DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

Rept.Bk.No. 80/79

LITHOLOGIES AND INTERPRETATIONS OF THE OBSERVATORY HILL BEDS, MARLA - 1A and -1B.

REPORT NO. 10 OF THE OFFICER BASIN STUDY GROUP

GEOLOGICAL SURVEY

Ву

BRIDGET C. YOUNGS

Fossil Fuels Section

CONTENTS	PAGE
ABSTRACT	1
INTRODUCTION	1
AGE AND STRATIGRAPHIC RELATIONSHIPS	2
METHOD OF STUDY	2
Logging Acetate Peels Thin Sections	3 4 4
DESCRIPTION OF CARBONATE LITHOLOGIES	4
Allochems	4
Intraclasts Peloids Ooids Fossil Fragments "Mudballs" Extraclasts Algal Plates	4 5 5 5 6 6 6
Matrices	7
Mud (micrite) Neomorphic Spar Cement and Vein Fills	7 7 8
Carbonate Rocks	.8
Mudstones Wackestones Packstones Grainstones Boundstones	8 8 9 9
Evaporites (excluding Dolomite)	10
DIAGENESIS OF CARBONATES	10
Micrite Envelopes Birdseyes Burrows Dewatering and Slump Features Stylolites Dolomite Silica Replacements Celestite	10 11 11 11 12 12 13 15
DESCRIPTION OF CLASTIC LITHOLOGIES	15
DEVELOPMENT OF POROSITY	16
Carbonate Rocks Clastic Rocks	16 17

.

CONTENTS (cont.	.)	
MINERALISATION		17
Fluorite Sulphides		17 18
ENVIRONMENTS OF	DEPOSITION	19
Carbonate Clastic Fa Cycles		19 20 21
GEOLOGICAL HIST	TORY	22
CONCLUSIONS ANI	RECOMMENDATIONS FOR FUTURE WORK	24
ACKNOWLEDGEMENT	ΓS	26
REFERENCES		27
	FIGURES	
Fig. No.	Title	Dwg. No.
1	Location Plan, eastern Officer Basin	S14893
.2	Distribution of facies and their characteristic features.	S14894
3	Section from Mt. Johns to Marla- 1A, -1B	S14895
4	Geological History	S14896
5	Spatial Relationship of facies	S14897
	PLATES	
<u>P1. No</u> .	<u>Title</u>	Photo No.
1	Intraclast and peloid grainstone, 107.00 m	31675
2	Chertified ooid grainstone, 225.35 m	31676
3	Chertified ooid grainstone, 225.35 m	31677
4	As above, crossed nicols	31678
5	Graded quartz grains, 201.80 m	31679
6	Dolomite mudstone, 231.35 m	31680
7	Dolomite mudstone with ?evaporite minerals, 146.75 m	31681
0	A 1	

As above, crossed nicols

31682

Dolomite mudstone and chert, 31683 122.00 m

As above, crossed nicols. 31684

APPENDICES

I Litholog

II Report of identification of a mineral at 179.80 m

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

Rept.Bk.No. 80/79 D.M. No. 271/79

LITHOLOGIES AND INTERPRETATIONS OF THE OBSERVATORY HILL BEDS, MARLA -1A and -1B

REPORT NO. 10 OF THE OFFICER BASIN STUDY GROUP

ABSTRACT

Detailed study of the predominantly carbonate lithologies in cores recovered from Marla-1A,-1B reveals that deposition of the Observatory Hill Beds at this location occurred in a shallow lagoon which developed on a broad, marine platform. Lithologies are mainly finegrained and dolomitic, with regular interbeds of packstones, algal boundstones and sandstones. Environments of deposition are interpreted as peri-sabkha to open lagoon.

A favourable environment for Mississippi Valleytype mineralisation exists throughout the 300 m of penetrated section. No indications of petroleum were noted.

The geological history of the sequence is interpreted and areas are outlined that may warrant the future attention of mineral and petroleum explorationists.

INTRODUCTION

This report presents a detailed description and interpretation of the lithologies of the Observatory Hill Beds in Marla-1A and -1B. It is intended to expand on the well completion report (Benbow, 1980a) and not to replace that report.

Marla-1A and -1B were drilled during 1979 as part of the South Australian Department of Mines and Energy's investigation into the petroleum potential of the Officer Basin (Fig. 1). The two wells were drilled only 15 m apart and full details of the drilling programme are presented in Benbow (1980a). A summary of all previous geological work in the Officer Basin is given by Pitt et al. (1980).

AGE AND STRATIGRAPHIC RELATIONSHIPS

The rocks studied in this report are assigned to the Observatory Hill Beds, defined by Wopfner (1969) as thinly interbedded siltstones and cherty carbonates. Outcrops of this formation and its correlative, the Wirrildar Beds, are poor and generally are scattered around the northern and southeastern margins of the Officer Basin (Fig. 1) (Pitt et al., 1980, p. 216). However, the beds have been intersected in a number of wells in the basin and these are summarised by Pitt et al. (1980).

Acritarchs recovered from Wilkinson-1 (Muir, <u>in</u> Gatehouse, 1979) and trilobites from Marla-1 (Jago, <u>in</u> Benbow 1980a) enable a Tommotian - Early Cambrian age to be assigned to at least the upper parts of the formation. The lower parts of the section may well be late Proterozoic in age.

Stratigraphic relationships between the isolated subsurface intersections of the Observatory Hill Beds are at present uncertain. Byilkaoora-1 drilled a complete section (224 m) of non-marine Observatory Hill Beds, Marla-1A and -1B drilled 296 m of marine beds with the top eroded and the bottom of the sequence not reached. Until palaeogeographic relationships and depositional facies are more precisely determined all Early Cambrian carbonate-clastic sequences in this part of South Australia are being assigned to the Observatory Hill Beds (Pitt et al., 1980).

METHOD OF STUDY

Marla-1A was drilled to a total depth of 215.30 m and Marla-1B to 379.40 m both terminating within the Observatory Hill Beds. The regional dip in this area is negligible and it has been possible to confirm that marker beds in the two wells

occur at almost the same levels: the depth differences vary but are of the order of 500 mm, and much of this is considered due to inaccuracies of drillers' measurements.

LOGGING

Both wells were fully cored through the Observatory Hill Beds (from 83 m depth) and it was therefore decided to study only Marla-1B in detail. The core was cut in half to allow textures and structures to be seen more easily than on the outer surface. The cut core was logged visually at the Glenside Core Library and a preliminary pictorial log drawn up.

The pictorial log (Appendix I) is modelled on the method used by Selley (1978, Fig. 0.1), that is, for clastic rocks a scale is used with the Wentworth grain size increasing to the left of a vertical base line, thereby attempting to present an immediate impression of predominant grain size. The sequence in Marla-1B, although containing interbedded and sometimes thick clastic sequences, is nevertheless mainly carbonate and a method was designed which would allow the clastics and carbonates to be shown on the same log but using different criteria. carbonate scale used in the litholog (Appendix I) also runs from the same vertical base line and the textural gradation from mudstone to grainstone is, to some extent, designed to represent the relative energy levels acting during deposition of the carbonate. This carbonate scale is in no way intended to represent grain sizes and is entirely separate from the clastic scale.

The final litholog for Marla-1B was drawn up after all petrologic work was completed and it incorporates data from Marla-1A. It is intended to show the major characteristics of each rock unit without using lengthy descriptions: rock

colours, bedding types, unit boundaries, accessory features and sample points are all shown graphically for each rock unit logged.

ACETATE PEELS

Over 40 acetate peels were made from cores from both Marla-1A and -1B. The samples were generally 150 mm long and were chosen to cover a wide range of carbonate lithologies. Etching and staining procedures were those of Davies and Till (1968) and peels were made using acetate drafting sheets.

The acetate peels were studied under a conventional petrological microscope and photomicrographs of some are used as illustrations in this report (Plates 1, 2, 5).

THIN SECTIONS

Thirty-five thin sections were cut from selected samples taken from both Marla-1A and -1B. Twenty-two of them have been described by petrologists at the Australian Mineral Development Laboratories (AMDEL) and copies of these descriptions appear in Benbow (1980a). The remainder were used to help in drawing up the final litholog.

Four of the thin sections have been used for photomicrographs to illustrate this report (Plates 3, 4, 6-10).

DESCRIPTION OF CARBONATE LITHOLOGIES

All allochemical terms used throughout this report are those common to all modern carbonate literature. Textural terms are those of Dunham (1962).

ALLOCHEMS

Intraclasts

Intraclasts are the most common allochems in the Observatory Hill Beds in Marla-1B. They range from small (less than 1 mm), subrounded clasts (Plate 1) to large (10 mm or more), angular and

platy ones which commonly are very little removed from their place of origin. Plates which display a clear algal origin are not included in this category (see "Stromatolites and Algal Mats").

Intraclasts at Marla are composed of calcite and dolomite mudstone and no coarser textured clasts were recognised.

Peloids

The term "peloid" is used in this text to mean a small, pellet-like object for which no mode of origin is recognised. This term was introduced by McKee and Gutschick (1969) and in no way implies a faecal origin.

Most of the peloids at Marla are ovoid to round, 1 mm or less in length and most commonly occur unassociated with other allochems. Their outlines can be difficult to discern owing to recrystallisation effects.

A less common category of peloids logged in Marla is slightly larger and more irregular than those already described and most probably is intraclastic in origin (Plate 1). They may occur associated with small intraclasts and the differentiation between these two classes of allochems can be difficult to determine.

Ooids

Ooids are rare in these rocks but, where they occur, they are well-rounded and well-sorted (Plates 2, 3, 4).

Recrystallisation and chertification commonly have obscured much of the structure of the ooids but several retain some of their original concentric texture (Plate 2).

Fossil Fragments

Fossil fragments are extremely rare and have been recorded only in the top parts of the Marla sequence (Thornton, 1978; Jago in Benbow, 1980a) and at 332.99 m. Early Cambrian trilobites have been recovered from the top of the section in Marla-1 (Jago, op. cit.) and characteristic hooks and fragments also are

recognised in peels from 87.85 m and possibly 107.00 m, and in a thin section from 332.99 m.

"Mudballs"

"Mudballs" occur in a few rock units below 288 m (Fig. 2). In a cut core, they appear very similar to oncolites but when viewed under a microscope they are scarcely discernible from their matrix and show none of the concentric laminae associated with oncolites. Also, they have no nuclei and occur only in mudstone matrices which contain no other allochems or indicators of shallow, high energy waters.

These "mudballs" could be pisolites associated with the formation of calcrete. However, their microscopic appearance does not correspond closely with that reported in the literature (Nagtegaal, 1969; Esteban, 1976). Wilson (1975, p. 82) suggests that such balls can be made by the diggings of arthropods; since the range of "mudballs" in Marla occurs within that for burrowing (Fig. 2), this interpretation could be feasible. For the moment the origin of these minor allochems remains an enigma.

Extraclasts

Extraclasts are almost entirely quartz grains and granules with rare feldspars, micas and heavy minerals. In the predominantly carbonate rocks they occur either with intraclasts, or without other allochems and in a carbonate mudstone matrix.

The quartz grains are commonly sand sized (0.5 to 1.0 mm), and some granules occur also. They are subrounded to rounded and generally show some grading (Plate 5).

Algal Plates

Stromatolitic material is recorded at Marla down to 309.20 m (Fig. 2) and much of it occurs as algal mats and broken mats (algal plates). The plates commonly are associated with and overlying the mats and, in some places, they are replaced by chert

(96.00 m). Many allochems recorded as intraclasts may in fact be of algal origin, but their distinction is not considered important with respect to environmental interpretations.

MATRICES

The term matrix is used here to denote any material surrounding allochems: mud (micrite), neomorphic (recrystallised) spar and cement.

Mud (micrite)

Mud, both calcite and dolomite, is a very abundant constituent of the Observatory Hill Beds in Marla-1A and -1B. Clayand some silt-sized quartz grains commonly are incorporated in the carbonate muds.

Calcite muds are all slightly ferroan and are of primary origin.

The pure, fine-grained dolomite muds are interpreted to be generally of very early diagenetic origin. Early dolomitisation in these rocks is pervasive but may be accompanied by some minor, late dolomitisation (Plate 6).

Neomorphic Spar

Considering their Palaeozoic age, these strata show very little evidence of recrystallisation, and the resultant formation of neomorphic spar, from the abundant calcite micrite originally deposited.

Neomorphic spar has been recognised using the criteria summarised by Bricker (1971, p. 149). It is rarely extensive but tends to be patchy and more prevalent in predominantly allochemical lithologies than in "pure" mudstones. Heavy recrystallisation is recorded in some peloidal lithologies and one rock unit (88.10 - 88.40 m) shows a typical "ghostiness" and in parts closely resembles a "grumeleuse texture".

Cement and Vein Fills

Grainstones are rare in Marla-1A and -1B and most packstones are well-endowed with mud, hence cement is rare. When present, it is ferroan to very ferroan calcite; no dolomite cement has been recognised.

Most of the recognised cement is bladed to drusy and all of this kind belongs to an early, first generation. In a few samples two generations of calcite cement are discernible (87.85 m, 107.00 m, 166.55 m, 295.25 m): the first is bladed to drusy, and the second coarse, blocky very ferroan calcite (Plate 1). The late generation commonly occurs in veins (107.00 m) but can also be seen replacing allochems (87.85 m, 107.00 m, 166.55 m) (Plate 1) and as an interparticle cement (295.25 m).

Mudstones

The dominant lithology in Marla-1A and -1B is mudstone, both calcite and dolomite (Appendix 1). It occurs throughout the section interbedded with boundstones, coarser-grained carbonates and clastic rocks.

The mudstones range from pure carbonate through slightly silty varieties to a few units with scattered (< 10%) allochems or quartz grains and granules.

Both calcite and dolomite mudstones occur above 175.50 m, whereas below that depth only dolomite has been recognised. Wackestones $\frac{1}{2}$

The most common wackestone is one in which the grains are sand- to granule-sized quartz and not carbonate allochems (e.g. 204.40 m, 208.20 m). Although such rock units technically may not be wackestones, because of their extraclast grains, it is

considered that similar conditions existed during deposition of both quartz and allochemical wackestones. Within some of the quartz wackestones the grains tend to be concentrated in layers or graded over a few centimetres. Minor amounts of peloid and "mudball" wackestones also occur.

All of the wackestones have a dolomite mud matrix. Packstones

Intraclast and peloid packstones are common; some contain only one allochem type but many have both. Sorting of the peloids is good but is variable for intraclasts. There are rare algal plate, "mudball" and quartz grain packstones. Packstones have both calcite and dolomite mud matrices: peloid packstones are predominantly dolomite, intraclastic rocks have both. Grainstones

Grainstones are rare in Marla-1A and -1B and, owing to recrystallisation and chertification (219.55 m, 225.35 m), are hard to identify. They occur only as thin lenses or interbeds (Plates 3 and 4).

All allochem types have been identified within grainstones and they occur in both calcite and dolomite rock units.

Boundstones

Stromatolites and algal mats occur throughout the section down to $309.20\ \mathrm{m}$ depth.

Stromatolites (columnar) are rare: a good example, approximately 100 mm high, occurs at 148.50 m and smaller varieties at 247 m, 266 m and 282 m.

By far the most common algal material occurs as mats (and their associated broken plates, see "Algal Plates", page 6).

Most of these mats are dolomite and the thickest developments occur below 200 m where they can be over 10 m thick (Fig. 2).

EVAPORITES (excluding Dolomite)

No evaporitic minerals, other than dolomite, have been positively identified in peels and thin sections of Marla-1A and -1B, and nowhere in the sequence do evaporites constitute rock-forming minerals (Fig. 2; Plates 7 and 8).

Some evidence of original evaporites occurs at 146.75 m where angular blades, subparallel to bedding, up to several millimetres in length and replaced by quartz and length-slow chalcedony strongly suggest the former presence of evaporite minerals (Folk and Pittman, 1971) (see "Silica Replacements", page 13) (Plates 7 and 8). Other possible evaporites are recorded at 327.64 m (see T.S. description, in Benbow (1980a)) and in several rock units of the core below 287.60 m. These occurrences are less diagnostic than those at 146.75 m: small irregular vugs are lined with calcite and may be moulds of earlier small, evaporite minerals.

DIAGENESIS OF CARBONATES

All of the carbonates have undergone lithification and many of them, particularly allochemical rocks, display a number of other diagenetic features which can aid in interpreting the sequence.

Recrystallisation and cementation have been discussed previously (see page 7).

Micrite Envelopes

Micrite envelopes are not extensively developed but have been recorded on intraclasts, peloids and some ooids at 107.00 m (Plate 1), 166.50 m, 219.50 m and 225.35 m. In some instances they have provided a "shell" for late sparry fill (Plate 1).

Birdseyes

Possible birdseyes have been recorded at 83.00 m, 307.50 m, 313.75 m, 320.75 m, 320.15 m and 338.60 m. All are seen in dolomite mudstones or wackestones. Those at 83.00 m occur parallel to bedding. Many of the other occurrences could be interpreted as small, irregular evaporite moulds although in some examples they appear too irregular for evaporites. It is probable that below 300 m both evaporite moulds and birdseyes exist in close association (Fig. 2); they both develop in similar environments and in this respect their accurate identification is not considered essential.

Nearly all of the birdseyes are partially to entirely filled with late, coarse calcite spar.

Burrows

Burrows are early diagenetic features, having developed during sedimentation in very shallow waters or on "hardgrounds". They have been recognised at Marla-1A and -1B predominantly below 280 m with a few near the top of the section (Fig. 2).

The burrows are nearly all irregular, mottled and neither vertical nor horizontal with respect to bedding. It is not possible to identify what organisms caused them.

A few rock units have been entirely bioturbated and all original bedding destroyed (360.80 m, 368.65 m) but mostly the burrowing has been less drastic.

Dewatering and Slump Features

The distribution of dewatering and small-scale slump (soft sediment deformation) features is shown on Figure 2. They are more abundant at the top of the section, in the mixed calcite and dolomite rock units.

Upward injection of beds is common. Especially good examples occur between 121.50 m, and 123.50 m where some injections are 100 mm in height; the average is 40 mm. These features contain abundant secondary chalcedony and small amounts of mica, ?nontronite and pyrite (see thin section descriptions in Appendix II in Benbow (1980a)). Abundant injection features occur also at about 170 m to 180 m; this is a brecciated zone containing abundant sulphides and dolomite which is coloured a green-grey by the inclusion of muscovite, chlorite and regularly interlayered chlorite-montmorillonite (see Appendix II).

Stylolites

Stylolites occur throughout the sequence and are particularly abundant in calcite rocks (mudstones and coarser textured lithologies) down to 158.60 m. An intraclast packstone at 166.50 m has an excellent development of stylolitic rock unit boundaries (see Appendix I).

Stylolites formed relatively late in the diagenetic history of these strata and their development probably accounts for much of the late secondary cement and coarse vein fills (see "Cement and Vein Fills", page 7).

Dolomite

Dolomite is the most common mineral in the Observatory
Hill Beds at Marla-1A and -1B. Below 175.50 m it is the only
rock-forming mineral and above that depth dolomite and calcite
rock units are interbedded with calcite ones (Fig. 2). Much of
the dolomite is very fine-grained (generally less than 0.1 mm, and
commonly 0.01 to 0.02 mm) (Plate 6), equigranular and is interpreted as very early diagenetic in origin, having replaced an
original calcite mudstone (e.g. 121.93 m, 124.70 m).

Similarly fine-grained, pervasive dolomite also occurs in rocks which clearly contained at least a few allochems and which were deposited with calcite mud (e.g. 122.64 m, 295.88 m and 332.99 m). These lithologies also are interpreted to have been dolomitised soon after deposition and may, in fact, have been altered at the same time as those mentioned above. Original calcite mud and the fact that "ghosts" of allochems are still visible may mean that lithification had occurred, at least partly, prior to dolomitisation.

A few thin sections clearly demonstrate the existence of later, coarser dolomitisation and the development of some associated porosity (e.g. 146.70 m, 231.35 m, 280.30 m and 347.33 m). Some of the coarser dolomite rhombs show the distinctive zoning of late-developed crystals (Plate 6) (Scholle, 1978, p. 132). In some cases the coarser-grained dolomite areas give the appearance of neomorphic (recrystallised) spar and it is believed that these could be the result of recrystallisation of early dolomite rather than the introduction of later dolomite (e.g. 122.64 m, 124.70 m and 307.20 m). The differentiation between these two latter categories is not always clear and it is possible only in rare cases to make unequivocal statements concerning the timing of much of the dolomitisation.

Silica Replacements and Void Fills

Silica replacements and void fills are common. On the litholog (Appendix I) only chalcedony has been distinguished from all other silica replacements which are identified as chert.

- (i) in hand specimens chalcedony can Chalcedony: sometimes be seen filling voids and fractures but it is most commonly identified under crossed-nicols where it shows a typical fibrous, radial texture (Plates 7 to 9). An interesting development of chalcedony occurs at 146.75 m where it is seen, along with ordinary secondary microcrystalline quartz, replacing distinctly angular and platy ?evaporite casts (Plates 7 and 8). This chalcedony is length-slow and this is consistent with the conclusion of Folk and Pittman (1971) that length-slow varieties are distinctive of sediments deposited in evaporitic environments.
- (ii) Chert: true chert is only that which has a fine, microcrystalline texture (see illustrations in Scholle, 1978). It is seen in ooid grainstones at 219.50 m and 225.35 m where chert has replaced the ooids (inside micrite envelopes) and a dolomite matrix; at 219.50 m, a coarser-grained quartz acts also as cement (Plates 2 to 4).
- (iii) Microcrystalline Quartz: nearly all of the material logged as chert is, in fact, microcrystalline quartz much coarser in size than true chert and commonly filling voids or acting as replacements. It varies in size from very fine (and hardly discernible) to several millimetres (megaquartz of Scholle (1978), p. 141): when acting as a cement it commonly shows a radial texture (Plates 3 and 4).

(iv) Authigenic Quartz Crystals: scattered authigenic quartz crystals occur throughout the section. They are rare but are readily identifiable when present: and some retain carbonate cores (107.00 m) (Scholle, 1978, p. 141).

Celestite

Celestite occurs as a rare secondary mineral throughout the section. In one sample (121.93 m) (Plates 9-10) it constitutes 15% to 20% of the rock; elsewhere it is present only in trace amounts. It is interpreted as a late diagenetic feature (see T.S. description, 121.93 m, in Benbow (1980a)). Celestite commonly occurs as a secondary mineral in rocks deposited in a sabkha environment (Scholle, 1978; p. 135).

DESCRIPTION OF CLASTIC LITHOLOGIES

Nearly all of the non-carbonate grains in the Observatory Hill Beds in Marla-1A and -1B are quartz, with up to 25% feldspar in only a few rock units and traces of micas, heavy minerals, pyrite and lithic grains throughout.

The sandstones and siltstones at Marla have calcite and dolomite cements: hence, a complete gradation exists from extraclast quartz wackestones (see page 8) and silty carbonate mudstones to carbonate-cemented sandstones, siltstones and claystones. Many units logged in these wells fall between the end members and there are numerous examples of thinly interbedded clastic rocks and carbonates (or calcareous clastics) (e.g. 116.00 m, 138.00 m, 178.00 m, 343.80 m).

The sandstones are predominantly fine- to medium-grained, subrounded to rounded, graded in small-scale (10 mm) cycles and some show channelling and cross-bedding (e.g. 116.00 m, 138.00 m, 149.85 m). Many of the sandstones contain mudstone intraclasts and thin, mudstone interbeds (e.g. 130.15 m, 152.50 m, 183.90 m, 196.60 m).

The best primary porosities developed in the sequence are in sandstones.

DEVELOPMENT OF POROSITY

CARBONATE ROCKS

Overall the carbonate lithologies encountered in Marla-1A and -1B are not appropriate for the development of primary porosity: grainstones are very minor and reefs unknown. A small amount of birdseye (fenestral) porosity may be developed, but much of it seen in this study has been filled or lined by calcite (279.20 m, 281.00 m, 307.45 m).

A few examples of secondary porosity have been recorded. The most noteworthy is that at 225.35 m (Plate 2) in which part of an ooid grainstone has been replaced by chert. All the ooids are now fine-grained, true chert; only patches of the matrix were replaced (or cemented) by chert and some areas of matrix remain void. The chert is seen to be replacing an earlier dolomite and rare dolomite rhombs are seen "floating" in the chert. This provides an unusual example of interparticle porosity associated with chertification (Plate 2).

A small amount of mouldic porosity, resulting from the leaching of evaporites, may be developed. In many cases it is difficult to differentiate it from birdseye (fenestral) porosity (see above).

CLASTIC ROCKS

The best porosities recorded in this study are developed in the coarser clastic rocks (sandstones). They are primary interparticle porosities between quartz and other grains in the more poorly-cemented rock units (e.g. 130.00 m, 230.40 m, 294.00 m). Visual porosity is estimated to be fair to good.

Some of the primary porosity in Marla -1A and -1B has been infilled by minerals (fluorite and sulphides); the part played by these porous strata in mineralisation is discussed below.

MINERALISATION

The major secondary minerals encountered in Marla-1A and -1B are fluorite and sulphides (predominantly pyrite). Figure 2 illustrates the clear zoning of these two minerals within the sequence: fluorite occurs only in the top 120 m, and sulphide is absent from the top 60 m. Very fine-grained pyrite is disseminated throughout the sequence (see thin section descriptions in Benbow (1980a)) and these occurrences are not logged. All sulphides reported in Appendix I are easily visible in hand specimen and are post-depositional pore-filling materials.

FLUORITE

Nearly all of the recorded fluorite is purple in colour and is easily seen in hand specimen. Eighty-six percent of these fluorite occurrences are in carbonate rocks (predominantly calcite packstones) and the majority of these are associated with late calcite veins, vugs and stylolites (e.g. 83.70 m, 91.50 m,

107.60 m). Minor amounts of fluorite are recorded in primary pores in algal material (88.40 m) and sandstones (100.15 m, 152.50 m). SULPHIDES

Apart from one definite record of chalcopyrite at 139.45 m, all sulphides logged probably are pyrite. In coarser-grained, porous lithologies some cubes up to 7 mm are developed, but generally the pyrite is seen as a non-cubic, pore-filling mineral.

Seventy-one percent of the recorded sulphide occurrences fill pores in fine- to medium-grained sandstones and areas up to 5 mm across have been noted (e.g. 181.05 m, 181.95 m, 182.05 m). The remainder of the pyrite occurs in a variety of predominantly dolomitic carbonates.

Although the sulphides are scattered throughout the sequence, a concentration occurs between 177.00 m and 183.20 m (see Appendix I). Here a variety of lithologies share an abundance of soft-sediment injection features, brecciation and a green-grey clayey material identified as dolomite with muscovite, chlorite and mixed-layer chlorite-montmorillorite (see Appendix II).

Some features of the mineralisation in Marla-1A and -1B are analogous to those recorded in large-scale Mississippi Valley-type lead-zinc deposits elsewhere in the world (Jackson and Beales, 1967):-

- (a) pyrite and fluorite are zoned and associated with relatively simple lithologies;
- (b) they occur in chertified limestones, dolomites and sandstones;
- (c) the area has not been subjected to significant postdepositional deformation and is close to the margin of a sedimentary basin;
- (d) an apparent general absence of igneous sources for the mineralising fluids;

- (e) deposits are close to the present-day surface; and
- (f) brecciation and sedimentary injection are common.

ENVIRONMENTS OF DEPOSITION

The Observatory Hill Beds in Marla-1A and -1B is a sequence of carbonate and clastic interbeds averaging 0.5 m to 2.0 m in thickness. Many of the carbonates are silty and the clastic lithologies are calcareous and dolomitic.

CARBONATE FACIES

Evidence such as micrite envelopes, peloids, intraclasts, algal material, burrows and channelling indicates that the entire sequence was deposited in shallow (no more than a few tens of metres) quiet waters. The trilobites attest to an Early Cambrian marine environment and the abundance of quartz grains indicates that a land area, acting as a detrital source, was nearby.

It is possible to refine this broad interpretation into three carbonate facies, and their distribution is shown on Figure 2:-

- (i) Peri-Sabkha, 380 m to 280 m: this facies is characterised by dolomite, some evaporites, burrows and "mudballs". No units in this facies indicate deposition in a true sabkha environment thick evaporite beds are absent but the lack of algal material clearly indicates a hostile and basically evaporitic environment marginal to a true sabka.
- (ii) Restricted Lagoon, 280 m to 170 m: a dolomitic but not evaporitic, algal-dominated facies with active burrowing organisms. This environment is envisaged as less saline and severe than the peri-

sabkha but nevertheless restricted lagoonal conditions, with perhaps some short-lived subareal exposure, existed throughout.

(iii) Open Lagoon, 170 m to 83 m: the presence of calcite rock units, rare trilobites and a decrease in algal material relative to the restricted lagoon facies indicate deposition in an environment more marine than the two lower facies but still on a platform and protected from open marine influence. The increase in the incidence of cross-bedding and channelling in the top 40 m (Fig. 2) relative to the deeper rock units probably indicates proximity to the shelf margin.

The facies described above correspond closely with the Standard Facies Belts numbers 7 and 8 of Wilson (1975, p. 26-27) and may record a transgressive episode that resulted in mainly carbonate deposition in the landward parts of a broad platform lagoon.

CLASTIC FACIES

The clastic rocks are not easily defined in terms of separate facies: the sandstones are lithologically similar throughout the sequence. They record the deposition of detrital quartz and other grains in tidal channels across a carbonate lagoon. The rounded to sub-rounded quartz grains encountered in the sandstone probably derived originally from Middle Proterzoic schists, granitoid rocks and quartz veins like those of the Ammaroodinna Inlier, which crops out 30 km southwest of Marla (Fig. 1) (Krieg, 1972). Poorly known regional extensions of this "basement high" are presumed also to be the source of some of the conglomerates and arkoses of the Late Proterozoic-Early Cambrian Wallatinna Formation (Fig. 3) (Benbow, 1980b; Townsend

and Robertson, 1980). It is likely that reworking of this formation produced the lithic grains recorded in Marla-1A and -1B.

The clastic interbeds commonly are 0.5 m thick and rarely are thicker than 1 m. Thus they are a relatively minor component of the penetrated facies and their significance is peripheral to the interpretation of the carbonate depositional environment. The litholog (Appendix I) records constant influxes of detrital material (predominantly quartz) into the shelf lagoon with a noticeably higher clastic component between 116.00 m and 201.50 m. This may reflect a more prolonged period of minor tectonic activity along the Ammaroodinna "basement high". CYCLES

Within this interpreted record of marine transgression it is possible to identify numerous cycles (not rhythms) within all three of the carbonate facies. Assuming that an episode of continuous deposition (a cycle) results in gradational boundaries between rock units within the cycle but in sharp upper and lower boundaries to the cycle, thirty-two whole or part cycles may be recognised in the Observatory Hill Beds at Marla-1A and Seventeen complete cycles are comprised of Mudstone -Packstone/Grainstone/Boundstone/Wackestone/Sandstone - Mudstone; fifteen part cycles are recognised also. Criteria applied to confirm this concept include erosional bases (e.g. 110.80 m, 223.50 m), and burrows (e.g. 234.80 m, 350.10 m) and micrite envelopes (107.00 m, 219.10 m) at the tops. Some cycles also vary in colour from grey at the base to buff at the top (e.g. 234.80 m to 229.80 m), indicating possible subaerial exposure towards their finish.

The significance of these cycles from only one well is difficult to discern. They do not appear to parallel any

of the well-documented cycles elsewhere in the world, e.g.
Yoredale cycles, U.K.; oolite-grainstone and lime mud-sabkha cycles
of the Williston Basin; "loferites" of the Alps in Europe (see
Wilson, 1975, for summaries of all of these). Until more data
are gathered from the marine facies of the Observatory Hill
Beds it is impossible to propose a model for their origin. A
much clearer picture of the Early Cambrian palaeogeography is
needed, and future studies of these beds should endeavour to
elucidate the causes and environments of the cycles, as an
understanding of them will lead to a clearer understanding of
the whole basin during the Cambrian.

GEOLOGICAL HISTORY

The overall lack of recrystallisation and similar degenerate diagenesis in Marla-1A and -1B indicates that the Observatory Hill Beds there have never been very deeply buried. Outcrops of Ordovician and Devonian strata in the Mt. Johns Range (Fig. 1) total little more than 2 000 m thickness (Krieg, 1973) and the Marla area was marginal to both the Permian Arckaringa and Mesozoic Great Artesian basins of deposition. Wopfner (1964) states that west of the Lake Eyre Lineament the Permian and Mesozoic sediments were deposited on a shelf which underwent repeated exposure and received only a relatively thin veneer of sediments. It is likely that the maximum Permian depositional thickness occurred in the Boorthanna Trough (400 m; Townsend, 1976) and that sediments in the Marla area were considerably thinner. Therefore it is probable that the Observatory Hill Beds at Marla have never been buried much deeper than 2 500 m to 3 000 m and that nearly all of this burial had occurred by the end of the Devonian Period. The comparative lack of diagenesis and low-grade metamorphism has enabled an attempt at unravelling the geological history of these

beds. Many of the thin sections and acetate peels examined contain one or more features which help in discerning this history (Fig. 4).

Figure 4 attempts to outline the order in which postdepositional processes acted on the Observatory Hill Beds. Parts
of the sequence are doubtful and some processes may have been almost
synchronous (e.g. celestite occurs with dolomite in a vein
at 108.58 m; early dolomitisation and the commencement of
diagenesis frequently are penecontemporaneous with deposition). A
clear indication of part of the history is gained at (i) 121.93 m
where vugs are lined first with chalcedony and then celestite;
(ii) at 146.70 m where early dolomite, replacing a calcite mudstone,
has been partially replaced by chert and chalcedony and the whole
has been cut by a later, coarsely-crystalline calcite vein (Plates
3 and 4); (iii) fluorite occurs with coarse, late calcite in
veins at 83.00 m.

The ninth stage shown on Figure 4, which is of major economic significance, may have been attained during the late Palaeozoic when the Observatory Hill Beds were buried and still sufficiently porous to provide a "plumbing system" for the up-dip transport of hot, metal-bearing brines. Upon contact with hydrogen sulphide in the sequence, metallic sulphides were deposited mainly in primary, interparticle pores. The conclusion that mineralisation occurred after dolomitisation, chertification and brecciation agrees with observations by Jackson and Beales (1967, p. 387).

Source rocks analysed from Marla-1A generally have a low total organic carbon content and are immature to marginally mature (McKirdy in Benbow, 1980a). However, analyses of the non-marine carbonates in Byilkaoora-1 and ?marine carbonates at Wilkinson-1 and Wallira West-1 (Fig. 1) show the Observatory Hill Beds elsewhere along the eastern margin of the Officer Basin

to have much better potential to generate petroleum (McKirdy & Kantsler, 1980). It is possible that suitable reservoirs exist both in the Observatory Hill Beds and in other Late Proterozoic or Palaeozoic formations (see Pitt et al., 1980, p. 219).

The work outlined in this report demonstrates that a fully-cored and carefully logged stratigraphic well can provide much information concerning environments of deposition, habitats of minerals and the geological history of an area. All of these data can then be used to outline areas for further exploration.

CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE WORK

Despite the absence of both the stratigraphic top and base of the Observatory Hill Beds in Marla-1A and -1B, the 300 m penetrated section clearly demonstrates the progress of a marine transgression across an area lying near a landmass which was contributing a supply of quartz detritus. This warm Early Cambrian sea spread across a stable shallow platform and hence carbonate to evaporitic sediments predominated. By Walther's Law of Facies, and knowing that the northeast-trending Ammaroodinna "basement high" lay to the northwest of the Marla area, it can be postulated that sediments of a more evaporitic and clastic nature were deposited between Marla and the "high" and more open-marine sediments away from it. Using this model it is possible to suggest areas in which facies of especial interest to mineral and petroleum explorationists may exist:-

(i) Sabkha Facies: these strata may be dolomitised, porous and evaporitic. They are the most likely hosts for Mississippi Valley-type mineralisation and also could provide excellent petroleum reservoirs (with the less-dolomitised and less-porous strata of the peri-sabkha facies as cap rocks). Rocks of this

facies may be below 380 m in Marla-1B and at increasingly shallower depths towards the Ammaroodinna "high" (Fig. 5).

(ii) Shelf Margin facies: grainstones and minor packstones, with either primary interparticle porosity or secondary inter- and intraparticle porosity derived from solution and, perhaps, dolomitisation. Again these strata are possible hosts for Mississippi Valley-type mineralisation (algal-rich, dolomitic rocks are more likely) and, with open marine, fine-grained cap rocks, would provide excellent petroleum reservoirs. Rocks of this facies may have been eroded from the Marla area but could remain close to the surface (provided erosion has not removed them entirely) in the more open-marine parts of the shelf (Fig. 5).

(iii) Clastic Interbeds: any of the carbonate lagoonal to sabkha facies believed to occur between Marla and the Ammaroodinna "high" will contain increasingly thicker interbeds of sandstones. These could provide porous reservoirs, interbedded in predominantly fine-grained carbonate cap beds, for both minerals and petroleum. These traps may be stratigraphic in nature with grain size and thickness decreasing away from the Ammaroodinna "high".

Although containing only some evidence of Mississippi Valley-type mineralisation, the sequence intersected in Marla-1A and -1B indicates that mineralising fluids may have been circulating in this area at a time when some porosity existed. Given suitable conditions, petroleum also may have been trapped.

The drilling of stratigraphic wells and their subsequent detailed logging and interpretation might well lead future explorers to the discovery of carbonate-hosted Mississippi Valley-type mineral deposits and to petroleum accumulations.

ACKNOWLEDGEMENTS

My thanks to Surender Chaku of Comalco for his help with the preliminary logging below 200 m and to Don Vinall and Ashley Smith who made the acetate peels.

REFERENCES

- BENBOW, M.C., 1980a. Well completion report, Marla-1A, -1B.

 Bept. Mines and Energy report 80/22 (unpublished).
- BENBOW, M.C., 1980b. Geological mapping in the Mt. Johns area.

 Report No. 6 of the Officer Basin Study Group. Dept.

 Mines and Energy report (in prep.) (unpublished).
- BENBOW, M.C., & PITT, G.M., 1979. Byilkaoora No. 1 well completion report. Dept. Mines and Energy report 79/115 (unpublished).
- BRICKER, O.P., (Ed.), 1971. Carbonate cements. The Johns Hopkins Univ. Studies in Geology, 19. The Johns Hopkins Univ.

 Press, Baltimore, Maryland. 376 pp.
- DAVIES, P.J. and TILL, R., 1968. Stained dry cellulose peels of ancient and Recent impregnated carbonate sediments.

 J. sedim. Petrol., 38:234-237.
- DUNHAM, R.J., 1962. Classification of carbonate rocks according to depositional texture. <u>In</u> Ham, W.E. (Ed.), Classification of carbonate rocks. Mem. Am. Assoc. Pet. Geol., 1, 108-162.
- ESTEBAN, M., 1976. Vadose pisolite and caliche. Bull. Am. Assoc. Pet. Geol., 60: 2048-2057.
- FOLK, R.L., and PITTMAN, J.S., 1971. Length slow chalcedony: a new testament for vanished evaporites. J. sedim.

 Petrol., 41: 1045-1058.
- GATEHOUSE, C.G., 1979. Well completion report, Wilkinson No. 1.

 Dept. Mines and Energy report 79/88 (unpublished).
- JACKSON, S.A., and BEALES, F.W., 1967. An aspect of sedimentary basin evolution: the concentration of Mississippi Valley type ores during late stage diagenesis.

 Bull. Can. Pet. Geol., 15: 383-433.
- KRIEG, G.W., 1972. The Ammaroodinna Inlier. Q. geol. Notes, geol. Surv. S. Aust., 41: 3-7.

- KRIEG, G.W. (Compiler), 1972. EVERARD, South Australia.

 <u>Explanatory Notes</u>, 1:250 000 <u>geological series</u>.

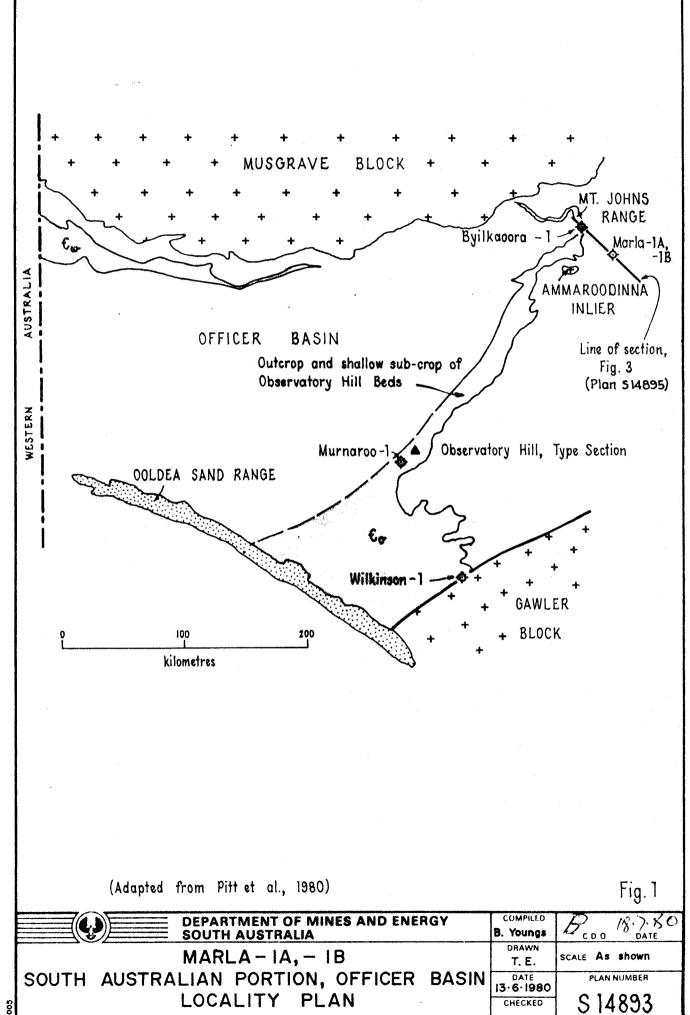
 Sheet SG/53-13. Geol. Surv. S. Aust.
- McKEE, E.D., and GUTSCHICK, R.C., 1969. History of the Redwall Limestone of northern Arizona. Mem. geol. Soc.

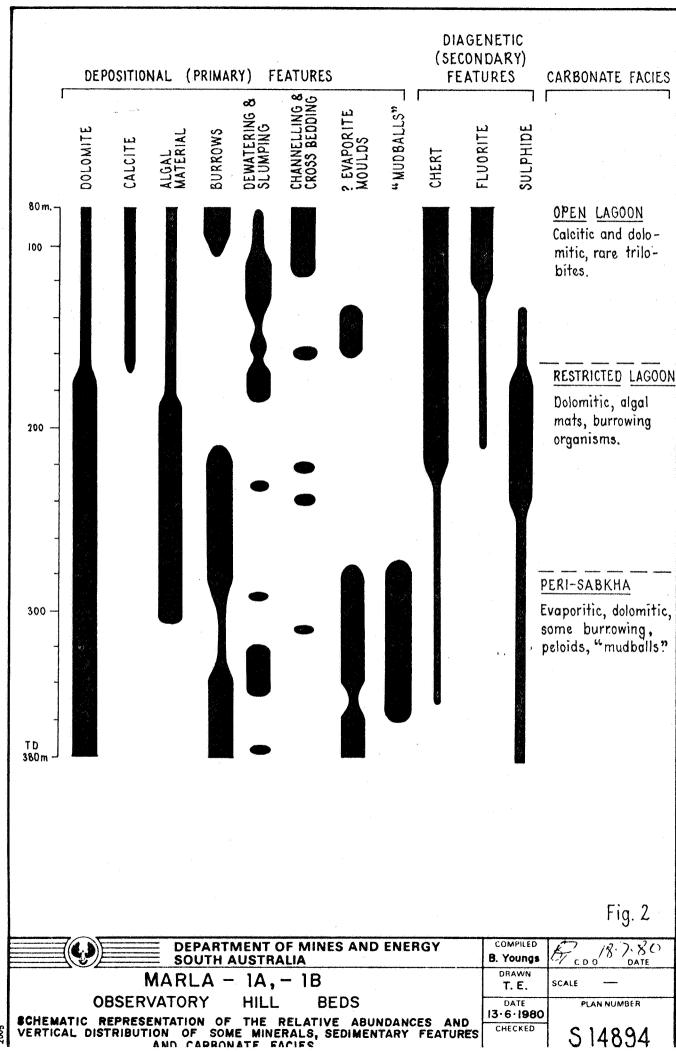
 Am., 114: 726 pp.
- McKIRDY, D.M., and KANTSLER, A.J., 1980. Oil geochemistry and potential source rocks of the Officer Basin, South Australia. Aust. Pet. Explor. Assoc. J., 20: 68-86.
- NAGTEGAAL, P.J.C., 1969. Microtextures in recent and fossil caliche. Leisse geol. Mededelingen, 42: 131-142.
- PITT, G.M., BENBOW, M.C., and YOUNGS, Bridget C., 1980. A review of recent geological work in the Officer Basin, South Australia. Aust. Pet. Explor. Assoc. J., 20: 209-220.
- SCHOLLE, P.A., 1978. A color illustrated guide to carbonate rock constituents, textures, cements and porosities.

 Mem. Am. Assoc. Pet. Geol. 27, 241 pp.
- SELLEY, R.C., 1978. Ancient sedimentary environments. Chapman and Hall, London, 2nd edition, 287 pp.
- THORNTON, R.C.N., 1978. The geological results of the drilling of Manya No. 1 and Marla No. 1. Mineral Resour. Rev., S. Aust., 143: 47-65.
- TOWNSEND, I.J., 1976. Stratigraphic drilling in the Arckaringa Basin, 1969-1971. Rep. Invest . 45, geol. Surv. S. Aust., 30 pp.
- TOWNSEND, I.J., and ROBERTSON, R.S., 1980. The Wallatinna Opal Diggings. Dept. Mines and Energy report 80/34 (unpublished).
- WILSON, J.L., 1975. Carbonate facies in geologic history.

 Springer-Verlag, Heidelberg, 469 pp.

WOPFNER, H., 1964. Permian-Jurassic history of the western
Great Artesian Basin. Trans. R. Soc. S. Aust., 117-128.
WOPFNER, H., 1969. Lithology and distribution of the Observatory
Hill Beds, eastern Officer Basin. Trans. R. Soc. S.
Aust., 93: 169-187.

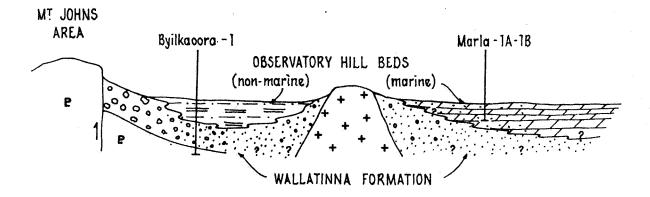




N.W.

S. E.

AMMAROODINNA INLIER EXTENSION



(No Vertical or Horizontal Scales)

See Figure 1, for approximate line of section (Plan S14893)

(Byilkaoora-1: see Benbow and Pitt, 1979; Marla-1A-1B: see Benbow, 1980a)

Fig. 3

	DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED B. Youngs	B 18.7.80
	MARLA - 1A,- 1B	DRAWN T. E.	SCALE
7005	DIAGRAMMATIC SECTION THROUGH NORTHEASTERN OFFICER BASIN, SHOWING FORMATION RELATIONSHIPS TOWARDS THE END OF DEPOSITION OF THE OBSERVATORY HILL BEDS	DATE 17-6-1980 CHECKED	PLAN NUMBER S 14895

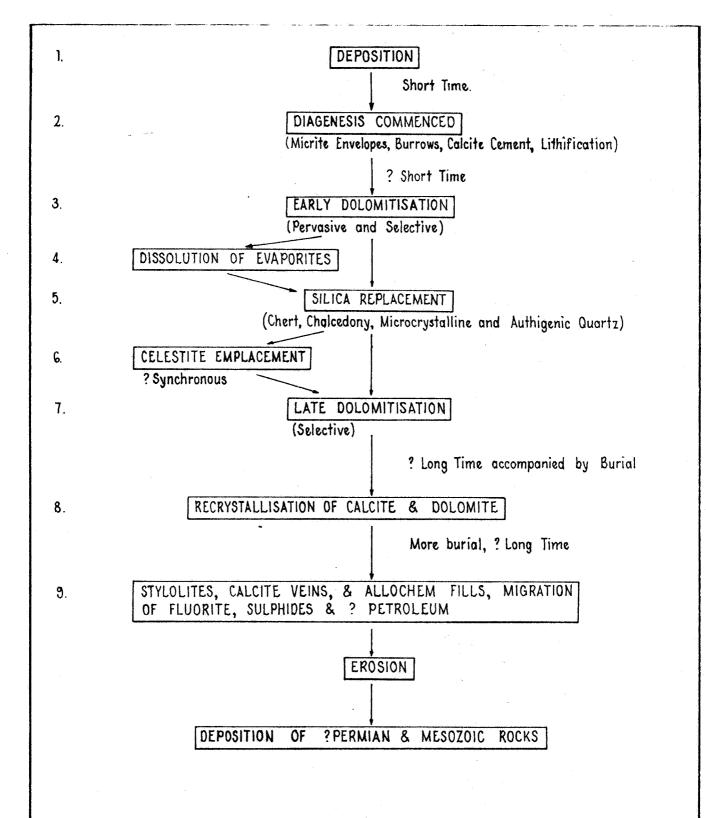


Fig. 4

	B. Youngs	CDO DATE
MARLA - IA,- IB	T. E.	SCALE
SCHEMATIC REPRESENTATION OF PROBABLE GEOLOGICAL	DATE 18 · 6 · 1980 CHECKED	PLAN NUMBER S 14896



S. E.

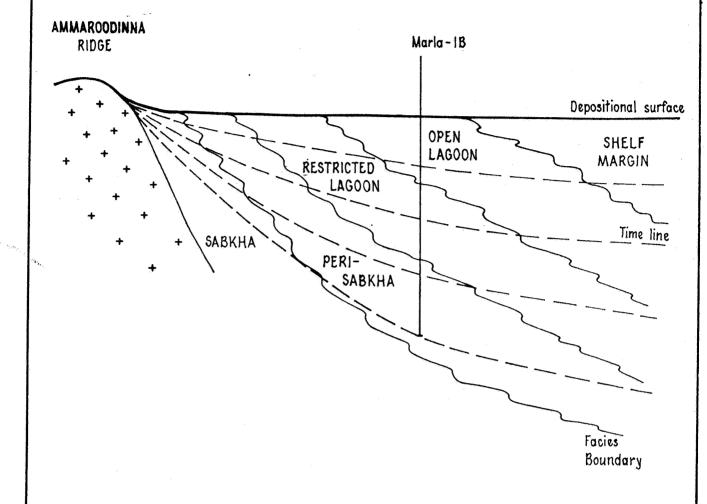


Fig. 5

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	B. Youngs	60 187.80 CDO DATE
MARLA-IA,- IB	DRAWN T. E.	SCALE
DIAGRAMMATIC REPRESENTATION OF SPATIAL RELATIONSHIP OF FACIES IN THE MARLA AREA AT THE TIME WHEN STRATA	10.0.1200	PLAN NUMBER
AT 83 METRES WERE BEING DEPOSITED IN MARLA I-B	CHECKED	S 14897

2005

Plate 1: Intraclast and ?peloid grainstone showing micrite envelope (m) around one grain and a later coarse, calcite infill (f). Stylolite at top of picture.

Marla-1B, 107.00 m, acetate peel, plain light. Photo No.: 31675

Plate 2: Chertified ooid grainstone with secondary interparticle porosity. Many ooids retain their original concentric textures.

Marla-1B, 225.35 m, acetate peel, plain light. Photo No.: 31676



0.5 mm

1.0 mm

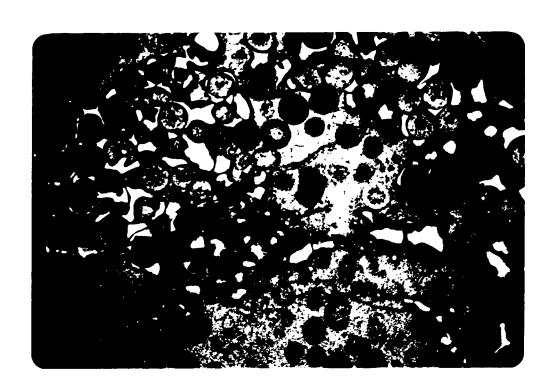


Plate 3: Chertified ooid granstone lens (a few ooids at the base remain unchertified) in a dolomite mudstone. Rare dolomite rhombs "float" in the chert. A late calcite vein cross cuts the lens vertically.

Marla-1B, 219.50 m, thin section, plain light.
Photo No.: 31677

Plate 4: As above. Shows microcrystalline quartz (q) replacing and cementing ooids.

Marla-1B, 219.50 m, thin section, crossed nicols.

Photo No.: 31678



0.5 mm



0.5 mm

Plate 5: Graded quartz grains in a dolomite boundstone.

Marla-1A, 201.80 m, acetate peel, plain

light.
Photo No.: 31679

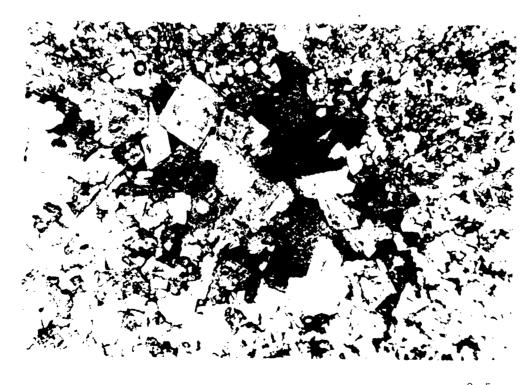
Plate 6: Dolomite mudstone showing rhombs and development of porosity. Large, zoned rhombs may be later.

Marla-1B, 231.35 m, thin section, plain

light. Photo No.: 31680



1.0 mm



0.5 mm

Plate 7: Dolomitic mudstone containing casts of ?evaporite minerals.

Marla-1B, 146.75 m, thin section, plain

light.

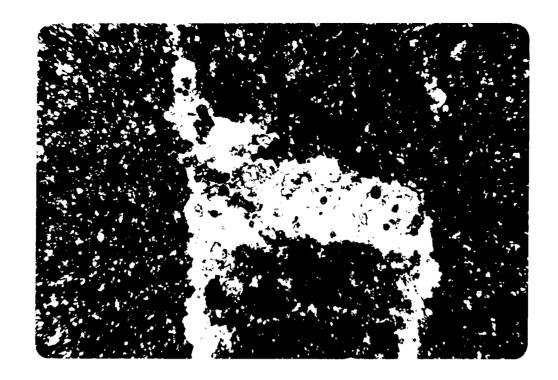
Photo No.: 31681

Plate 8: As above showing chalcedony (c) and microcrystalline quartz (q) infilling the casts.

Marla-1B, 146.75 m, thin section, crossed

nicols.

Photo No.: 31682



0.5 mm

0.5 mm

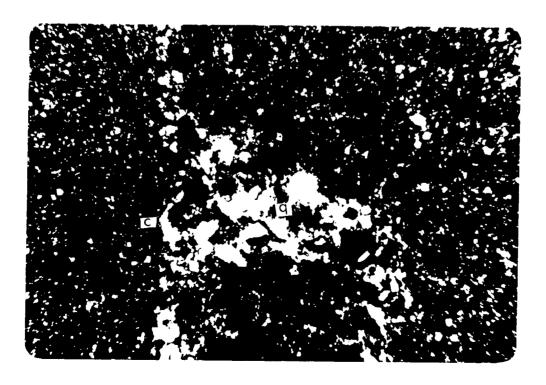


Plate 9: Dolomitic mudstone containing an area of dolomite (d), celestite (ce) and chert (ct) replacement. Dolomite rhombs "float" in the chert, i.e. they are earlier.

Marla-1B, 122.00 m, thin section, plain light.
Photo No.: 31683

Plate 10: As above showing chert as chalcedony (c) and microcrystalline quartz (q). This plate suggests that chert replacement occurred before celesite (ce).

Marla-1B, 122.00 m, thin section, crossed nicols.
Photo No.: 31684



0.5 mm



0.5 mm

APPENDIX I
Litholog, Marla-1B

Compiled by B.C. Youngs, and S.K. Chaku (below 200 m)

LEGEND FOR MARLA 1-B LITHOLOG

ROCK TYPES

Limestone (calcite)



Dolomite



Calcareous claystone



Dolomitic claystone



Calcareous siltstone



Dolomitic siltstone



Sandstone

ROCK UNIT BOUNDARY TYPES

Sharp

Gradational

Erosional



Stylolitic



Deformed

ALLOCHEMS AND SEDIMENTARY FEATURES

Intraclsts

Peloids

Mud balls"

Oncolites 9

Ooids 0

Stylolites

Birdseyes

W) **Burrows**

W Channels

N Dewatering, slumping

6 Fossil fragments

Stromatolites, algal mats ର

Algal plates €

Mud cracks

(R) Vugs

Microfaulting

Evaporite minerals *

Abundant

Rare

Ab

R

φ Porosity

ROCK COLOURS BEI	ODING	THICKNESS
------------------	-------	-----------

ROCK	COLOURS	BEDDI	NG THICKNESS	ACCES	SORY MINERALS
Bf	Buff	Lm	Laminated (0.5 mm)	Calc	Calcite
B1	B1ack	V.Tn	Very thin (5-10mm)	Сср	Chalcopyrite
Bn	Brown	Tn	Thin (10-100mm)	Cd	Chalcedony
Gr	Grey	Md	Medium (100-300mm)	Ch	Chert
Gn	Green	Tk	Thick (300mm-1m)	F1	Fluorite
Cm	Cream	V.Tk	Very thick (1-3m)	Qutz	Quartz
Pk	Pink	Ms	Massive	S1	Sulphide

P1 Pale Ind Indistinct MdMedium Brwd Burrowed

Dk Dark Stylo Stylolitic

Sample points are indicated - 1A, 1B = well number, TS = thin section, P = acetate peel.

Logged by B.C. Youngs **CARBONATES** Colour Phble Gnle V.Cs Crse Medm Medm Fine Slts CLASTIC **ROCKS** 83. IA: T5,83.10 27? Lun-Вf V.Tn

V. f-grnd. Rare clay & mica grus. A. in vect. veins +? b-eyes // b bodg. Calc. in b-eyes. Angular -> subrada intras in buff mix. Mr Ab Fluorspar is zoned in T.S.; occurs in veins styles, b. planes 4 some burrows. Is both purple 4 coorners. **₩** Ab Ind Md. gr A 18 = 75 84.55 1B=T5, 84.70 20 IA = P 85 50 Silty throughout, with concentrations of silt in some parts.

N in sub-veit veins. Tu Bf n Layers of rad-subrad guy gons (v.coe-gran) upto 10 mm thick.
V. fine launs. Bf-Lm -PL. gr Ind 86 Lamnd. - v. thin & some thin intra. beds. Вf V. fine, ak. bitum. lanuns. Lm-De-watering a 86.40 m. V.Tn N 87 Bf a ? W gr W #R Thin interbeds of wackert. * packet. R. OR 2 genrns. cement. DR. gr Md 1B=P,87.85 4 Bf A Ina. pkst. E styles ina. bods. It in mex. My At Some rexn. -> "grunneleuse" 9 18=P,89 40 Ma.gr Alg. pl., pckst. (rexd) & Fi in porros of algal pls. Sho Md.gr N R 89 Few v.cse. → gran grus in beds upt 10 mm thick; some silt → v.f. sst. 30 mm Chert bleccia at base, infilled E buff mudst + mudst. intras. Subrad. frags. \mathcal{C} Bf a Im -Ch Pl.gr In **₩** R Ma.gr FL R PL in fine veins a pores // to body. plo. Tu

Latitude: 27⁰ 28' Longitude: 133⁰ 44' 55"

Logged by B.C. Youngs

CARBONNIES & 30 50 50 50 50 50 50 50 50 50 50 50 50 50	170	ngrtude :	133	44 55					
CLASTIC OF STATES OF STATE			11 11 11						
CLASTIC OF STATES OF STATE	07.	S	ist Ist	ts.					
CLASTIC OF STATES OF STATE	CAF	BONATES E	3 5 5	Ç					
90 88 had a lease 15 mm = birg pinks, case, alter as serviced gard gard gard colored in the serviced gard gard gard colored in the serviced gard gard colored gard gard colored gard gard colored gard gard gard gard gard gard gard gar				Σ			р	n	
90 88 had a lease 15 mm = birg pinks, case, alter as serviced gard gard gard colored in the serviced gard gard gard colored in the serviced gard gard colored gard gard colored gard gard colored gard gard gard gard gard gard gard gar		San	đst.			es H	Ė		
90 88 had a lease 15 mm = birg pinks, case, alter as serviced gard gard gard colored in the serviced gard gard gard colored in the serviced gard gard colored gard gard colored gard gard colored gard gard gard gard gard gard gard gar	OT ACTITO	9998	E e H	8		ΗS	ģ		
90 88 had a lease 15 mm = birg pinks, case, alter as serviced gard gard gard colored in the serviced gard gard gard colored in the serviced gard gard colored gard gard colored gard gard colored gard gard gard gard gard gard gard gar		552.5	A HH	ੜੀ		<u>a</u> 5	ğ		
The first bedding a tight of both the first bedding a tight of both the first bedding a tight of both the first bedding a tight to be first bedding a tight to both the first bedding a tight to be first beddin	RUCKS		1 1 1	Ÿ			ΉЦ		
Page 10-19-19-19-19-19-19-19-19-19-19-19-19-19-		1 - 1 - 1 -		1,2,2	2.7 4	0 35	Τ.	T.	Basal 15 mm = buff pink, calc., sitst -> sst.
Pl. g. Th. Pl. g.						1,4	Ma	n	E scattered guts gras above it.
Sect of the insighted has each them the following of the first transmitter bound of the fir				<u> </u>		1 -	-		
10-77, 91-70 Phd. gr Phd. gr						Pi gr	1_		Stat has injected into least above
Pla gr Pla gr						1/ac (%)	In	n	Salar star agreement and agreement a
Ma. gr Pro Pro Pro Pro Pro Pro Pro Pro Pro Pr				╶ ╒╵╻ ┖┰┺	<u>-</u>	(0) -114/			
Ma. gr Pro Pro Pro Pro Pro Pro Pro Pro Pro Pr							1	A	Rexd, & fl. 4 calc. in ungs. Some fl
18.79 1.70 18. 19 1.70 19. 19				 	디				. also in stylos.
By U.Th. By Was placed above. CORE LOSS 95 18:19.92 18:19.92 18:19.93 The Was already by Same Bases before the boundary of algel these of the alg		10=75,91.70				Ma gr		_	One level has a 15 mm intia. Pkst.
By V.Th. Pr. By V.Th. Pr. By Pr. By V.Th. By		•		│┍┖┯┖╻┖	- 		1	1 -	Your chart intro a forman at base
Bf V.Th R got: in board 10 even. 18. 19. 280 18. 280 18.					97	, 📗	<u> </u>		
PRINCESO FAULTED 18. 19. 19. 19. 19. 19. 19. 19. 19. 19. 19				ĬĬŢĬŢĬŢ	나니 ''	1	11.74	1	190. 3 6. 1 10
18-1,9380 By Station of algal mass of algal place						ا مل		₩ R	got. in basar to wim.
18-1,9380 By Station of algal mass of algal place		-MICRO- FAUL	789	77.77	77	gr- 05	V.Tn		
Bf United badded student of the style of the		IA - P 92.80		<i>ケーテーテラ</i>	<u> </u>	Pn - [6n) Pc		
Bf V.Th. Bf V.Th. B R Their, algal layers at top. CORE LOSS 95 Ma. gr Ma. gr Ma. gr Mas above. Channelland base Pha. gr Ma. gr Mas Benealt a top, grades down to there. Bf V. Th. Benealt at top, grades down to the top with fine bedding a style's b. p's at the top. Bf V. Th. Benealt at top, grades down to the top bedding a style's b. p's at the top. Pha. gr Ma. gr Mas Benealt at top, grades down to the top bedding a style's b. p's at the top. Pha. gr Mas Benealt at top, grades down to the top bedding a style's b. p's at the top. Bf. V. Th. Benealt at top, grades down to the top bedding a style's b. p's at the top. Pha. gr Mas Benealt at top, grades down to the top bedding a style's b. p's at the top. Bf. V. Th. Benealt at top, grades down to the top bedding a style to the top. Bf. V. Th. Benealt at top, grades down to the top bedding a style to the top. Bf. V. Th. Benealt at top, grades down to the top bedding a style to the top. Bf. V. Th. Benealt at top, grades down to the top bedding a style to the top. Bf. V. Th. Benealt at top, grades down to the top		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	9	ブファン	_ a				time intervers of argai mais +
18:1,937 On P. Bf- V. Tin- B P. There, adjud layons at top. CORE LOSS 95 The Winner of The Channellan trace The gr Tin of the trace of the trace Plant gr Tin of the trace of the trace of the trace. Plant gr Tin of the trace of the tr						'	١,	.1	I all a contract to the contra
Professional Control of the Control			ببلج			BE		B Ab	se lange have grans.
Prob. Bf V. Tr. B R Thin, algal lagons at top. CORE LOSS 95 10 Prob. as above. Channeller base Channeller base Channeller base Channeller base Channeller a base Channeller a base Channeller at base Channeller Channelle			\perp	7777	Z -	,	V.Tn		
Prob. 25 above. CORE LOSS 95 Th U Prob. 25 above. Channellan brose The Apr Time of the breaking a stylo'c b. p's at bruse. Pha. gr V. Time of the breaking a stylo'c b. p's at bruse. 96 Ma. gr Pina gr Cheety a carb. algal plates a mass. Brundat: at top, grades down to interbedded music a channelled sits. Mu who can a gran quety gross in lame bros. Mu who we a gran quety gross in lame bros. Mu who a gr Time of the calc. uns., some brdg. pl. a stylo. Calc. abo. Stylos. increase downwards Ph. gr Time of the calc. then de. File was off the calc. then de. File units of the calc of the calc. then de. File units of the calc of t		18=1,93.7	Y-	7777		1		₩ R	
Prob. 25 above. CORE LOSS 95 Th U Prob. 25 above. Channellan brose The Apr Time of the breaking a stylo'c b. p's at bruse. Pha. gr V. Time of the breaking a stylo'c b. p's at bruse. 96 Ma. gr Pina gr Cheety a carb. algal plates a mass. Brundat: at top, grades down to interbedded music a channelled sits. Mu who can a gran quety gross in lame bros. Mu who we a gran quety gross in lame bros. Mu who a gr Time of the calc. uns., some brdg. pl. a stylo. Calc. abo. Stylos. increase downwards Ph. gr Time of the calc. then de. File was off the calc. then de. File units of the calc of the calc. then de. File units of the calc of t			₹	, , , , ,		. 1		1	
CORE LOSS 95 The Work as above. Channelled bane Channelled bane The Pha gr Th Phat Pha gr Th Phat Bf V. Th Bf V. Th Phat Gr Phat Gr Phat Gr Phat Graph algar paths 4 mats. B gundot at top, grader down to have bedded studets a channelled sith bode. At much way be algat. Phat Gr Phat Gr Phat Went also and 97.90-99.15: in sith breca. Phat Gr Phat Gr Phat Went also and 97.90-99.15: in sith breca. Phat Gr Phat Gr Phat Went also and 97.90-99.15: in sith breca. Phat Gr Phat Gr Phat Went also and 97.90-99.15: in sith breca. Phat Gr Phat Gr Phat Went also and 97.90-99.15: in sith breca. Phat Gr			<i>\</i>	1- L L				1	
The probe as above. Chan wellow book. The probe bodding or stylo'c b. p's at book. The probe bodding or stylo'c b. The probe boddi						PL. Bf-		- ଜେନ	Thin, algal layers at top.
The Channelled trace Promage To May Promage			·			- uu	170	+	,
The Western base Proposed of the state of t							ŀ		
The Chammels of trace Proposed as above. Chammels of trace Fine bredding a stylo'c b. p's at bruse. Proposed as above. Proposed as above. Chammels of trace at top, grader down to town to some one a gran quity gras in some look. By which we are a gran quity gras in some look. All weder was bruse. Proposed as above. Chammels of trace at top, grader down to town. By which as above. Chammels of trace at top, grader down to town. By a grader down to stylo. Proposed at the pro				L055	200	.			
Probable of the state of the st					- 43		 		Con as about
PM. gr Tn Shut finer bedding & style'c b. p's at trure. 96 Md. gr Ma & Cuecty & carb. algal pates & mato. 8 Bundot. at top, grades down to luter bedded rundot. A chancelled sets. 30ml one on & gran. gutz gras. in Some bros. All mudot. may be algal. 1 West. Calc. Uns., some brdg. pl. & style. 1 Culc. also. Styles. increase durinvards 1 Mod. gr Tn Mr. Wugo > 2 mm filled & calc. then A. F. F. Years off styles. ? burrowed. 1 By & Un F. & ? algal lamn. bov and brose.		*************************************					.1	1 .	
The street of styles. I have been of styles.		·	·		~	PL: Ma. gr			
96 Md. gr Ma g G Checty & carb. algal pales & mats. Brundst. at top, grades down to with bedded hunder. a chanvalled site. Some one. & gran. gutz gras. in Jame bods. All mudst. may be algal. Freg. Ms Vert. (alc. uns., some bodg. pl. & style. (alc. abso.) Styles. inchase dammards Mod. gr Tn July Wugs -> 2 mm filled & calc. then A. F. Yems off styles. ? burvowed. By & Un. A. ? algal lanen. towards trave.				 	┍┸╼╢	My gr		5/2	finer bedding 4 style's b. p's at
Md. gr Pha & Checky & carb. algal plates 4 mats. Brundst. at top, grades down to with bedded Mudot. 4 chanvelled sits. Jone one. 4 gran. gutz gras. in Jone bods. All mudot. may be algal. Lutra. bed a 97.90-298.15: in situ brecc. Vext. Calc. uns., Jone bodg. pl. 4 stg br. Calc. also. Stylos. increase downwards Ph. gr Ph. A. Vings -> 2 mm filled & calc. then A. Fr. Galler of stylos. ? burrowed. By Survey. Ph. gr V. To F. ? algal lamn. bowards base.					\square		Tn		
Bg. V. In			F		76	Mr an	Ma	B 20	Checter & carb. algal dates & mats.
Bf- V. In Window bedood Aundow. 4 channelled 35th. Jose Dress. All mudow may be algal. There . bed a) 97.90-98.15: in situ brecen. Pk-gr Ms West. Calc. uns., some brdg. pl. 4 styler. Calc. also. Styles. increase downwards Rol. gr Tn Mr West. Styles. ? busvowed. Pl. gr V. Tn A ? algal lann. bowards brase.		. 			'	110.71	1		
Bf- V. In W Some one. 4 gram. quit gras. in Some brds. All mudst. may be algal. Intra. brd a) 97.90-498.15: in site. brecen. Pk-gr Ms Pk-gr Ms West. Calc. uns., some brdg. pl. 4 stylo. Calc. also. Stylos. increase dammards Pk-gr Ms Weins of stylos. ? burvowed. Pl. gr V. Th A ? algal lann. bowards trase.			\mathcal{A}		<u> </u>	1	ł		Boundst at top, grades down to
PR-gr Ms Vings -> 2 mm filled E cale then A. Fi Both so the soft styles. The styles of styles of styles. The styles of styles of styles of styles. The styles of styles of styles of styles of styles. The styles of styles of styles of styles of styles of styles. The styles of st			7			00	l.,	P	Some one of grown out over the Some
All pundst. may be algal. Intra. bed a) 97.90-98.15: in site brecen. Verk. Calc. uns., some belg. pl. * stylor. Calc. also. Stylos. increase dimenwards Red. gr Tn Revenued. Bot * Lim. R. ? algal lawn. towards base.							V. In	ju 1	Dedo.
Pk-gr Ms Pk-gr					二	(gr)			
PR-gr Ms Vest. case. uns., some bolg. pl. 4 stylo. Casc. asso. Stylos. increase downwards Mod. gr Tn A vems off stylos. ? burrowed. Bf 4 Lm- Pl. gr V. Tn A ? asgal larun. bowards boxe.						1		1 1	•
PR-gr Ms Vest. case. uns., some bolg. pl. 4 stylo. Casc. asso. Stylos. increase downwards Mod. gr Tn A vems off stylos. ? burrowed. Bf 4 Lm- Pl. gr V. Tn A ? asgal larun. bowards boxe.					ŢĮ.		1	1 1	
PR-gr Ms Vest. case. uns., some bolg. pl. 4 stylo. Casc. asso. Stylos. increase downwards Mod. gr Tn A vems off stylos. ? burrowed. Bf 4 Lm- Pl. gr V. Tn A ? asgal larun. bowards boxe.						1	·		
PR-gr Ms Vest. case. uns., some bolg. pl. 4 stylo. Casc. asso. Stylos. increase downwards Mod. gr Tn A vems off stylos. ? burrowed. Bf 4 Lm- Pl. gr V. Tn A ? asgal larun. bowards boxe.			F					اسدا	Intea led a) 97.90 > 98.15 · in cir.
PR-gr Ms Vest. cake uns., some bodg. pl. 4 stylo. Cake. also. Stylos. increase downwards Stylos. increase downwards Ways -> 2 mm filled E cake then A. Fr. Revens off stylos. ? burrowed. Pl. gr V. Tr. R. ? asgal larun. bowards base.					7 98			vv-?	brecen.
PR-gr Ms Calc. also. Stylos. increase downwards Not. gr Tn Mr Vings -> 2 mm filled & calc. then A. Fr. Veins off stylos. ? burrowed. Pl. gr V. Tn R. ? algal lawn. bowards base.			ŀ	┸┰┸┰┸	 '			1	Vert. cake uns some body pl. + stato.
Pk-gr Ms Stylos. increase downwards			ţ		_	1	1	15 KR	calc. also.
Mod. gr Tn Mor Vings -> 2 mm filled & calc. then St. Ft. Bf 4 Lm - R ? algal lawn. towards trase.			ŀ	┰┸┰┸┰	4	Pb-9-	Me		Stylos increase downwards
Mod. gr Tn Mor Vings -> 2 mm filled E cale. then dr. Fr By veins off style. ? burrowed. Pl. gr V. Th R ? adgal lawn. bowards base.			į.			, , Jr	,		•
Mod. gr Tn Mor Vings -> 2 mm filled & calc. then A. Fr Veins off styles. ? burrowed. Bf & Lin- Pl. gr V. Tn R ? algal lawn. bowards base.			ŀ	-1 	- 49				
By + Lim & ? algal lanen bowards base.			ļ		 ''	1			
By + Lim & ? algal lanen bowards base.			<u>_</u>		4				
By + Lim & ? algal lanen bowards base.			[0		파	Md. gr	Tn	Mr &	Vugs -> 2 mm filled E cale. then St. Fr
100 Pl. gr V. Th R ? algal lanen. towards trase.		· */.=***********************************		1111	4				
		F		444	-4	P1. gr		n	e argal lamin. Downdo tase.
		11111	4		100	لــــــا	<u></u>		

Latitude: 27⁰ 28' Longitude: 133⁰ 44' 55" Logged by B.C. Youngs **CARBONATES** Colour Cble Gnle Gnle Crse Crse Fine Fine Clys CLASTIC **ROCKS** Above 101 20: v.cse. → gran. in channels. Cor. parts have Fi infilis. 6 ኞ Below 101.20: algal pl. 4 intrao. indicate some high energy envents. w Bf + 5/15 Pl. gr 101 A 102 Bf-(g) Md slet. - sized interbeds, graded. Bf -PR Some Tn thin V. cse . - gran layers . a Some BF -Lm -B PL. gr Tn - Pk Bf-Cm A. in wispy veins 105 V.Tn - (PR) º ନ ? algal mats predom in basal 100 mm PR-gr Ms J gr-(4) 20 mm intra bed at base. 106 Patches of microspar throughout. Stylo. gr IA= P, 106.90 107-1B= P, 107.00 Oblitic - intradastic grunt at top.

Style & vein at base. Mic. envx.
A. fills ungs & pose in? algal mul. at a geners. Coment. bace. TR-# ?G gr Ms Bf Lm A STAR One vein (5 mm) run vert. 7 contains A 4 Calc. : 9 A before calc. h PL.gr Lm-4 Bf Braciated layers: ? some algal. Tu ⁷€ IA = 75, 108.58 Some fine chanciled beds & one -gran. infils. Bf 4 Lm-M5 R PL. g. € R ?Ω Tu St. Brecen. 4 dewatering in basal 100 mm. W At Numeron, graded channelled deps. = 10 > 20 mm. Cor. bases are filled E. A. Thin ft. veins along + subparalled to Вf Tn

bodg. pls. 109 80: 20 mm ht. breccia & ? chart

curs-cuts bodg.

Latitude: 27⁰ 28' Longitude: 133⁰ 44' 55"

Logged by B.C. Youngs

CAE	RBONATES E	Pckst Wckst Bndst Mudst					
11.50	CCITERIOR (C	A S S S S S S S S S S S S S S S S S S S			bes		No.
	San	ndst.	į	g H	į.		
CLASTIC	Cble Pble Ghle V.Cs	Medm Fine Slts Clys	, , ,	Colour	Bedding		
ROCKS	ರ¤೧>೧	1 2 2 2 0		<u> </u>	й		
	8IIII	7777	T 110		7	1	1
			<u></u>	Pl. gr	Lm-	 	Genette Suicedd - Edd Outs Gono in
		2272	-	-BF	In		Genly, Subrad - rdd gubz grns. in Channels: up bo gran. 5ize
				BF	Uni - Ta	w.	Shallow x-beds.
			=///_	+ -	Ta	2	Graded cycles.
				gr	Ns	STW R	A coment in a grainst to 111.30 in 1-A.
		-1-1-1-1	_	"		?₩	Subcircular areas black c. 10 mm diam., = brecco. / chent/ minerly.?
			_ //2	 	1100 0	4	Regr. interbeds: gr. bt. E buff mudor.
			,,, ,	gr ¢ Bf	In -	56 R	Regr. interbeds: gr. bt. t tiff mudst. Intras. of gr. cab. in buff mudsts. ? Chart oplant. in 20 mm, subad. area
	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,			-"		?ca	at 112.25.
				gr	Md- Ms	Car	? petoidal lens, E. I man pt. truff "rind". 1 ? chare lens, o. 10 mm.
			//3	1		1	
						SI.	
	(1B=P, 113.50		-			Ms R	
		7,7,7				ch	
	IA=T3, 113.97	1,7,7	- //4			?*	
				 		M	C. C. Indiana
•			-	30	Tn- stylo.	ST AL	
				1	3	on on	One untra. bed E stylo's buds. no top, another near base (E pink untx.).
			= //5_	(PR)		R R	Thin, dk.,? bitum. laninae.
	****		<u> </u>	Pk	Ma	∞?	10mm,? algal pl./intra bed at base
		7777	• (Tu-	Ch A	50 mm West bed at top: A in some pore spaces. Banded chert - nob Magadi.
		7777	•	βf	Md	S	FL d'Cale in vont. Veins x-cutting chart area.
			_116			Mr K	Rose ose-gmd. gras. in basal beds.
						1	Cycles generally < 10 mm. Med ose. grus, at bases of cycles;
		2 2 2	•	Bf -	Lm-	? ca	thicker cycles are or. 4 contain
		2-1-2-1	_ 117	Pl. gr	In	. ,	? pink felopar + a green mul. (1-27.)
	_		- ''/	(06)			? some chalcedony cement.
	Interteds Shown			(Pk) 4			Chart a 119.50 appears to be early:
	Diagramatically			(gn)			Mudot one incorporated unto it of distorted by its growth.
	, ,	2	4.6				Stylo. a 119-120m.
			-118				
		F.,	i				
				· 1	1		
		<u> </u>	119	İ		1	
			"			1	
		一一一			1		
						Ch	
		<u> </u>	1		ľ	W	

Logged by B.C. Youngs

Latitude: 27⁰ 28'
Tomaitude: 133⁰ 44' 55" **CARBONATES** Bedding Colour CLASTIC **ROCKS** 121 Many upward in features 12150

> 123.50; upto 100 mm light,
auge 30-50 mm. Thin buses & fan
out upwards Contain predon
Cherty met, & yellow mineral SI Ar 18=75, 121-93 A Œ Cd (non tronite) + fe + ? pyrite. 18: 75, 122.64 123 Poss. 2 genrus. of dolutin. 18=75, 123-20 Ch in T3. 122.64. 13=75, 124.70 Pl.gr-(PK) Ch R SLR Sw As Many stylo'c. bdg. pls. Tn Chest leuses parallel to bdg - bm -> grey. 126 Dk, bitum. lamn. in upper 300 mm. g 127 Br-gr 14=75,128.10 (? from unix 128 Lm-Numerons dark ? brum lann. V. In Ch R As above but generally less course: Lin-129 sillst. -> f. sst. interbeds Pl. gr V.In

La Lo	titude : 27 ⁰ ongitude :	⁾ 28' 133 ⁰ 44' 55"			L	ogged	by B.C. Youngs
CAF CLASTIC	Sands	me f Wokst ts Bndst ys Mudst	Morton	Colour	Bedding		
ROCKS	Cble Pble Gnle V.Cs	[] [] [] [] [] [] [] [] [] [] [] [] [] [₽ 130	8	A B		
			7 70	BF -	1	ø	Mdcoe., subiddrdd. y rane v. ose. Some mudst. mtras. to feveral cons.
	·		<u> </u>	Bf	-	**	Some midst. utras. to several cons.
			/3/				
			· - -				
			-132	Ma.gr	Lun - Tn	?@ R Ch R ⊕ R	Dank, wispy.? bitum. lamns. Vugo E calate. Small 90 chart in one coe. gmd. (lum) band.
			-/33	Bf a Pl. gr		G S	Well rad. → subrad. qutz. grns. in sst. beds; med. → one. ssts.
	G.						
	19=73, 134 • 12		134	Lt. Bn-		Ø GAR PORR	Rave patches of wregs. brecc'd cheet 4 Some chart lenses' paralled to bedding. ? A in veins & calcite.
			_/35			? h	?Bitum layer a> 136.80 → 136.88 m.
			_/36				
	18= T5,136·50		- 137				
		CORE BADLY DISTURBED				-	·
	IA = 73, 138 · 04		- 138	Bn 4 gr	(Lm)- V-Tn		Some sst. beds also have medcse. qu'z grains + are graded (fine 1), Chalcopyrite in poos of sst. a) 139.45m.
		7777	-/39			Cap R	

Latitude: 27⁰ 28' Longitude: 133⁰ 44' 55"

Logged by B.C. Youngs

	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	55 11 55					
CAI	RBONATES {	Pckst Wckst Bndst Mudst			b	1	·
	Sar	ndst.		es Tr	iri	•	
CLASTIC ROCKS	Cble Pble Gnle	Medm Medm Medm Sire Sire Sire Clys		Metres Colour	Bedding		
		1111	- 14 <i>0</i>	Bf	Ms		7
		7777	2			Ch 1	Q DR., wispy? bitum. nutl.
		1,1,1,1	\exists	Bf +	(Lm)	- GR	on, bropg to the same to the s
			14 I	I .	V.Tn	& R	
			=			o qui	
		777	#			a qui	3.
		777	Ę		ļ		
	IA=T5,142.10	444	142	2			
	,						
	,	1,1,1,			†,	10	Dr., wispy bitum. lamns.
		4,7,7	_	Bf -	Lm-	Ch/0	Man packst : 142.60 → 142.75 m.
		7,7,7	- 143	(gr)	V.Tn	M. R	T.S. suggests relic ? ooids / peloids.
		7777	-	1		62	ug.Intra. packst.: 142.60 → 142.75 m. T.S. suggests relic ? ocids/peloids. Extensive explacement by quarts.
		7777	:				
	IA = T5, 143.85		\		ļ		
		7777	/44	Į.		5/5 R	Rane graded, small cycles of mudst.
,		777	-	gf.	Ms		
			1				
	1A= P, 144.90	7-7-7-7		00	Lm-	98	? bitum. lamas. Lutias. at base.
	 		145	+	algal Lm-	AR R?	Extensive calcite ung.
	· · · · · · · · · · · · · · · · · · ·			Bt	(Ms)		Scattered rdd. qutz. grns. throughout. ? brtum. lannuae at top.
	IA=T3, 145.60			Bf-	Ind	SL	Jrns. = 85% med-ose quiz + 15% carb. intras ? rave opids & peloids also.
			,,,	(gr)	ma	2 200	grain content increases downwards.
	***		146	Bn		? R O P Ch R	"St in algal layer at 145.98m.
	In=P 146:50			gr-	1	14 Lar R	Carc. plates parallel to body .: ? evaps.
	1B=P, T5, 146.70		Ī	(Bn)		Ch R	
	18-75, 146.75	<u> </u>	147	-		Cu Ø	Chent: bounds a irregr. areas paralled to bdg.
		<u> </u>	F '''		1	P	Dk. wispy? bitum. met. in basal
		<u> </u>	L	Bn	Ms	* ? (d	200 Runs arradas into limit below
		\ 	[:		feel shows pseudom. of ? gypsum brodes.
		4 · , - · , -	148	1			Chalcodoug replaces? evaps. in TS
		K-,,) , , , , , , , , , , , , , , , , , , ,
				Spd Ok.Ba	Lm		? bitum. lamns.
	1B = P, 148.75			a	U.Tn-	6	Two separate, distinct stroms. are visible: Ige. Columns 20-30 mm wide;
	IA = P, 148-90		-149	gr a (bn)	In	A	smaller, thinner lower wreger. Wumns!
			7.7			Ch R ?* R	
							? gypsum blades in interstrom. areas.
				Bf 4 (9r)	Tn	₩ Ab	Intras.: Subrad., 3-40 mm.
			150	gr	LOU.TA	A	

Latitude: 27⁰ 28' Longitude: 133⁰ 44' 55"

Logged by B.C. Youngs

	-							
C2	ARBONATES &	Pckst Wckst Bndst	Mudst					
CLASTIC ROCKS	0 0 0 0 0	dst.			Metres	Beddina		
	1A=13,150·45	0.0	0.00	0 15	gr	Tn	Casc Ø?	
				// // // // // // // // // // // // //	1 gr +	Lm	ବ	Some mudst beds are alpai. V. thin, fine sit interbeds. Dk. ? bitumn. lanns.
					Lt.gr	V.TR	ـ ما	Fine vent. calc. veins.
				- IS:	2 - gr	- Ius	W	
		0.0		/ /s.	gr 3		A S	As for 150 m & FL cout. a 152.85 m. Some mudst. beds.
	·	· · · · · ·			gr	Un - V.Tn	ဓ	
		0	5.7.7.7.7		35 7 PL. 3n	V.Tn- Tn	100	Gran. + pebble layers Esst. Sulph. in 5 and pore.
				154	gr- (Bn)	Lm- V.Tn	6	
	IR=P, 155-15		7777	- -			0	See lab calate usi. I'lli.
•				- 156	Bf 4 (g+)	Lm- U.Tn	Ch W	OK, thin, ? bitum. lamns. throughout.
	Minor 18=9, 156 85 Bndst	,		- 157	g. (4)	Lan- V. Tn	Ω ∞, Θ	
	1A=P, 157.90 1A=P, 158.50			- 158	gr	Me - Ind	1 Ab	Some intras.: result from extensive stylotization. Powerive chart at 158 50 m. Also some grast & dawy cout? Some pekst., microspar/rexa. Structure gammeleuse"—hard to identife!
				- <i>159</i>	gr	Lm - V.Tn	Si W R	Structive gnimeleuse — hard to identify! Thin, ? bitum. wis ps. throughout. Soft seduct. defin. at top.
			4 4 4		35 = g.	V.Tn	1 00	Soft sednet. define. I at 159.40m.
	[- 160	gra (sf)		₩ ? a	Channels are shallow, E Pace qub. grns> grans. Bitum. lawns. ? algal lancus.

Latitude: 27⁰ 28' Longitude: 133⁰ 44' 55" Logged by B.C. Youngs CARBONATES CLASTIC ROCKS 1B=SRA, 160.80 m Lmgr + V.Tn (Bf) V.Tn-Tn Ch R Bf-gr (below c. 161.5) 163 ? Magadi West a 164.20m. ?an 1A @ | ? algal plate breccia a 164.45 m 165 grey their parallel a subparable bedding. Cu Ab Bf Ms 166 1A=P, 166.30 1B=P, 166.55 Veny porous. 2 generations Recupitallized. gr Md Mic. Grus. 167 В₽ Md-Ind 168 A.gr + R Sands = med. - v.coe. - gran. Rare calcité veins. 7 (Bf) ? R P Pare A. in veins at top.

Latitude: 27⁰ 28' Longitude: 133⁰ 44' 55" Logged by B.C. Youngs CARBONATES Bedding Sandst. V.Cs Crse Medm Fine Slts Cble Pble Gale CLASTIC **ROCKS** PL.gr Lm-+ BF V.Tn 0 [IA=P, 170.95 P. gr MA Ab 1B=P,171.50 4 Bf Ms -Ind 4 (gn) Chart parallel and subparallel to Ch Ab bedding. Ω Soft sednut. injectn. as 175.00 m. 173 gr 4 A Pluor. ¿ chart at 175.25 m. 8f-Bn 114 Ms-Вf Înd Rdd. - Subrodd. gutz. grns., rone v.ose. - gran. gr Ma Lm-V.Tn DR. bitum. lanens. ? boundot. A. gr 20 Injn. zone of mudot. E ar. grus. in vent.
Md. - gran. quiz., rad. - subrad.
Sulph. in pass, upts 2 um. 52 5L 2) R Bf -A. gr Ms -Ind gr 4 (gn) V. Igo. cubes of pyrite. \mathfrak{I} 178 Sulph in? algal lutt. as 179.80 — infilling pures. Lm -SL AL gr + Tn Slumping - injection always closely assed. E green und : 10 gn Q R Irreg. in many

Latitude: 27⁰ 28' Longitude: 133⁰ 44' 55" Logged by B.C. Youngs CARBONATES Bedding Colour CLASTIC **ROCKS** Basal 500 mm is an almost pure intra wackert. 0. Ab Bf.gr Lm-V.Tn SL Ab As above (180+). green nuneral to 182: Ω Sulphides abundant throughout in power of bedding pls. . good ex. at 181.95, 182.05, 181.05. W 13.10 IA= P, 182.05 -183 CATS Pows parallel to bdg. filled i chalced. Plat-bedded at bop to intradastic Bf + Dk. Bn-BL ?6 + distorted at base. 184 Predominantly <u>used</u> - cse. i some mudst. beds of intras. Leuses of chaced rplant. Cd PL. gr 4 Bf C. J.B 1A=P,184.90 175 ? Magadi Chert in peel a 184.90m. 185 Lm -A.g. V.Tn 186 Mr PL.-Ma. Lm Bu 18:P, 186.80 A 🔑 Ch R 187 Similar to above but len Ch Pt. Bn LMardence of algal lamins. **B** V.Tn a gr Chert parallel to bdg. 188 SUR Some fine, gr., sst. interbeds. M R

Calc

Bf = gr

Ms

Sdo. + grans. in must. mtx.

Latitude: 27⁰ 28' Longitude: 133⁰ 44' 55"

Logged by B.C. Youngs

CARBONATES	Grnst Pckst Wckst Bndst Mudst					
CLASTIC 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Consequence of the construction of the constru	lan	Colour	Bedding		
		190	gr	Lm- V.Tn	● R Cd Sw R	wegr. Concentre challedony.
		191	Bn-gr	Lm- V.Tn- (Tn)	Ch Mr R	Check parallel to bedding.
		193	g _r		(d	Some thin,? bitum visps. Chalcedony generally parallel to bdg.
Interveds shown diagramatically, not at cornet		194				Hopper Xiels
dept hs .		195			:	
		176				
	777	- 197	(8f)	V.Tn- Tn	••	Munot. layers 4 Intro. 4 rdd Subrdd. V. coe. — grans. in sst. No good grag.
/A=T5,198·77		198	gr	Tu -	a 1 7 R 8 R	Some algal mats a 198.45m. Chart associated to microfaulting 4 a small-scale breccia.
	7,7,7, 7,7,7, 7,7,7,	- 199	g _r			Some Ige - scale, normal faulting.
1777		200		-	<i>F</i>	fredom. med, -ose. sst.

Latitude: 27⁰ 28' Longitude: 133⁰ 44' 55"

Logged by B.C. Youngs & S.Chaku

Longitude :	133 44' 55"					
CARBONATES E 2	Wckst Wckst Bndst Mudst			_		
Sands			Colour	Bedding	1	
		70		T		1
1A=P, 200.50	7777	-	 	Lm-	4	
1A-P 20050 (? lasé of above unit)		201		V.Tn	6 + Ch R	
	(1, 1, 1		8f - (gr)	Bcd Tn	Calc R R	(alcaneous sst. E rad subrad. grus. Calc. in ungs and brecciated area.
40.4				1	@ Ab	Thin brum. lanimae
14=1,20150	11111	202	gr a	Lm- V.Tn	-	Butras. 4 Snd. grns. were abundant
	4444	-	(sf)	V. /n	Ch B	Rave St. in top 500 mm.
		-		1	R R	Graded layers c. 20 nm thick.
	7777	- 203				•
		103	ļ			
	1,1,1,1,1	-				
	7777					
Co. 0.200 to	1.7.7.7.7	- 204		-		
· \{ \(\frac{18 = \rho, 204 \cdot 40}{\cdot} \)	10 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		 	 		
	10/11/0/					fredom. med. gutz. grns. (some coe> gran.): Wackest. texture, E non-cart. grns.
	10/1/19/1	-205	A.gr	Ms -		Indistruct graded I-dg.
•				Ind		, ,
	10/11/0/	⊢ .				
	W. 1. 1. 1. 1.	– 206 –	.			
	10111	-,		۵.		Numch less quarty than above: almost wackest. mudst.
	444		PL. gr	Mr- ind		Macrest / Muast.
	7-7-7					
		- 207		Ms-	MIR	
		- ,	n.gr.	Ind		
	7777					
	7777	- 208				
	770777		j		STOR	Minor Calate ungs.
			Pl. gr	Ms- Înd		As for 204.40 - 206.00 m. wackest.
	13/1/1/	- 209		ma		
	777,77	-				
			•			
	101,1,1,1	. 210				
, , , , , ,	1 1 1					

Latitude: 27⁰ 28' Longitude: 133⁰ 44' 55" Logged by B.C. Youngs & S.Chaku CARBONATES Bedding Colour CLASTIC 0 Dismicrite. Minor calc. veining & A. 4 Quiz. Brwd. 1/5 3f 212 a R 1B=P, 212.30 R R ø Thin bitum. laminae , 214.40-214.70m. 215 Bf -V As above but danker. Brwd. Ok. gr Thin (cm.+) peloidal packet. beds. W Ab Heavily burrowed. Dk. 9r Brud. Calcite veining. 219 cu R Lm-Calcule veining. Dh. gr 18=75,219-50 Cd V.Tn An 8 mm oxid grst. Lens a 219.55: Checkfied/chaladony. 1B=P, 219.55 Miarite envelopes.

MARLA 1-B

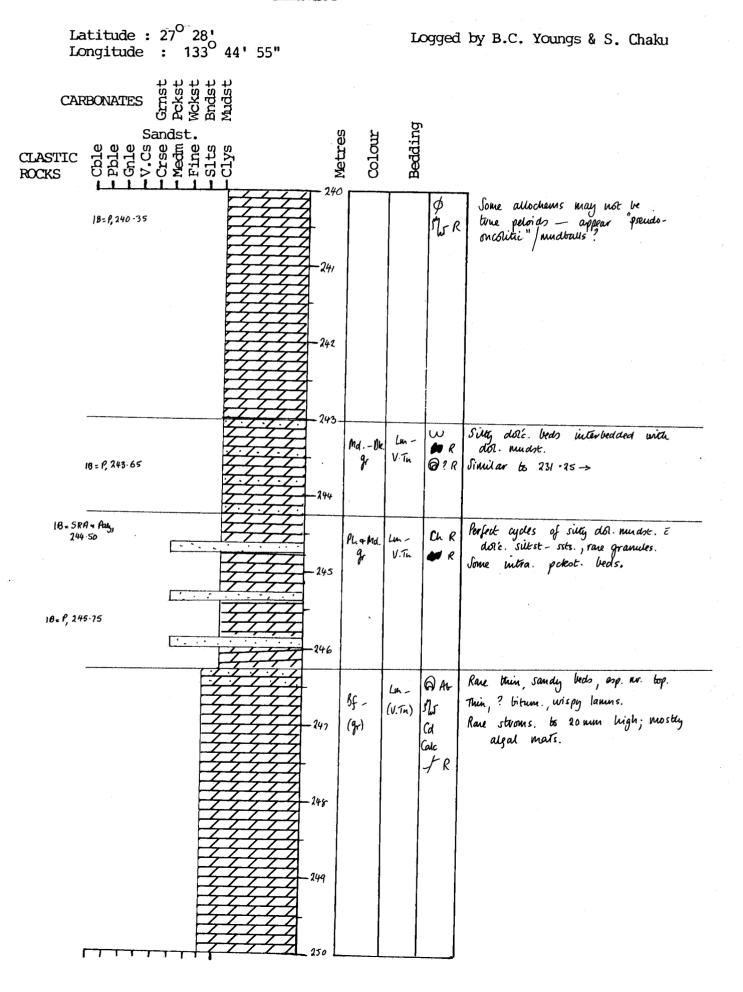
LITHOLOG

Latitude: 27^o 28' Longitude: 133^o 44' 55"

Logged by B.C. Youngs &S.Chaku

_						
CARBONATE	ű Grnst Pckst Wckst Wokst Bndst			_		
CLASTIC 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Sandst. W.C.S. S.		Colour	Bedding		
		220				
		221	gr + 3f - Pl. Bu	Lm	₽R N₅ R	Thin bituminous lanunae. Thin rave algal place breccias. Due chalced ung.
18= P, 222-1	s 77	27	Ina - On Gr	Tu	A R ∂ R ? W	Interledded silty mudst & dol'c. siltstone. Calc. infills some burraux/ungs. Pos. v. late — coasse, blocky.
1 B=5R A+ Pay 223.45	,	223	g	Lun- Tn	Ø+cd.	Thin, fine-sst. beds (x-bad.). Chalcodony in bugs.
18= P, 224·50		- A24			ch	224.50: 100 mm of intrao. 7 fine 55t. Rare wispy bitum laminae.
		225				224.75: Channel fill E intras. 4? Chalædony clats.
18-1,225-35		7.7. 7.7.	PL + DR.	Tn	o cn Si o	Thin, rare dol. hundst. lamns. Sulph. is parallel to bdg. Micr. Eur Indy of development in ooid layers.
		226	BF.	Lm- Tn	ch 15	Calaite veining.
-	72 72	227	PL. gr	In		Thin bitum. laninae. Non-cart. grains, is quaits. Small-scale grading. Thin mudst. lanins. D base.
	// / // / // / // /	-228	R.a Md. Gr	Lm - V.Ta	1 1	Scattered rounded qub. grus. Thin bitum laminae
		229	Dk. gr	Lm	₩	Thin bituminous wisps. Intras may be algal.
- remayanalman and a said	777	7.7	Вf	Lu	ϕ	Porono areas in sandy beds.
	7.17	/·/ l l	~(T)	,,,,		

Latitude: 27⁰ 28' Longitude: 133⁰ 44' 55" Logged by B.C. Youngs & S. Chaku **CARBONATES** Sandst. CLASTIC ROCKS 230.15 : \$ bed & sulphides. Some sand grains are down to fine-grad. Dol. mudt. lamas. " intras. Some intras. ? algal. Вf 01 🛭 (alc. ?ନ \mathfrak{N} fine sst. - sltst. this out, some pure much. 1B=T5, 231.55 Lm -Thin de, wispy bituminous lamns. Calate veining (ferroan calate), v. late = 00e. Ma. + Tn Dr. gr 233.70 : peloidal packet interbeds. 2 gourns. dolmtzu. in T.S. - Coarse, Zoved 2ndg. xb. 18=P, 233.70 234 235 ! WAt ? Burrowed, esp. top 150 cm. Breciation also: 1B=P, 235-10 Brwd. Ø Calc. Md.g ? due to burrowing. latate veining a rare vrigs. (Lm-Tn) MJR 236 237 238 239 8-Calc. Md .- Ok. Brwd.-Much as above but pelvids and Tn intras. Less burnaving than above. Some burnows are filled & calate, than? dissolved. (Tud.)



Latitude: 27⁰ 28' Longitude: 133⁰ 44' 55" Logged by B.C. Youngs & S. Chaku CARBONATES Bedding 252 M R Med. 4 same coe.- v. coe. quanty grains in a dolonite mudot. mtx. Mootly Wackest., rare mudot. text. (<10%). V.Tn -Bf -(gr) Tn

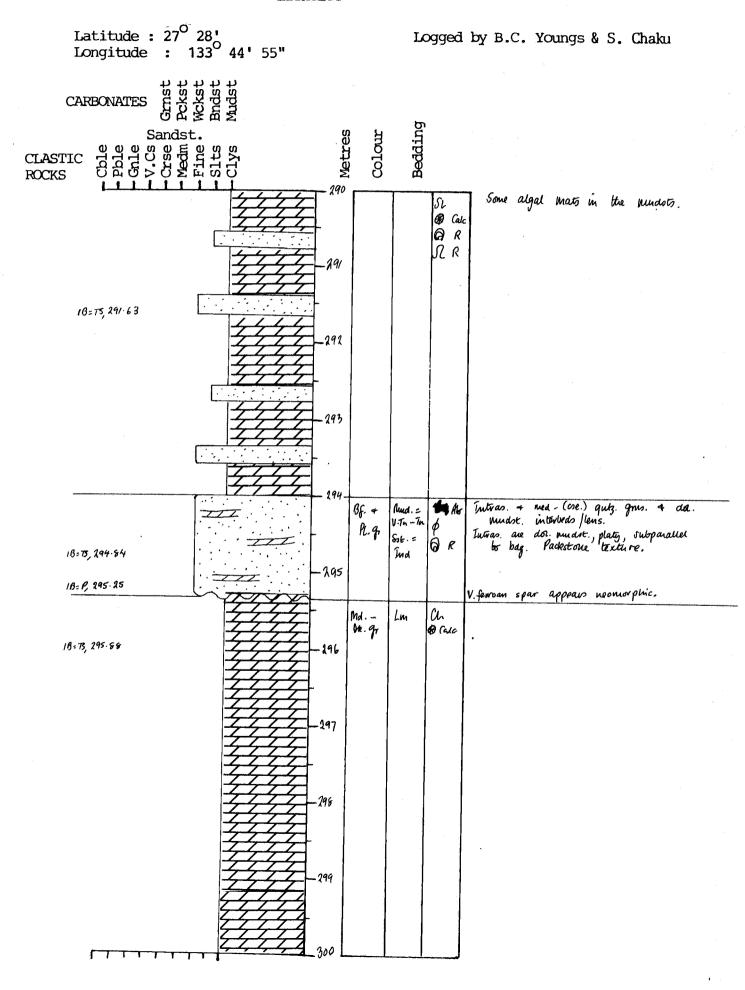
Latitude: 27⁰ 28' Longitude: 133⁰ 44' 55" Logged by B.C. Youngs & S. Chaku **CARBONATES** Sandst. CLASTIC Pare sst. grains. Lm-Bf Rave dk., bitumns. lamns. Tn Calc. vein & sulph. blebs to 3 mm. 18= P. 260.90 As above, & rave packet. beds. Fine-med. sd. gms., & rave soe.-v.coe. N R Tn-Bf -SUS R Ind. ? burrowed in basal 150 mm. D AL Bf 4 (Pr. gr) a (Lm) Ch **B** Cak. lined 264 265 ଜ Stroms. to 20 mm, mostly mato. Md. gr Lm-Some nexn .- microspar. 4 (BF) (V.In) 268 269 Med. - se. guts grns. at base. Brak Top 100 mm: buff, & scattered quy, grns. Brwd.

Latitude: 27⁰ 28' Longitude: 133⁰ 44' 55" Logged by B.C. Youngs & S. Chaku **CARBONATES** Bedding Colour **ROCKS** Thin wispy bitum. lamns. Sf. - gr Cu Ab Lmgenerally mats, rare small stroms. Dr. gr. Tu @ AL hire - med. gutz. gras. throughout. 8 @ Calc (gr) V.Tu-Allorheus are quiz. grns. In Some grading. Brwd Burnowed in parts: some boundst. text. remains @ Calc Len -Thin dk., bitum. launs. V.In -276 graded leds in ssts. Some one. -v. coe. grans in ssts. Channelling also. Pla DK. Lm-8 V.Tn Minor algal mats throughout. 6 R iu Sulphide w Intradast pokst. beds in parts. 1B= P, 277.80 278 -119 Some "mudballs" in q zone. Some of may be due to birdseyes. Some owns suggest dolun. of a pel./intra. hd gr Sto R ?W R pokst. (T.S.).

Latitude: 27^o 28' Longitude: 133^o 44' 55"

Logged by B.C. Youngs & S. Chaku

1.0	nigi cade	• 100 44 00					
CAI	RBONATES	Grnst Pckst Wckst Bndst Mudst			·		
	5	Sandst.	•	X H	Bedding	,	
CLASTIC	9 9 9 9	S E S E S E S E S E S E S E S E S E S E		<u> </u>	33.		
ROCKS	55.5	Crse Medm Medm Fine Slts Clys	1	Colour	ά.		
NUCKS	لتت		<u> </u>	o	<u></u>		
	1B=T3, 280.30	777	Д ""		1	W?	2 genms, doluntyn, in T.S.
		777		1	4	- ?	
		777	<u>d</u>	1			·
		777	7	1		1	
		11111	2 - 281		 	→ As	\$? due to birdseyes.
		7-1-1-1-1	7	Dk. gr	Tn - Ind	ϕ	p : mix is owereges.
		4,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1	Z -		Ind]′	1
		77777	Z				
		7777	282	 	-	10	
		7,7,7,7		Dk. gr		ନ	Mostly mats, race stroms.
		7777	Ξ		1	₩ R	Calate veins a vugs.
		11/1/	A .	+ (Bf)		W R	
		1,1,1,1				& Calc	
		7,7,7	283	1		K	1
		444	7	1		1	
		7,7,7,7	コー			1	
		7,7,7	<u> </u>				·
		7777	\exists	}		1	
		7777	284	1		1	1
		7,7,7	Ⅎ			1	
	•	2777	7			-	
		770/77	.	Di. a	140 -	51	Gran mad a (see al see) and a see
		7/1/1/	285	Dk. gr	Lm- V.Tn- (Tn)	OR	Fine-med. 4 (ne v. ne.) qutz. grains in a dol. muax. mtx - wackest. text.
		1.7.7.	7		(Tn)		Oord lans a 284.95 m.
		7777	7	Dk. q	Lm-	$ \omega $	Supplide in fine-grad sets.
			<u>:</u> †	(Md)	V.Tu	Si	
		4,1,1,1]	gr		Sp R	
			-286		ļ	<u> </u>	
		444]	Dr. gr	Lm-	?ଜ	? some algal mats.
		7,1,1,	-1	1	(U.TA)	SI - wing	,
		7,7,7	_	1		100	·
		11/1/	-	1		i I	
		7,7,7,	287				
		7,7,7				i	
-			-}-				Base may be a numor unconformity.
		4,1,1,	1				
		7,7,7,	188	DK. gr		R 1 yr	Rexd.: calc. filled power in parts.
		1.1.1.1		J 4/		?* \$	
		444	1 1			9	
		7,7,7,	}	ļ		₩ R	
		7,7,7	1			Ch R	
		1111	289				
		7,7,7,	}	ł			
		1,7,7,7]	- 1		1	
		1777	1	Md. 4	Lm-	Cd	Chalman, i leta a
	¥_	17777	4	Dr. gr	V.Tn	Cd R	Chaladony in leds & ings paracles to bolg.
	1111	1111	1-290 L]	:*	way.



Latitude: 27[°] 28' Longitude: 133[°] 44' 55" Logged by B.C. Youngs & S. Chaku CARBONATES Bedding Colour CLASTIC **ROCKS** 18=P, 302.00 302 306 @ R Md.-DK. Thin bitum lawns. WR gr Rexd → calc. in ongs. 307 18:13, 307-20 Ø \$ 255 Vug /? birdseyes are ē feman calc. linea /filled Md. - Jk. End gr 1B=P, 308.00 ? fossil fragment on peel. 9RA = 308.00 A Ab gr. q P Bf 309 Md. -OK. gr Lm-V.In

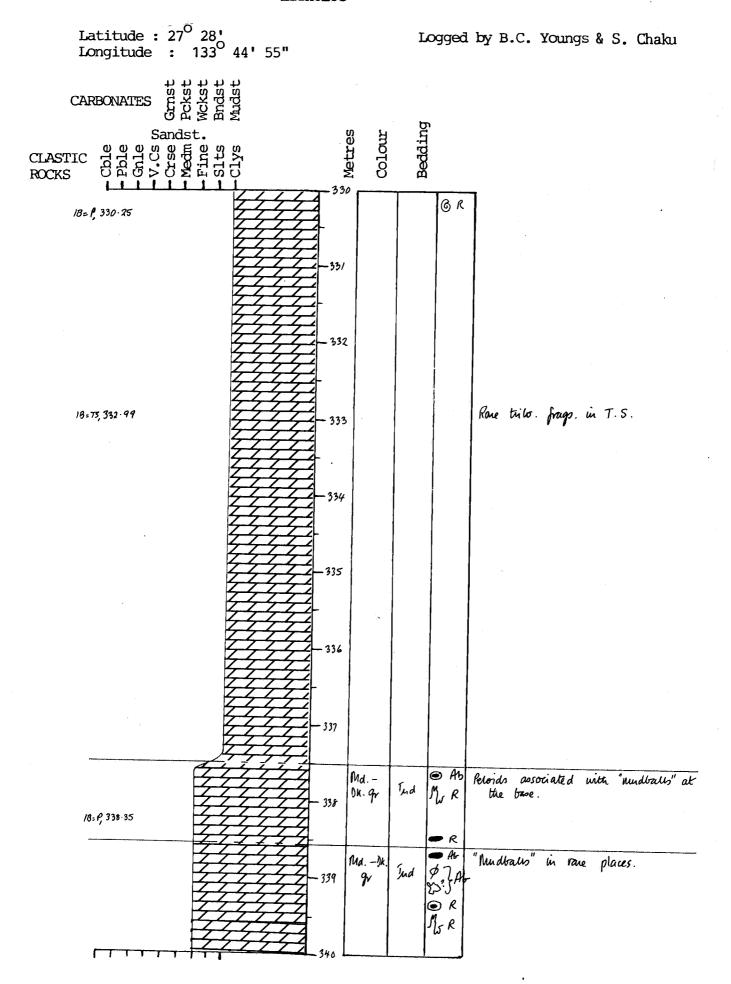
Latitude: 27⁰ 28' Longitude: 133⁰ 44' 55" Logged by B.C. Youngs & S. Chaku CARBONATES ROCKS Fine - med. 5sts; oser. as top. Some grading Md Bf Calate veining. Pl.gr Lm-4 Bf Tn ²€ have, their sandy lenses at base. Md.gr 10 w Ca Burnswed at bop. \bigcirc Dk.gr 314 Bwd. ? birdseyes might be evap. casts. ϕ ? **⊘** R Ind. 315 Dk.gr. Lm 316 318 319

DK. gr

Predominantly "mudballs", few peloids.

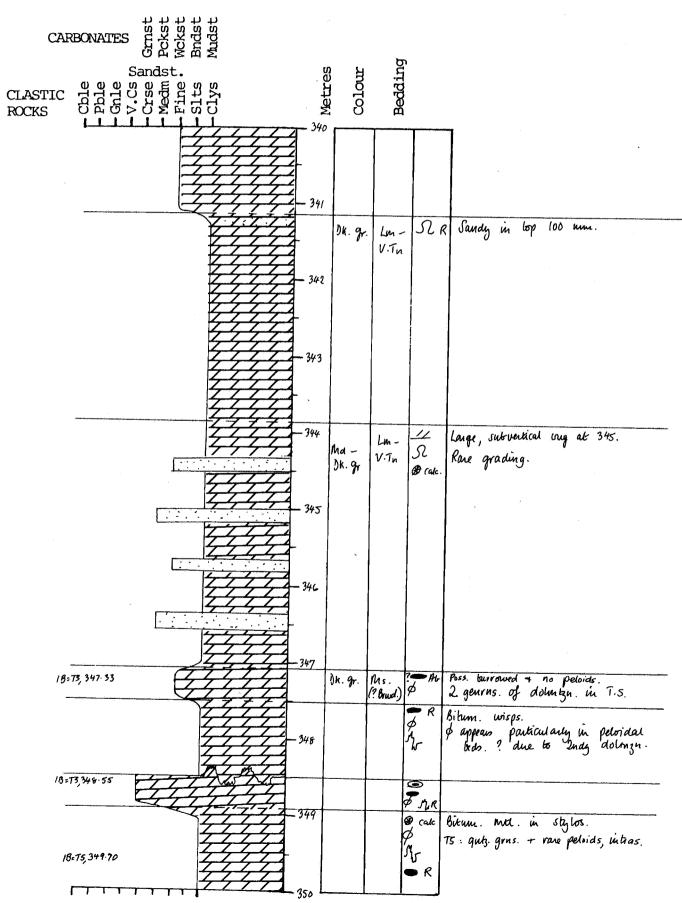
Latitude: 27⁰ 28' Longitude: 133⁰ 44' 55" Logged by B.C. Youngs & S. Chaku CARBONATES Colour CLASTIC Very similar to 367.50 ->.

\$\operate{g}\$? due to dedoloruitization or brivaseyes or evaporites. Md.- IX. Ind \$ P. J MrR Coarse, v. late calcite fills large / kindseyes. 321 18=P, 321-10 322 323 Calcite veining. DK.gr Lm Ω a R 324 325 Bf R Ω ! Dk. gr. Calate veining. Lm Chalcedony may be replacing evaps. **₩** (alc 18=73,327.64 Cot ?* 328 329 Ak. gr Dark bitum. wisps.



Latitude: 27⁰ 28' Longitude: 133⁰ 44' 55"

Logged by B.C. Youngs & S. Chaku



Latitude: 27⁰ 28' Longitude: 133⁰ 44' 55" Logged by B.C. Youngs & S. Chaku Grnst Pckst Wckst Bndst CARBONATES Bedding Colour CLASTIC ROCKS Burnswed: 350.30, 351.27. DK.gr In a Ø R Intras. : 350.75. (Brwd.) Cm R Suppliede in rave thin sst. lenses. 351 ର R St R 352 1B=73,352.61 Set have graded beds. Dr. gr Lnn -Quarty / challed - lined onep in sst. 353 Muddy 5st. Calcite Veining. Dr. gr. Ms 4 R 354 18=P, 354.70 Calate veins. DK. gr (Lm)_ DK. gr Ind -356 Race Mudot interbedo. В£ Ind 357 Calate veins. Wispy bitum lamms. DK. gr Lm-V.In 358 Interas. at top. Mud.= Veining & chalcedouy. Vein a 358.50 m. Lm -V.Th SL R, in sand. Sulphides in sots.

Latitude: 27⁰ 28' Longitude: 133⁰ 44' 55"

Logged by B.C. Youngs & S. Chaku

CAF	RBONATES	Grnst Pckst Wckst	Mudst					
CLASTIC ROCKS	Cble Pble Ghle	Medine A		7 34	Metres		pedaling	
				7				
				362	8F	Brwd Ms	1- 0 p R ?*	? evaps. in burrowed bedo.
		77		363	Ok. gr	hs	\$ A6	Trong pass of ready.
					dk. gr		ø	Carake veining.
		·		364	Bf	Tu - hid		Calate veining. Wiopy breum mee.
				365	DK.gr	Lm		
_					DK. gr	Ms	Mr R	Two peloid wackent. interbedo.
					dk. gr	Ms	AL-	Some beds may be grainstones.
				- 367 - - 368	Ma. – Dk. gr	Lun	Ø (alc	(alc. veining. \$\phi\$ bowards base \$\tilde{c}\$ sandy beds.
١	, , , , , , , , , , , , , , , , , , ,			- 369	Bf - gr		Ø (a)c Ø (a)c V ?*	, stories our c suring vews.

Latitude: 27⁰ 28' Longitude: 133⁰ 44' 55" Logged by B.C. Youngs & S. Chaku Bedding Colour CLASTIC Dk.gr Calcite veining Lm -BF V.Tn 372 Equal amounts of sst. 4 number. Graded beds in sets. Rare mudst. beds. Tu Qub. grains & granules. -374 Dr. gr luat top Vin 375 376 Dr. gr Brwd. - Bf 1* **

\$R Ind - 378 Dk. gr \$ at base. Dk.g. Lm-Minor sand a 378.80 (fine gmd.). V.Tn Total Depth = 379.40

-380

APPENDIX II

Identification of a Mineral at 179.80 m, Marla-1B

Ву

AMDEL

EXAMINATION OF GREENISH MATERIAL IN BORE CORE

1. INTRODUCTION

A piece of bore core from Marla 1-B (179.80 m) was submitted by Bridget Youngs of the South Australian Department of Mines & Energy. Abundant green-grey fine-grained material of clay-like appearance was to be identified.

2. PROCEDURE

An X-ray powder diffraction photograph was taken, and supplementary evidence was obtained from low-angle X-ray diffractometer traces of the material with and without treatment with glycerol.

3. RESULTS

The green material was found to be a mineral mixture. Dolomite was abundant, and the remainder of the material was a mixture of roughly equal amounts of three phyllosilicates, namely muscovite, chlorite and regularly-interstratified mixed-layer chlorite-montmorillonite.