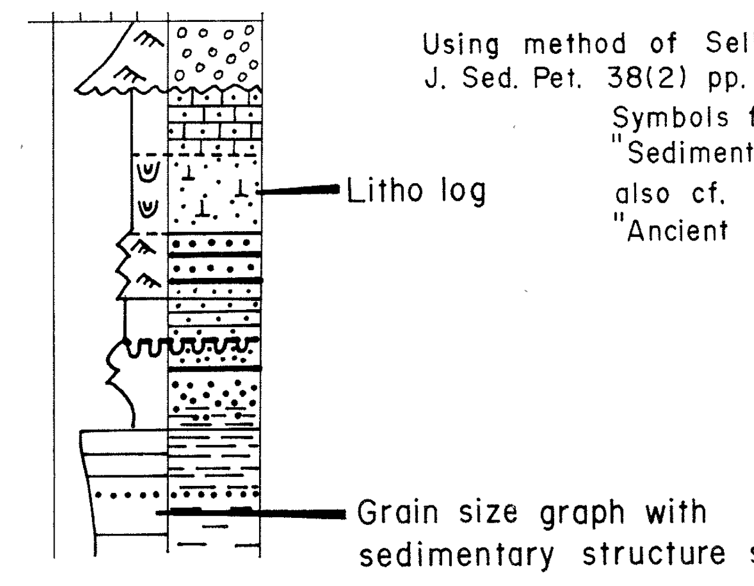
348·6m portion of qtzite cobble.
349·5m lowest recorded quartz pebble.

Cross-laminations in interbedded siltstones and claystones are no longer sub-horiz. but dipping.
Intersecting clay-filled joints are common.

First appearance at 342m of slightly metamorphised, shallowly dipping quartzitic sandstones with kaolinitic veins and joint structures. Dips range from about 15° to 25°; while the amount of kaolinitic brecciation appears to increase with depth. This intermediate "basement" also contains minor laminations of dark grey argillaceous siltstones and claystones.

80-237b

REFERENCE FOR GRAIN SIZE AND LITHO LOG.



Using method of Selley R.C., 1968
J. Sed. Pet. 38(2) pp. 363-372
Symbols from Selley or Bouma A.H., 1962
"Sedimentology of Flysch Deposits" (Elsevier)
also cf. Selley, R.C. (1978)
"Ancient Sedimentary Environments" (2nd ed.) (Chapman & Hall)

Colour: use the G.S.A. Rock Colour Chart based on the Munsell System.

Sedimentary Structures: use column for written details, place symbol in grain size column.

Framework Type: Q = quartz   RF = rock fragments   F = feldspar CO_3 = carbonate   HM = heavy minerals.

Roundness: using Power's scale.
V.A. = very angular   A = angular   S.A. = sub-angular   S.R. = sub-rounded   R = rounded   V.R. = very rounded

Sorting: based on Folk, R. (1968) "Petrology of Sedimentary Rocks." (Hemphill's) pp. 103-105
V.P. = very poor   P = poor   M.W. = moderately well   W = well sorted   V.W. = very well sorted   M = modal sorting

Porosity Type: state whether pores are interconnected or not.

SHEET NO. 2 OF 2