DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

Rept. Bk. No. 80/22

MARLA-1A, MARLA-1B WELL COMPLETION REPORT. REPORT NO. 5 of the OFFICER BASIN STUDY GROUP.

GEOLOGICAL SURVEY

By

M.C. BENBOW

MAY, 1980.

D.M. No. 271/79

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DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

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MARLA-1A, MARLA-1B WELL COMPLETION REPORT. REPORT NO. 5 of the OFFICER BASIN STUDY GROUP.

SUMMARY

SADME Marla-1A and -1B were drilled 15 m apart near the northeastern outcrop margin of the Officer Basin, 30 km south-east of SADME Byilkaoora-1 (Fig. 1). The principal objective was to further assess the petroleum generating potential of the Observatory Hill Beds which had produced oil shows in Byilkaoora-1 and were known to underlie the Great Artesian Basin in an earlier well, SADME Marla-1 (Thornton, 1975).

Marla-1A and -1B reached total depths of 215.30m and 379.40m respectively. Both wells penetrated a thin veneer of aeolian sand of the Great Victoria Desert, overlying sediments of the Great Artesian Basin (Bulldog Shale and Cadna-owie Formation) and the Observatory Hill Beds of the Officer Basin. Marla-1A and -1B intersected 132.2m and 296.4m of Observatory Hill Beds respectively, comprised of laminated and non-laminated limestones and dolomites (sandy, silty and clayey in part, and calcitic in part), dolomitic calcareous sandstones and intraclastic dolomite. Limestone with traces of fluorspar predomina tes in the upper 90 m with burrowed dolomite in the lower 200 m. Very thin black organic laminae are common in the lower carbonates. Traces of pyrite, celestite and minor chert occur throughout.

The Observatory Hill Beds intersected in Marla-1A and -1B are very different from those intersected in Byilkaoora-1. Conspicuous in the latter and absent in the former are oil shows and calcite pseudomorphs after evaporite minerals

(shortite and trona). Furthermore the Byilkaoora-1 intersection may be divided into five units, which contrasts with the two-fold stratigraphic subdivision recognised here for Marla-1A and -1B.

A playa lake model has been proposed for Byilkaoora-1, but a marine environment of deposition is suggested here for the Marla-1A and -1B carbonates; a northeast oriented low lying land barrier may have separated the two areas.

INTRODUCTION

In 1978 SADME Wilkinson-1, drilled on the southeastern margin of the Officer Basin (Fig. 1), intersected a sequence of carbonates (Gatehouse, 1979) with excellent source rock potential for hydrocarbons (McKirdy, 1979; Kantsler, 1979). These carbonates are part of the Observatory Hill Beds (Wopfner, 1969), considered Early Cambrian in age at Wilkinson-1 (Muir in Gatehouse, 1979). Byilkaoora-1 subsequently was drilled in May-July 1979 by SADME to assess the petroleum-generating potential and to gain a complete stratigraphic section of the Observatory Hill Beds on the northeastern margin of the Officer Basin. In Byilkaoora-1 significant hydrocarbon shows were discovered: a range of oil types bled from calcite veins and vugs in a carbonaceous carbonate/siltstone sequence (Benbow and Pitt, 1979). Furthermore, sulphides are ubiquitous in this sequence (including chalcopyrite and sphalerite), and a thick accumulation of evaporite-related sediments contains calcite pseudomorphs after minerals that include shortite and trona.

As a consequence of Byilkaoora-1, Cambrian sediments in the eastern Officer Basin have assumed an increased significance in hydrocarbon, evaporite and metallic minerals search.

Marla-1 had been drilled in 1974, approximately 30 km southeast of Byilkaoora-1, to identify the high speed seismic refractor computed to be at about 135 m. Here the depth to magnetic basement was computed at more than 1000 m below surface (Thornton, 1975). Dolomites, dolomitic siltstones and limestones were intersected between 83.0 m and 106.0 m (T.D.) and these were considered to belong to the Observatory Hill Beds. Early Cambrian trilobites were found in this interval (J. Jago, Appendix V). Marla-1A and -1B were subsequently drilled to extend the section seen in Marla-1 and to further test the petroleum generating potential of the Observatory Hill Beds of the eastern Officer Basin.

DRILLING SUMMARY

Marla-1A was spudded on 24th July 1979 and reached a total depth of 215.3m on 14th August 1979. It was abandoned prior to the proposed T.D. of 700 m, with no circulation established, because of stuck rods (to avoid organic contamination, no mud or lubricant additives were used).

Marla-1B, positioned 15 m north of Marla-1A, was also planned to drill to 700m. Marla-1B was spudded on 14th September 1979 and was abandoned on 9th October 1979 at 379.4m when severe mechanical problems with the rig required an extensive overhaul.

Cuttings were taken at 3m intervals during rotary drilling from surface to 83.1m (Marla-1A) and 83.0m (Marla-1B). For Marla-1A continuous NQ coring commenced at 83.1m and continued to 215.3m. Core recovery was 100%. For Marla-1B HQ coring commenced at 83 m and continued to 230.1m. NQ coring continued to the total depth of 379.4m. Core recovery again was 100%.

WELL HISTORY

Well Data

Well Name and Number

South Australian Department of Mines and Energy

Marla-1A and -1B.

DME Bore Nos. 5643000SW000 31 (1A)

5643000SW000 32 (1B)

Location

Marla-1A

Latitude 27° 27' 51"

Longitude 133° 44' 59"

Marla-1B is 15 m north of Marla-1A and 15 m east of Marla-1 (sited at seismic shotpoint EH 222).

Access

By survey track approximately 1 km east of and parallel to the Tarcoola-Alice Springs Railway line, 23 km south of Marla.

Map Reference

1:250 000 WINTINNA

1:100 000 Marla (5643).

Elevation

Both wells:

284.5 m	Natural Surface
284.8 m	Top of casing
285.2 m	Approx. platform level.

Total Depth

Marla-1A 215.3m

Marla-1B 379.4m.

	Marla-1A	Marla-1B
Date Drilling Commenced:	24.7.79	14.9.79
Date Drilling Terminated:	14.8.79	8.10.79
Actual Drilling Time:	15 days	19 days
Date Well Terminated:	14.8.79	9.10.79
Date Rig Released:	14.8.79	9.10.79

Status: Dry and abandoned.

Drilling Data

Name and address of Drilling Contractor

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

Drilling Rig

Make: Mindrill

Type: 10L

Rated Capacity: 500 m using NQ rods; 800 m using BQ rods.

Motor: Lombardine, 4 cylinder Diesel, 48 HP @ 3000 RPM.

Mast

Make: Mindrill

Type: Swivell

Rated Capacity: -

Pump

Make: John Bean Triplex

Type: Model 435

Size: 2 3/4" stroke, 2 3/4" bore.

Motor: Pedders, Model TH2

Power Rating: 16.4HP, 400psi continuous, 800psi discontinuous.

Hole Dimensions

Marla-1A		Marla-1B	
0-83.1 m	114.30mm	0-83 m	140mm
83.1-215.3 m	NQ	83-230.1 m	HQ
		230.1-379.4 m	NQ

Casing and Cementing Details

Marla-1A

Size	Grade	Depth
80mm	steel pipe with Q Series thread	0-83.1m

Marla-1B

Size	Grade	Depth
100mm	screwed and socketed	0-83.0 m
80mm	black pipe	
	steel pipe	0-230.1 m left in hole.

Bit Records

Marla-1A

1 used 114.30mm (4½") Varel 3 core Rock Bit. V2 Regular. From 4.84m to 21.00m

1 new " " " " " " " " " " " 21.00m to 83.10m

1 used 158.75mm (6¼") " " " " " " " " " 0m to 4.84m.

2 only NQ 75.8mm Reamer Shells diamond set Mindrill from 83.10m

2 only NQ 75.8mm Core bits multi-step diamond set Mindrill to 215.30m

1 x 152.4mm (6") casing sawtooth bit Ream over stuck 5" casing to 4.84m

1 x 130.175m ($5^{1}/8$") PQ tungsten shoe bit remaining over 3" pipe from 4.84m to 20.00m

3 x 122.81mm ($4^{58}/64$") PQ shoe bits diamond set Mindrill ream over 3" pipe from 20 to 83.12m.

3 x 91.82mm ($3\ ^{5}/8$") NX casing shoe bits diamond set Mindrill ream over stuck NQ rods

1 x 91.82mm ($3\ ^{5}/8$") HQ rod shoe bit diamond set Mindrill from 83.12m to 129.32m.

Marla-1B

1 x used (165-100mm) 6½" Varel 3 core Roller Bit V3 Regular. From 0m to 3.00m.

1 x used (139-700mm) 5½" " " " " " V2 " " 3m to 30.00m

1 x new " " " " " " " " V2 " " 30m to 83.00m

1 used HQ Reamer shell 96mm. Diamond Set Mindrill from 83.00m.

2 new HQ Core Bits 96m Multi Step " " " to 230.11m

1 used NQ 75.8mm Reamer shell Diamond set Mindrill From 230.11

1 new NQ 75.8mm Core Bit Multi-Step Diamond set Mindrill to 379.40m

Drilling Fluids Used

Marla-1A

Surface to 83.1m.	Baroid Aquagel high yield bentonite 25 kgs per 900 litres Water. 6 sacks used.
83.10m to 129.32m.	Baroid Aquagel Opened out hole after 3 sacks used. Reaming over stuck Drill Pipe. Same mix as above.
83.10m to 215.30m	NQ Coring. Straight water no additives.

Marla-1B

Surface to 83.00m	Baroid Aquagel high yield bentonite 25 Kgs per 900 litres water. 6 sacks used.
83m to 379.40m	Romud/Ro-plate 2.25 litres per 450 litres water 150 litres Ro-plate used.

Water Supply

Drilling water was obtained from nearby railway cuts, filled after recent rains.

TABLE 1

SUMMARY OF STRATIGRAPHY OF MARLA-1A AND-1B

AGE	FORMATION	DEPTH, TOP OF UNIT (m)		THICKNESS (m)	
		Marla-1A	Marla-1B	Marla-1A	Marla-1B
Quaternary	Aeolian sands	0.0	0.0	3.0	3.0
Early Cretaceous	Bulldog Shale	3.0	3.0	50.0	50.0
	Cadna-owie Formation	53.0	53.0	30.1	30.0
Early Cambrian	Observatory Hill Beds	83.1	83.0	132.2+	296.4+

For a detailed description of the interval 0-83 m the reader is referred to Thornton (1975).

Formation Sampling

Cuttings. These were collected at 3-m intervals from surface to 83.1m (Marla-1A) and to 83.0m (Marla-1B).

Coring. Continuous coring commenced at 83.10m (Marla-1A) and 83.00m (Marla-1B) and finished at 215.30m (Marla-1A) and 379.40m (Marla-1B).

Water Sampling. None collected during drilling.

Electric Logs. These may be run at a later date. Logs are available for Marla-1 to TD:106.0m (Thornton, 1975).

REGIONAL GEOLOGICAL SETTING

Marla-1A and -1B are located near the northeastern margin of the Officer Basin, southeast of the Mt. Johns Range, approximately 30km southeast of Byilkaoora 1 and 30km northeast of the Ammaroodina Inlier (Figs. 1, 2).

Regional studies of the Officer Basin are contained in Krieg (1969), Krieg et al. (1976), Jackson and van de Graaff (in prep.) and Pitt et al. (1980). A review study of the South Australian part of the Officer Basin, of which study Byilkaoora-1, Marla-1A and -1B are part, is being undertaken by the Officer Basin Study Group of the S.A. Department of Mines and Energy. A final report from that Group should be available about late 1980.

Background literature to the Officer Basin in the Mt. Johns area is listed in Pitt and Youngs (1980) and discussed by Krieg (1973), who compiled results of mapping the EVERARD 1:250 000 geological sheet and described a stratigraphy for the area. Subsequent mapping of the Mt. Johns Range (Benbow and Pitt, 1979; Benbow, 1980) has enabled revision and refinement of this stratigraphy: recent mapping indicates it is possible to subdivide the Observatory Hill Beds in at least the Mt. Johns Range area.

The area largely is covered by a veneer of red aeolian sands of the Great Victoria Desert. These overlie the Tertiary Mt. Sarah Sandstone and the Cretaceous Bulldog Shale and Cadna-owie Formation which have been affected by a late Tertiary silicification and ferruginization. The subsurface Cadna-owie Formation and outcropping Bulldog Shale lie near the western margin of the Great Artesian Basin. The Permian Arckaringa Basin lies to the south and east of Marla-1A and 1B (Fig. 1).

The Early Cambrian Observatory Hill Beds of the Officer Basin crop out poorly to the north of Marla-1A and -1B, especially on the eastern margin of the Mt. Johns Range and farther west at Cartu Hill. In Byilkaoora-1 (drilled by SADME in July 1979), they are represented by a carbonaceous dolomitic sequence with interbedded and interlaminated siltstone and claystones, and may be divided into five units. Significant hydrocarbon shows were discovered where a range of oil types bled from calcite veins and vugs. Sulphides, ubiquitous in this sequence, include chalcopyrite and sphalerite. Calcite pseudomorphs after the evaporite minerals trona and shortite occur in the middle three units.

The Observatory Hill Beds overlie dolomitic conglomerates of the "Davies Bore Conglomerate".

A playa lake environment of deposition has been proposed for the Observatory Hill Beds in Byilkaoora-1 and close affinities with the Eocene Green River Formation in the U.S.A. have been suggested (White and Youngs, in press).

Manya-1 and Mt. Willoughby-1, drilled 46 km south-southwest and 60 km southeast of Marla-1 respectively, intersected dolomites with dolomitic sandstone, shale and siltstone at 146 m (Manya-1) and 624 m (Mt. Willoughby-1). Chert nodules in Mt. Willoughby-1

very tenuously suggest that these carbonates belong to the Observatory Hill Beds, although they have been described as belonging to the Devonian Cootanoorina Formation (Thornton, 1971). The carbonates of both these wells are overlain by the Permian Boorthanna Formation of the Arckaringa Basin.

WELL STRATIGRAPHY

Description of Units

Unnamed (Quaternary) Depth Interval Marla-1A Surface to 3m
Marla-1B Surface to 3m

A thin veneer of red medium to very coarse grained aeolian sands.

Bulldog Shale (Early Cretaceous) Depth Interval 3m- c.53.0m(1A)
3m- c.53.0m(1B)

Claystones of the Bulldog Shale have been ferruginized red and black and silicified in the upper 21m. Below this depth the claystones are mottled mauve pink yellow and white and are porcellanitic in part. The claystones are silty, becoming very finely sandy with depth.

Cadna-owie Formation (Early Cretaceous) Depth Interval c.53.0m-83.1m (1A)
c.53.0m-83.0m (1B)

This formation is represented by medium to coarse grained dark brown sands that lighten with depth. Quartz grains are subangular to subrounded. The sands are clayey at the base, and in Marla-1B at the top. Thornton (1975) tentatively interpreted the slightly sandy yellow clays in Marla-1 to

be Permian Boorthanna Formation. In Marla-1B for example there is 30-40% subangular to angular medium quartz in yellow brown clay, and these are here considered to belong to the highly variable Cretaceous Cadna-owie Formation.

Observatory Hill Beds (Early Cambrian) Depth Interval

1A 83.1-215.3 m (TD)

1B 83.0-379.4 m (TD)

Both wells intersected a sequence of light grey (in the uppermost part) to dark, thinly to very thinly bedded, laminated to non laminated calcareous fine grained dolomites and limestones. Limestones predominate in the upper 90 m and dolomites, burrowed in part, in the lower 200 m (Appendices II and III). Interbedded and interlaminated are fine to coarse sandstones often with intraclasts of carbonate and minor oolitic carbonate. A few stromatolitic dolomites occur within the upper limestones.

The carbonates are fine grained (0.1mm-0.3mm) and contain about 5% clay (Appendix II) or silt (Appendix III).

The sorting of sandstone is moderate to poor with a range in grain size from silt, through to granule. The larger grains especially are rounded to well rounded but the finer grains tend to be subangular to subrounded. Quartz is the major mineral component. Some of the quartz grains have an internal stressed fabric or deformation lamellae. Feldspar forms up to 20% of the fine sand, and biotite and muscovite occur in small amounts throughout. Intraclasts of carbonate range up to greater than 3cm and may be angular or elongate with rounded ends.

Graded bedding with an upward fining of sand grains, with or without a sharp base, is a common feature. Occasional small scale cross bedding occurs throughout. Dark laminae, flat to wavy, are very fine grained and probably composed in part of organic matter. Sand or silt injection into carbonates is common.

Stylolites are a conspicuous feature of these carbonates, showing much variation in style and frequency (see plates I-V). They commonly occur between different carbonate lithologies; they may contain soft black organic matter and may grade into or be associated with the thin dark laminae. Stylolite formation has been so intense in places as to form a "stylolitic breccia" (plate V).

Vertical and subvertical calcite veining occurs throughout and this postdates the formation of stylolites. At several places calcite passes into fluorspar which may also occur throughout as irregular shaped pods frequently infilling primary pores (1-3 mm). In Marla-1A at 111.3m depth, fluorspar cements ooids of carbonate. Calcite-lined vugs become more conspicuous with depth, especially in the dolomitic sandstones, and the calcite may be quite dark.

Traces of pyrite occur throughout, generally as silt sized grains scattered in carbonate. Pyrite also occurs as part of detrital grains of quartz and feldspar. It can impart a yellow to reddish staining where oxidation has occurred.

In a number of places less than millimetre-size transparent crystals with hexagonal cross section have been identified as celestite (RS 82, 108.58-108.65m; Appendix II).

Incipient chert formation takes one of three forms in Marla-1A and -1B. It can occur as blueish, concentrically-structured partially silicified dolomite in bands parallel to or cross cutting the lamination in irregular shaped veins. The core is hard, translucent and non-calcareous becoming calcareous outwards. The chert bands may be bounded by "microstylolites". Plate IV shows a second form of incipient chert formation. In this case the stylolite appears to predate the silicification. A third form

Plate I (photo No. 31514) Depth interval 136.12-136.22 m, Marla-1B. Graphitic filled large scale stylolite in calcareous dolomite. Note striations. Pin is 18 mm long.

Plate II (photo No. 31515) Depth interval 106.60-106.66 m, Marla-1B. Fine stylolites in calcareous dolomite. Pin is 18 mm long. Curved lines are diamond-saw striations.

Plate III (photo No. 31516) Depth interval 151.70-151.83, Marla-1B, Large scale stylolite with internal structure in calcareous dolomite. Stylolite is at the junction of two carbonates of slightly different lithology and filled by black ?organic material. Stylolites appear to cross cut calcite veining. Pin is 18 mm long.

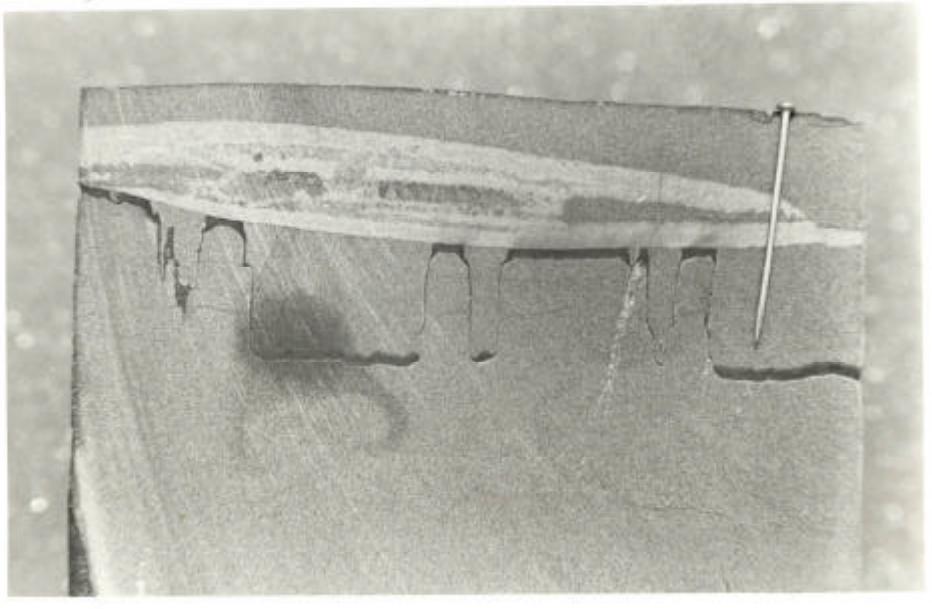


Plate IV (photo No. 31517) Depth interval 127.00-127.11 m, Marla-1B. Light area shows incipient silicification (still slightly calcareous). The continuity of its lower margin suggests it post dates formation of the stylolite. Note the discontinuity of the very fine, hairline stylolites across the large stylolite. Lithology is a calcareous dolomite. Pin size 18 mm.

Plate V (photo No 31518) Depth interval, 106.90-107.05 m, Marla-1B. "Stylolitic breccia" in dolomite. Pin size 18 mm.

is as irregular, diffuse, grey-brown, slightly calcareous areas in grey calcareous carbonate.

DISCUSSION AND COMPARISON WITH BYILKAOORA-1

A shallow marine environment of deposition is suggested for the carbonates of Marla-1A and -1B. Trilobites were recorded in Marla-1 between 87.8m and 87.9m (Appendix V) attesting to a marine environment and this is suggested also by the presence of celestite in Marla-1, a diagenetic mineral seen in shallow marine carbonates (Bathurst, 1975). The trilobites give an Early Cambrian age for these sediments (J. Jago, Appendix V).

The sandy intraclastic carbonates indicate shallow water, and the presence of silt to granule sized detritus suggests a close source with periodic sediment influx. Sedimentation was rapid enough to give rise to a reducing environment, indicated by traces of pyrite and the preservation of organic matter.

Several terrigenous sources are indicated by bimodality of grain size of some sandstones and by the contrasting excellent rounding of very coarse to granule sized grains, and the sub-angularity of fine sand grains. A metamorphic source, possibly the basement ridge which crops out as the Ammaroodinna Inlier, is indicated by the grain lithologies and by deformation lamellae seen in some of the coarse quartz component.

The carbonates of Marla-1A and -1B are very different from, and at least 70 m thicker than, those intersected in Byilkaoora-1, 30km to the northwest. In Byilkaoora-1 the Observatory Hill Beds can be divided into five units. Furthermore the oil shows and the calcite pseudomorphs after the evaporite minerals shortite and trona seen in Units 2, 3 and 4 of Byilkaoora-1 are notably absent in Marla-1A and -1B. The nature of the organic material in the carbonates in the two areas is quite different (Appendix IV), further suggesting

different environments of deposition. The red brown siltstone-claystone of Unit 5 which occurs around the margin of the Mt. Johns Range and at the Observatory Hill Beds type section (Wopfner, 1969) is absent at Marla-1A and -1B.

White and Youngs (in press) suggest an alkali playa lake environment for the Observatory Hill Beds in Byilkaoora-1 and recognise close affinities with the Eocene Green River Formation in the U.S.A. A low lying land barrier is suggested between Byilkaoora-1 and Marla-1, -1A and -1B; it was probably a northeasterly extension of the exposed Ammaroodinna Inlier, suggested by prominent structural and geophysical trends in this direction.

The marine carbonates of Marla-1, -1A, and -1B contain traces of fluorspar in their upper portion, hinting at the possibility of Mississippi Valley type mineralisation.

CONCLUSIONS

1. Marla-1A and Marla-1B were drilled to total depths of 215.3 m and 379.4 m respectively, intersecting a sequence of carbonates of the Observatory Hill Beds.
2. The sequence (132.2 m and 296.4 m thick in Marla-1A and Marla-1B respectively) consists of laminated to non-laminated limestones and dolomites, dolomitic calcareous sandstones and intraclastic dolomite.
3. The Observatory Hill Beds intersected in Marla-1A and Marla-1B are lithologically quite different from those of Byilkaoora-1.

   Differences noted are:

   (a) there is a broad, two-fold division in the Marla wells with an upper sequence in which limestone predominates and in which fluorspar occurs in minor and trace amounts, and a lower sequence in which burrowed dolomite predominates.

(b) the evaporite minerals that include trona and shortite seen in units 2, 3 and 4 of Byilkaoora-1 are notably absent in the Marla Wells.

(c) the nature of the hydrocarbon extracts from the Byilkaoora and Marla wells is different in both yield and character.

(d) different environments and basins of sedimentation are interpreted: a playa lake model has been proposed for Byilkaoora-1, and a shallow marine environment is proposed here for Marla-1A and Marla-1B.

4. Permian sediments are absent in Marla-1A and -1B; the ?Permian identified in Marla-1 now is considered to be Cretaceous Cadna-owie Formation. This places the northern limit of the Arckaringa Basin south of Marla-1A and Marla-1B.

MCB:NK

M.C. BENBOW

M C Benbow

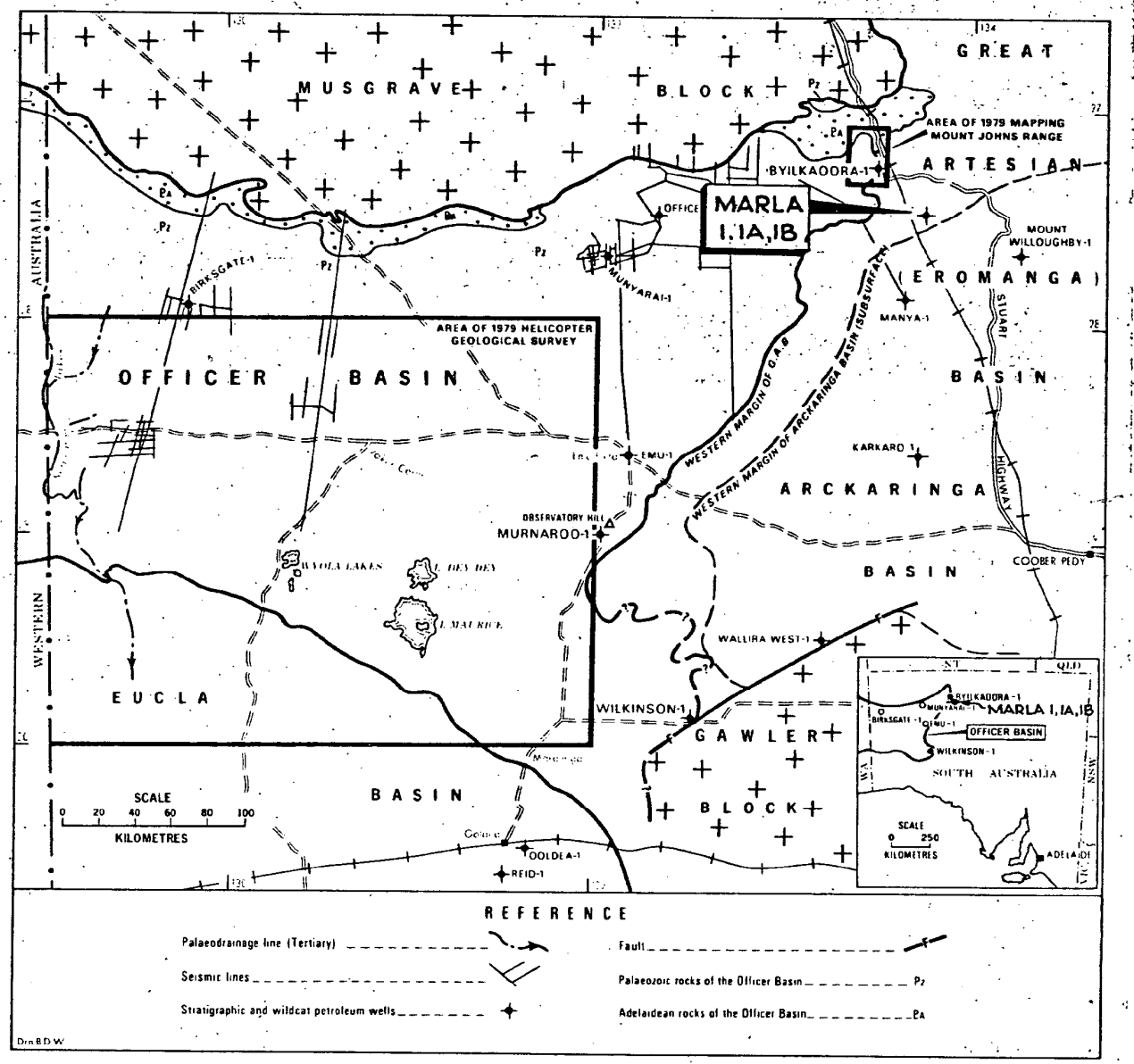


Figure 1

	DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	SCALE: AS SHOWN
COMPILED: M. BENBOW	MARLA 1, 1A, 1B STRATIGRAPHIC WELLS	DATE: 31st Jan. '80
DRN: C.J.W. CKD:	REGIONAL SETTING	PLAN NUMBER 514618
16/5/80		

1799

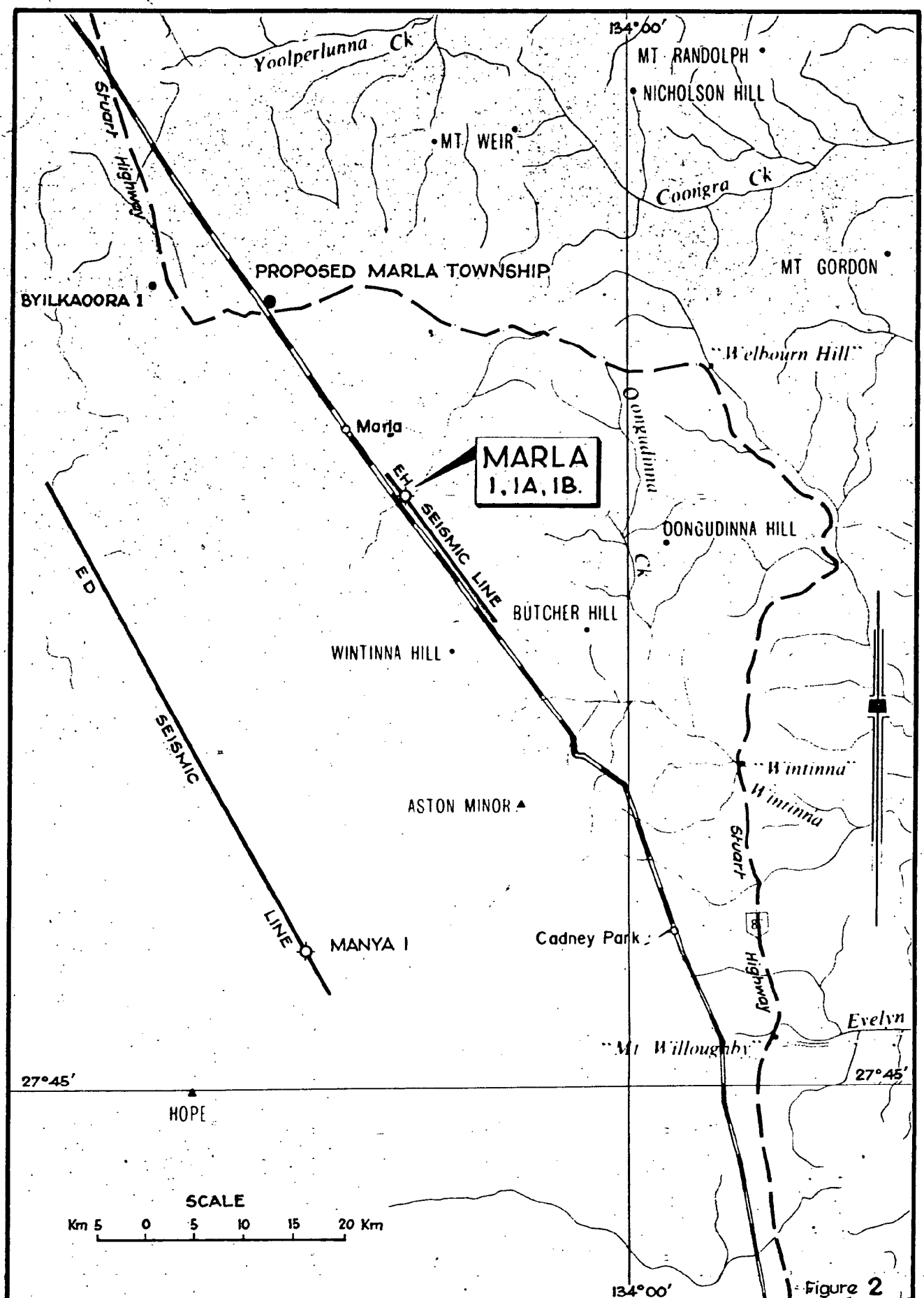


Figure 2

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

COMPILED M. BENBOW	C.D.O. DATE
DRAWN C.J.W.	SCALE 1:500,000
DATE 31st Jan '80	PLAN NUMBER 514619
CHECKED 16/5/80	

MARLA 1, 1A, 1B STRATIGRAPHIC WELLS
LOCALITY PLAN

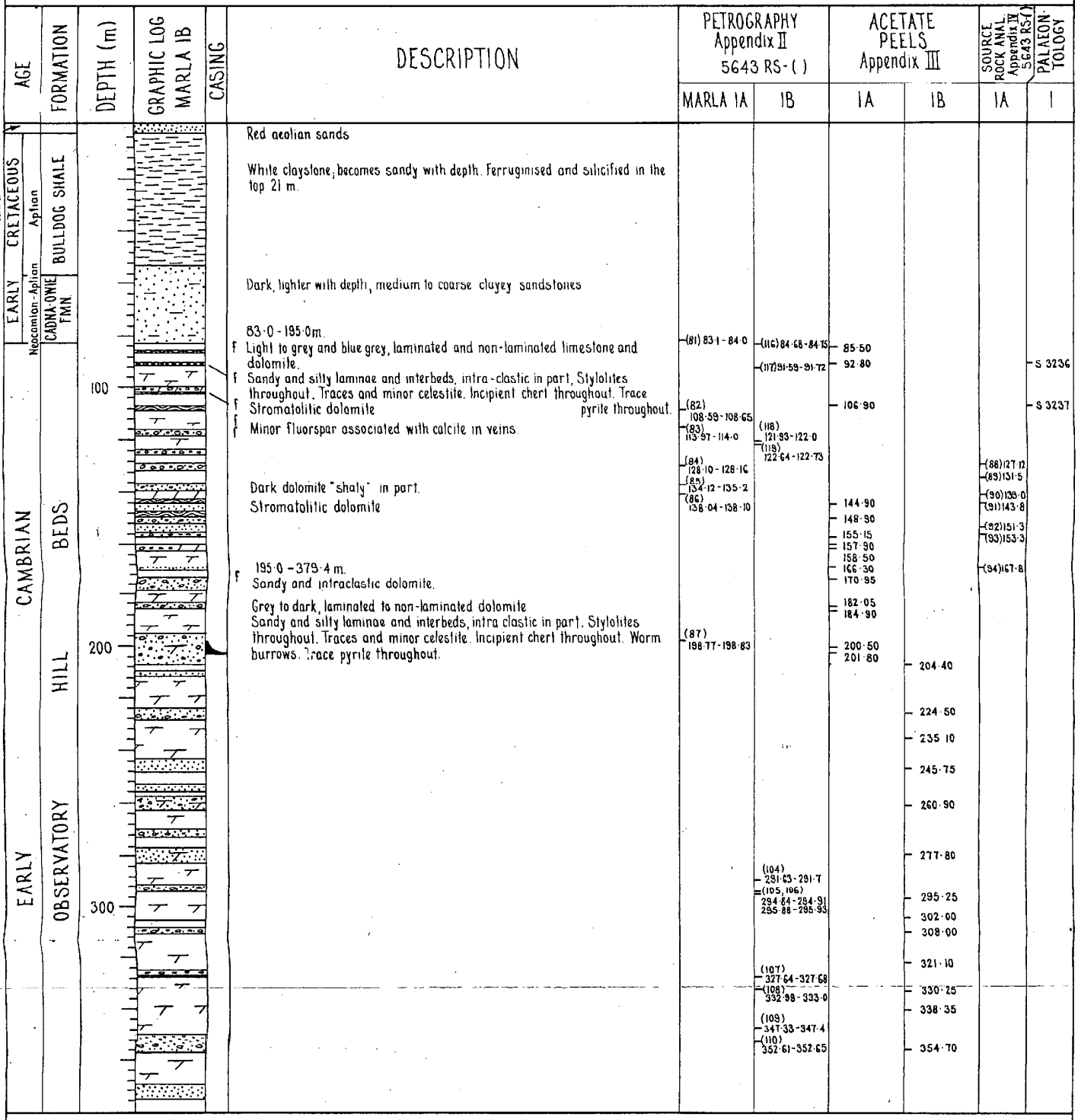
1799

DEPARTMENT OF MINES AND ENERGY — SOUTH AUSTRALIA

COMPOSITE LOG

MARLA 1 1A 1B

LOCATION 27°27'51" 133°44'59" ELEVATION 285 metres (M.S.L.) COMPILED M.C. Benbow



Marla 1 drilled Sept. 1974 by S.A.D.M.E. Total depth 106·8 m.
" 1A " July 1979 " " 215·3 m
" 1B " Sept. 1979 " " 379·4 m.

NQ core 83·10 - 215·3 m.
HQ core 83·0 - 230·1 m.
NQ core 230·1 - 379·4 m.

NOTE:- Marla 1B is open hole with 203·1 m of casing left in hole allowing for future re-entry and deepening.

PLAN NUMBER 80-136

FIG 3

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APPENDIX I

CORE DESCRIPTION SHEETS

MARLA-1A: 83.1 m to 215.3 m

MARLA-1B: 83.0 m to 379.4 m

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

CORE DESCRIPTION

DEPTH . . . . . INCLINATION . . . . . .

LOGGED BY . . . . . DATE DRILLED . . . . . .

REFERENCE . . . . . .

DEPTH (m)	GPAPHIC LOG		DESCRIPTION
			Legend
		b	broken core
		n.l.	non laminated
		w.l.	weakly laminated
		p	porous
			dolomite
			sandy dolomite
			silty dolomite
			clayey dolomite
			intraformational dolomite (intraclastic dolomite)
			stromatolitic dolomite
			stylolite
	c		calcite vein
			vug
			concentric ringed features

S14627a'

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

MARLA -1A

CORE DESCRIPTION

DEPTH 83.10-100 m INCLINATION vertical

LOGGED BY MCB DATE DRILLED July/Aug. 79

REFERENCE

DEPTH (m)	GPAPHIC LOG		DESCRIPTION
			CORING commenced at 83.10m
83		w.l.	silty dolomite: light grey, v.f. silty-clay infill irregular bedding partings, ? fluorospar lower 10 cm. 83.10-83.87
84			
85		w.l.	silty dolomite: light, lam. of vf orange carbonate, black c.g. clasts, sr.-sa. rare, intraclastic in part. 83.87-85.45
86			
87			dolomite: grey, f. wavy lam. subl ca. 85.45-87.95
88		w.l.	
89			dolomite: grey 87.95-88.95
90			
91		nl	silty dolomite to dolomitic siltstone: yellowish grey, up to vc-granule clasts of dark rounded ? calcite, sr.-sa. translucent vc.qtz. <5%. 88.95-90.48
			dolomite: light grey 90.48-90.66
92			dolomite: stylolites common, ⊥ca, core breaks along them, vf silt grains of red mineral, probably fe 0. 90.66-91.10
93			silty dolomite: grey, disruption of lam. toward 91.65 91.10-91.65
94			dolomite: light, lam. show evidence of disruption. 91.65-92.73
95		w.l.	dolomite: yellowish, finely laminated, disruption, vc qtz. clayey interbeds or lam. qtz is sr.-r., milky to translucent, matrix is calcareous. tr. pentlandite on one granule size grain, intraclastic in part. 92.73-93.59
96			dolomite: light, disrupted orangy calc. lam. in pale green slightly calcareous claystone, occasional grains of m.-f. s.r. qtz., lam ± ca. 93.59-94.20
97			dolomite: light, darkens toward base. 94.20-95.37
98			intraclastic dolomite: stylolites are common, infilled by dirty grey clay, "splotchy" texture, tr. fluorspar in vein. 95.37-95.71
99		w.l.	dolomite: light, disruption of lam. 95.71-96.55
100			dolomite: grey, "splotchy" texture, stylolites common. 96.55-96.73
			dolomite: light lam., much disruption in part, sandy in part, grains up to granulesize 96.73-97.82
			dolomite: light 97.82-99.00
			dolomite: grey. lam. 99.00 -99.12
			dolomite: grey, black non-fluorescing patches up to 2cm long, of irregular shape. 99.12-99.44
			dolomite: light grey, lam. in part, sandy interbeds. 99.44-100.18

S14627a"

DEPARTMENT OF MINES AND ENERGY — SOUTH AUSTRALIA

MARLA -1A

CORE DESCRIPTION

DEPTH 100-120 INCLINATION

LOGGED BY MCB DATE DRILLED July/Aug. 79

REFERENCE

DEPTH (m)	GRAPHIC LOG		DESCRIPTION
100		b	dolomite: 100.18- 100.40
101			dolomite: grey 100.40-103.09
102			intraclastic dolomite, light grey green, silty and clayey lam., disruption of lam. 103.09-103.61
103			
104			sandy dolomite: light pink, grey green, clasts sr.-r. transparent qtz. 10-20%, up to vc-granule, dispersed throughout. 103.61-104.05
105			dolomite: green light and minor reddish lam. irregular coarser calc. patches with qtz grains up to cg. <10% 104.05-105.00
106			dolomite: light yellowish, lam., 104.05-105.00
107			dolomite: grey, lam. in part, calcite vugs 106.70-197.05, black alteration over last 10cm. 105.00-107.40
108			dolomite: light, lam. 107.40-108.20
109			dolomite: light, minor f-m. sandy lam. 108.20-108.52
110			dolomite: light, lam., bands 1cm or less of bluish grey f. carbonate alternate with vf sand (calc.) 108.52-108.98
111			dolomite: light 108.98-110.05
112			dolomite: darker, lam., sandy in patches 110.05-110.45
113			dolomite: light grey, lam. + ca., lighter orange irregular banding, fluorspar cement at 111.30m. 110.45-113.42
114			dolomite: grey, stylolites very common + ca., wavy, filled with black clayey material doesn't fluoresce. 113.42-114.17
115			dolomite: light 114.17-115.00
116			dolomite: red to orange lam. in greyish green, lam. of sa.-sr. translucent qtz. in silty matrix range up to granule size average vc., calcareous oolitic layers. 115.00-116.97
117			dolomite: light, becomes lam. toward base with greenish clay lam. 116.97-117.61
118			dolomite: lam. disruption, sericite at 117.70-117.85 117.61-118.22
119			dolomite: v.c. sandy in part. 118.22-120.30
120			

S14627b

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

MARLA -1A

CORE DESCRIPTION

DEPTH 120-140 INCLINATION

LOGGED BY MCB DATE DRILLED Aug.79

REFERENCE

DEPTH (m)	GRAPHIC LOG		DESCRIPTION
120			dolomite: light green, lam. inpart, sandy intervals of qtz sr.-r., vc-granule, in clayey matrix. 120.30-123.25
121			
122			
123			
124			dolomite: light, lam. 123.25-124.62
125			dolomite: grey, lam. intraclastic over basal 10cm with black veining 124.62-127.65
126			dolomite: light green, grey, yellowish and dark lam., a little whispey over 128.10-128.16, a few light clay clasts, orange f.-m., may be ferruginized feldspar, injection of clay into sand. 127.65-128.73
127			dolomite: light, clay-silt lam. 128.73-129.42
128			dolomitic sandstone inter. lam. dolomitic claystone: qtz 795% sa.-sr. mod. - poor sorting, a few rounded elongate clasts, some dislocation. 129.42-130.00
129			dolomite: grey green, lam. 130.00-131.16
130			dolomite: blue grey, yellow brown black lam. 131.16-131.73
131			dolomitic m. sandstone: light, qtz. granule rounded clasts, bluish and translucent, m. grains are sa., irreg. calcite veining. 131.73-131.82
132			dolomite: greenish silty lam., minor m. sand lam., black disrupted. Coarsens toward base to clayey dolomite sandstone. 131.82-132.62
133			dolomite: light, lam., micro faulting 132.62-133.74
134		b	dolomite: grey, fractures filled by graphitic clay 133.74-133.80
135		w.l.	dolomite: light grey 133.80-133.96
136		n.l.	silty dolomite: dirty grey 133.96-135.40
137			dolomite: grey, lam, minor lighter silty lam. black disrupted irregular lam. 135.40-135.97
138		b	dolomite: dirty grey 135.97-136.14
139			dolomite: dark grey 136.14-136.57
140		p	dolomite: mod. grey 136.57-136.82
			dolomite: intraclastic 136.82-137.38
			dolomitic sandstone: 137.38-138.49
			dolomite: broken along lam. 138.49-139.15
			dolomitic sandstone: 139.15-139.20
			dolomite: dark lam., black "shaley" partings calcareous f.-vc. sandstone: qtz. sr.-r. finer grains sa.-sr. 139.20-139.43
			dolomite: grey, lam. 139.43-139.61

S14628c

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

MARLA-1A

CORE DESCRIPTION

DEPTH 140-160 m INCLINATION

LOGGED BY MCB DATE DRILLED Aug. 79

REFERENCE

DEPTH (m)	GRAPHIC LOG		DESCRIPTION
140			Calc. m. sandstone: 140.27-140.33
141			Dolomite: sandy in part, poorly sorted. 140.33-140.90
			Dolomite: conspicuously lam., poorly sorted sandy lam. 140.90-142.00
142		p	Calc. v.f. sandstone: light, irregular calcite veining. 142.00-142.44
143			Dolomite: grey, lam., black lam. very conspicous. 142.44-143.07
		w.l.	Dolomite: black criss-crossing very fine veining, disruption. 143.07-143.50
144		p	Stromatolitic dolomite: grey, disrupted whispey black lam. 143.50-143.60
			Dolomite: dirty grey. 143.60-143.83
145		b	Dolomite: irregular calcite veining. 143.83-144.87
146			Dolomite: 144.87-145.17
147		p	v.c. sandy dolomite: trace fluorspar 145.17-145.23
			m.c. sandy dolomite: poorly sorted, qtz. s.r.-r. for coarser grains, disruption at base. 145.23-146.14
148			Dolomite: dark grey, lam. 146.14-147.47
		nl	Intraclastic dolomite: dark grey. 147.47-147.63
149			Dolomite: dirty grey. 147.63-148.34
150		nl	Calcite veined dolomite: 148.34-148.39
		p	Dolomite: grey. 148.39-148.64
151		nl	Dolomite: mod. grey. lam., microfaulting. 148.64-149.33
152			Stromatolitic dolomite: fine wavy lam.
		nl	Dolomite: dirty grey. 149.62-149.80
153			Dolomite: black irregular veining around intraclasts of dolomite. 149.80-150.16
154		p	Dolomite: grey, lam., breaks along graphitic lam. 150.63-150.78
			Dolomitic f.-m. sandstone: grey, contains some light grey intraclasts of dolomite. 150.78-151.24
155			Intraclastic dolomite: sandy, much recrystallisation 151.24-151.48
156			Dolomite: grey, lam. of f. sand. 151.48-152.78
			Dolomite: grey, black irregular veining in partly intraclastic brecciated carbonate 152.78-153.16
157			Dolomite: lam., black graphic veining lam. 153.16-153.87
158			Dolomite: light grey. 153.87-154.03
			Dolomite: slightly sandy to dolomitic sandstone. 154.03-155.00
159			Dolomite: dark grey, lam., some disruption, injection of sand. 155.00-155.10
160			Calc. dolomitic sandstone: 155.10-155.27
			Dolomite: dark grey, lam., initially light and m.-c. sandy. 155.27-157.78
			Recrystallised carbonate: 157.78-159.03
			Dolomite: grey, lam. 159.03-166.10

S14627d

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

MARLA -1A

CORE DESCRIPTION

DEPTH 160-180 INCLINATION

LOGGED BY MCB DATE DRILLED Aug.79

REFERENCE

DEPTH (m)	GRAPHIC LOG		DESCRIPTION
160			
161			
162			
163			
164			
165			
166			Stromatolitic dolomite: 166.10-166.40
		p	Dolomite: grey, numerous vugs. 166.40-166.65
167			Dolomite: grey. 166.65-168.00
168		p	Sandy dolomite: grey. 168.00-168.38
			Dolomite: grey. 168.38-169.34
169			Dolomite: grey, numerous lam. partings. 169.34-170.00
170		p	Calc. dolomitic sandstone: poorly sorted, qtz up to granule size, s.r.-r., finer grains are s.a.-s.r. 170.00-170.10
171		p	Dolomite: grey. 170.10-171.67
172		p	Intraclastic dolomite: clasts up to 3-4 cm., a.-s.a., of lam. and non lam., light grey dolomite, minor c. sand 2%, very thin graphite "cements" clasts. 171.67-172.00
173			
174			
175			Calc. dolomitic m. sandstone: lam., inter lam., dolomite, mod-poor sorting, passes down into grey dolomite, tr. fluorspar especially at mound 176.0 m. 172.00-177.12
176			
177			
178		b	Calc. dolomitic m.-c. sandstone and lam. dolomite: core broken throughout. 177.12-183.32
179			
180			

S14627e

DEPARTMENT OF MINES AND ENERGY — SOUTH AUSTRALIA

MARLA -1A

CORE DESCRIPTION

DEPTH 180-200 INCLINATION

LOGGED BY MCB DATE DRILLED July/Aug.79

REFERENCE

DEPTH (m)	GPAPHIC LOG		DESCRIPTION
180			
181			
182			
183			
184			183.32-195.56 Dolomite: grey, lam., silty to v.f. sandy lam., in part, black graphitic lam., minor whispey disruption, thick to micro-calcite veining, more conspicuously lam. from 192.0 m., intraclastic between 193.41-193.54.
185			
186			
187			
188			
189			
190			
191			
192			
193			
194			
195			
196			195.56-196.16 Calc. dolomitic m. sandstone: poorly sorted, clasts of rounded dolomite up to 1-1½ cm. long, elongate ⊥ ca.
197		nl	Dolomite: grey, minor graphitic lam. 196.16-198.32
198			
199		p	Dolomite and interlam. silt-m. sandstone: sands are poorly sorted, ranging in size from v.f.-granule, coarser grains are s.r.-r. 198.32-199.00.
200			Dolomite: dark, lam. 199.00-200.10

S14627f

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

MARLA -1A

CORE DESCRIPTION

DEPTH 200-215.3 m. INCLINATION

LOGGED BY MCB DATE DRILLED Aug. 79

REFERENCE

DEPTH (m)	GRAPHIC LOG		DESCRIPTION
200		p	200.10-200.80 Dolomite: intensely calcite cemented, very sandy in part.
201			Dolomite: dark lam., minor intraclastic dolomite, silty to m. sandy lam., black graphitic lam.
202			
203			201.96-204.44 Dolomite: grey, black fine lam., lam. of intraclastic dolomite, sandy to silty lam.
204			
205			204.44-206.83 m.-c. sandy dolomite: light grey, wide range of grain size from silt to granule, criss-crossing stylolitic veins.
206			
207			206.63-208.00 Dolomite: light grey, sandy in part, poorly sorted, trace pyrite.
208			
209			208.00-211.44 m.-c. sandy dolomite or cal. dolomitic sandstone: larger qtz. grains and spherical and very well rounded, largest grains are up to 0.6 cm diam., and include carbonate, coarsens upwards.
210			
211			
212			211.44-215.30 Silty dolomite: light grey, lam. in part.
213			
214			
215			215.30 m T.D.

S14627g

SHEET 7 OF 7

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

MARLA -1B

CORE DESCRIPTION

DEPTH 83.00-100.0 INCLINATION

LOGGED BY MCB DATE DRILLED Aug.79

REFERENCE

DEPTH (m)	GRAPHIC LOG		DESCRIPTION
			Clayey dolomite: light, yellowish, laminated, tr. fluorspar in basal few centimtres, vertical calcite veins. 83.00-83.74
			Dolomite: grey, intraclasts of angular carbonate cemented by orange brown silty calcareous matrix in part, tr. fluorspar in vertical veins and pods, in upper part there are dark brown cubic crystals of ?pyrite. 83.74-84.95
83			Dolomite: light pinkish brown, bladed silt size clasts seen in a few places, ?pyrite concentrated in some lam. 84.95-85.50
84			Dolomite and sandy intraclastic dolomite: lam, of m. sand injected into light dolomite, sands grains of qtz. primarily up to v.cg, well rounded to s.r. and s.a.,
		n.l.	dark bladed mineral silt size scattered in dolomite, not well sorted. 85.50-86.02
85			Dolomite: bluish grey, lam., stromatolitic from 86.23-86.56, v.f. sand to silt injection, soft sediment lam. disruption, yellow to orange stained "lams" and vertical "veins". 86.23-86.56
86			Dolomite: inter mixing of blue grey and grey brown dolomite, could be due to the effect of solution alteration. 86.56-87.65
87			Dolomite: blue grey. 87.65-88.00
			Dolomite: disruption, fluorspar pod 3 cm long. 88.00-88.35
88			Dolomite: blue grey, lam. toward base, some disruption. 88.35-88.49
89			Dolomite: light, lam., ?stromatolitic", sand injection along bedding plane, lighter and light dolomite "inter mixed" to some degree, darker lam. of v.f. sand to silt over the last 18 cm. up to v.c.-granule, s.r.-s.a. qtz. scattered, poorly sorted. 88.49-89.19
90			Dolomite: grey, very fine, thin elongate ?celestite crystals. 89.19.89.90
		n.l.	Dolomite: stylolites prominent, some 'mixing', intraclastic development, 1 mm d 'hexagonal' crystals of ?celestite, intraclastic at the base.89.90-91.11
91			Dolomite: light, lam., soft sed. disruption, yellow stained areas with v.f. silt size grains of pyrite. 91.11-92.00
92			Dolomite: pink, "inter mixed" tr. black soft substance, v.f. sand injected lam. tr. pyrite. 92.00-92.45
93			m. sandy dolomite: disruption bedding, sandy lam. and scattered throughout, grains of qtz. up to v.c., larger grains r.-s.a., a few vugs, intraclastic in part, much disruption toward base. 92.45-93.01
94			Dolomite: white, much "inter mixing" initially, passes into light lam.
95		n.l.	93.01-93.78
			NO RECOVERY
96			Dolomite: light. 93.78-94.45
97			Dolomite: lam., silty, disrupted toward base. 94.45-95.17
			Dolomite: grey, disrupted, interesting textures, crystals of ?celestite, intraclastic
98		b	at base. 95.17-95.31
			Dolomite: light brown grey, lam. v.f. sandy (qtz. feld. and black bladed mineral)
99		n.l.	intraclastic, very thin beds and lam., low angle cross bedding. 95.31-96.00
			Dolomite: lam., sandy to silty in part, s.r.-r., f.-m. qtz., interbeds of med-poor
100		w.l.	sorting, tr. soft black substance along bedding, sandier toward base. 96.00-96.24
			Dolomite: light pinkish to yellow, initially "inter mixed". 96.24-97.00
			Dolomite: grey. 97.00-98.78
			Dolomite: light, silty lam., qtz. is a., bladed mineral 5%. 98.78-99.72

S14628a

DEPARTMENT OF MINES AND ENERGY — SOUTH AUSTRALIA

MARLA -1B

CORE DESCRIPTION

DEPTH 100-120 INCLINATION

LOGGED BY MCB DATE DRILLED

REFERENCE

DEPTH (m)	GPAPHIC LOG		DESCRIPTION
100			
101			Dolomite: greenish grey to grey. lam., tr pyrite, bladed mineral, oolitic between 101.60-101.63. oolitic 99.85-101.73
102		p	Intraclastic dolomite: grey, lam., white calcite cemented, clasts several cm. long. 101.73-101.80 Dolomite: grey, lam., fine intraclastic in part, calcite lined vugs. 101.80-102.05
103		w.l.	Stromatolitic dolomite: 102.05-102.76
		b	
104			Dolomite: grey. 102.76-103.42
105		w.l.	Dolomite: silty to v.f. sandy, intraclastic in part. 103.42-103.74
			Silty dolomite: mixed colours, greenish grey and reddish, scattered grains qtz. up to cg., r-s.r., poorly sorted. 103.74-104.41
106			Dolomite: grey to white, silty light lam. 104.41-105.32
107			Dolomite: grey, pinkish in part, lam., becomes intraclastic at 105.75. 105.32-105.90
			Dolomite: stylolites numerous, tr. fluorspar at 106.95. 105.90-107.00
108			Dolomite: grey, in top 2 cm. intraclastic, includes 1 mm diam. "oolites", tr. soft black substance unusual texture due to recrystallisation of carbonate, giving rise to white calcite patches ½cm. 107.00-107.51
109			Stromatolitic dolomite: silty in part, v.f. sandy lam., needle like crystals ?celestite in calcareous matrix. 107.51-108.40
110		b	Dolomite: light grey, lam., light silty lam., "inter mixing", r.-s.r. v.f. sand grains throughout, sand injection, bluish grey chert replaced dolomite. 108.40-108.70
111			Dolomite: light, lam., silt-v.f. sandy lam. 110.00-110.30
112			Dolomite: purplish grey "inter mixed", silty sandy in part, r. c.g. qtz. tr.fluor-spar at 110.74. 110.30-110.77
113			Dolomite: grey. 110.77-111.05
			Dolomite: grey. 111.05-112.03
114			Dolomite: light altered carbonate in grey dolomite, alteration ⊥ Ca. 112.03-112.42
115			Dolomite: grey. 112.42-112.77
			Dolomite: grey and light reaction features ⊥ Ca. 112.77-112.87
116		b	Dolomite: grey, weak lam. 112.87-112.97
			Dolomite: light "reaction" band. 112.97-112.99
117		b	Dolomite: grey, lam. 112.99-114.23
		b	
118			Dolomite: grey, core broken along stylolites, intraclastic at base. 114.23-115.05
			Dolomite: pinkish grey. 115.05-115.25
119			Dolomite: pink grey, irregular alteration, this has been cut by calcite and fluor-spar veins. 115.25-115.34
120			Dolomite: light, silty minor intraclastic toward base. 115.34-116.00
			Dolomite siltstone: black soft matter in lam., up to ½ cm. diam. circular or annular in part. 116.00-117.11
			Sandy intraclastic dolomite: 117.11-117.19
			Silty dolomite: light grey, lam., bands of 'chalcedonic' looking chert, replaced dolomite, m-c sandy in part. 118.00-119.15

S14628b

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

MARLA-1B

CORE DESCRIPTION

DEPTH 120-140 m . . . . . INCLINATION . . . . . .

LOGGED BY MCB . . . . . DATE DRILLED . . .

REFERENCE . . . . . .

DEPTH (m)	GRAPHIC LOG		DESCRIPTION
120			Dolomite: light grey, incipient chert, tr. bladed dark mineral, tr. orange alteration, could be iron oxide staining, dark silt size reddish spots probably iron oxide. 119.15-120.35
121			Dolomite: light grey, clayey, silty lam., tr. incipient chert. 120.55-121.46
122			Dolomite: light, lam., at 121.94 yellow lam., disrupted by sandy injection, sandy and intraclastic in the top, also there are broad veins in which chert has developed, tr. of sericite assoc. with chert and tr. of yellow carbonate mineral 121.46-123.22
123		b	Dolomite: light pink, lam., intermixing. 123.22-123.67
124			Dolomite: grey, interbeds of poorly sorted m.-c. sands, tr. bladed dark mineral, a few qtz grains with deformation lamellae, tr. feldspar. 123.67-123.88
125			Sandy intraclastic dolomite: 123.88-123.95
126			Dolomite: light, lam., a little clayey. 123.95-124.17
		w.l.	Dolomite: light to yellowish in part, silt size quartz in part, tr. bladed mineral, irregular incipient chert in pods, porous in part. 124.17-125.00
127			Dolomite: dark grey, several bands of incipient chert, light central part is non calcareous, gets calcareous away from centre, dark lam., become conspicuous lower down. 125.00-128.21
128			Dolomite: light, darker toward base. 128.21-128.65
129		b	Clayey dolomite: light, m.-c. sandy interbeds, at 129.40 halite casts in yellowish clayey lam., in the lower half red spots of iron oxides across and parallel lam., several chert bands near base. 128.65-130.24
130			Calc. m. sandstone: mod. to poor sorting, a few v.c.-granule rounded grains of qtz. feldspar, tr. of dark bladed mineral, a few light carbonate intraclasts up to 4cm. elongate, rounded ends. 130.24-132.56
131			Dolomite: light, sandy in part. 132.56-131.00
132			Clayey dolomite: light, greenish and reddish. 131.00-131.85
133			Dolomite: dark lam., orange iron oxide staining at the base. 131.85-132.24
134			Dolomite: grey. 132.24-132.40
			Dolomite with m.-c. sandstone injection: calcite crystallised as irregular veins. 132.40-132.58
135			Silty dolomite: light thinly lam., claystone at the base. 132.58-133.13
		nl	Calc. m.-c. sandstone and dolomite: incipient chert in lower half. 133.13-133.25
136		b	Dolomite: light brown grey, lam., irregular chert pods and veins in the upper part. 133.25-134.38
137		w.l.	Dolomite: brown grey, some incipient chert. 134.38-137.25
		b	Claystone: black, v. thinly lam. 137.25-137.32
138		b	Dolomite: brown grey, lam., clayey in part, calc, very sandy claystone, intraclastic in last 17 cm. 137.32-138.00
		b	
139		b	Dolomite: grey, very dark in part, silty and sandy lam. in upper part. 138.00-139.05
140			Dolomite: dark, shaley. 139.05-139.28
			Dolomite: grey, silty lam., microfaulting, passes down into v.c. poorly sorted calc. sandstone, chert at base. 139.28-139.54

S14627c

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

MARLA -1B

CORE DESCRIPTION

DEPTH 140-160 m INCLINATION

LOGGED BY MCB DATE DRILLED

REFERENCE

DEPTH (m)	GRAPHIC LOG		DESCRIPTION
140		n.l.	Dolomite: brownish grey. 140.00-140.20
141			Dolomite: silty lam., very dark f. lam., sandy in part, poorly sorted. 140.20-141.23
			Dolomite: as above not sandy incipient chert. 141.23-142.73
142			Dolomite: dark, irreg. black veining and alteration, looks like solutions here invaded country rock. 142.73-143.45
143			Stromatoltic dolomite: calcite has grown in tight "distorted" lam. 143.45-143.60
144		p	Dolomite: dark lam. in upper part, calcite veined in base. 143.60-143.80
			Dolomite: brown grey, tr. incipient chert. 143.80-144.82
145			Dolomite: brown grey, silty, fine black criss crossing stylolitic veining. 144.82-145.03
			Dolomitic sandstone: incipient chert. 145.03-145.06
146		p	Intraclastic dolomite: clasts s.a., black criss crossing stylolitic veining. 145.06-145.18
147			Sandy dolomite: light poorly sorted, calcite veins cross cut black fine irreg. veining. 145.18-145.45
148		wl	Calc. dolomitic c. sandstone: poorly sorted, larger grains of r. qtz., intraclasts of light dolomite, tr. pyrite, sand dolomite at base. 145.45-146.04
149			Dolomite: dark, lam. pitted. 146.04-146.65
			Dolomite: grey brown, dark incipient chert, in upper 11 cm white needle like crystals up to ½ cm. may be celestite, incipient chert. 146.65-148.40
150		p	Stromatolitic dolomite and interbedded dark dolomite: 148.40-148.90
151		b	Dolomite: dark. 148.90-149.30
152		wl	Stromatolitic dolomite: 149.30-149.51
			Intraclastic dolomite: light, clasts a., matrix of dark carbonate. 149.51-149.70
153			Silty to sandy dolomite: 149.70-149.98
			Calc. m.-c. dolomitic sandstone: intraclastic at base. 149.98-150.49
154			Silty dolomite: 150.49-151.20
155			Dolomite: grey 151.20-152.51
			Dolomite: dark, silty to sandy. 152.71-152.62
156			Dolomite and interbedded sandstone: w.r. granule size grains of qtz. (with deformation lamellae), tr. pyrite. 152.62-152.90
157			Dolomite: grey, lam., silty to clayey lam. 152.90-153.62
			Intraclastic dolomite and sandy dolomite: 153.62-153.96
158			Dolomite: grey finely lam in part, black vein like lam ⊥ Ca. more evident at depth, brecciated toward base. 153.96-155.49
159			Dolomite: light, lam. in part. 155.49-156.15
160			Intraclastic dolomite and interbedded dolomite: sandy, clasts w.r.-r. up to granule size, includes quartz exhibiting deformation lamellae. 156.15-156.81
			Dolomite: grey, lam., dark f. lam., silty and sandy in part, some dislocation. 156.81-157.27
			Dolomite: grey, lam., disruption textures. 157.27-157.62
			Dolomite: dark grey, recryst. of carbonate to form white irregular patches in dark rock, pores from which carbonate has dissolved. 157.562-157.92
			Dolomite: grey, irregular black veinlike stylolites, v.f. needle like crystals of ?celestite. 157.92-158.77
			Dolomite: grey, lam., some disruption at top. 158.77-159.34
			Dolomite: grey, lam. 159.34-160.34

S142828 d

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

MARLA -1B

CORE DESCRIPTION

DEPTH 160-180 m INCLINATION

LOGGED BY MCB DATE DRILLED

REFERENCE

DEPTH (m)	GPAPHIC LOG		DESCRIPTION
160			160.34-160.45 Intraclastic dolomite:
161			160.45-161.85 Dolomite: grey, silty and sandy lam. in upper part.
162			161.85-162.20 Dolomite: grey, calcite vein post dates stylolites
163			162.20-164.05 Dolomite: grey, lam. in upper part.
164			164.05-164.65 Dolomite: grey, stylolites very common.
165			164.65-165.18 Dolomite: grey.
166		b	165.18-165.42 Clayey dolomite:
167		wl. wl.	165.42-166.14 Dolomite: light grey brown.
168			166.14-166.35 Dolomite: light grey brown, incipient chert - dark patches lam.
169			166.35-166.58 Dolomite:
170			166.58-166.77 Dolomite: bluish grey, carbonate recryst. to give white patches superimposed.
171			166.77-168.00 Dolomite: light brown grey, silty toward base, partings common.
172			168.00-168.60 Silty dolomite: sandy interbed and lam.
173			168.60-170.24 Dolomite: light grey, partings common; at 170.09 white chert with internal concentric structure.
174			170.24-170.43 Dolomitic sandstone: intraclastic.
175			170.43-171.34 Dolomite: light grey, black clay fills veinlike fractures around minor brecciated intervals.
176		p	171.34-172.43 Intraclastic dolomite:
177		p	172.43-175.40 Dolomite: bluish grey, incipient chert some dislocation and micro faulting, tr. ?fluorspar in base.
178			175.40-176.00 Dolomite: light brownish grey, even textured, very calcareous.
179			176.00-183.00 Intraclastic dolomite, sandy to sandstone with interbedded light dolomite: tr. pyrite, some of the carbonate is grey greenish.
180			

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

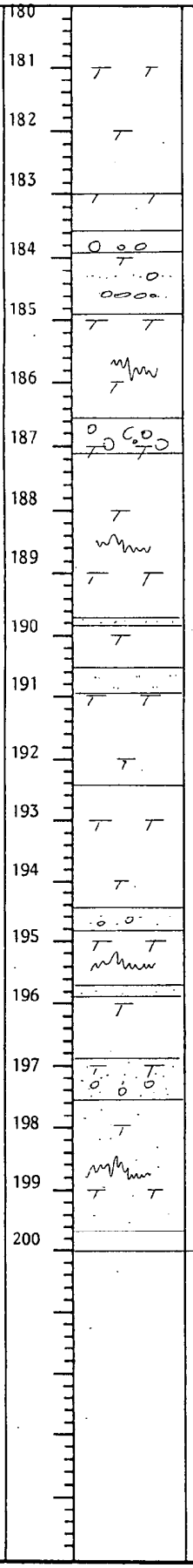
MARLA -1B

CORE DESCRIPTION

DEPTH 180-200 INCLINATION

LOGGED BY MCB DATE DRILLED

REFERENCE



DEPTH (m)	GRAPHIC LOG		DESCRIPTION
180			
181			
182			
183			Dolomite: grey, lam., minor intraclastic, minor chert. 183.00-183.56
184			Intraclastic dolomite: clasts of grey lam. dolomite, passes upwards into distorted lamination, parallel distorted lam. and stringers of light bluish white cencentric structured nodular bands, they also cut across the disrupted lam. 183.56-183.91
185			Interbedded intraclastic dolomite and sandy dolomite to dolomite: clasts s.r.-a. grey dolomite, in very calc. light silty dolomite in lower 10 cm., thereafter light r.-s.a. dolomite up to 3 cm long. 183.91-184.86
186			Dolomite: brownish grey, lam. 184.86-186.57
187			Intraformational dolomite: 186.57-187.06
188			Dolomite: light grey, lam., bluish grey chert. 187.06-189.72
189			
190		p	Dolomitic sandstone: dark and white, fine, sandy in lower half. 189.72-189.83
191			Dolomite: grey, lam. 189.83-190.56
192		w.l.	Silty dolomite: 190.56-190.96
193			Dolomite: grey, 1-2 mm calcite lined pods at the base. 190.96-192.45
194			Dolomite: grey, silty and sandy lam, in part, black fine lam., fining upwards, tr. chert. 192.45-194.46
195			Dolomitic v.f. sandstone and intraclastic dolomite: soft black bladed mineral silt size, 1-2%. 194.46-194.80
196			Dolomite: grey, black lam. 194.80-195.67
197			f. sandy dolomite: intraclasts of light dolomite, grey chert band at 195.73. 195.67-195.87
198			Dolomite: grey, lam., at 196.77 concentric ringed bluish-white chert. 195.87-196.87
199			Sandy intraclastic dolomite: 196.87-197.56
200			Dolomite: grey, lam. at base, minor chert alteration. 197.56-199.71
			Sandy intraclastic dolomite: 199.71-201.96

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

MARLA-1B

CORE DESCRIPTION

DEPTH 200-220 m INCLINATION

LOGGED BY MCB DATE DRILLED Sept.79

REFERENCE

DEPTH (m)	GPAPHIC LOG		DESCRIPTION
200			
201			
202			
203			Dolomite: grey, black fine lam., lam of intraclastic carbonate, sandy to silty lam. 201.96-204.44
204			
205			m.-c. sandy dolomite: light grey, wide range of grain size, from silt to granule, criss-crossing stylolitic veins. 204.44-206.83
206			
207			Dolomite: light grey, sandy in part, poorly sorted, tr. pyrite. 206.83-208.00
208			
209			m.f. to c. sandy dolomite: larger qtz grains are spherical and well rounded, largest grains up to 0.6 cm and include carbonate, coarsens upwards, black stylolitic veining, criss-crossing in part. 208.00-211.44
210			
211			
212			Silty dolomite: light grey, lam. in part. 211.44-215.42
213		b	
214			
215			
216			Dolomite: grey vugs prominent, up to 102 cm diam. 215.42-217.50
217			
218			Dolomite: grey, irregular shaped black "veins cement" brecciated carbonate. 217.50-219.00
219			
220			

S14628g

DEPARTMENT OF MINES AND ENERGY — SOUTH AUSTRALIA

MARLA-1B

CORE DESCRIPTION

DEPTH 220-240 m INCLINATION

LOGGED BY MCB DATE DRILLED Sept. 79

REFERENCE

DEPTH (m)	GPAPHIC LOG		DESCRIPTION
220			
221			219.00-223.17 Dolomite: grey, dark lam., not well defined, calcite cemented fracture, 'micro' stylolites, minor sand lam. irregularly shaped due to soft sediment deformation, often associated with intra-calsts of dolomitic, oolitic (0.3mm diam)
222			
223			223.17-223.44 Interlaminted dolomite and dark sand:
			Dolomite: grey
224		w.l.	224.48-224.68 Interlaminated dolomite and tar sand:
225		w.l.	225.49-225.86 Calcareous m.-c. sandstone, poorly sorted, intraclasts up to 2 cm. of cr.r. dolomite, cross bedded.
226			225.86-226.55 Dolomite: grey, lam. not conspicuous, ⊥ Ca.
			Dolomite m sandstone: poorly sorted, grains up to v.c., rounded, a few dolomite intraclasts, some what porous, vugs lam. diam., passes gradationally into below.
227			
228		H Q core	226.86-227.00 Dolomitic m. sandstone: poorly sorted, grains up to v.c., rounded, a few dolomite intraclasts, somewhat porous, vugs lam. diam., passes gradationally into below.
229			
230			227.00-227.53 Interlaminated dolomite and dolomitic sandstone: black wavy veinlike lam.
			230.06-230.11 Dolomitic sandstone: dark grey, poorly sorted, light dolomite, intraclasts rounded up to 1 cm.
231		p	230.11-231.00 Interlaminated dolomitic sandstone and dolomite:
232			231.00-231.50 Dolomitic m. sandstone: grey, mod-poorly sorted, intraclasts of light grey carbonate, somewhat irregular in shape.
233		N Q core	231.50-234.17 Interlam. v.f. calc. sandstone and dolomite: sand mod-poorly sorted, few intraclasts light grey dolomite, sandstone in dark.
234			
235		b	
236			
237		nl	
238			
239			
240			

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

MARLA -1B

CORE DESCRIPTION

DEPTH 240-260 m INCLINATION

LOGGED BY MCR DATE DRILLED Sept. 79

REFERENCE

DEPTH (m)	GRAPHIC LOG		DESCRIPTION
240			
241		nl	234.87-242.60 Dolomite: dark grey
242			
243			242.60-244.30 Dolomite: grey, lam ⊥ Ca.
244			
245			244.30-246.00 Interlam. grey dolomite v.f. calc. sandstone:
246			246.00-246.28 Silty sandy dolomite:
		p	246.28-246.53 Dolomitic sandstone: poorly sorted, coarsens downwards.
247			246.53-247.57 Silty to sandy dolomite:
248		nl	Dolomite: grey
		p	247.57-248.22 Silty sandy dolomite:
249			248.22-250.15 Silty to sandy dolomite: lam.
250			250.15-258.43 Silty to sandy dolomite: lam. in part, with dark carbon rich hairline lam., minor coarse sandy lam.
251			
152			
253			
254			
255			
256			
257			
258			
259			258.43-260.00 Sandy dolomite: clasts s.r.-r. up to ½ cm, coarser toward base of basement lithologies, minor stylolites.
260			

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

MARLA -1B

CORE DESCRIPTION

DEPTH 260-280 m INCLINATION

LOGGED BY MCB DATE DRILLED Sept. 79

REFERENCE

DEPTH (m)	GRAPHIC LOG		DESCRIPTION
260			
261		wl	
262			260.00-261.50 Dolomite: grey, 1% qtz. throughout, s.a.-r.-f.-c.
263			261.50-261.87 m.c. sandy dolomite: intraclasts of light dolomitic have weakly defined boundaries.
264		b	261.87-263.10 f.-v.c. sandy dolomite: qtz s.a.-s.r., carbon filled stylolites
265			263.10-263.30 sandy dolomite: clasts include range of lithotypes up to granule size, generally well rounded.
266			263.30-263.90 Dolomite: grey.
267			266.00-271.00 Dolomite: grey, intraclasts dolomite in sand rich lam. and very thin beds, at 269.05 for example there are m. sands cemented by black carbonates, grains up to granule size of s.a.-s.r., v.f. qtz. and feld.
268			
269			
270			
271			
272			271.00-271.68 Dolomite: grey, whispey lam. of black carbon rich clay, defined ⊥ ca., black hairline fractures parallel lam., darkens at base.
273			272.30-274.13 Dolomitic f. sandstone and interlam. dolomite/v.f. sandy dolomites: intraformational clasts of light dolomite in sandstone, s.r.-r. elongate, up to 5 cm long, generally oriented sub ⊥ ca., sandy generally v.f.-f., clasts qtz. up to granule size, s.r.-r., carbon in matrix of sand and follow around irregularly outlined intra-clasts of dolomite.
274			
275			274.13-274.72 Dolomite: light grey calcareous sandstone interlam.
276			274.72-275.00 Dolomite: light grey.
277			276.13-278.00 Interlam. calc. silt to v.f. sand/light dolomite: lam ⊥ ca., intraclasts light dolomite up to 2 cm long r., sand made up of qtz. and kaolinized feld., black graphitic lam. partings.
278			278.00-279.27 Calc. v.f. sandstone: med to poor sorting, minor interlam. of dolomite.
279			
280			

DEPARTMENT OF MINES AND ENERGY — SOUTH AUSTRALIA

MARLA -1B

CORE DESCRIPTION

DEPTH 280-300 m INCLINATION

LOGGED BY MCB DATE DRILLED Sept. 79

REFERENCE

DEPTH (m)	GRAPHIC LOG		DESCRIPTION
280			
281		nl	279.27- 280.40 Sandy dolomite: grey.
		p	280.40-281.00 Sandy dolomite: grey, black carbon filled irregular veins.
282			281.40-282.00 Dolomite: dark grey.
			282.00-283.00 Silty Dolomite: dark lam. ⊥ ca.
283		nl	
284			
285			284.64-285.12 Calc. f.-m. sandstone:
			285.12-286.00 Interlam. dark silty dolomite calc. f.-c. sandstone.
286			286.00-287.86 Silty dolomite: dark, lam ⊥ ca., a few lam. of m.-v.c. sand, minor sediment disruption, very dark carbon rich lam. lightens in colour toward base.
287			
			287.60-289.00 Sandy dolomite: dirty grey, carbonate recrystallised in places.
288			
		p	289.00-289.28 Silty dolomite: dark, lam ⊥ ca., lam. disappear toward base and become disrupted, irregular shaped calcite veining.
289		nl	
			289.28-289.48 Sandy dolomite: grey.
			Calc. v.c. sandstone: black, carbon in matrix, poorly sorted.
290			290.25-293.21 v.f. sandy dolomite: dark, lam. ⊥ c.a. and disrupted, dark stylolites cross cut lam. but generally parallel pyrite associated with vertical calcite veins, sandier and coarser at 291.16.
291			
292			
293			
		p	
294		p nl	293.40-295.28 Calc. v.f.-f. sandstone: intraclastic light dolomite common, from ½ cm to 4 cm., black whispey carbon filled contorted lam.
295			
			295.38-297.00 Silty dolomite: dark grey, lam ⊥ ca., minor m.-c. sand lam.
296			
297			297.00-301.00 Silty dolomite: dark, lam. ⊥ ca., occassional irregular white calcite pods and veins, minor silt to m. sand lam. dark lam disrupted in part.
298			
299			
200			

S14 628k

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

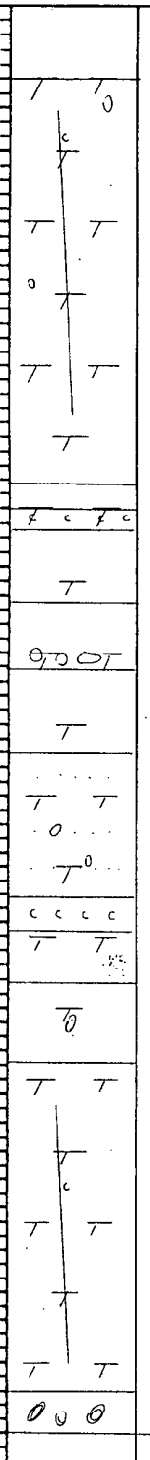
MARLA -1B

CORE DESCRIPTION

DEPTH 300-320 m . . . . INCLINATION . . . . . .

LOGGED BY . . MCB. . . . . DATE DRILLED . Sept.. 79 . .

REFERENCE . . . . . .



	301.00-306.66 Silty dolomite: dark lam. ⊥ ca., occassional vugs, irregular pods and vertical veins of calcite, minor intraformational brecciation.
n.1.	
	306.66-307.00 Dolomitic siltstone: irreg. dark distorted lam.
n.1.	
p	307.00-307.31 Dolomite: much irregular shaped calcite vein- ing.
	307.31-308.30 Dolomite:
n.1.	
	308.30-309.22 Dolomite: intraclastic over last 10 cm.
	309.22-310.40 Dolomite:
	310.40-312.45 Silty dolomite and calc. m.c. sandstone: qtz mainly, larger grains s.a.-s.r. some reworked lighter carbonate clasts, a.-s.a., several c.m. long.
	312.45-312.91 Dolomitic siltstone: thick calcite recryst. parallel veining.
	312.91-313.67 Dolomitic siltstone:
	313.67-314.79 Dolomitic siltstone: dirty grey, irreg. dark "veining".
b n.1. p	
	314.79-319.40 Dolomitic siltstone: minor disruption.
n.1.	

S146281

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

MARLA -1B

CORE DESCRIPTION

DEPTH 320-340 m INCLINATION

LOGGED BY MCB DATE DRILLED Sept. 79

REFERENCE

DEPTH (m)	GRAPHIC LOG		DESCRIPTION
320			
321		b	319.40-320.08 Dolomitic siltstone: characterised by annular ringed features 0.25-2 cm diam.
322		nl. p	320.08-323.15 Dolomitic siltstone: to silty dolomite
323			323.15-326.53 Dolomite: grey, lam. ⊥ ca., interlam., silt to m.-c. sandstone.
324			
325			
326			
327			326.53-326.97 Calc. dolomitic m.-c. sandstone: grains up to v.c., coarsens downwards.
328			
329			
330			
331			326.97-335.94 Dolomite: dark, finely lam., initially over the first 2/3 m. White calcite thick pody veins // lam., that appear to have been distorted, granule size white c.-s.r. clasts in lam. that appear to be no different from the calcite veins in texture.
332			
333			
334			
335			
336			
337		nl.	335.94-338.00 Dolomite: irregular black "veining" generally sub ⊥ ca.
338			
339		b p	338.00-341.17 Dolomite:
340			

S14628m

SHEET 13 OF 15

DEPARTMENT OF MINES AND ENERGY—SOUTH AUSTRALIA

MARLA -1B

CORE DESCRIPTION

DEPTH 340-360 m INCLINATION

LOGGED BY MCB DATE DRILLED Sept. 79.

REFERENCE

DEPTH (m)	GPAPHIC LOG		DESCRIPTION
340		p	
341			341.17-347.20 Dolomite: grey, lam., some distortion, minor interlam., of silt to c. sand especially toward base.
342			
343			
344			
345			
346			
347		p	347.20-350.34 Dolomite:
348			
349			
350			
		wl.	350.34-350.60 Dolomite:
351		n.l.	350.60-351.00 Dolomitic sandstone and dolomite: sandstone poorly sorted, intraclasts of dolomite up to 2 cm.
352			351.00-351.27 Dolomite: dark, lam. ⊥ ca.
353			351.27-351.74 Sandy dolomite: very distorted, irregular v.f. sand lam.
			351.74-352.55 Dolomite: dark lam. ⊥ ca.
354			352.55-353.00 Dolomitic m. sandstone interlam. dolomite: clasts up to granule size, t.r. pyrite, carbonate recrystallised.
355		n.l.	353.00-353.72 Dolomite: dark, lam., ⊥ ca.
356			353.72-354.58 Calc. dolomitic f.-m. sandstone: dark, lam. ⊥ ca.
			354.58-355.40 Dolomite:
357			355.40-356.32 Dolomite: grey
			356.32-356.70 Sandy dolomite: intraclastic
358			356.70-360.80 Dolomite: dark, lam. ⊥ ca., minor interlam. silt and sand, intraclasts of dolomite in sandy lam.
359			
360			

S14628n

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

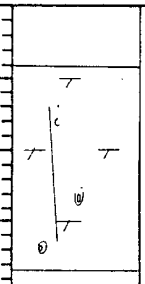
MARLA -1B

CORE DESCRIPTION

DEPTH 360-380 m INCLINATION

LOGGED BY MCB DATE DRILLED Sept. 79

REFERENCE



DEPTH (m)	GPAPHIC LOG		DESCRIPTION
360			
361			360.80-363.71 Dolomite: Dark, lam. ⊥ ca.
362		n.l.	
363		p	
364			363.71-365.09 Dolomite: Dark, lam. ⊥ ca.
365		n.l.	365.09-366.00 Dolomite: Stylolite.
366		n.l.	366.00-367.24 Dolomite:
367		p	367.24-368.60 Dolomite: Dark, lam. distorted midway.
368			368.60-369.21 Dolomite: Dark, irregular black pody veins, sub perpendicular ca.
			369.21-371.66 Dolomite: Irregular pody veining, obscured by recryst. & porosity
369		n.l.	371.06-372.07 Dolomite: Irregular black pody veins obscured by recrystallisation.
370		n.l.	372.07-372.16 Dolomite c. sandstone light colour, a little porous.
371			372.16-372.40 Dolomite:
		c n.l. p	372.40-372.73 Dolomitic sandstone: light, poorly sorted, grains up to granule (sr-r) coarsens toward bottom.
372			372.73-373.42 Dolomite:
373			373.42-374.35 Dolomitic sandstone:
374			
375			374.35-376.40 Dolomite: Grey lam. ⊥ ca., minor sand lam. and intraclastic brecciation.
376			
377			376.40-378.25 Dolomite:
378			378.25-379.40 Dolomite:
379			TD 379.40

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APPENDIX II

PETROGRAPHY

S. Whitehead, AMDEL

MARLA-1A

5643 RS 81	83.10-84.00 m dolomite
5643 82	102.58-108.65 m dolomite containing celestite
5643 RS 83	113.97-114.0 m dolomite
5643 RS 84	128.10-128.16 m dolomite, silty dolomite, dolomitic siltstone
5643 RS 85	134.12-134.20 m dolomite
5643 RS 86	138.04-138.10 m dolomite, dolomitic fine grained sandstone
5643 RS 87	198.77-198.83 m dolomite, dolomitic sandstone

MARLA-1B

5643 RS 116	84.68-84.75 m intra formational conglomerate with tr. fluorite
5643 RS 117	91.59-91.72 m limestone
5643 RS 118	121.93-122.00 m dolomite with celestite
5643 RS 119	122.64-122.73 m silty dolomite
5643 TS 104	291.63-291.70 m sandy dolomite
5643 RS 105	294.84-294.91 m dolomitic, calcareous sandstone
5647 RS 106	295.88-295.93 m dolomite
5643 RS 107	327.64-327.68 m dolomite
5643 RS 108	332.99-333.00 m carbonaceous pyritic dolomite
5643 RS 109	347.33-347.40 m dolomite
5643 RS 110	352.61-352.65 m dolomitic, calcareous sandstone.

Sample: 5643 RS 81; TS42122

Location: Marla 1A; 83.10-84.00 m.

Hand Specimen:

A pale grey, fine-grained rock with some contorted, thin seams of yellowish-brown material.

Thin Section:

The sample contains over 95% of very fine-grained dolomite which is slightly turbid and may contain clay, but this is not visible microscopically. The dolomite contains a few very small mineral grains and mica flakes, but probably the main impurity is clay. There are a few small patches of clear, slightly coarser-grained dolomite and most of these are about 0.1 mm to 0.3 mm in size. This dolomite could have crystallized in small voids from which a mineral had been leached but those present in the thin section do not show any persistent or recognisable shape except that most of them are about equidimensional and a few are oval. Clear dolomite has also filled a few small tension fractures.

The thin seams noted in the hand specimen are of shale stained pale brown and some of these are finely contorted and resemble stylolitic seams. Some of these thin seams intersect and merge with some small fractured zones.

Conclusion:

Very fine-grained dolomite with a few thin seams of shale. Although there are a few small aggregates of clear dolomite which probably crystallized in small leached voids, there is no definite evidence to suggest the former presence of evaporite minerals.

Sample: 5643 RS 82; TS42123

Location: Marla 1A; 108.58-108.65 m.

Hand Specimen:

A very pale grey and pale buff, fine-grained rock. The buff to slightly brownish bands were found to be finely porous, probably due to leaching.

Thin Section:

Mineral assemblage:

	%
Dolomite	>90
Celestite	Trace-1 (more locally)
Quartz	Trace
Mica	Trace
Clay	Undetermined

The rock is composed almost entirely of fine-grained dolomite, much of which has a grain size of between 0.01 and 0.03 mm, with a few larger crystals up to 0.05 mm in size. There are a few very small quartz grains, most of them less than 0.05 mm in size, and a few very small detrital mica flakes. The dolomite probably also contains and undetermined amount of clay impurity which is not visible in the thin section because of the optical properties of the dolomite.

The slightly porous, brownish bands in thin section have numerous, small, leached voids generally between 0.05 and 0.1 mm in size with some up to 0.3 mm long, but the shapes are not sufficiently distinctive for the identity of the leached mineral to be determined. These slightly porous bands also contain a few small crystals of celestite which were identified by optical properties determined on fragments separated from the hand specimen. This occurs generally in elongate patches 0.1-0.3 mm long and it is noticeable that in areas up to 0.5 mm in size irregular and isolated patches of celestite are in optically continuity. Celestite is also present with dolomite in a small, cross-cutting vein 0.2-0.4 mm thick. It is not possible to determine from the thin section whether the leached voids present in the brownish layers once contained celestite or whether the celestite now present has filled some of the leached voids but not others.

Conclusion:

Dolomite containing minor celestite. There are small, leached voids in some slightly porous layers and most of the celestite is concentrated in these layers.

Sample: 5643 KS 83; TS42124

Location: Marla 1A; 113.97-114.0 m.

Hand Specimen:

A fine-grained, grey rock with a few very thin, dark seams.

Thin Section:

This sample is also composed almost entirely of fine-grained dolomite with trace amounts of detrital mica and an undeterminate amount of clay obscured by the dolomite. The thin, dark seams noted in the hand specimen are of dark brown shale containing a few very small quartz grains and probably the dark brown colour is due to organic staining or carbonaceous material. These thin shale layers are slightly wavy or contorted and in a few places they grade into, or are associated with, some very thin, highly contorted stylolitic seams which also have concentrations of carbonaceous material.

The turbid, fine-grained dolomite contains numerous small spots of coarser-grained, clear dolomite generally between 0.05 and 0.1 mm in size and although most of these are equidimensional a few are elongate. This clear, coarser-grained dolomite probably filled small voids from which an undetermined mineral was leached, but the shapes are not sufficiently well preserved or distinctive for this to be identified. Similar clear, coarser-grained dolomite has filled a few small tension fractures which are about at right-angles to the bedding and to the stylolitic seams and similar dolomite has crystallized along the boundaries of two of the thin carbonaceous shale layers.

Conclusion:

Dolosite with some thin seams of carbonaceous shale. The very small aggregates of clear dolomite may have filled voids from which a mineral was leached but there is insufficient evidence for this mineral to be identified.

Sample: 5643 RS 84; TS42125

Location: Marla 1A; 128.10-128.16 m.

Hand Specimen:

A buff-coloured, fine-grained sediment with some thin, darker coloured layers generally less than 1 mm thick.

Thin Section:

Mineral assemblage:

	%
Dolomite	65-70
Quartz and feldspar	15-20
Detrital mica	10-15
Heavy mineral grains	Trace
Oxidized pyrite	Trace

This is a thinly bedded sediment containing abundant dolomite and varying proportions of silt-sized detrital quartz, feldspar, muscovite and biotite and a few very small heavy mineral grains. There are layers up to 3 mm thick which are composed almost entirely of dolomite and these are interbedded with other layers containing varying amounts of silt. Some of the layers would be classified as silty dolomite and others as dolomitic siltstone. Two layers show evidence of graded bedding with higher proportions of coarser-grained quartz and feldspar at the base grading up to dolomite containing only detrital mica and little or no quartz and feldspar. In one area there is some small-scale cross-bedding and some of the silty layers are lenticular. In one area some of the coarser silt has invaded disrupted, fine-grained dolomite layers, possibly during compaction and de-watering of the sediment.

Many of the dolomite layers contain trace to minor amounts of minute iron oxide grains only a few microns in size and in external shape some of these resemble microspherular pyrite. No evidence suggesting the former presence of evaporite minerals was found in the section.

Conclusion:

Interbedded dolomite, silty dolomite and dolomitic siltstone. There is minor graded bedding and lensing and also some evidence of soft-sediment deformation.

Sample: 5643 RS 85; TS42126

Location: Marla 1A; 134.12-134.20 m.

Hand Specimen:

A buff-coloured, fine-grained sediment with some poorly defined, broad banding.

Thin Section:

The rock is composed almost entirely of dolomite and probably an undetermined amount of clay obscured by the dolomite. There is a trace of fine-grained detrital quartz and feldspar in one very thin layer and a minute trace of detrital muscovite.

The dolomite is slightly coarser-grained than the previous sample and most of it has a common grain size of 0.02-0.04 mm. The texture is uniform throughout the rock but there are slight variations in concentration of iron oxide staining which occurs along grain boundaries and in interstices. No other minerals were found and there is no evidence to suggest the former presence of evaporite minerals.

Conclusion:

Dolomite containing very little clastic detritus.

Sample: 3643 RS 86; TS42127

Location: Marla 1A; 138.04-138.10 m.

Hand Specimen:

The sample has layers 2-8 mm thick which are very fine-grained and vary from grey to buff in colour, and these are interbedded with a few thin layers containing some moderately coarse-grained quartz and feldspar.

Thin Section:

The composition varies in different layers but an overall estimate is as follows:

	%
Dolomite	65-70
Quartz	15-20
Feldspar (mainly microcline)	10-15
Detrital muscovite and biotite	3-5
Leucoxene	Trace
Pyrite	Trace

The sample contains layers composed predominantly of very fine-grained, turbid dolomite varying in thickness from less than 1 mm to about 6 mm, and these are interbedded with some layers of fine-grained, dolomitic sandstone which contain at least 60-70% of well-sorted quartz and feldspar grains 0.05-0.1 mm in size with a little detrital mica and some interstitial dolomite. Some of these layers of fine-grained sandstone contain a few scattered larger grains of quartz and feldspar 0.5-1 mm long and most of these are rounded. The coarser-grained layer noted in the hand specimen is about 5 mm thick and this is distinctly bimodal in that it contains up to 40-50% of large quartz and feldspar grains 0.8-1.5 mm in size with a matrix of fine-grained sandstone similar to that in the other layers of dolomitic sandstone. This coarser-grained layer also contains a few rounded grains of dolomite and sandy dolomite up to 1 mm in size and, in a layer adjacent to this, there is one large fragment 1.5 mm in size of moderately coarse-grained dolomitic sandstone. There is one moderately large grain of sandstone or quartzite containing a concentration of pyrite and there are traces of very fine-grained pyrite in some of the larger microcline grains which appear to have been fractured and partly weathered, probably before they were incorporated in this sediment.

One of the layers in the area sectioned shows graded bedding and some of them have wavy boundaries resulting in local lensing, particularly of the sandy layers.

Conclusion:

Fine-grained dolomite interbedded with dolomitic, fine-grained sandstone, siltstone and a layer of coarser-grained dolomitic sandstone which is distinctly bimodal. A few grains in this layer contain a little pyrite, probably indicating reducing conditions at the time this layer accumulated.

Sample: 5643 RS 87; TS42128

Location: Marla 1A; 198.77-198.83 m.

Hand Specimen:

The sample contains a moderately coarse-grained sandy layer, a very fine-grained, pale grey layer, and a moderately fine-grained, darker grey layer.

Thin Section:

The composition varies in different layers and an overall estimate would have little meaning.

The darker layers are of dolomitic sandstone containing at least 40% of detrital quartz, up to 20% of detrital feldspar, mainly microcline, a few heavy mineral grains, mainly leucoxene and zircon, and one or two lithic grains, mainly quartzite. In most of these sandstone layers, or portions of layers, the clastic detrital material is bimodal in that there are some larger grains 0.5-1 mm in size with varying proportions of smaller grains 0.05-0.2 mm in size. One coarser-grained layer contains a higher proportion of larger grains 1-1.5 mm and a few to 2 mm in size with relatively minor, finer-grained sand in interstices. There are also a few well-rounded grains of dolomite up to 1.5 mm in size. These sandstone layers are cemented by fine-grained dolomite and one or two interstices contain a little pyrite.

Interbedded with the sandstone layers there is a layer 10 mm thick composed almost entirely of fine-grained dolomite which has a common grain size of less than 0.02 mm. This dolomite layer has a few detrital flakes of mica and a few (less than 1%) minute opaque grains which are probably pyrite or oxidized pyrite.

In the sandy layers a few of the larger feldspar crystals which appear fractured and weathered contain trace to minor amounts of very fine-grained pyrite and one is partly encrusted by pyrite. These are similar to the feldspar grains containing pyrite noted in the previous sample and suggest reducing conditions prior to, or during, accumulation of the sediment.

No evidence to suggest the presence of evaporite minerals was found.

Conclusion:

Fine-grained dolomite interbedded with dolomitic, feldspathic sandstone, most of which is bimodal.

DESCRIPTION OF CARBONATE SEDIMENTS FROM MARLA 1B

Sample: 5643 RS 116; TS42815

Descriptive Information:
Observatory Hill Beds from DDH Marla 1B at 84.68 - 84.75 m

Hand Specimen:
A pale grey to slightly brownish-grey, fine-grained rock with the structure of an intraformational conglomerate in that there are some rounded elongate and irregularly-shaped fragments of darker, very fine-grained rock in a slightly paler-coloured matrix. The rock has subparallel, but contorted, thin seams containing brownish clay and there are a few dark aggregates and also purplish-coloured aggregates which were found in thin section to be fluorite.

Thin Section:

Mineral Assemblage	%
Calcite	>90
Fluorite	2-3
Shale	2-3
Quartz	trace
Opaque material	trace

The rock is composed predominantly of very fine-grained calcite and the structure is that of an intraformational conglomerate in that there are elongate fragments several millimetres in size of turbid micritic calcite and one almost spherical grain of micritic calcite 4 mm in size in a matrix of slightly paler-coloured and less turbid calcite, much of which is very fine-grained but which contains some patches of clearer, coarser-grained calcite. Some of the fragments of micritic calcite are at least partly rounded and some appear angular. In general, they are moderately closely packed and a few have been subsequently fractured and cut by thin veins of clear calcite.

There are a few thin bands or seams of slightly brownish shale up to 1 mm thick and most of these have a rather contorted and wavy shape. There are also some very thin, highly contorted stylolitic seams containing brown-stained argillaceous or organic material.

Some interstices between the rounded and elongate fragments of micritic calcite contain medium-grained sparry calcite with some aggregates of intergrown fluorite crystals 0.5 mm to 2 mm in size. Some of this fluorite is almost colourless, some shows a faint patchy pale purplish colour and some fluorite has smoky brown staining which tends to occur in zones in the crystal.

Conclusion:
Limestone intraformational conglomerate with thin seams of shale and a little fluorite.

Sample: 5643 RS 117; TS42816

Descriptive Information:
DDH Marla 1B at 91.58 - 91.72 m

Hand Specimen:
A pale buff-coloured rock with a few thin seams of darker orange-brown. It contains a few small, elongate and hexangonal crystals up to about 1 mm in size scattered throughout the rock.

Thin Section:

Mineral Assemblage	%
Calcite	>95
Quartz	2-3
Dolomite	trace-1
Clay	minor

The rock is composed predominantly of fine-grained calcite and the small crystals noted in the hand specimen are prismatic quartz crystals.

The calcite varies in grain size and staining and in some zones these variations suggest relict textures in that there are small round and some irregularly shaped patches 0.2 to 0.4 mm in size of turbid, micritic calcite with a matrix of slightly coarser-grained, clear calcite and in other zones there are larger patches of turbid micritic calcite up to 1 mm in size with a matrix of coarser-grained sparry calcite. Although these textures are moderately well defined in some zones there is no clear evidence as to their origin.

The quartz occurs as small prismatic crystals varying in size up to about 1 mm long and these have crystallized in the limestone. Most of them contain a few very small inclusions of calcite and one was found to have crystallized as an overgrowth on a small detrital quartz grain but most of them do not show any nucleus of a detrital grain. Dolomite occurs mainly along subparallel, thin dark seams which are contorted and may be incipient stylolitic seams. Most of the dolomite occurs as small euhedral crystals generally less than 0.1 mm in size surrounded by calcite. Some of these thin seams and also a few other areas in the limestone are stained possibly indicating the presence of some clay but this cannot be quantitatively estimated as it is obscured by the optical properties of the carbonate minerals.

Conclusion:
Limestone containing scattered small authigenic quartz crystals and minor dolomite.

Sample: 5643 RS 118; TS42817

Descriptive Information:
DDH Marla 1B at 121.93 - 122 m

Hand Specimen:
Part of the sample is a pale-buff, very fine-grained carbonate rock and this has a zone extending over at least half the width of the core in which there are some pale grey to colourless crystals and crystalline aggregates. This zone also has a few flakes of muscovite and some thin veins of a yellow clay mineral which is probably an iron-bearing montmorillonite (?nontronite) but positive identification of this would require X-ray diffraction. The pale-buff carbonate shows indistinct layering but in the zone containing the crystals there are only scattered patches or remnants of carbonate.

Thin Section:

Mineral Assemblage	%	
Dolomite	50-60	(varies)
Quartz	25-30	
Celestite	15-20	
Muscovite	1-2	
Montmorillonite clay(?)	1-2	

The host rock is a very fine-grained dolomite which contains traces of very fine-grained mica and quartz and probably also contains some clay obscured by the optical properties of the dolomite but does not show any other special features. This zone in the dolomite has, at some time, been invaded by solutions but whether this was due to a local concentration of fractures or to some other cause is unkown. Aggregates of celestite crystals, some of them at least 4 mm in size, are developed in this zone and in places celestite can be seen filling small fractures in the dolomite. In places, the celestite is closely associated with some deformed muscovite crystals, the origin of which is uncertain but at least some of the muscovite appears to have formed in a fracture or vein. Some of the muscovite is cut by small veins of celestite and in one area textures strongly suggest that some of the muscovite was replaced by the celestite. Some dolomite has also been replaced by celestite and in these areas the celestite contains remnants of dolomite as small inclusions.

This zone also contains moderately abundant chalcedonic quartz which has probably spread out from small fractures in the dolomite and some may have filled voids. Much of this chalcedonic quartz shows radiating fibrous textures and there are some imperfectly formed spherulitic structures. Locally the chalcedonic quartz grades into coarser-grained quartz including a few small euhedral crystals which generally contain small inclusions of dolomite. Quartz and celestite are closely associated and in many places celestite has filled small fractures or veins cutting the chalcedonic quartz. There are also areas where celestite appears to have filled the interior of voids which were lined by the chalcedonic quartz and in general the evidence, therefore, suggests that the quartz crystallized before the celestite. The patterns formed by the quartz relative to dolomite indicate that most of it probably crystallized in fractures or voids in the dolomite.

The yellowish clay noted in the hand specimen occurs mainly as small veins

cutting the other minerals and also occurring along some boundaries between dolomite and quartz and therefore it is of relatively recent origin compared with the other minerals.

There are a few small crystals of calcite included in some of the celestite crystals.

Conclusion:

A fractured or deformed zone in dolomite contains moderately abundant secondary or introduced quartz, a little muscovite of undetermined origin and a moderate amount of celestite which crystallized after both quartz and muscovite. There is a trace of yellow clay probably an iron-bearing montmorillonite which formed relatively late in the history of the rock.

Sample: 5643 RS 119; TS47818

Descriptive Information:
DDH Marla 1B at 122.64 - 122.73 m

Hand Specimen:
A very pale grey, fine-grained sediment with a few darker layers and one layer 1.5 mm thick which contains a yellow mineral. Some layers contain a few visible quartz grains.

The section was cut to include the layer containing the yellow mineral but another part of the sample which was not included in the thin section contains some irregular aggregates of quartz associated with traces of muscovite and with some crystalline dolomite. Celestite was not found when portions of these aggregates were examined separately in refractive index liquids. It is clear that some of these small patches of quartz have formed in small fractures or voids but the possibility that some of this quartz could have replaced crystals of an evaporite mineral cannot be entirely excluded.

Thin Section:

Mineral Assemblage	%	
Dolomite	>90	
Quartz	2-3	
Detrital muscovite and biotite	trace	
Potash feldspar	trace	
Leucoxene grains	trace	
Clay	minor	(local concentration)

The sediment is composed mainly of very fine-grained, slightly turbid dolomite and variations in grain size and turbidity suggest some disturbances to the sediment early in its history. There are some thin layers containing silt and sand-sized detrital quartz grains with a few scattered larger grains of quartz and silicified rock up to 2 mm in size and in a few places, the patterns of distribution of the silty material suggests that it was mobile soon after the sediment accumulated and some of it invaded disrupted layers of the very fine-grained dolomite. Two layers containing silty material show graded bedding with the coarser-grained detrital quartz grains up to 0.05 mm in size being concentrated at the base and in contact with a finely undulating surface of the underlying, very fine-grained dolomite. There are a few small grains of leucoxene in this silty material and a few detrital flakes of muscovite and biotite. In one of these layers showing graded bedding there is an elongate crystal or aggregate of celestite 0.8 mm long.

The yellow layer noted in the hand specimen contains silt-sized detrital quartz, a little mica and some elongate grains or fragments of micritic dolomite in a matrix containing dolomite and very fine-grained, yellow clay which has a moderate birefringence and therefore probably belongs to the montmorillonite group. As it has a yellowish to slightly greenish colour it is probably the iron-bearing montmorillonite clay mineral - nontronite and it is similar to the small veins of yellow clay occurring in the sample from about 122 m. This layer also has a few scattered

larger detrital quartz grains 1 to 2 mm in size.

Conclusion:

Silty and slightly sandy dolomite with one layer containing a yellow-clay mineral possibly nontronite. One zone in the sample contains some patches of secondary or migratory quartz and a trace of muscovite similar to that at 122 m. There is a trace of celestite.

DESCRIPTION OF DOLOMITIC ROCKS AND LIMESTONES CONTAINING QUARTZ AND SOME CARBONACEOUS MATERIAL

Sample: 5643 RS 75; TS42032; Depth 142.10 m

Hand Specimen:

A pale greyish-brown, finely porous, fine-grained rock with some poorly defined layering almost at right angles to the direction of the drill hole. There are a few thin seams of dark carbonaceous material and a small vein of white carbonate. In parts of the rock there are also small vugs lined with quartz crystals and there are similar small patches of quartz. One of these small vugs contains a crystal of another mineral which was examined in a temporary oil mount and found to be celestite and another quartz vug contains some small crystals of pyrite.

Thin Section:

A visual estimate of the minerals is as follows:

	%
Dolomite	>90
Calcite	trace-1
Quartz	3-5
Pyrite	trace-1
Celestite	trace

Most of the rock is composed of a porous mass of very fine-grained dolomite containing a few scattered, small crystals of quartz generally less than 0.1 mm in size and a few cubic crystals of pyrite up to 0.05 mm in size. No definite evidence could be found to show the reason for the porosity but it is possible that the rock once contained another, more soluble mineral which has been leached. This porosity varies in some parallel bands and is the main cause of the banding noted in the hand specimen. There is little or no variation in the concentration of very small quartz crystals in the area sectioned but there is one thin band containing a higher concentration of pyrite crystals.

Patches of vuggy quartz varying in size from 0.5 mm to over 6 mm long are scattered through the rock and many of these show some evidence of former crystal shape generally in the form of one or two straight edges. It is therefore suggested that these could have been moderately large crystals of an evaporite mineral and although a few of them could be interpreted as showing some approximate resemblance to halite in general shape, this is certainly not sufficiently well preserved for the former mineral to be identified. A few of the vugs lined with quartz contain small crystals of calcite and one contains a crystal of celestite. There is also an isolated crystal of celestite about 0.8 mm long in the fine-grained dolomite.

Conclusion:

Porous, slightly pyritic dolomite with small quartz vugs which could have replaced crystals of an evaporite mineral. The rock also has some thin seams of carbonaceous material.

Sample: 5643 RS 76; TS42033; Depth ~~140-85~~

Hand Specimen:

A moderately fine-grained, grey rock with some irregular, thin seams of dark carbonaceous material some of which could be stylolitic seams. Some zones and poorly defined bands in the rock are porous and the numerous small voids are lined with tiny quartz crystals with a few carbonate crystals.

Thin Section:

A visual estimate of the minerals is as follows:

	%	
Calcite	55-60	
Quartz	40-45	
Dolomite	trace	
Clay	trace-1?	
Carbonaceous material	1-2	(varies)
Pyrite	trace	

This is a moderately fine-grained limestone in which some zones have been extensively replaced by quartz.

Some zones in the rock are composed of a structureless mass of fine-grained calcite with a common grain size of less than 0.05 mm and this contains a few scattered aggregates and crystals of migratory and recrystallized quartz generally between 0.5 and 1 mm in size but there are a few larger, elongate aggregates. Most of these small patches of quartz do not show any definite shape but there is one with an almost square cross-section with slightly concave sides which could be interpreted as a former hopper-faced cubic crystal typical of halite crystals, however, caution is advised in interpreting these structures. Additional quartz overgrowths have grown out from this former (cubic?) crystal and these overgrowths contain numerous inclusions of calcite where they have partly replaced the surrounding calcite. The fine-grained limestone contains a few small patches or wisps of dark carbonaceous or organic material, a few flakes of mica and a trace of leucoxene.

The thin section contains two extensively silicified zones 6 to 8 mm thick now composed predominantly of fine to medium-grained quartz with scattered remnants of fine-grained calcite, traces of dark brown material and a few small crystals of pyrite. Relict textures marked by lines of fine-grained, dark brown material or staining outline many oval, curved and rounded areas 0.2 to 1 mm in size but there is no conclusive evidence as to the origin of these except that the shape of a few suggest that they could have been oolites. Some of these oval bodies are now voids lined with small quartz crystals and some have been replaced by finer-grained turbid quartz stained pale brown. Interstices between these former rounded to oval bodies or oolites contain varying proportions of secondary quartz and remnants of calcite. One of these zones contains a thin seam of dark brown carbonaceous material or carbonaceous shale crowded with small crystals of carbonate, some of which may be dolomite.

At one end of the thin section there is a zone of coarsely crystalline calcite containing elongate fragments of dark brown carbonaceous shale composed mainly of carbonaceous material mixed with small flakes of mica and probably some argillaceous material. This may represent a disrupted layer of carbonaceous shale which has been invaded by coarsely crystalline calcite.

Conclusion:

Partly silicified limestone with minor carbonaceous shale. Relict textures in some layers suggest that they may have contained oolites or similar rounded grains or fragments.

Sample: 5643 RS 77; TS42034; Depth 145.60 m

Hand Specimen:

A very pale grey rock containing some concentrations of rounded quartz grains 0.5 to 2 mm in size. There are also some elongate fragments a few millimetres long of pale grey to almost white, fine-grained rock.

Thin Section:

A visual estimate of the constituents is as follows:

	%	
Calcite	70-75	
Quartz	20-25	
Potash feldspar including microcline	1-2	
Argillaceous material	2-3?	(difficult to estimate)
Detrital muscovite	trace	
Lithic grains	trace	
Carbonaceous material	trace	
Pyrite	trace	

This sediment contains poorly sorted detrital quartz, feldspar and lithic grains 0.2 to 2 mm in size, a few detrital muscovite flakes and some rounded, generally elongate fragments of turbid limestone 1 to 2 mm in size cemented by a matrix of moderately fine-grained calcite containing small, turbid patches stained by argillaceous material. Many of the larger detrital quartz grains are well rounded and some of these are partly surrounded by overgrowths of secondary quartz which penetrate the surrounding calcitic matrix and these overgrowths contain a few small inclusions of carbonate. Potash feldspar grains are subrounded to sub-angular and some show twinning typical of that in microcline and in general these do not show overgrowths. Lithic grains include two large grains 1 to 2 mm in size of acid volcanic rock composed largely of feldspar and quartz and relict textures in one of these suggests that it may have originally contained some tridymite. These grains of volcanic rock are subrounded. Detrital muscovite flakes are up to 1 mm long and generally deformed. Variations in colour or staining, turbidity and grain size mark the positions of rounded and generally elongate fragments of limestone and one of these has a possible relict oolitic texture not very clearly preserved.

The mineral and lithic grains are scattered through a matrix composed mainly of fine-grained calcite with patches of staining probably due to the presence of some fine-grained argillaceous material. This matrix also contains a few small authigenic crystals of quartz and there are a few irregular patches of medium-grained, secondary quartz containing very numerous small inclusions of calcite. There are a few small concentration of dark brown to opaque material in interstices between calcite crystals and there are a few small grains of sulphide probably pyrite.

Conclusion:

Sandy limestone showing some evidence of intraformational conglomerate. The clastic detritus includes some coarse-grained quartz and potash feldspar and also a few subrounded grains of acid volcanic rock.

Sample: 5643 RS 78; TS42035; Depth ~~150.45 m~~

Hand Specimen:

A pale grey sandstone with a porous zone 2 to 3 cm thick containing some coarser-grained detrital material and also some elongate fragments of fine-grained rock. The section was cut to include portion of this porous zone and portion of the grey sandstone.

Thin Section:

A visual estimate of the minerals is as follows:

	%	
Quartz	55-60	
Dolomite	35-40	
Potash feldspar	2-3	(possibly more)
Lithic grains	trace	
Detrital mica	trace	
Tourmaline	trace	
Sulphide	trace	

The grey sandstone is composed of moderately well-sorted quartz and feldspar grains and a few lithic grains most of which are between 0.2 and 0.4 mm but there are some larger grains up to 0.6 mm. The larger grains are slightly more abundant in some poorly defined bands but there is no clear evidence of bedding. Many of these detrital grains are subrounded, a few are well rounded and the smaller ones are mainly subangular. Lithic grains include a few of acid volcanic rock similar to those noted in the previous sample and these contain concentrations of extremely fine-grained sulphide probably pyrite. They vary in size up to 1 mm and are subangular to subrounded. The sandstone also contains a few rounded grains of dolomite and one of quartzite. The detrital grains are loosely packed and generally just touching. There is no evidence of interpenetration and only a few are welded at points of contact. Interstices contain fine-grained dolomite and there are many interstitial voids but it is not possible to determine from the thin section whether or not these voids once contained another mineral.

The coarser-grained zone contains some detrital quartz, microcline and lithic grains 1 to 2 mm in size and also some elongate and irregular patches or fragments of fine-grained dolomite. These are very loosely packed, generally not touching and are cemented by a matrix of dolomite containing a few much smaller quartz and feldspar grains and mica flakes. The coarser-grained zone is separated from the finer-grained sandstone by a very thin layer less than 1 mm thick of dolomitic siltstone containing higher proportions of detrital muscovite and of fine-grained sulphide than the remainder of the rock.

Conclusion:

Dolomitic sandstone containing minor detrital feldspar and a few lithic grains including some rounded grains of pyritic, acid volcanic rock. The sediment also contains some rounded grains and elongate fragments of dolomite and it is cemented by dolomite.

Sample: 5643 RS 104; TS42714

Location:
DDH Marla 1B at 291.63 - 291.70 m. Reported to be Observatory Hill Beds.

Hand Specimen:
A pale grey sedimentary rock with layers 1 to 5 mm thick of very fine-grained sediment alternating with generally thicker layers of coarser-grained sediment.

Thin Section:

Mineral Assemblage	%
Dolomite	60-65
Calcite	5-10
Quartz	25-30
Potash feldspar	2-3
Lithic grains	trace
Leucoxene	trace
Clay	2-3?
Pyrite	trace

The rock contains a few thin layers of fine-grained dolomite 1 to 2 mm thick alternating with much thicker layers which contain varying proportions of dolomite and detrital quartz and feldspar.

The coarser-grained layers contain poorly sorted quartz and feldspar grains varying in size from 0.1 to 1.5 mm and most of these are sub-angular to subrounded. There are also a few rounded fragments 0.5 to 2 mm in size composed of extremely fine-grained, micritic dolomite and there are a few very thin, elongate wisps of brown-stained material probably mainly shale containing minute grains of pyrite. There are a few other lithic grains most of which are too fine-grained for their origin to be determined and some of these also contain fine-grained pyrite. The mineral and lithic grains are scattered through a matrix composed mainly of intergrown dolomite crystals 0.02 mm to 0.1 mm in size and in this dolomitic matrix there are scattered aggregates of calcite of similar grain size to the dolomite. The matrix also contains small areas of brown-stained clay generally with trace amounts of extremely fine-grained pyrite and it is possible that the brown colour could be due to organic staining in the clay. Because the clay tends to be obscured by the optical properties of the carbonate minerals, it is not possible to give an accurate quantitative estimate of the amount of clay present in the carbonate matrix.

There is one thin layer containing a higher proportion of detrital quartz and feldspar and correspondingly less dolomite and this could be classified as a dolomitic sandstone but in general, the carbonate minerals predominate.

The thin, finer-grained layers are composed almost entirely of intergrown dolomite crystals up to 0.02 mm in size and they contain trace amounts of very fine-grained pyrite and minor clay.

Conclusion:
Sandy dolomite interbedded with thin layers of very fine-grained dolomite. There is a trace of very fine-grained pyrite and probably some organic staining in the argillaceous material. There has been some reworking of fragments of very fine-grained dolomite and therefore portions of the rock could be classified as intraformational conglomerate.

Sample: 5643 RS 105; TS42715

Location:
DDH Marla 1B at 294.84 - 294.91 m.

Hand Specimen:
The sample has a thick layer of grey sandstone containing some elongate fragments up to 15 mm long of paler grey, very fine-grained rock found in thin section to be dolomite and interbedded with this sandstone there are a few continuous, thin layers of similar fine-grained dolomite. The rock has split along one very thin layer or lamination of dark shale.

Thin Section:

Mineral Assemblage	%
Quartz	50-55
Potash feldspar	20-25
Lithic grains	trace
Mica and chlorite	trace
Dolomite	15-20
Calcite	5-10
Shale	trace
Leucoxene, tourmaline and zircon	trace
Carbonaceous material	trace
Pyrite	minute trace

The coarser-grained layer in this sample contains detrital quartz and feldspar grains which are moderately well sorted in that many are between 0.15 and 0.3 mm in size but there are also some larger grains 0.4 to 0.8 mm in size with a few up to 1 mm and one quartzite grain almost 2 mm in size. These grains vary from angular to subrounded and there are even a few well-rounded grains. Lithic grains are mainly of quartzite and there are a few detrital mica and chlorite flakes and a few heavy mineral grains mainly leucoxene, tourmaline and zircon. There are a few very thin wisps of dark brown to opaque material probably carbonaceous matter and there are traces of clay. This sandstone layer also contains some elongate fragments of layers of very fine-grained, micritic dolomite up to 2 mm thick and also portion of a thin layer of dolomite over 10 mm long which has been deformed or folded into a very irregular shape. This suggests disturbance to the sediment early in its history and it is possible that the coarser-grained sandy material invaded disrupted layers of the fine-grained dolomite. Detrital grains in this sandstone are loosely packed and generally just touching or not quite touching but a few are welded where they are in contact. Interstices contain varying proportions of calcite and dolomite with calcite being more abundant in some zones and dolomite in others.

At one end of the section there is a thin layer of fine-grained dolomite and this contains fine laminae and a few thin wisps of brown-stained micaceous shale in which the colour could be due to organic staining. There is a similar, but discontinuous, thin laminae of organically-stained shale separating the dolomitic sandstone from a layer of finer-grained, sandy dolomite.

Conclusion:
Dolomitic and calcareous, feldspathic sandstone with thin layers of fine-grained dolomite and laminae of organically-stained shale. There has been some disturbance early in the history of this sediment and deformed fragments of dolomite layers are now included in the sandstone.

Sample: 5643 RS 106; TS42716

Location:
DDH Marla 1B at 295-88 - 295.93 m.

Hand Specimen:
A pale grey, fine-grained sediment with layers a few millimetres thick defined by slight variations in colour.

Thin Section:

Mineral Assemblage	%
Dolomite	> 90
Quartz and feldspar	1-2
Mica and chlorite	1-2
Clay	undetermined (minor)
Pyrite	minute trace

The rock is composed predominantly of fine-grained dolomite and in general, layers 1 to 2 mm thick with a common grain size of 0.01 to 0.02 mm alternate with thin layers of slightly coarser-grained dolomite and these coarser-grained layers contain a little detrital mica and chlorite and also probably contain some clay although this is obscured by the optical properties of the dolomite. There are also a few pockets or irregular layers containing low concentrations of sand-sized detrital quartz and feldspar grains but these do not form continuous or well-defined layers. A few larger quartz and feldspar grains 0.5 to 1 mm in size are scattered through the rock.

The sediment has been disturbed before it was consolidated and although there are some isolated, elongate fragments of the finer-grained dolomite surrounded by the slightly coarser-grained and slightly silty dolomite suggesting an intraformational conglomerate, there is also some evidence showing that layers of the fine-grained dolomite have been disrupted and invaded by the coarser-grained sediment.

Conclusion:
Dolomite with minor sandy and silty dolomite. Bedding has been disturbed early in the history of the sediment.

Sample: 5643 RS 107; TS42717

Location:
DDH Marla 1B at 327.64 - 327.68 m.

Hand Specimen:
A fine-grained, finely laminated grey sediment with some very thin laminae of carbonaceous shale along which the rock tends to split. The sample contains an irregularly-shaped, almost white mass, found in thin section to be mainly secondary quartz and this has replaced aggregates of an undetermined mineral which may have been concretionary but some of the layers appear to be domed over this white mass. It has also penetrated along some planes parallel to the bedding. There is also a layer in the sediment which contains some oval to spherical grains now composed of similar white quartz.

Thin Section:

Mineral Assemblage	%	
Dolomite	>70	
Secondary quartz	20-25	
Detrital quartz and feldspar	1-2	
Detrital mica	1-2	
Calcite	2-3	(local)
Carbonaceous shale	trace	

The sediment is composed predominantly of fine-grained dolomite and there are slight variations in grain size and in turbidity or staining in different layers which vary in thickness from 0.2 mm to about 2 mm. There are a few very thin laminations or seams of dark brown micaceous shale stained by organic material and there are a few thin wisps of similar carbonaceous shale. Some layers of dolomite contain a few detrital quartz and feldspar grains which vary in size from less than 0.05 mm to about 0.8 mm and there are also a few detrital mica flakes. There is one very thin layer which could be classified as fine-grained, dolomitic sandstone.

The almost white masses noted in the hand specimen are composed of secondary quartz and calcite and in general, the secondary quartz predominates. This quartz occurs as intergrown crystals 0.1 to 0.3 mm in size and in some of the larger masses there are a few radiating aggregates of quartz, one of which has a diameter of 3 mm. Throughout this quartz there is abundant evidence of relict textures in the form of staining and minute voids and these relict textures show that the quartz replaced masses of some moderately fine-grained, pristmatic or almost fibrous mineral, but the external shape of these small crystals has not been preserved. The general appearance of these relict textures suggests that it may have been a sulphate mineral but this cannot be confirmed. In some of the zones of quartz which have crystallized across the earlier rock fabric there are a few very tiny ?remnants of the earlier mineral but these are only a few microns in size and they are too small to be identified. They do, however, have a higher refractive index and also a higher birefringence than quartz and therefore the mineral replaced was probably not gypsum. There is some moderately coarse-grained calcite in the interior of these patches of secondary quartz and this does not show relict textures. In the layer containing scattered, isolated patches of this secondary quartz the silicified bodies vary in size from 1 to 5 mm and most of them are elongate and a few are almost oval in shape. The larger ones also contain calcite

in the interior and the quartz shows similar relict textures to those in the larger, irregular mass occurring in the centre of the sample.

Conclusion:

Layered dolomite with traces of carbonaceous shale and sandy dolomite. It has an irregular mass and also some smaller, scattered bodies in which secondary quartz has replaced aggregates of a fine-grained, prismatic to almost fibrous mineral which could have been a sulphate but which cannot be positively identified from the available evidence.

Sample: 5643 RS 108; TS42718

Location:
DDH Marla 1B at 332.99 - 333.00 m

Hand Specimen:
A dark grey, fine-grained sediment.

Thin Section:

Mineral Assemblage	%
Dolomite	>95
Quartz	trace
Detrital mica	trace
Leucoxene	trace
Pyrite	1-2
Clay	undetermined (minor)
Carbonaceous or organic staining	<5

This sample is composed almost entirely of intergrown dolomite crystals which vary in size from a few microns up to 0.03 mm and interstices between these dolomite crystals contain brown-stained organic material or possibly organically-stained clay. There are also minute grains of pyrite scattered throughout the rock occurring in interstices and also included within some of the dolomite crystals and at least a few of these are spherical. There are a few larger patches or aggregates of pyrite up to 0.05 mm long and these are present in higher concentration in some zones or bands than in others. There are a few thin wisps of dark brown, carbonaceous shale or carbonaceous material up to 0.2 mm long.

The dolomite contains a few scattered detrital grains of quartz and feldspar up to 0.15 mm in size and a few small flakes of mica. There is a higher concentration of mica in one discontinuous and poorly defined band which also has higher concentrations of brown organic or carbonaceous staining and also of pyrite.

Conclusion:
Carbonaceous and pyritic dolomite.

Sample: 5643 RS 109; TS42719

Location:
DDH Marla 1B at 347.33 - 347.40 m.

Hand Specimen:
A slightly porous, grey rock which has a mottled appearance due partly to slight variations in colour and partly to the results of leaching.

Thin Section:

Mineral Assemblage	%
Dolomite	>95
Calcite	2-3
Quartz	trace
Opaque material	minute trace

The rock is predominantly dolomite but there is a much greater variation in grain size than in other samples of dolomite described above. There are irregular patches of fine-grained dolomite with a common grain size of about 0.01 to 0.03 mm and these zones are lightly stained dull brown and some also contain minute opaque grains which are probably pyrite but which are too small to be positively identified in thin section. Surrounding and separating these patches of finer-grained dolomite there are zones of coarser-grained, clear dolomite containing crystals 0.1 to 0.5 mm in size and some of these patches of coarser-grained dolomite also contain calcite which generally occurs in interstices between dolomite crystals. The zones of finer-grained, more turbid and possibly slightly pyritic dolomite vary in size from 0.5 mm to about 2 mm and in general, no regular pattern could be recognized in the distribution of finer-grained and coarser-grained zones.

There are a few scattered voids generally in zones containing calcite and some of these are lined with a film of very fine-grained clay. There is one very thin seam containing wisps of dark material probably carbonaceous matter and at one end of the hand specimen there is a much higher concentration of probably similar carbonaceous material along a ?stylolitic seam.

Conclusion:
Dolomite containing minor calcite. It shows more evidence of recrystallization than the other samples and also slight leaching.

Sample: 5643 RS 110; TS42720

Location:
DDH Marla 1B at 352.61 - 352.65 m

Hand Specimen:
A grey sediment with a thick layer containing coarse sand-sized detrital quartz grains and a thin layer of much finer-grained material. There are traces of dark material and of very fine-grained pyrite.

Thin Section:

Mineral Assemblage	%
Quartz	50-60
Dolomite	20-25
Calcite	20-25
Potash feldspar	5-10
Detrital mica	trace
Leucoxene	trace
Clay	2-3
Pyrite	trace

The coarser-grained layer contains moderately well sorted quartz and feldspar grains most of which are between 0.5 and 1 mm in size but there are some outside of these limits. There are also a few grains of quartzite and a few rounded fragments of reworked, fine-grained dolomite. Many of the quartz grains are subrounded to well-rounded and feldspar grains are subangular to subrounded. Fine-grained pyrite has invaded a few partly weathered feldspar grains and traces of pyrite are also present along small fractures in a few quartz grains and in interstices in one of the fine-grained quartzite grains. This suggests that reducing conditions prevailed where this sediment accumulated. There are a few small patches of brown-stained clay and some wisps of darker brown material which may be either organically-stained clay or carbonaceous material and clay. There are very few heavy mineral grains mainlyleucoxene and very rare zircon and there are a few detrital mica flakes. In this coarse sandy layer the detrital grains are loosely packed and generally just touching or not touching. Interstices contain varying proportions of fine-grained dolomite and slightly coarser-grained calcite.

There is one layer 4 mm thick containing much finer-grained detrital quartz and feldspar with a common grain size of 0.05 to 0.1 mm and this contains a slightly higher concentration of heavy mineral grains and also of very small crystals of pyrite. It is cemented by an abundant matrix of fine-grained dolomite and is in contact with a layer composed predominantly of fine-grained dolomite which has only minor amounts of detrital quartz, feldspar and mica.

Conclusion:
Dolomitic and calcareous, feldspathic sandstone with a thin layer of fine-grained, sandy dolomite. The sediment contains traces of carbonaceous material and pyrite.

APPENDIX III

Descriptions of Carbonate Lithologies in 28 Acetate Peels, Marla-1A and -1B

(A full description and interpretation of carbonate lithologies in Marla-1A, -1B will appear in Youngs (1980)).

Bridget C. Youngs
Fossil Fuels Section

Brief Descriptions of Acetate Peels, Marla-1A and-1B

Twenty-eight acetate peels were made from selected intervals as follows:

Marla-1A -	85.50 m
	92.80 m
	106.90 m
	144.90 m
	146.50 m
	148.90 m
	155.15 m
	157.90 m
	158.50 m
	166.30 m
	170.95 m
	182.05 m
	184.90 m
	200.50 m
	201.80 m
Marla-1B -	204.40 m
	224.50 m
	235.10 m
	245.75 m
	260.90 m
	277.80 m
	295.25 m
	302.00 m
	308.00 m
	321.10 m
	330.25 m
	338.35 m
	354.70 m

Marla 1A

85.50 m: Silty dolomitic mudstone

Flat-bedded to slightly wavy, finely laminated dolomite mudstone. Silty throughout, with concentrations of silt in some layers.

92.80 m: Very silty calcite mudstone with quartz granules and ?chert alteration patches

Vaguely layered, very silty mudstone (similar to 85.50 m but much more silty) with some silty layers also containing subrounded to rounded quartz grains (0.5-1.0 mm). Areas of pervasive ?chert alteration. Porous.

106.90 m: Calcite mudstone

Calcite mudstone completely lacking bedding. Patches of microspar throughout. Some small-scale stylolites. Porous.

144.90 m: Silty mudstone

Similar to 85.50 m, with more silty layers throughout. Extensive later calcite veining.

146.50 m: Silty mudstone with ?bituminous laminae

Silty calcite mudstone lacking bedding, layering or grading. Dark, ?bituminous laminae at regular intervals parallel to bedding; small irregular patches of chert associated with them. Rare small, rounded patches (<1 mm) of dark material. Porous.

148.90 m: Mudstone with ?bituminous laminae

Calcite mudstone with thin (3 mm), interbedded ?bituminous laminae. Some subangular to angular, average 0.2 mm, ?carbonate fragments throughout the mudstone. An area of brecciation in the centre of the peel shows that chert and then calcite invaded and disrupted the mudstone layers; ?bituminous material in this zone also.

155.15 m: Silty mudstone with ?bituminous material

Silty, calcite mudstone with vague, disrupted layering. Coarse secondary calcite spar occurs in small, irregular patches in the ?bituminous material. Porous.

157.90 m: ?Peloidal packstone with intraclasts

Top 10 mm is a ?peloidal packstone with some microspar recrystallisation (as for 158.50 m). The remainder of the peel is a recrystallised ?peloidal packstone which has some carbonate intraclasts and a small amount of in situ brecciation. This brecciation is partly associated with the development of small-scale stylolites and has varying amounts of dark, ?bituminous material injected into it.

158.50 m: Intraclast and peloidal packstones

Large, dolomitic mudstone intraclasts showing evidence of only slight removal from site of formation. Veins and patches of recrystallisation occur in the intraclasts. Silty ?bituminous mudstone is the matrix of the packstone. Centre of peel has an area of pervasive, secondary chertification which grades into carbonate material. Top 25 mm is a peloidal packstone with a microspar matrix.

166.30 m: Intraclast packstone

Subrounded to rounded (rarely subangular) calcite mudstone intraclasts (average 0.5-2.0 mm, but can be larger) in a recrystallised microspar matrix. Heavily recrystallised and "ghosty" throughout. Rare chert intraclasts at the base.

170.95 m: Dolomite and ferroan calcite mudstone underlain by intraclast packstone

A disturbed dolomite and silty ferroan calcite mudstone bed contains a few small (2 mm), chert intraclasts and is underlain by carboante intraclast packstone. Intraclasts of laminated carbonate in a silty

calcite mudstone matrix with many irregular, ?dolomitic replacement patches.

182.05 m: Silty calcite mudstone

Silty calcite mudstone without any bedding, grading or layering. Some silty, stylolitic laminae. Irregular patches of chert occur vaguely parallel to bedding - sharp margins, not gradational - and some are associated with stylolites.

184.90 m: Silty calcite mudstone with a ?chert nodule

Silty mudstone with rare stylolites parallel to bedding. One nodule (8 mm x 18 mm) occurs parallel to bedding - banded, with minor core of pure chert and outer layer of carbonate-chert mixture. ?Magadi-type chert.

200.50 m: Calcareous siltstone-sandstone with intraclasts and rare intraclasts and rare pebbles

Predominantly a very calcareous cemented siltstone and sandstone which also contains quartzite intraclasts and small pebbles, and silty carbonate mudstone intraclasts. Secondary calcite veining has occurred and also resulted in some patches of coarse, calcite cement.

201.80 m: Intraclast wackestone and mudstone interbeds

Graded layers of intraclastic material (subrounded, upto 2 mm) and small, subrounded quartz granules (c. 1 mm) which grade upwards into silty mudstone. Each graded layer is approximately 20 mm thick.

Marla 1B

204.40 m: Intraclast and quartz granule layers with calcareous mudstone interbeds

Very similar to 201.80 m (Marla 1A) but layers are on a larger scale and intraclasts and granules are larger. One bed contains fragments averaging 1 to 3 mm (rarely 6-7 mm), both carbonate intraclasts and quartz granules. Very thin vertical calcite veins. Top 10 mm appears ?stromatolitic with regular thin laminae of dark and light calcareous material.

224.50 m: Intraclast and quartz granule layers interbedded with silty calcite mudstone

Very similar to 201.80 m and 204.40 m. Mudstone layers appear as plain dolomite "yogurt". One ?mud crack at top left of peel, penetrating an intraclastic bed.

235.10 m: Slightly calcareous brecciated mudstone with dark, ?bituminous partings

Slightly calcareous mudstone appears to have been brecciated in situ by the injection of dark, ?bituminous material. Brecciated pieces average 5 mm, subrounded to rounded and many have coarse, ferroan calcite replacement in centres.

245.75 m: Intraclast and quartz granule layers interbedded with dolomite mudstone

Similar to 201.80 m and 224.50 m. Perfect cycles, each 50 mm, grading from basal coarse layer to dolomite "yogurt". Cross-beds and small-scale channels occur in the coarser beds below the mudstones. One ?mud crack at top of peel.

260.90 m: Silty calcite and dolomite mudstone

Silty carbonate mudstone with rare, small, subrounded quartz grains throughout. Some fine, dark, ?bituminous laminae.

277.80 m: Graded cycles (245.75 m etc.)

Very similar to 245.75 m, with ?algal lamination in dolomite mudstone at base. Cross-beds and channelling.

295.25 m: Dolomite intraclasts in a sandstone matrix

Platy, subparallel to bedding, ferroan dolomite mudstone intraclasts (30 mm x 10 mm) in a sandstone of rounded to subangular quartz grains (average 0.25-1.0 mm, some 2-3 mm) and some granules. Rare, small carbonate grains also. Very thin, dark, ?bituminous laminae throughout. Very porous matrix. Basal 10 mm is composed of flat, dolomitic ?algal laminae.

302.00 m: Calcareous mudstone

Fine grained, silty calcite mudstone. Non-graded, monotonous, with rare, thin, dark, ?bituminous laminae.

308.00 m: Very slightly calcareous mudstone with ?evaporite moulds

Extremely porous and permeable calcareous mudstone with numerous small, irregular vugs, some partly filled with small, ferroan calcite crystals. Vugs may be moulds of ferroan evaporite crystals.

321.10 m: Very similar to 308.00 m

One well-developed, dark stylolite at base.

330.25 m: Dolomite mudstone with dark, ?bituminous laminae

Monotonous dolomite mudstone layers with regular, wavy, ?bituminous laminae.

338.35 m: Dolomite mudstone

No evidence in this peel of the "pseudo-nodules" seen on the core surface. Monotonous, dolomite mudstone with vertical calcite veins and one stylolite.

354.70 m: Dolomite mudstone with "pseudo-nodules"

Similar to 338.35 m but with "pseudo-nodules" more obvious and distinct. "Pseudo-nodules" appear to have been ?intraclastic but show some vague concentric banding. One large vertical, ferroan calcite vein and several dark, ?bituminous semi-stylolites. Porous.

Interpretations

The suite of rocks examined in these acetate peels was deposited in a mixed silty-carbonate environment in which energy levels varied from almost negligible (e.g. flat-bedded mudstones) to relatively high (e.g. intraclastic and quartz granule beds). A source of predominantly fine-grained, clastic material was continually in existence close to the carbonate basin.

No evidence favouring either a marine or non-marine origin has been seen in these peels; however, the weak evidence for evaporite moulds (308.0 m and 321.1 m) and ?Magadi-type chert (184.9 m) may indicate a playa-lacustrine origin similar to that proposed for the Observatory Hill Beds in Byilkaoora 1 (Benbow and Pitt, 1979). If the Observatory Hill Beds in Marla 1A and 1B were deposited in a playa-lacustrine environment, I suggest that the lithologies in these wells represent more marginal facies than those encountered in Byilkaoora 1.

APPENDIX IV

SOURCE ROCK ANALYSES, MARLA-1A

by

D.M. McKirdy and H.W. Sears

INTRODUCTION

Eight core samples of the Observatory Hill Beds were selected for analysis as part of a continuing program of source rock studies of Cambrian sediments from the Officer Basin (McKirdy and Kantsler, 1980 a,b). The main purpose of this work was to compare the organic-richness, maturity and hydrocarbon-generating potential of the Cambrian carbonates in Marla-1A with that of stratigraphically equivalent sequences at Byilkaoora-1, Wilkinson-1 and Wallira West-1. Of particular interest was the question of whether or not the regular acyclic sesterterpanes (C_{21}-C_{25} isoprenoid alkanes) and the irregular acyclic C_{30} isoprenoid, squalane, were present in the extracts of the Marla carbonates. Such compounds occur in relatively high concentration in evaporitic sediments from elsewhere in the Officer Basin where they appear to be markers of halophilic bacteria (McKirdy and Kantsler, 1980 a,b).

METHODS AND RESULTS

The analytical methods used and the results obtained are summarised in the attached AMDEL report (Source-Rock Analysis - Other Basins, Progress Report 30).

With the exception of sample 1, all core samples analysed were grey dolomites. Total organic carbon (TOC) values fall in the range 0.05-0.57%; samples 3 and 5 are above average (>0.25%) for ancient carbonates. Shale (sample 1) from stylolitic partings in the dolomite of sample 2 is rich in organic matter (TOC = 4.56%).

C_{15+} extract data are plotted in Figure 1 which shows that hydrocarbon yields are very low (<10 mg/g TOC) and that the carbonates are immature to marginally mature. A lack of maturity

also is evident from the bimodal naphthene distribution (e.g. Figures 2 and 3) of most samples. The high molecular-weight mode (maximum at ca. n-C_{27} position) comprises steranes and triterpanes which are susceptible to thermal degradation during the principal phase of hydrocarbon generation. Extract n-alkane profiles have a maximum at C_{16}-C_{18} and indicate an algal source for the organic matter. Uniformly low pristane/phytane ratios (<2) show that anoxic conditions prevailed during its deposition and early diagenesis. The bimodal n-alkane distribution of the stylolitic shale parting (maxima at C_{17} and C_{27}: Figure 2a), together with its high TOC value and the extremely low hydrocarbon content of its extractable organic matter (≤3% EOM), probably are artefacts of the pressure solution process which gave rise to the stylolite.

The C_{21}-C_{25} sesterterpanes and squalane were not detected in any of the samples analysed. This suggests that sabkha-type evaporitic conditions similar to those which prevailed at Byilkaoora-1 (non-marine), or at Wilkinson-1 and Wallira West-1 (marine), were not extant at the Marla locality during the deposition of the dolomites from 127-168 m depth in Marla-1A.

FURTHER WORK

Studies currently are in progress to compare the clay mineralogy and kerogen composition of sample 1 (stylolitic shale) and sample 2 (host carbonate). Kerogens also are being isolated from samples 3 and 5 for elemental analysis. This information will permit a more definitive assessment of the rank (atomic H/C ratio) and type of the dispersed organic matter. A suite of 8 core samples from 148-270 m depth in Marla-1B has been submitted to AMDEL for routine source rock analysis. The results of this additional work will be reported in future Departmental publications.

REFERENCES

McKirdy, D.M., and Kantsler, A.J., 1980a. Oil geochemistry and potential source rocks of the Officer Basin, South Australia. APEA J., 20(1) (in press).

McKirdy, D.M. and Kantsler, A.J., 1980b. Oil geochemistry and assessment of hydrocarbon-source potential of Cambrian and Devonian rocks, Officer Basin, South Australia. South Australian Dept. Mines and Energy, Report Book 80/10 (unpublished).

FIGURES	TITLE	Drg. No.
1	Maturation state and hydrocarbon potential, Observatory Hill Beds, Marla-1A.	S-14699
2	Gas chromatograms of alkanes from Observatory Hill Beds, 127.12 m depth, Marla-1A:	
	a. sylolitic shale parting	
	b. host carbonate	S-14700
3	Gas chromatograms of alkanes from selected carbonates, Observatory Hill Beds, Marla-1A:	
	a. laminated silty dolomite, 131.50 m depth	
	b. dolomite, 139.0 m depth	S-14701

Key to Figures 2 and 3:

Numbers refer to carbon-number of normal alkanes; f-h are the acyclic C_{18}-C_{20} regular isoprenoids (note: g = pristane; h = phytane).

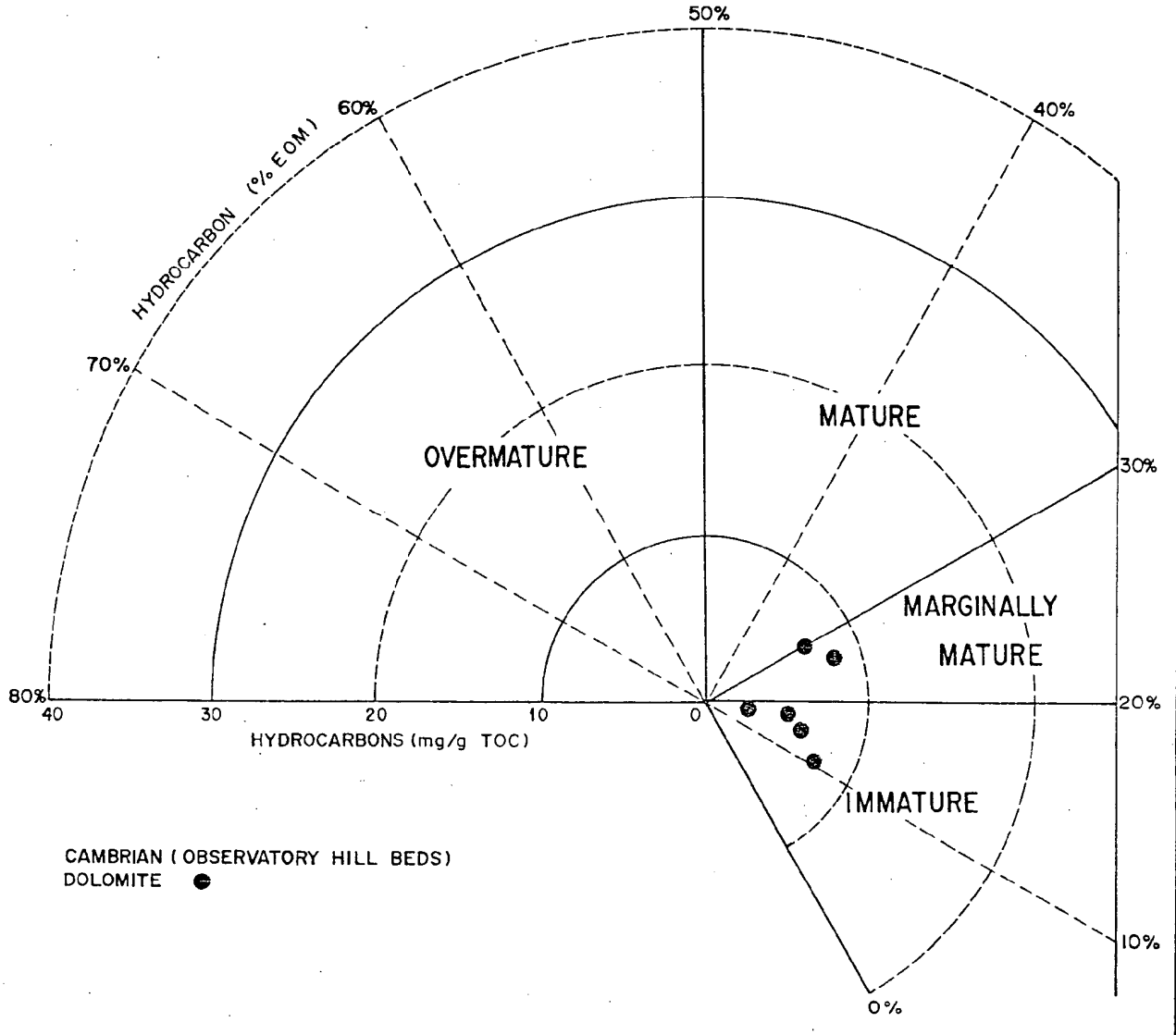


FIG. 1

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

COMPILED: D.M.M.

DRAWN: S.R.

SCALE:

DATE: 20/3/80

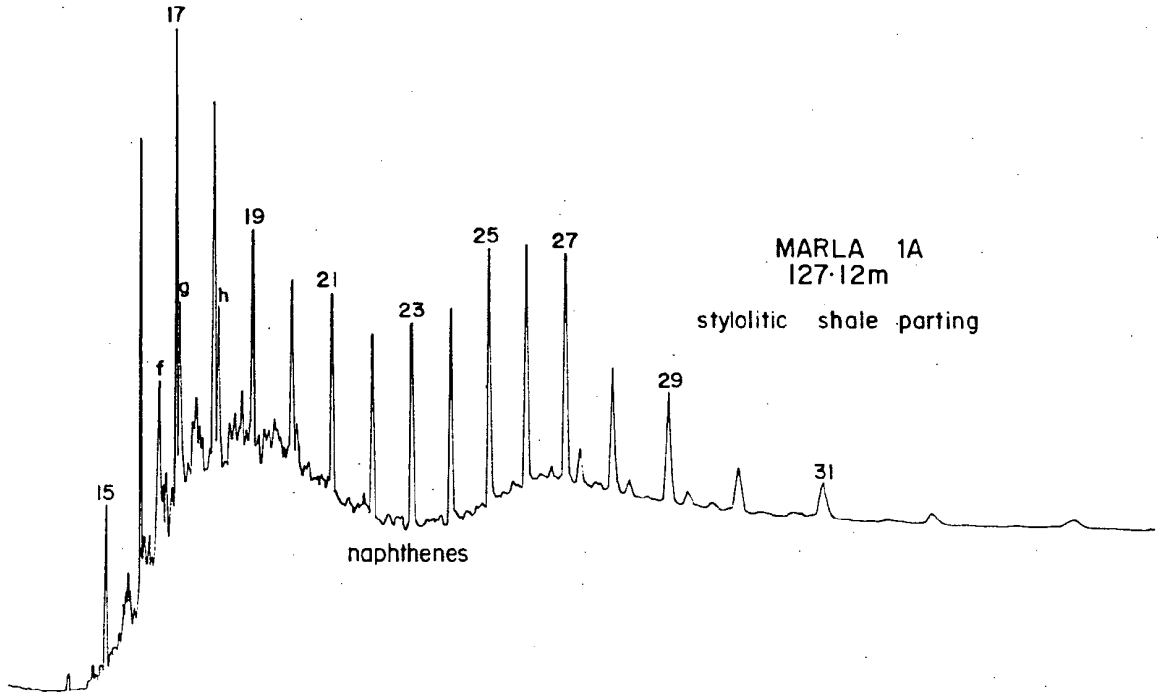
CHECKED:

PLAN No. S14699

MARLA 1A

MATURATION STATE AND HYDROCARBON POTENTIAL OBSERVATORY HILL BEDS

1881



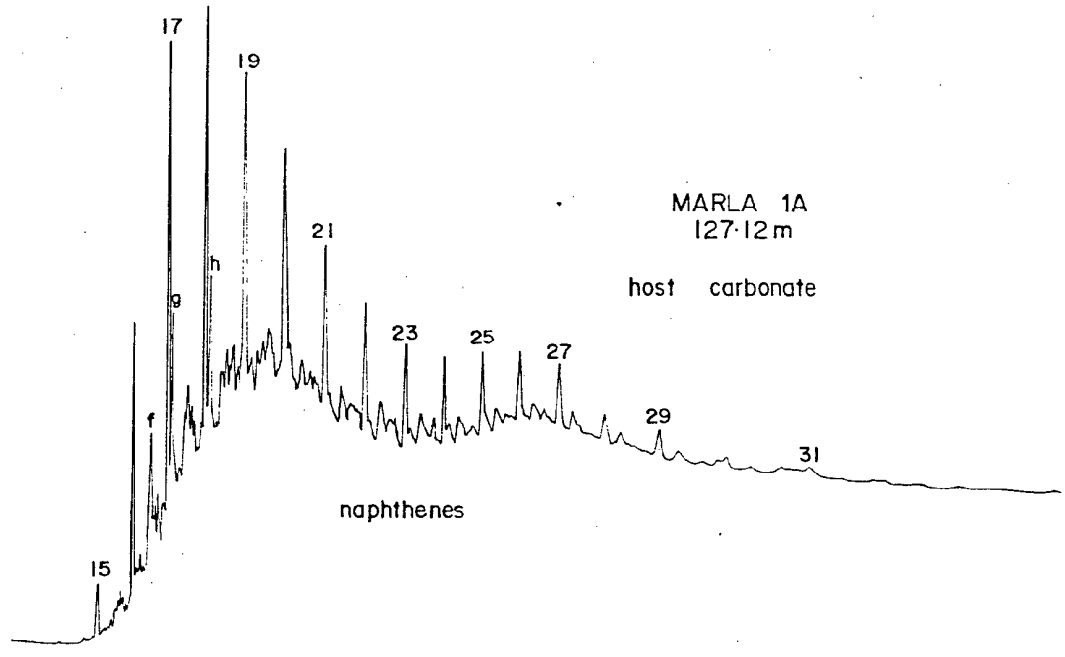


FIG. 2

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

MARLA 1A

GAS CHROMATOGRAMS OF ALKANES
127·12m DEPTH

COMPILED D.M.M.	CHK'D DAT.
DRAWN S.R.	SCALE
DAT 21/3/80	PLAN NUMBER S14700

1881

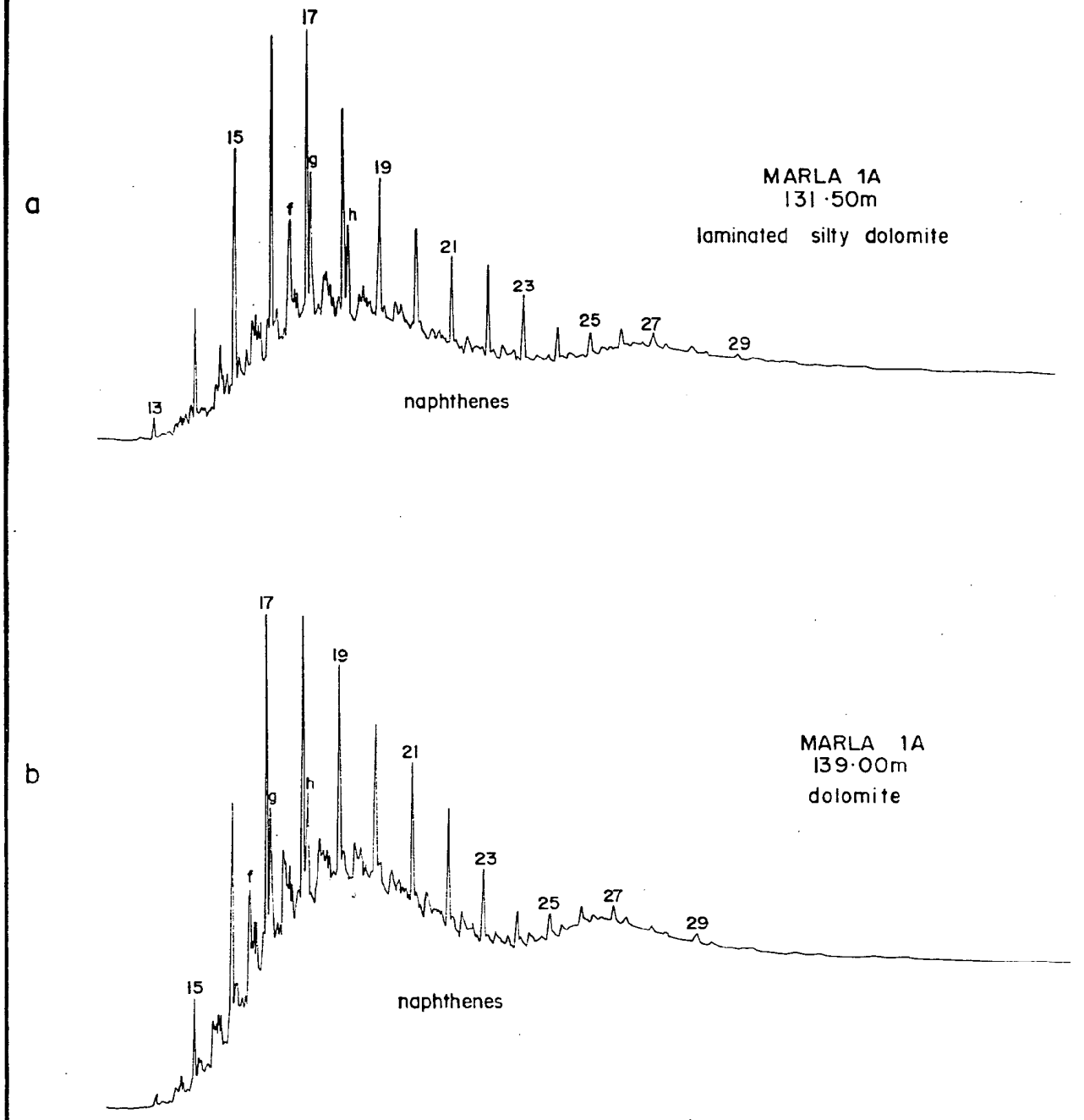


FIG. 3

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

MARLA 1A

GAS CHROMATOGRAMS OF ALKANES
131·50m & 139·00m DEPTH

COMPILED D.M.M	C.E.S. E.A.
DRAWN S.R.	SCALE
DATE 24/3/80	PLAN NUMBER S14701
CHECKED	

1981

The Australian
Mineral Development
Laboratories

nington 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: GS 1/1/231 (B1814/80)

Your Ref: 11.06.537

amdel

4 January 1980

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

Attention: Dr D.M. McKirdy

SOURCE-ROCK ANALYSIS -

OTHER BASINS

PROGRESS REPORT NO. 30

Investigation and Report by: H. Sears

Manager, Geological Services Division: Dr Keith J. Henley

for Norton Jackson
Managing Director

ot Plant: Osman Place
Thebarton S.A.
Telephone 43 8053
anch Laboratory: Perth

jd

SUMMARY OF ANALYTICAL METHOD

Total organic carbon was obtained by combustion after acid leaching of carbonate minerals. The finely pulverised sample was extracted with 87% chloroform - 13% methylalcohol and the extract evaporated to remove the solvent. Asphaltenes were removed from the extracted organic matter with petroleum ether and the asphaltene free fraction separated by liquid chromatography on 20 parts activated alumina under 80 parts activated silica gel. The saturates were eluted with petroleum ether, the aromatics with mixed solvent-benzene 15% in petroleum ether 85%, and the polar compounds with methanol containing approx. 10% benzene. Residual strongly polar compounds were not eluted.

The saturate fractions were examined by gas chromatography using the following operating parameters:

Column SCOT 45m x 0.5 mm diameter coated with OV101.
Injection and detection temp 300°C
FID detection
Nitrogen carrier 4 mls/minute
Column temperature 60° for 3 mins, then programmed at 4° per minute to 180°C, held for 1 minute and reprogrammed at 3° per minute to 255°C and held for 60 minutes.
Alkane concentrations were obtained by measurement of peak areas above naphthenic hump.

SOURCE ROCK

SAMPLE NO.	1
WELL:	MARLA # 1A
SAMPLE IDENTIFICATION:	RS88 Sheet 5643
DEPTH:	127.12m
TYPE OF SAMPLE:	Hand picked dark shale from styolitic partings of drill core.

Total organic carbon (TOC)	4.56	%
Weight of sample extracted	2.58	gm
Extracted organic matter (EOM)	2400	ppm
EOM as fraction of TOC	52.6	mg/g
Wt. EOM	6.2	mg

Analysis of extracted organic matter:-

Asphaltenes	56.5	% (wt)
Saturates	1.6	%
Aromatics	<1.6	%
Resins	22.6	%
Loss on column	17.7	%

n-Alkane distribution of saturates:-

N-Alkane	C_{13}	C_{14}	C_{15}	C_{16}	C_{17}	C_{18}	C_{19}	C_{20}	C_{21}	C_{22}	C_{23}
Rel abund.	--	0.3	3.0	8.2	9.5	7.4	5.4	4.8	5.0	5.1	5.4
n-Alkane	C_{24}	C_{25}	C_{26}	C_{27}	C_{28}	C_{29}	C_{30}	C_{31}	C_{32}	C_{33}	C_{34}
Rel abund.	5.8	6.8	7.0	7.6	5.3	5.5	2.9	2.7	1.0	0.8	0.5

Isoprenoid distribution in saturates:

IP16	IP18	Pr	Ph
	3.17	3.91	3.27

$\frac{IP16}{IP18}$	$\frac{IP18}{Pr}$	$\frac{Pr}{Ph}$	$\frac{IP18}{nC_{18}}$	$\frac{IP18}{nC_{19}}$	$\frac{Pr}{nC_{17}}$	$\frac{Ph}{nC_{18}}$
	0.81	1.19		0.39	0.41	0.44

SOURCE ROCK

SAMPLE NO.	2
WELL:	MARLA 1A
SAMPLE IDENTIFICATION:	RS 88 Sheet 5643
DEPTH:	127.12 m
TYPE OF SAMPLE:	Drill core whole sample

Total organic carbon (TOC)	0.18	%
Weight of sample extracted	67.0	gm
Extracted organic matter (EOM)	54	ppm
EOM as fraction of TOC	30.0	mg/g
Wt. EOM	3.6	mg

Analysis of extracted organic matter:-

Asphaltenes	38.9	% (wt)
Saturates	13.9	%
Aromatics	2.8	%
Resins	36.1	%
Loss on column	8.3	%

n-Alkane distribution of saturates:-

n-Alkane	C_{13}	C_{14}	C_{15}	C_{16}	C_{17}	C_{18}	C_{19}	C_{20}	C_{21}	C_{22}	C_{23}
Rel abund.	--	--	1.6	8.1	15.5	14.5	12.5	9.5	6.8	6.0	4.7
n-Alkane	C_{24}	C_{25}	C_{26}	C_{27}	C_{28}	C_{29}	C_{30}	C_{31}	C_{32}	C_{33}	C_{34}
Rel abund.	3.9	3.8	3.5	3.5	2.2	2.5	1.4	--	--	--	--

Isoprenoid distribution in saturates:

IP16	IP18	Pr	Ph
		6.65	5.35

$\frac{IP16}{IP18}$	$\frac{IP18}{Pr}$	$\frac{Pr}{Ph}$	$\frac{IP16}{nC_{17}}$	$\frac{IP18}{nC_{18}}$	$\frac{Pr}{nC_{17}}$	$\frac{Ph}{nC_{18}}$
		1.24			0.43	0.37

SOURCE ROCK

SAMPLE NO.	3
WELL:	MARLA 1A
SAMPLE IDENTIFICATION:	RS 89 Sheet 5643
DEPTH:	131.5 m
TYPE OF SAMPLE:	Drill Core

Total organic carbon (TOC)	0,57	%
Weight of sample extracted	84.6	gm
Extracted organic matter (EOM)	86	ppm
EOM as fraction of TOC	15,1	mg/g
Wt. EOM	7.3	mg

Analysis of extracted organic matter:-

Asphaltenes	23,3	% (wt)
Saturates	13.7	%
Aromatics	2.7	%
Resins	38.4	%
Loss on column	21.9	%

n-Alkane distribution of saturates:-

N-Alkane	C_{13}	C_{14}	C_{15}	C_{16}	C_{17}	C_{18}	C_{19}	C_{20}	C_{21}	C_{22}	C_{23}
Rel abund.	1.1	5.8	13.0	17.1	15.7	12.0	8.4	6.0	5.5	5.4	3.9
n-Alkane	C_{24}	C_{25}	C_{26}	C_{27}	C_{28}	C_{29}	C_{30}	C_{31}	C_{32}	C_{33}	C_{34}
Rel abund.	2.0	1.3	0.9	0.9	0.5	0.5	--	--	--	--	--

Isoprenoid distribution in saturates:

IP16	IP18	Pr	Ph
		7,95	5.18

$\frac{IP16}{IP18}$	$\frac{IP18}{Pr}$	$\frac{Pr}{Ph}$	$\frac{IP16}{nC_{15}}$	$\frac{IP18}{nC_{16}}$	$\frac{Pr}{nC_{17}}$	$\frac{Ph}{nC_{18}}$
		1.54			0.51	0.43

SOURCE ROCK

SAMPLE NO.	4
WELL:	MARLA 1A
SAMPLE IDENTIFICATION:	RS90 Sheet 5643
DEPTH:	139.0 m
TYPE OF SAMPLE:	Drill Core

Total organic carbon (TOC)	0.21	%
Weight of sample extracted	84.4	gm
Extracted organic matter (EOM)	47	ppm
EOM as fraction of TOC	22.4	mg/g
Wt. EOM	4.0	mg

Analysis of extracted organic matter:-

Asphaltenes	17.5	% (wt)
Saturates	7.5	%
Aromatics	22.5	%
Resins	37.5	%
Loss on column	15.0	%

n-Alkane distribution of saturates:-

N-Alkane	C_{13}	C_{14}	C_{15}	C_{16}	C_{17}	C_{18}	C_{19}	C_{20}	C_{21}	C_{22}	C_{23}
Rel abund.	--	0.6	4.5	11.9	17.9	16.2	12.1	9.0	8.5	7.2	4.3
n-Alkane	C_{24}	C_{25}	C_{26}	C_{27}	C_{28}	C_{29}	C_{30}	C_{31}	C_{32}	C_{33}	C_{34}
Rel abund.	2.1	1.5	1.3	1.3	0.6	1.0	--	--	--	--	--

Isoprenoid distribution in saturates:

IP16	IP18	Pr	Ph
		7.55	6.03

$\frac{IP16}{IP18}$	$\frac{IP18}{Pr}$	$\frac{Pr}{Ph}$	$\frac{IP16}{nC_{17}}$	$\frac{IP18}{nC_{18}}$	$\frac{Pr}{nC_{17}}$	$\frac{Ph}{nC_{18}}$
		1.25			0.42	0.37

SOURCE ROCK

SAMPLE NO.	5
WELL:	MARLA 1A
SAMPLE IDENTIFICATION:	RS 91 Sheet 5643
DEPTH:	143.8 - 143.9 m
TYPE OF SAMPLE:	Drill Core

Total organic carbon (TOC)	0.27	%
Weight of sample extracted	98.75	gm
Extracted organic matter (EOM)	86	ppm
EOM as fraction of TOC	31.9	mg/g
Wt. EOM	8.5	mg

Analysis of extracted organic matter:-

Asphaltenes	28.2	% (wt)
Saturates	22.4	%
Aromatics	3.5	%
Resins	28.2	%
Loss on column	17.7	%

n-Alkane distribution of saturates:-

N-Alkane	C_{13}	C_{14}	C_{15}	C_{16}	C_{17}	C_{18}	C_{19}	C_{20}	C_{21}	C_{22}	C_{23}
Rel abund.	--	--	1.5	6.8	12.0	13.1	11.7	10.0	9.6	9.8	7.9
n-Alkane	C_{24}	C_{25}	C_{26}	C_{27}	C_{28}	C_{29}	C_{30}	C_{31}	C_{32}	C_{33}	C_{34}
Rel abund.	5.0	3.6	3.0	2.2	1.4	1.3	0.7	0.4	--	--	--

Isoprenoid distribution in saturates:

IP16	IP18	Pr	Ph
		5.35	4.65

IP16/IP18	IP18/Pr	Pr/Ph	IP16/nC_{18}	IP18/nC_{28}	Pr/nC_{17}	Ph/nC_{18}
		1.15			0.44	0.38

SOURCE ROCK

SAMPLE NO.	6
WELL:	MARLA 1A
SAMPLE IDENTIFICATION:	RS 92, Sheet 5643
DEPTH:	151.3 - 151.4m
TYPE OF SAMPLE:	Drill Core

Total organic carbon (TOC)	0.10	%
Weight of sample extracted	147.2	gm
Extracted organic matter (EOM)	43	ppm
EOM as fraction of TOC	43.0	mg/g
Wt. EOM	6.4	mg

Analysis of extracted organic matter:-

Asphaltenes	53.1	% (wt)
Saturates	9.4	%
Aromatics	4.7	%
Resins	20.3	%
Loss on column	12.5	%

n-Alkane distribution of saturates:-

N-Alkane	C_{13}	C_{14}	C_{15}	C_{16}	C_{17}	C_{18}	C_{19}	C_{20}	C_{21}	C_{22}	C_{23}
Rel abund.	--	--	0.5	9.7	21.0	18.6	11.1	9.2	9.4	8.5	4.4
n-Alkane	C_{24}	C_{25}	C_{26}	C_{27}	C_{28}	C_{29}	C_{30}	C_{31}	C_{32}	C_{33}	C_{34}
Rel abund.	2.3	1.8	1.3	1.1	0.6	0.5	--	--	--	--	--

Isoprenoid distribution in saturates:

IP16	IP18	Pr	Ph
		8.55	6.8

$\frac{IP16}{IP18}$	$\frac{IP18}{Pr}$	$\frac{Pr}{Ph}$	$\frac{IP16}{nC_{16}}$	$\frac{IP18}{nC_{18}}$	$\frac{Pr}{nC_{17}}$	$\frac{Ph}{nC_{18}}$
		1.26			0.41	0.36

SOURCE ROCK

SAMPLE NO.	7
WELL:	MARLA 1A
SAMPLE IDENTIFICATION:	RS 93 Sheet 5643
DEPTH:	153.3 - 153.4m
TYPE OF SAMPLE:	Drill core

Total organic carbon (TOC)	0.065	%
Weight of sample extracted	104.9	gm
Extracted organic matter (EOM)	47	ppm
EOM as fraction of TOC	72.3	mg/g
Wt. EOM	4.9	mg

Analysis of extracted organic matter:-

Asphaltenes	51.0	% (wt)
Saturates	8.2	%
Aromatics	2.0	%
Resins	16.3	%
Loss on column	22.5	%

n-Alkane distribution of saturates:-

n-Alkane	C_{13}	C_{14}	C_{15}	C_{16}	C_{17}	C_{18}	C_{19}	C_{20}	C_{21}	C_{22}	C_{23}
Rel abund.	--	0.5	5.3	14.5	18.2	16.2	11.5	8.8	7.7	6.5	3.6
n-Alkane	C_{24}	C_{25}	C_{26}	C_{27}	C_{28}	C_{29}	C_{30}	C_{31}	C_{32}	C_{33}	C_{34}
Rel abund.	1.7	1.2	0.9	1.3	0.5	0.9	0.3	0.4	--	--	--

Isoprenoid distribution in saturates:

IP15	IP18	Pr	Ph
		8.35	5.80

$\frac{IP15}{IP18}$	$\frac{IP18}{Pr}$	$\frac{Pr}{Ph}$	$\frac{IP16}{nC_{15}}$	$\frac{IP18}{nC_{18}}$	$\frac{Pr}{nC_{17}}$	$\frac{Ph}{nC_{18}}$
		1.44			0.46	0.36

SOURCE ROCK

SAMPLE NO.	8
WELL:	MARLA 1A
SAMPLE IDENTIFICATION:	RS 94, Sheet 5643
DEPTH:	167.8m
TYPE OF SAMPLE:	Drill Core

Total organic carbon (TOC)	0.05	%
Weight of sample extracted	88.1	gm
Extracted organic matter (EOM)	51	ppm
EOM as fraction of TOC	102	mg/g
Wt. EOM	4.5	mg
Analysis of extracted organic matter:-		
Asphaltenes	60.0	% (wt)
Saturates	6.7	%
Aromatics	<2.2	%
Resins	6.7	%
Loss on column	24.4	%

n-Alkane distribution of saturates:-

N-Alkane	C_{13}	C_{14}	C_{15}	C_{16}	C_{17}	C_{18}	C_{19}	C_{20}	C_{21}	C_{22}	C_{23}
Rel abund.	--	--	3.5	14.5	18.4	14.4	9.8	7.9	8.2	8.7	5.7
n-Alkane	C_{24}	C_{25}	C_{26}	C_{27}	C_{28}	C_{29}	C_{30}	C_{31}	C_{32}	C_{33}	C_{34}
Rel abund.	2.7	1.7	1.3	1.5	0.7	0.8	0.2	--	--	--	--

Isoprenoid distribution in saturates:

IP16	IP18	Pr	Ph
		8.00	5.21

$\frac{IP16}{IP18}$	$\frac{IP16}{Pr}$	$\frac{Pr}{Ph}$	$\frac{IP16}{nC_{18}}$	$\frac{IP18}{nC_{18}}$	$\frac{Pr}{nC_{17}}$	$\frac{Ph}{nC_{18}}$
		1.44			0.46	0.36

APPENDIX V

Examination of fossils from Marla-1

FURTHER EXAMINATION OF FOSSILS FROM MARLA No. 1,

DEPTH 87.85 METRES

I refer to my preliminary report of May 15, 1979, regarding a trilobite in limestone at a depth of 87.85 metres in Marla No. 1.

Two further fragmentary trilobites have been obtained from this limestone. One of these specimens (and probably both) belongs in the Redlichiacea and is probably related to Eoredlichia, an early Early Cambrian trilobite reported from both China and Australia. The specimen, I previously identified as a protolenid, may in fact be a juvenile form of the Redlichiacean.

Conclusion: The limestone at 87.85 metres in Marla No. 1 has a probable early Early Cambrian age.

J. B. JAGO

School of Applied Geology
South Australian Institute of Technology

ADDITIONAL INFORMATION
NOT
HELD IN
WELL COMPLETION REPORT

MARLA 1B DENSITY DETERMINATION

DEPTH	DENSITY	DEPTH	DENSITY
83.0	2.61	103.0	2.61
83.5	2.68	103.5	2.57
84.0	2.69	104.0	2.65
84.5	2.69	104.5	2.41
85.0	2.71	105.0	2.49
85.5	2.59	105.5	2.70
86.0	2.65	106.0	2.70
86.5	2.71	106.5	2.69
87.0	2.78	107.0	2.68
87.5	2.71	107.5	2.60
88.0	2.70	108.0	2.66
88.5	2.69	108.5	2.63
89.0	2.71	109.0	2.66
89.5	2.54	109.5	2.52
90.0	2.72	110.0	2.53
90.5	2.74	110.5	2.65
91.0	2.70	111.0	2.71
91.5	2.66	111.5	2.71
92.0	2.66	112.0	2.65
92.5	2.60	112.5	2.72
93.0	2.58	113.0	2.70
93.5	2.52	113.5	2.70
94.0	2.51	114.0	2.65
95.0	2.70	114.5	2.68
96.0	2.69	115.0	2.67
96.5	2.51	115.5	2.52
97.0	2.65	117.0	2.47
98.0	2.44	118.0	2.55
98.5	2.65	118.5	2.36
99.0	2.66	119.0	2.56
99.5	2.63	119.5	2.65
100.0	2.75	120.0	2.58
100.5	2.54	121.0	2.50
101.0	2.58	121.5	2.48
101.5	2.66	123.0	2.48
102.0	2.43	124.0	2.62
102.5	2.75	125.0	2.66

MARLA 1B DENSITY DETERMINATION

DEPTH	DENSITY	DEPTH	DENSITY
125.5	2.65	148.5	2.67
126.0	2.65	149.0	2.64
126.5	2.62	149.5	2.48
127.0	2.68	150.0	2.57
127.5	2.83	150.5	2.46
128.0	2.57	151.0	2.51
129.0	2.51	151.5	2.72
130.0	2.40	152.0	2.72
131.0	2.46	152.5	2.34
131.5	2.36	153.0	2.53
132.0	2.57	154.0	2.72
133.0	2.62	154.5	2.62
134.0	2.50	155.0	2.61
134.5	2.40	155.5	2.54
135.0	2.40	156.0	2.63
135.5	2.65	156.5	2.60
136.0	2.65	157.0	2.64
136.5	2.61	158.0	2.66
137.0	2.62	158.5	2.71
138.0	2.60	159.0	2.67
139.0	2.55	159.5	2.60
139.5	2.33	160.0	2.52
140.0	2.63	160.5	2.62
140.5	2.38	161.0	2.68
142.0	2.42	161.5	2.47
142.5	2.61	162.0	2.66
143.0	2.60	162.5	2.65
143.5	2.39	163.0	2.64
144.0	2.62	163.5	2.73
144.5	2.52	164.0	2.66
145.0	2.53	164.5	2.64
145.5	2.60	165.0	2.51
146.0	2.40	166.0	2.50
146.5	2.35	166.5	2.49
147.0	2.45	167.0	2.46
147.5	2.48	167.5	2.58
148.0	2.26	168.0	2.49

MARLA 1B DENSITY DETERMINATION

DEPTH	DENSITY	DEPTH	DENSITY
169.0	2.67	191.0	2.76
170.0	2.57	191.5	2.72
171.0	2.47	192.0	2.66
171.5	2.61	192.5	2.72
172.0	2.42	193.0	2.65
173.0	2.67	193.5	2.60
173.5	2.64	194.0	2.55
174.0	2.62	195.0	2.75
174.5	2.62	195.5	2.56
175.0	2.59	196.0	2.78
175.5	2.31	196.5	2.53
176.0	2.42	197.0	2.47
176.5	2.53	197.5	2.77
177.0	2.41	198.0	2.80
177.5	2.50	199.0	2.79
178.0	2.44	199.5	2.54
180.0	2.59	200.0	2.66
181.0	2.50	200.5	2.76
182.0	2.49	201.0	2.71
182.5	2.51	201.5	2.70
183.0	2.67	202.0	2.74
183.5	2.64	203.0	2.78
184.0	2.56	203.5	2.77
185.0	2.72	204.0	2.75
185.5	2.79	204.5	2.73
186.0	2.51	205.0	2.70
186.5	2.48	205.5	2.70
187.0	2.56	206.0	2.73
187.5	2.64	206.5	2.65
188.0	2.66	207.0	2.70
188.5	2.57	208.0	2.69
189.0	2.68	208.5	2.64
189.5	2.30	209.0	2.62
190.0	2.70	209.5	2.66
190.5	2.60	210.0	2.73

MARLA 1B DENSITY DETERMINATION

DEPTH	DENSITY	DEPTH	DENSITY
210.5	2.84	228.5	2.77
211.0	2.71	229.0	2.74
211.5	2.65	229.5	2.74
212.0	2.75	230.0	2.53
212.5	2.75	230.5	2.61
213.0	2.74	231.0	2.57
213.5	2.64	231.5	2.75
214.0	2.71	232.0	2.74
214.5	2.67	232.5	2.73
215.0	2.55	233.0	2.73
215.5	2.78	233.5	2.75
216.0	2.76	234.0	2.76
216.5	2.79	234.5	2.77
217.0	2.76	235.0	2.79
217.5	2.78	235.5	2.75
218.0	2.77	236.0	2.71
218.5	2.80	236.5	2.78
219.0	2.80	237.0	2.79
219.5	2.81	237.5	2.79
220.0	2.85	238.0	2.79
220.5	2.79	238.5	2.76
221.0	2.81	239.0	2.75
221.5	2.82	239.5	2.75
222.0	2.78	240.0	2.78
222.5	2.80	240.5	2.75
223.0	2.67	241.0	2.70
223.5	2.77	241.5	2.81
224.0	2.78	242.0	2.69
224.5	2.81	242.5	2.74
225.0	2.73	243.0	2.83
225.5	2.78	243.5	2.81
226.0	2.63	244.0	2.80
226.5	2.63	244.5	2.73
227.0	2.61	245.0	2.63
227.5	2.70	245.5	2.71
228.0	2.79	246.0	2.71

MARLA 1B DENSITY DETERMINATION

DEPTH	DENSITY	DEPTH	DENSITY
246.5	2.77	265.0	2.82
247.0	2.78	265.5	2.75
247.5	2.67	266.0	2.78
248.0	2.79	266.5	2.79
248.5	2.74	267.0	2.82
249.0	2.76	267.5	2.83
250.0	2.78	268.0	2.83
250.5	2.82	268.5	2.72
251.0	2.82	269.0	2.77
251.5	2.80	269.5	2.83
252.0	2.80	270.0	2.83
252.5	2.75	270.5	2.85
253.0	2.81	271.0	2.82
253.5	2.83	271.5	2.80
254.0	2.83	272.0	2.76
254.5	2.83	272.5	2.74
255.0	2.82	273.0	2.80
255.5	2.83	273.5	2.68
256.0	2.83	274.0	2.59
256.5	2.83	274.5	2.76
257.0	2.83	275.0	2.74
257.5	2.76	275.5	2.80
258.0	2.78	276.0	2.75
258.5	2.74	276.5	2.80
259.0	2.73	277.0	2.69
259.5	2.77	277.5	2.74
260.0	2.83	278.0	2.73
260.5	2.79	278.5	2.69
261.0	2.79	279.0	2.67
261.5	2.76	279.5	2.68
262.0	2.80	280.0	2.74
262.5	2.77	280.5	2.73
263.0	2.79	281.0	2.63
263.5	2.82	281.5	2.77
264.0	2.81	282.0	2.79
264.5	2.78	282.5	2.80

MARLA 1B DENSITY DETERMINATION

DEPTH	DENSITY	DEPTH	DENSITY
283.0	2.79	302.0	2.72
283.5	2.80	302.5	2.71
284.0	2.78	303.0	2.74
284.5	2.76	303.5	2.78
285.0	2.72	304.0	2.77
285.5	2.69	304.5	2.77
286.0	2.76	305.0	2.77
287.0	2.77	305.5	2.76
287.5	2.77	306.0	2.76
288.0	2.77	306.5	2.74
288.5	2.82	307.0	2.72
289.0	2.78	308.0	2.67
289.5	2.72	308.5	2.80
290.0	2.72	309.0	2.82
290.5	2.80	309.5	2.81
291.0	2.70	310.0	2.83
291.5	2.44	310.5	2.83
292.0	2.56	311.0	2.62
292.5	2.39	311.5	2.72
293.0	2.67	312.0	2.54
293.5	2.64	313.0	2.76
294.0	2.50	313.5	2.77
294.5	2.57	314.0	2.73
295.0	2.54	314.5	2.78
295.5	2.76	315.0	2.80
296.0	2.76	315.5	2.78
296.5	2.65	316.0	2.79
297.0	2.76	316.5	2.79
297.5	2.77	317.0	2.76
298.0	2.76	317.5	2.77
298.5	2.77	318.0	2.79
299.0	2.77	318.5	2.79
299.5	2.74	319.0	2.75
300.0	2.74	319.5	2.81
300.5	2.72	320.0	2.69
301.0	2.73	320.5	2.72
301.5	2.71	321.0	2.71

MARLA 1B DENSITY DETERMINATION

DEPTH	DENSITY	DEPTH	DENSITY
321.5	2.77	340.0	2.74
322.0	2.81	340.5	2.65
322.5	2.79	341.0	2.78
323.0	2.82	341.5	2.75
323.5	2.76	342.0	2.76
324.0	2.75	342.5	2.76
324.5	2.75	343.0	2.78
325.0	2.78	343.5	2.66
325.5	2.79	344.0	2.72
326.0	2.78	344.5	2.63
326.5	2.63	345.0	2.76
327.0	2.57	346.0	2.76
327.5	2.68	346.5	2.62
328.0	2.75	347.0	2.80
328.5	2.77	347.5	2.61
329.0	2.77	348.0	2.61
329.5	2.77	348.5	2.72
330.0	2.75	349.0	2.67
330.5	2.76	349.5	2.75
331.0	2.77	350.0	2.76
331.5	2.77	350.5	2.67
332.0	2.75	351.0	2.78
332.5	2.76	351.5	2.74
333.0	2.77	352.0	2.77
333.5	2.76	352.5	2.54
334.0	2.78	353.0	2.74
334.5	2.75	353.5	2.71
335.0	2.76	354.0	2.69
335.5	2.77	354.5	2.78
336.0	2.79	355.0	2.77
336.5	2.77	355.5	2.78
337.0	2.79	356.0	2.48
337.5	2.78	356.5	2.65
338.0	2.80	357.0	2.77
338.5	2.71	357.5	2.80
339.0	2.70	358.0	2.72
339.5	2.67	358.5	2.76

MARLA 1B DENSITY DETERMINATION

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DEPTH	DENSITY	DEPTH	DENSITY
359.0	2.75	376.0	2.79
359.5	2.68	376.5	2.74
360.0	2.71	377.0	2.74
360.5	2.75	377.5	2.78
361.0	2.73	378.0	2.78
361.5	2.69	378.5	2.75
362.0	2.68	379.0	2.77
362.5	2.80		
363.0	2.75		
363.5	2.78		
364.0	2.82		
364.5	2.73		
365.0	2.75		
365.5	2.78		
366.0	2.72		
366.5	2.75		
367.0	2.77		
367.5	2.67		
368.0	2.78		
368.5	2.76		
369.0	2.67		
369.5	2.73		
370.0	2.77		
370.5	2.75		
371.0	2.81		
371.5	2.77		
372.0	2.71		
372.5	2.65		
373.0	2.68		
373.5	2.54		
374.0	2.54		
374.5	2.67		
375.0	2.68		
375.5	2.70		