

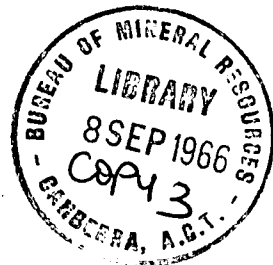
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PETROLOGICAL STUDY OF CAMBRIAN SEDIMENTS IN ALICE NO. 1 WELL,
AMADEUS BASIN, NORTHERN TERRITORY

by

A. Fehr

Institut Francais du Petrole

The information contained in this report has been obtained by the Department of National Development, as part of the policy of the Commonwealth Government, to assist in the exploration and development of mineral resources. It may not be published in any form or used in a company prospectus without the permission in writing of the Director, Bureau of Mineral Resources, Geology and Geophysics.

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CONTENTS

	<u>Page No.</u>
ABSTRACT	1
INTRODUCTION	1
LITHOLOGICAL UNITS	1
Arumbera Sandstone	2
Chandler Limestone equivalent	2
Giles Creek Dolomite	2
Shannon Formation	3
Goyder Formation	3
Pacoota Sandstone	4
CORE DESCRIPTIONS	5
CONCLUSIONS	15
APPENDIX: Short petrological description of surface samples	
ABBREVIATION LIST	
PLATE 1: Lithological log of Cambrian sediments in well Alice No. 1.	

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ABSTRACT

The Cambrian carbonates in the Alice No. 1 well consist of an upper calcareous part and a lower dolomitic part. The former shows in places probably algal reef development and coarse anhydrite of secondary origin; in the latter there is a primary, felty anhydrite, overlying rock salt and red beds. Reef development and salt lenses could be responsible for the seismic structure at the location of the well.

INTRODUCTION

Alice No. 1 well is situated 17 miles SE of Alice Springs (Northern Territory). It penetrated mainly Lower Palaeozoic sediments and bottomed in the Lower Cambrian Arumbera Sandstone at a depth of 7518'. Further details of the wells' history are given in the well completion report Alice No. 1 by Exoil (NT) Pty. Ltd. (1964).

This detailed petrological study has been undertaken to establish a finer lithological subdivision of the Cambrian sediments in subsurface than given in the mentioned report, comparing them with surface lithologies. Another purpose was to evaluate the importance of the biohermal development in these carbonates and of evaporites, either or both eventually responsible for the seismically positive structure.

In order to get a more detailed and precise idea of the lithologies (discrepancies of three different descriptions of the same material), all of the regularly spaced cores have been studied in thin section. The remaining rock slab of the thin section has been polished and then treated by Alizarin red S, the calcite-dolomite ratio easily being recognizable.

The cuttings were examined in regular intervals of 100'. Plastic mounts of the cuttings, stained by Alizarin red S previous to covering, gave a clear idea of their composition and structures. Most of the examined cuttings were thin sectioned. The observations on mounts and thin sections were consistent with the carbonate log where the thicker line corresponds roughly to the calcite content, the one on the right to the dolomite content. (See well log, plate 1). For comparison, short petrological descriptions of Cambrian surface samples from the Amadeus Basin are given in an appendix.

Lithological units.

The following paragraphs deal more with general aspects of the lithological intervals, considering environmental factors and diagenetical changes. Descriptive details are given on the composite log and in the appendix 1: Core descriptions.

Arumbera Sandstone (L. Cambrian) 7518-7140'.

This formation is represented in the well by a hard, ferruginous, red brown, dolomitic and micaceous siltstone. The rock is in places characterized by a bimodal grain size distribution (the coarser fraction being better rounded), and by the abundance of worm tracks and burrowing.

The clastics, mainly quartz and minor microcline, are coated by limonite and later by authigenic overgrowths. The high limonite content is therefore depositional. The sediment represents real red bed facies deposited under strongly oxydising conditions probably in a coastal environment.

? Chandler Limestone equivalent (L. Cambrian) 7140-6618'.

Typical for this interval is predominant rock salt with plastic textures and lenses of red brown dolomitic clay. Thicker intercalations of very ferruginous mudstone with single rounded clastics of quartz, minor feldspar and patches of white anhydrite confirm the highly saline environment. Contrasting to outcrops, the sediments of the formation in depth are poor in calcite; "felty" primary anhydrite is common.

Giles Creek Dolomite *(Early M. Cambrian) 6618-5147'.

This lithological unit consists of a lower part with predominant dolomite and minor shale and an upper part with predominance of shale and minor dolomite. The subdivision of the Giles Creek dolomite is mainly based on the Schlumberger logs.

Characteristic for the whole interval is the abundance of the "felty" type of anhydrite, i.e. small tiny anhydrite prisms as single crystals or interwoven in lenses and irregular patches. The lack of a predominant orientation suggests their growth in a still unconsolidated sediment, i.e. their primary nature as precipitate from solution in an evaporitic (probably silled) basin. The association of the felty type with finer dolomite is significant. It seems that with more anhydrite present, the sedimentation plane is more disturbed and crenulated (by plastic flow).

Beside this predominant variety, the very coarse anhydrite occurs with diam. more than 2mm. The large crystals are surrounded or include well preserved dolomite rhombs. A similar type fills irregular fissures or may occur as intergranular filling (analogous to the Fontainebleau calcite).

It appears that this coarse anhydrite type preferentially occurs in coarser grained dolomite. The common occurrence of the two coarse types is logical, as the primary felty anhydrite type is easily dissolved by connate waters and redeposited in dolomite with more pore space.

The shales of this lower part are often dark grey, dolomitic, enclosing ramifying lamellae and streaks of anhydrite. Yellow chert replaces here occasionally in a final stage the carbonates and sulphates.

Predominant shales and minor dolomite interbeds in the upper part are often strongly limonitic and the felty anhydrite type seems somewhat less prominent.

In core 18, dolomitic pellets (tending to oolites) have coarse crystalline anhydrite cores. It is less probable that the anhydrite entered the microcrystalline, dense pellets during diagenesis; primary anhydrite probably acted as nucleus for precipitation of the carbonate and coarsened by recrystallisation.

* The names "Giles Creek Dolomite" and "Shannon Formation" are defined by A. Wells et. al. (1965).

Minor very well fine bedded dolomite at the top of this part could be of algal origin. In places, contorted lenses of siltstone in the limonitic dolomite suggest activity of churning organisms under strongly oxidizing conditions. A shallow marine to coastal environment for these sediments cannot be excluded.

Shannon Formation (M. Cambrian) 5147-3804'

This formation exhibits a considerable limestone portion. The lowermost part consists of very light rather pure limestone. Characteristic are here small globules (d 0.25mm.) of radiant calcite needles, with a cryptocrystalline, often dolomitic centre. Recrystallized oolites must be excluded as there are no concentric velictic structures left and no coarse nucleus visible. The rosettes of consistent size are thought to be of algal origin.

Coarse calcite of rounded shape suggest fossil debris, the organic structure being lost by recrystallisation. Fragments of algal limestone, consistent presence of rounded quartz and pellets, scour-and-fill contacts between dolomitic and calcareous beds indicate high energy environment in more open marine conditions.

Anhydrite is still present as very coarse crystals with a strong tendency to develop their crystal faces. Pellet inclusions indicate that the sulphate replaced a pre-existing calcite matrix. The calcite of the rosettes is easier replaced by the anhydrite than the cryptocrystalline, dolomitic centre.

The middle part has dolomite, limestone and dark shale (occasionally very argillaceous) interbedded. Algal limestone is common, and there are coarse fossil fragments of possible Echinoderms. The low silt content consists of quartz and reshaped microcline euhedra (see below: Goyder Formation). Oolitic limestones may develop in places: The ooliths show often 3 concentric zones: Centre microcrystalline calcite, main part consisting of coarse dolomite and a rim of cryptocrystalline calcite. It appears that the dolomitisation of the ooliths occurred during deposition, when the ooliths were still capable of moving before the final cryptocrystalline calcite was deposited. Coarse anhydrite replaces only the latter, not the dolomitic part.

The upper part has a predominance of dolomite over limestone, minor dark grey shale intercalations. The dolomite may contain fragments of collophane. The limestone contains sometimes abundant fossil fragments (trilobites). Dark grey micaceous shale interbeds may show many compacted worm burrows, probably under intertidal conditions.

In the whole formation, rounded apatite is a significant accessory.

Goyder Formation. (U. Cambrian) 3804-3004'.

Typical is the predominance of very fine to fine arkosic sandstone with a shaly part in the middle and dolomite at the top.

The arkoses exhibit all stages of silicification and especially feldspathisation. The K-feldspar (microcline, up to 40% of rock) has generally a subrounded, dusty, detrital core and a heavy overgrowth of purer feldspar of slightly different optical orientation. In many cases the overgrowths tend to reconstitute crystal faces (rhombic sections). All these phenomena of authigenic growths make the rock tight.

The dolomite in the upper part with minor transitions to arkosic sandstone may contain abundant glauconite of detrital nature, as the grains are often broken. Collophane with internal organic structure is always present as well as recrystallized fossil fragments. A trace of rounded garnet is typical for this formation. A neritic environment with strong wave action is indicated.

Pacoota Sandstone (L. Ordovician) Base 3004'.

In this well, it is a fine, dolomitic quartz sandstone with heavy quartz overgrowth. Limonite coatings appear to precede the authigenic enlargement of the quartz. Collophane fragments as in the Goyder Formation underneath point to shallow marine conditions.

Core descriptions of Cambrian sediments in the well
Alice No. 1 (Amadeus Basin)

Pacoota Sst

C8: 2977' 4": Qz-sandstone, sl. dolomitic

Pink, unbedded, occ. leached spots. Large, irregular patches or short fissures of white calcite. Porous, but hard.

Micro: 95% Qz (d 0.2mm.) interlocked, large contacts and heavy overgrowths, primary grains coated with limonite. Many small pores left. Few qz undulose, metamorphic. Dol, void filling, coarse, mainly anhedral, occ. rhombs with growth zones. Dol developed before qz overgrowth. Few collophane, org. debris. Acc, Tour, zircon rd.

Goyder Formation

C9: 3125' 4": Dolomite, sandy, glauconitic

Green-white sprinkled, with very abundant glauconite, lighter and darker sl. wavy beds, separated by thin dark clay stringers. Nests of brownish collophane. The more dolomite, the lighter the dolomite. Lenses of white pure dolomite.

Micro: 70% Dol, as interlocking anhedral, d 0.7mm. Irregular patches of euhedral dolomite (d 0.06-0.12mm.). Dol probably recrystallized bioclasts, as some with remainder of org. structures. 30% Qz, subrd, sortg mod, d often 0.3mm, vague concentration in lenses. Occ. large contacts, or qz sl. resorbed by dol. Glauc, less rounded, more fractured than below, more dirty. Few frag chert, quartzite. Collophane more broken (reworked?), occ rounded. It may also cement silt grains, in round frag. Acc apatite, round garnet, zircon.

C9: 3127'-4": Dolomite, sandy, very glauconitic

Green-white sprinkles, very vaguely bedded, abundant well sorted glauconite. Brownish collophane.

C9: 3129'-4": Arkose, very fine, glauconitic, sl. dolomitic

Very light grey, very regular planar lamellae by arrangement of glauconite of different size. Brownish debris of collophane. Qz often with X faces. d 0.12mm.

Micro: 60% Qz, interlocked and large contacts, no overgrowths, contacts prob. by dissolution. Microcline, 30%, often overgrowths and interlocking, development of euhedra, projecting into quartz. Dol, crs as intergranular, patchy vug filling or as original clast with org ? structure. Qz close or within dol. may show resorption (not K-feldspar). Glauc, variable size, (0.25-0.06mm.) prob frag of bigger rounded grains, which have often thin, radiant, slightly lighter coating, occ. shrinkage fissures. Org. collophane bone rests common. Pyrite agglomerates. Acc. Tour, rounded apatite, muscovite, zircon, trace garnet.

C 10: 3410'-4": Shale, dol. with minor silt beds, lenses.

Dark greenish grey, rather hard with white grey sharp lenses or streaks of fine siltstone. Occ. silt injections. Shale contains much mica, esp. biotite. Thick interbeds (several cm) of white massive Qz sandstone.

Micro: Illite, dense, parallel, with variable admixture of cryptocrystalline dol and dolorhombs. Some fine muscovite. Abundant carbonaceous matter and fine pyrite. Beds or lenses of dol. siltstone or silty dolomite with dol. euhedra, d 0.06mm, silt K-feldspar, qz with overgrowths, muscovite (biotite), with patchy chert cement. Silt lenses often rimmed by fine pyrite. Muscovite may be disoriented by slumping. Acc. Ap, Tourmaline.

C10: 3412'4": Shale-Siltstone interbeds.

Shale black, rather indurated, very micaceous (biotite) with sharp laminae and lenses of white grey siltstone, occ. slumped. Small agglomerates of pyrite. Few patterns of injected silt (or mud crack fillings?)

C11: 3577'4"-8": Arkose, very fine

Medium grey, uniform, dense with minor wavy sharp shale stringers containing abundant horizontal worm tracks, minor load casts.

Micro: 60% Qz interlocked, large contacts occ. overgrowths. Microcl 30%, fresh interlocked with overgrowths towards euhedral against qz. Core of K-feldspar often dusty, rim is limpid. Euhedral Dol and calcite as crs vug fillings, fontainebleau structure. Qz and Fsp often crystal faces around pores. Streaks with abundant rounded zircon. Acc. round apatite common, Tour, titanite, trace garnet.

Shale stringers with illite and some muscovite.

C11: 3579'-4": Shale with silt lenses, dol. mudbeds.

Dark grey, with sharp light grey, often flat cross bedded silt intercalations and subhorizontal concentrations of light grey, small cryptocrystalline dol patches or lenses ("cloudy"). The whole transected by micaceous silt "injections".

Micro: Shale fine illite, fine parallel muscovite, minor biotite, fine silt admixture and some dol; subparallel stringers of microcrystalline dolomite with some silt and beds of euhedral dol., d 0.05mm with 30% angular silt of qz and K-feldspar, partly with overgrowth interlocked and abd mica. "Silt injections" contain 70% Qz, subang to subrd of moderate sortg, occ with large overgrowths and 20% K-feldspar with overgrowths, 10% illite. Deformed thin clay stringers indicate plastic movements. Acc. apatite, tour, zircon, tr. garnet.

C11: 3581'-4": Siltstone dol, interbeds silty Dol and shale

Light grey dol siltstone (or silty Dol) in sharp beds, lenses or chips, broken by strong current or flat cross bedded in black grey shale; few white patches.

Micro: Silt beds, angular qz and microcline, the latter with overgrowths or euhedral, and dol euhedra, some parallel muscovite (biotite), Tour, apatite. Sharp layers of microcrystalline Dol, occ sl. coarser with some carbonaceous material, enclosing silt injections or lenses. Stringers of dol. illite or muscovite (biotite), carbon streaks.

C11: 3583'-4": Qz - Sandstone.

Light grey, mod sorted, d 0.27 (-0.6)mm, massive, but silty interval with sharp, fine dark grey wavy clay laminae. Thick interbeds (over 2cm) of black grey, unbedded shale, micaceous.

C11: 3585'-4": Qz sandstone, sl. dolomitic

Very light grey, unbedded, very porous, x faces. Few dk green grey chert grains, subrounded. Few coal debris. Occ thin wavy stringers of black clay, associated with light green clay, agglomerations of pyrite.
Micro: Qz, 85%, sorting moderate, d 0.3mm (0.6-0.15mm), larger grains better rounded. In places large contacts, but overgrowths rare. 5% Microcline, fresh, some with thin overgrowths, including fine dolomite, or reshaping euhedra. Overgrowths and core twinned, but latter more very fine inclusions. Few frag of metaquartzite. 10% Dolomite, in oolite fragments, minor pellets or coatings on quartz and feldspar, as irregular fine patches or as coarse vug fillings. Accessories are rounded tourmaline, trace garnet, mica, also quartz with inclusions of tourmaline prisms.

C11: 3587'-4": Siltstone, sl. dolomitic.

Medium grey, vague subparallel slightly darker streaks, occ sl wavy, or light green grey with very fine dark micaceous shale lamellae, containing horizontal worm tracks.

C11: 3589'-4": Siltstone, dolomitic and shale interbeds.

60% sharp beds of light grey, fine lamellar dolomitic siltstone, with flat cross bedding or scoured base, up to 1 cm thick, interbedded with 40% shale with very fine silt lamellae, often penetrated by sub vertical sand tubes, thick in shale, thin in siltstone, the lamellae of which are bent around these sand fillings (prob. by injection).

C11: 3591'-4": Dolomite and arkosic siltstone interbeds.

Sharp beds of light green grey silty and medium green grey dolomite, often 1cm thick and sandy siltstone layers, dark grey, with coaly debris and pyrite, sub vertical coarser burrows.

Micro: 50% of rocks are beds of euhedral dolomite, d 0.1mm, with fine muscovite, minor greenish biotite, and some coaly debris. Siltstone consists of angular quartz (d 0.06 mm) mosaic (29%), some muscovite and 30% microcl with overgrowths, tending toward euhedra. Minor beds of subrounded quartz, d 0.4mm. Smaller quartz, feldspar and dolomite grains projecting into the former. Burrows filled with quartz and feldspar silt and sand, slightly calcareous.

C11: 3593'-4": Sandstone, very fine, with shale interbeds.

Sandstone light grey and tight, occ well bedded with flat cross bedding or scour-and-fill texture, shale as darker stringers, including sand lenses of wavy chips and numerous worm tracks.

C11: 3595'-4": Sandstone, very fine, arkosic, and shale interbeds.

Sandstone light grey, very fine, well thin bedded ($\frac{1}{2}$ mm lamellae) often flat cross bedded or truncated, 60% of total rock. Sharp, black shale interbeds with very thin silt lamellae and numerous worm tracks, the former bending around the latter. (Intertidal sediments?)

Micro: Qz 50%, bimodal, as very fine sand, d 0.08mm, well sorted, interlocked with overgrowths and as minor medium sand, d 0.35 (0.6)mm, less sorted, with strong overgrowths, interlocked, subrounded; Microcline, 40%, subrounded, bimodal like quartz, always with overgrowths or rex euhedra, overgrowths slightly different orientation, limpid. 10% Dolomite, as polycrystalline pellets and as euhedra in finer grade, associated to muscovite, minor biotite. Accessories rounded apatite, tourmaline and zircon. Wavy carbonaceous shale stringers with muscovite.

Shannon Formation

C12: 3885'-4": Dolomite with silty limestone beds.

Light-medium green grey, vague dolomite beds with white calcareous patches (burrows?) and very light grey silty calcareous beds occ cross bedded, with very thin dark grey shale and muscovite lamellae, or ships of dolomite, and may show scoured base. Many vertical, prob compacted worm burrows.

Micro: Microx dolomite with few coarser rhombs, d 0.04mm and small muscovite (biotite) and very fine pyrite, low silt content. Interbedded are graded silt beds, sharp at the base, of predominant microcl and quartz with overgrowths, or euhedra, cemented by more than 50% coarse calcite, occ as fontainebleau structure, with common muscovite, minor slightly chloritized biotite in thin beds. Acc tourmaline, rounded apatite, and org. collophane frag.

C12: 3887'-4": Limestone, bioclastic, (pelletal)

White to light grey, microx vaguely patchy, medium green grey wavy stringers of silty clay, often with fine pyrite, muscovite minor biotite.

Micro: Calcite microcrystalline, with many poorly defined, cryptocrystalline pellets. Irregular patches of coarse calcite, vug fillings, occ. flocculent. 10% rex shell fragments trilobites? Rare ang. silt with overgrowths. Sharp wavy illite-mica stringers with some fine pyrite. Acc tourmaline, zircon, chlorite.

C12: 3889'-4": Dolomite, euhedral, d 0.05mm, with sl. coarser patches, veins of coarser dolomite. Stringers of clay with silt of qz and K-feldspar (overgrowths), often sl. stylolitic. Vug fillings by calcite, coarse, Phosphatic bone rests. Few subrounded medium sized Qz, occ resorbed by dolomite.

C13: No recovery

C14: 4191'-4": Limestone, algal? bioclastic

Medium grey, with globules and pellets, with white fossil fragments. Horizontal and thinner vertical stylolites. Fine, hard, silty, cryptox limestone beds. Small pyrite agglomerations. Few dolomite vug fillings.

70% of rock consists of calcite rosettes, d 0.6mm, prob. algae, with microx core. Some crs fragments of Echinoderms and rounded mud fragments, occ coated with cryptox calcite and vertical needles (prob by rex. Large fragments of silty limestone with some bioclasts, mica. Silt is often microcline with overgrowths or reshaped euhedra, penetrating into fossil boundaries. Pelletic beds contain parallel silt streaks. Acc. yellow tourmaline.

C14: 4193'-4": Limestone, oolitic, some anhydrite.

Light grey, oolites lighter, d 0.6mm, brownish pellets, some chertified. Minor light green grey beds of dolomite, cryptox.

Micro: Oolites have often microx calcite in centre, than coarse dolomite euhedra predominant, than coated by cryptox calcite. Cores also quartz grains, silty limestone. Rounded frag of fine pelletal limestone, occ with silt lamellae or algae? Oolites cemented by coarse calcite, prob by recrystallisation. Close to oolites, calcite is often vertical, needles, further away from more equant grains. Some oolites almost unrecognizable by recrystallisation. In a final stage, coarse anhydrite replaces calcite between oolites and their calcite coatings, maintaining its crystal faces. Dolomite rhombs within oolites bodies only rarely affected.

C15: 4525'4" - 8": Dolomite, silty and shale lamellae. (A)

Dark grey, microx; with sharp, light grey, sl. wavy thin beds or stringers of fine silty dolomite, coarse white dolomite and dark clay lamellae with some pyrite.

Micro: Microx dol anhedral, d 0.02 mm, parallel carbonaceous streaks; beds of dolomite rhombs, coarser with qz silt (-20%), mica often scour-fill contact, occ slumping; shale beds are illite and dolomite, mica and carbonaceous streaks.

Dolomite, with frag of algal limestone (B)

Medium grey, with dark grey cryptox beds, light grey silty beds and layers with light grey to light brown grey rounded fragments of algal limestone. Some well rounded Qz grains (up to 1mm), some scattered pyrite.

Micro: Dolomite, microcrystalline with rhombs d 0.05mm, including angular qz and microcl silt, and few well rounded qz (-0.5mm), some muscovite and some rounded fragments of algal? limestone. Subparallel bundles of anhydrite prisms. - Minor beds qz silt, some microcline with overgrowth and dolomite rhombs. - Silt beds with more Qz sand grains, well rounded, poorer sorting, d 0.7mm. large subrounded fragments of probably algal limestone, cement occ. replaced by coarse anhydrite and mica. Acc round tourmaline.

C15: 4527'-4": Limestone, pelletal, minor dolomite beds.

Very light grey, cryptox with small, slightly lighter pellets. Minor thin medium green grey, micaceous shale beds. Many large anhydrite prisms (up to 4mm), including pellets.

Micro: Calcite interlocked, of variable size (0.05-0.1mm). Many radiant, calcareous algae. Pellets are microcrystalline and dolomite, some single dolomite euhedra, d 0.1mm. Rare thin Qz and microcline silt beds, with some muscovite. Dark grey wavy clay lamellae. Large authigenic prisms of anhydrite (up to 5mm) including mud pellets, coarse dolomite rhombs, oolitic remains. Strong tendency of anhydrite to develop crystal faces. It appears that calcite rosettes around pellets are easier replaced than dolomitic mud pellets in the centre. Acc. pyrite, tourmaline, rounded apatite, and in most cases surrounded by radial calcite needles.

C16: 4843'4" - 8": Dolomite with silty limestone beds.

60% light green grey, microx, wavy, sl. flocculent beds of dolomite and predominant light grey or light brown, calcareous beds with more dolomitic pellets in sharp contact (scour-fill) with medium brown, silty, finer, flat x bedded, calcareous beds, also sl. pelletal. Large wavy, dark grey clay lamellae. Some coarse calcareous vugs. The whole cut by subvertical clay microstylolites.

Micro: Pelletal limestone: microx dolomite pellets d 0.15-1.5mm, or irregular chips, cemented by coarser calcite. - Microx dolomite, with clay stringers. - Vague concentrations of Qz+K-fsp silt in calcite, minor dolomite. Mica with pellets. - Vugs and fissures filled with coarse calcite. - Some fossils.

C16: 4847'4" - 8": Limestone, dolomitic

Medium grey, crypto crystalline, some dark clay stringers, many coarser lighter calcareous patches. Subvertical microstylolithitic clay lamellae, some vugs with coarse calcite.

Micro: Microcrystalline, with more than 50% dolomite rhombs and rare silt (Qz, Kfsp). Patches of coarse calcite, prob by local recrystallisation. Silt more concentrated in clay stringers, mica. Occ flocculent limestone fragments (algal?). Very coarse calcite could be vug fillings or fossil fragments.

Giles Creek Dolomite

C17: 5165'-4": Dolomite, argillaceous, ferruginous, silty

Dark brown, poorly bedded, few lenses of anhydrite.

Micro: 60% of rock is dolomite, euhedra d 0.1mm, with some silt and irregular stringers of limonitic illite, minor muscovite or biotite (chlorite). Irregular concentrations of qz and minor microcline silt (20%). Intergranular, very limonitic illite. Acc: tourmaline, zircon.

C17: 5167'-4": Dolomite, ferruginous-clayey, sl. silty.

Dark brown, microx, very vague, slightly lighter streaks. Sporadic patches of anhydrite. Very micaceous.

C17: 5169'4"-8": Dolomite, ferruginous, very silty.

Red brown, with wavy contorted lenses (and chips?) of sl. lighter siltstone, prob. by intensive churning. Fine mica.

Micro: More than 50% dolomite rhombs or cryptox with limonitic clay. Irregular concentrations of Qz and microcline (some plag), twinned Kfsp with untwinned authigenic rims. With silt are mica, orientation disturbed by churning. Patches of unoriented felty anhydrite. 10% limonitic clay stringers. Acc. rounded apatite, some pyrite with silt.

C17: 5171'4"-8": Dolomite, ferruginous.

Chocolate brown, cryptox, sl. platy, unbedded, rare small anhydrite lenses.

C17: 5173'-4": Dolomite, cl. calcareous, well bedded, (algal?)

Very light grey, cryptox, very well fine bedded, sl. wavy evtl algal.
Micro: Dolomite, rhombs d often 0.04mm with minor sl wavy, (calc) micro-crystalline lamellae. Coarser beds often contain intergranular anhydrite, which may include dolomite rhombs. Accessory green biotite.

C18: 5449'4"-8": Dolomite, ferruginous, silty, pelletal

Chocolate-brown, microx, hard, unbedded, with lighter, vague sl. calc. pellets and red brown stringers of limonitic clay. Few lenses of coarse anhydrite, Fe nearby leached out.

Micro: Dolomite microx, d 0.005mm with few coarse anhedra and rare qz silt. Up to 10% sl. coarser-x pellets, d 0.2mm, in their core occ. coarse anhydrite, replaced by marginal dolomite. Vague boundaries by rex. Subparallel limonitic stringers.

C18: 5451'4": Dolomite, ferruginous, fine silty.

Strongly rusty brown, rather hard, cryptox, very weak, lighter wavy streaks of greenish leached patches. Occ. groups of small anhydrite lenses.

C18: 5453'4"-8": Dolomite, ferruginous, silty, sl. calc, pelletic (-oolitic)

Red brown, weak, sl. wavy streaks, silty, fine pelletal, minor oolites, with subvertical stringers of rusty dolomite, evtl. by injection. Subparallel ragged patches of fine anhydrite.

Micro: Dolomite, variable grain size, rhombs (d 0.01-0.07mm) and up to 30% microx pellets, d 0.3mm, with limonitic coating also inside, tending to oolites. Some composite pellets. Some pellets have coarse anhydrite core, dolomite rim and limonite coating. Few anhydrite prisms scattered, common mica, limonite patches often with parallel limonite rims inside.

C18: 5455'-4": Dolomite, silty, shaly, ferruginous

Chocolate brown, weak lighter streaks, cryptox, minor sharp lenses of anhydrite (3cm long). Slight fine silt admixture in places, muscovite, minor biotite.

C19: 5723'-4": Dolomite, ferruginous, shaly

Chocolate brown, weak lighter streaks, lenses, cryptox. Irregular lenses of coarse anhydrite. Parts with very fine silt often leached, light grey. Green grey shale streaks.

Micro: Dolomite, cryptox with dense limonitic lenses (chips?), single crystals and agglomerates of unoriented anhydrite, minor subparallel muscovite.

C19: 5725'4"-8": Dolomite, ferruginous, shaly.

Chocolate brown, cryptox, sl. shaly, argillaceous, weak sl. wavy beds or lenses, streaks, possibly chips by slight slumping. Some low angle cross beds.

C19: 5727'-4"-8": Dolomite, sl. ferruginous, anhydritic.

Medium green grey, ferruginous patches, unbedded, with few anhydrite lenses. Rare green grey, denser clayey beds. Fine irregular pellets of light brown grey cryptocrystalline dolomite.

Micro: In cryptocrystalline dolomite with accessorial silt and fine muscovite are single needles to irregular agglomerates or unoriented anhydrite. Very minor dolomite rhombs, d 0.03mm.

C20: 6062'-4": Dolomite, anhydrite patches.

Medium brown, microcrystalline dense, with fine, regular, sl. wavy bedding, of prob. algal origin. Patches of anhydrite filling intergranular space, also in fissures. Thin surfaces of black grey shale.

C20: 6064'-4": Dolomite, with anhydrite beds.

Dark green grey, often silty, with fine pyrite. Sharp, irregular areas of purer, white dolomite with scattered anhydrite. Flakes of green grey, very dense argillaceous dolomite.

60% cryptocrystalline dolomite, with vague, loose silt concentrations with some pyrite. Single crystals or wavy beds or pure lenses of euhedral anhydrite. Wavy beds of illite with large pyrite crystals. Mica, idiomorphic tourmaline.

C21: 6096'-4": Dolomite, sl. calcareous, silty.

Dark grey, minor sl. calcareous, medium grey beds, spotted and reworked beds more than 2cm thick. Dolomite in darker beds occ. finely pelletal.

Micro: Microcrystalline, in silty part rhombs up to 0.03mm, in partly streaky silt some fine muscovite. Vague pellets or clasts of crypto-crystalline dolomite. Acc. tourmaline.

C21: 6098'-4": Dolomite, with coarse anhydrite.

Medium brown grey with lighter wavy beds and patches. Coarse anhydrite scattered.

Micro: Dolomite rhombs of variable size, 0.03-0.1mm. Irregular patches, consisting of very coarse crystals of anhydrite, often separated by dolomite into areas of equal extinction, d 2mm. - Dolomite close to anhydrite euhedral, also single euhedral or groups included in anhydrite, which appears to enter preexisting vugs or pores, fissures. Irregular subparallel stringers of cryptocrystalline dolomite with much less anhydrite, with flocculent or finely pelletal structure. Form and distribution of anhydrite depends on grain size of dolomite. In some cases microstylolites with limonitic impurities go through anhydrite, forming after the latter.

C22: 6116'-4": Dolomite, anhydrite.

Dark green grey, wavy lenses, patches, stringers, fine lamellar chips. Wavy lamellae of anhydrite, often associated with black clay laminae, and some irregular anhydrite veins.

Micro: Dolomite partly rhombs, with lenses of quartz silt (20%) admixture,

anhedral anhydrite, some mica. Irregular beds of subparallel, fairly euhedral anhydrite (minor gypsum), enclosing irregular patches of cryptox dolomite. Minor lenses of unoriented anhydrite euhedra. Fine pyrite with silt. Acc tourmaline, chlorite (from biotite). Oil in fractures.

C22: 6118'-4": Dolomite.

Dark greenish grey, weak light grey lenses or beds, rather hard, clouds of fine pyrite.

C23: 6121'-4": Dolomite.

Dark greenish grey, cryptox, occ fine, wavy, dark grey shale laminae, flocculent parts could be algal. Irregular patches of silicified dolomite, few qz sand grains.

C23: 6127'-4": Dolomite, silty with anhydrite streaks.

Dark greenish grey, with minor wavy lenses of darker anhydrite. Purer dolomite lenses slightly brownish, silty.

Micro: Stringers of silty dolomite (angular quartz up to 30%), some parallel anhydrite prisms interbedded with patches, lenses or fine bedded flakes of illitic dolomite. Beds occ microfaulted or graded with silt at base. Sharp wavy beds, lenses of anhydrite euhedra (d 0.01mm), 30%. The smaller or the more dolomitic the anhydrite lenses, the less oriented are the anhydrite prisms. Pyrite in silty parts, anhydrite. S shaped bedding could be produced by slumping.

C23: 6129'-4": Shale, dark grey, dolomitic.

Lighter unbedded, more dolomitic part and darker well bedded more argillaceous part. Hair fissures with dark clay filling small aggregates of pyrite.

C23: 6131'-4": Shale, dolomitic, sl. anhydritic

Black grey, rather hard, bedding very weak, vague lighter, more dolomitic lenses.

C23: 6133'-4": Shale, dolomitic, anhydrite lenses.

Dark grey, less fissile than above, sl. undulous, rough parting. Sharp light grey to white lenses of pure dolomite. Black grey ramifying lamellae and streaks of anhydrite.

Micro: Diffuse stringers of dense illite, minor small muscovite with small quartz silt lenses very fine pyrite and strings of microx dolomite. Lenses, pockets, folded beds of unoriented anhydrite prisms with incipient gypsification. Acc. detrital biotite and apatite.

C24: 6443'-4": Anhydrite with dolomite.

Anhydrite, dark grey, pure transparent, interbedded with light greenish grey dolomite sharp irregular laminae, patches, pellets. Dolomite laminae strongly crenulated, bands often with peculiar "smoky" internal structure, prob originated by swelling and flowing sulphate.

Micro: Anhydrite prisms d 0.01mm, 80% arranged in flow structure, subparallel crystals, disoriented by or flowing around dolomite patches. Sharp bands, patches or pellets of microx dolomite, "smoky" structure by whirly anhydrite inclusions. Anhydrite includes some coarser dolomite rhombs, biotite and glauconite. Anhydrite and dolomite probably primary, but rex.

C24: 6445'-4": Dolomite, anhydritic.

Light greenish grey, hard, very dense, hard in places, prob silicified. Fine light brown patches of anhydrite, occ in planes ressembling algal growth.

Micro: Dolomite rhombs (d 0.04mm), in places cryptox pellets or fine patches. Patches, lenses of 10% coarse anhydrite. Dolomite rhombs project or are included in anhydrite. Distribution of anhydrite depends on structure of dolomite and appears to be introduced after the latter. Anhydrite also in vugs and fissures, occ as globules, d 0.01mm, evtl. replaced fossils. Minor pockets of unoriented felty anhydrite. Final yellow chert replaces all of them.

?Chandler Limestone equivalent

C25: 6758'-4": Dolomite, sl. argillaceous.

Light olive grey, slightly mottled. In places very calcareous.

C25: 6760'-4": Shale, dolomitic, sandy-silty.

Light olive grey with light brown grey lenses (pellets?) and thin, slightly darker bedding. Subparallel fissures and pockets filled by pink anhydrite. Single well rounded quartz grains scattered d 0.6mm.

Micro: Predominantly cryptox dolomite and clay (kaolinite?) with fine mica, some dolomite rhombs with dark centre and microx dolomite pellets. Quartz, minor microcline as well rounded grains up to 1mm d and silt (25%). Fissures filled by very coarse crystals of anhydrite, pockets by felty anhydrite.

Acc. rounded zircon.

C25: 6762'-4": Mudstone, dolomitic, ferruginous, silty-sandy

Red brown, unbedded, rare lighter lenses, dense. Single round quartz grains scattered, nests of white anhydrite.

Micro: Predominant microx dolomite and limonitic clay with some muscovite. Few microx dolomite pellets. Quartz, some microcline, as subangular silt and subrounded sand (20%). Patches of anhydrite prisms, d 0.4mm, unoriented without relation to sedimentation plane.

C26: 6876'-4" Halite, transparent very coarse crystalline,
6878'-4" brownish, often fractured by swelling,
6880'-4" lenses of red brown grey, dolomitic clay
6882'-4" with some silt.
6884'-4"

Arumbera Sandstone

C27: 7305'-4": Siltstone, ferruginous

Intensively red brown, hard, with fine brown shale streaks, or well fine bedded lenses. Few patches of loose round qz sand grains d up to 0.4mm, minor dark grey chert. On sedimentation plane abundant muscovite.

Structure prob by churning, reworked.

Micro: Quartz 60% in irregular distribution, moderate sorting d 0.05-0.25mm, coarser grains better rounded, very minor sl. better rounded microcline surrounded by a limonitic illite muscovite-dolomite matrix.

Acc. rounded apatite, tourmaline.

C28: 7518'-4": Shale, ferruginous.

Red brown, with silt lamellae, 3mm thick, hard. On some beds interference ripples, depressions filled by muscovite (silt). Few horizontal worm tracks.

C28: 7520'-4": Siltstone, ferruginous, sandy.

Red brown, vague sl. wavy laminae of lighter, softer shale. Abundant wormtracks and burrowing. Fillings coarser and more micaceous. Abundant fine mica on parting. Few low angle beds, sporadic slumping. Few lenses of well rounded quartz grains d up to 1mm. In places, Fe leached out, concentrated in limonitic spots.

Micro: Quartz in fine beds, angular silt d 0.05mm, minor concentrations with coarser, better rounded grains, cemented by patchy limonite (d up to 0.25mm). Minor fresh microcline. Dolomite coarser in sandy beds, finer in shale beds, often rounded crystals coated with limonite, and then rex. Illite in shale breaks.

Conclusions.

The study has shown, that the subdivision of the Cambrian carbonates into a dolomitic lower part (Giles Creek Formation) and an upper, more calcareous part (Shannon Formation), recognized at the surface in the eastern part of the Basin, is also valuable in well Alice No. 1.

The abundance of anhydrite, as primary felty type in the Giles Creek Dolomite, as secondary, "migrated" coarse type in the Shannon Formation is recognized. The potential to build a structure by plastic flow of the sulphates cannot be overlooked.

Presence of radiant calcite globules of possibly algal origin in the Shannon Formation point to the possibility of reef development, eventually responsible to originate a positive structure.

Appendix

Short petrological description of surface samples from the Amadeus Basin.

Arumbera Sandstone
Mount Liebig sheet:

- ML 105/1: Arkose, 50% quartz, 50% microcline with overgrowths.
105/5: Quartz sandstone, sl. feldspathic, many chert pebbles
105/3: " , 10% chert.

Alice Springs sheet:

- 200A: Arkose, glauconitic, dolomitic cement
39B: Arkose, K-feldspar 50% with overgrowths.
39: Arkose, similar, kaolinite fragments.

Rodinga sheet:

- 39A: Arkose, very fine, limonitic, 25% microcline. Minor chert fragments, overgrowths postlimonitic.

Jay Creek Limestone:

Henbury sheet:

- HY 89C: Oolitic limestone, ooliths radiant (algal?)
89D: " , ooliths radiant, recrystallized bioclasts.
153: " , large ooliths, radiant recrystallisation.
159: Pelletal limestone, sl. bioclastic, well rounded sand.
89B: " , pellets, chips, few oolites.
89A: Oolitic limestone, bioclasts, multiple ooliths.

Alice Springs sheet:

- AS 113: Oolithic limestone, occ. fine authigenic quartz.
105: Pelletal limestone, "

Giles Creek Dolomite:

Alice Springs sheet:

As 292: Dolomite, pelletal (oolitic), coarse bioclasts, abundant poorly sorted, subrounded sand

242(1): " , mottled, sl. bioclastic, limonitic

242 : " , mottled, calcite in vugs

Goyder Formation:

Henbury Sheet:

HY 76A: Quartz sandstone, very fine, grains interlocked

75A: Limestone, oolitic, ooliths radiant and concentric

75B: Dolomite, recrystallized bioclasts, some pellets, oolites.

75E: " , silt quartz, K-feldspar, strong overgrowths, collophane fragm.

75D: Limestone, silt quartz, K-feldspar, bioclasts.

Mount Liebig sheet:

ML 148 (1): Quartz sandstone, very fine, interlocked.

Lake Amadeus sheet:

LA 547: Dolomite, algal pellets.

ABBREVIATIONS

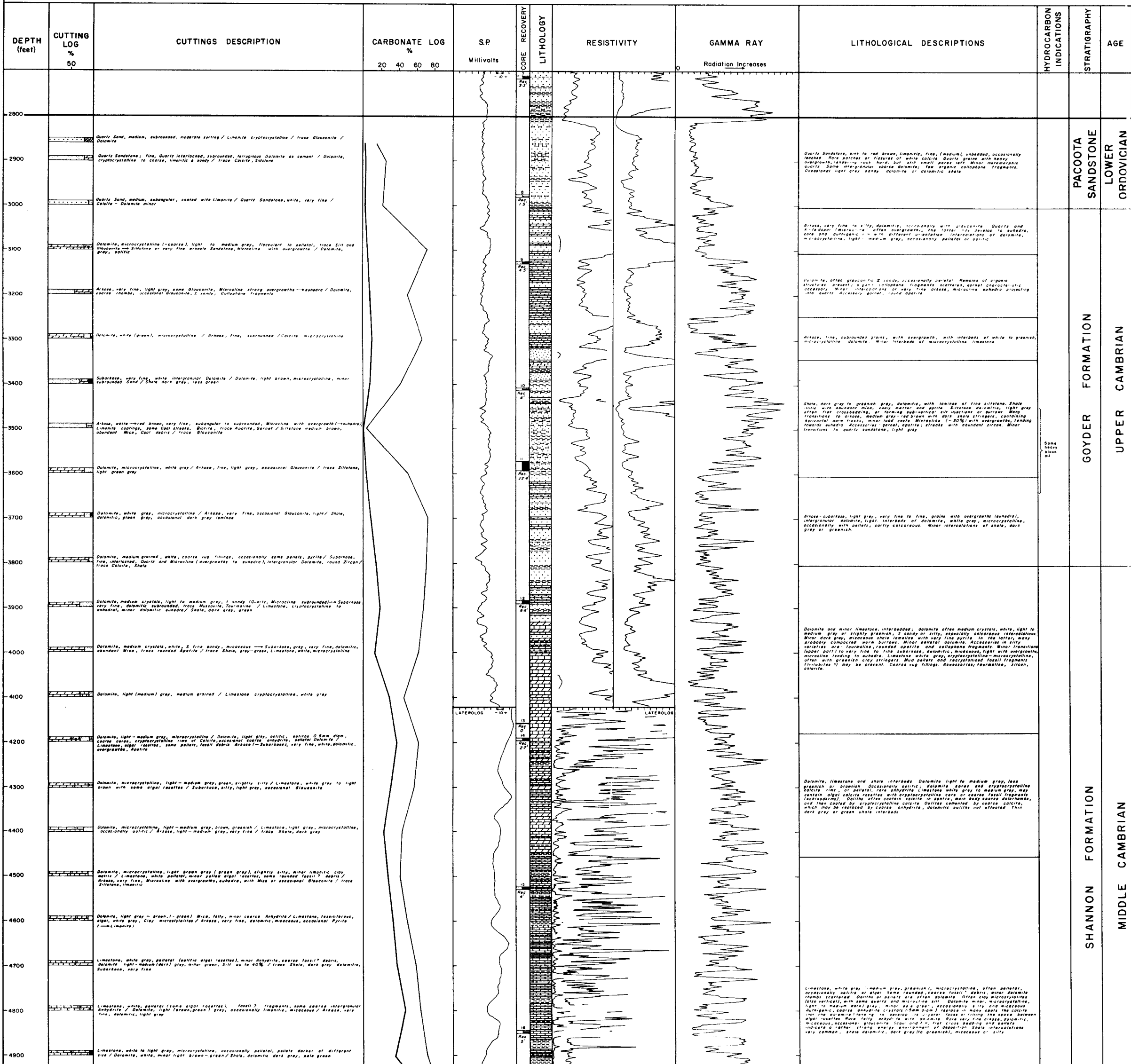
abd	abundant	prob	probably
acc	accessory		
ang	angular	qz	quartz
calc	calcareous	rd	rounded
crs	coarse	sl	slightly
d	diameter	Tour	tourmaline
Dol	dolomite, dolomitic	x	crystal, crystalline
dk	dark	X-bedded	cross bedded
esp	especially		
Fsp	feldspar		
frg	fragment		
Glauc	glaucinite		
microcl	microcline		
mod	moderate		
occ	occasionally		
org	organic		

Lat. 23° 54' 47" S
 Long. 133° 58' 00" E
 K.B. 1753' A.S.L.

ALICE NO.1.
(CAMBRIAN)

SCALE : 1 inch = 200 feet

EXOIL (N.T.) Pty Ltd
 AMADEUS BASIN
 N.T.



GOYDER FORMATION

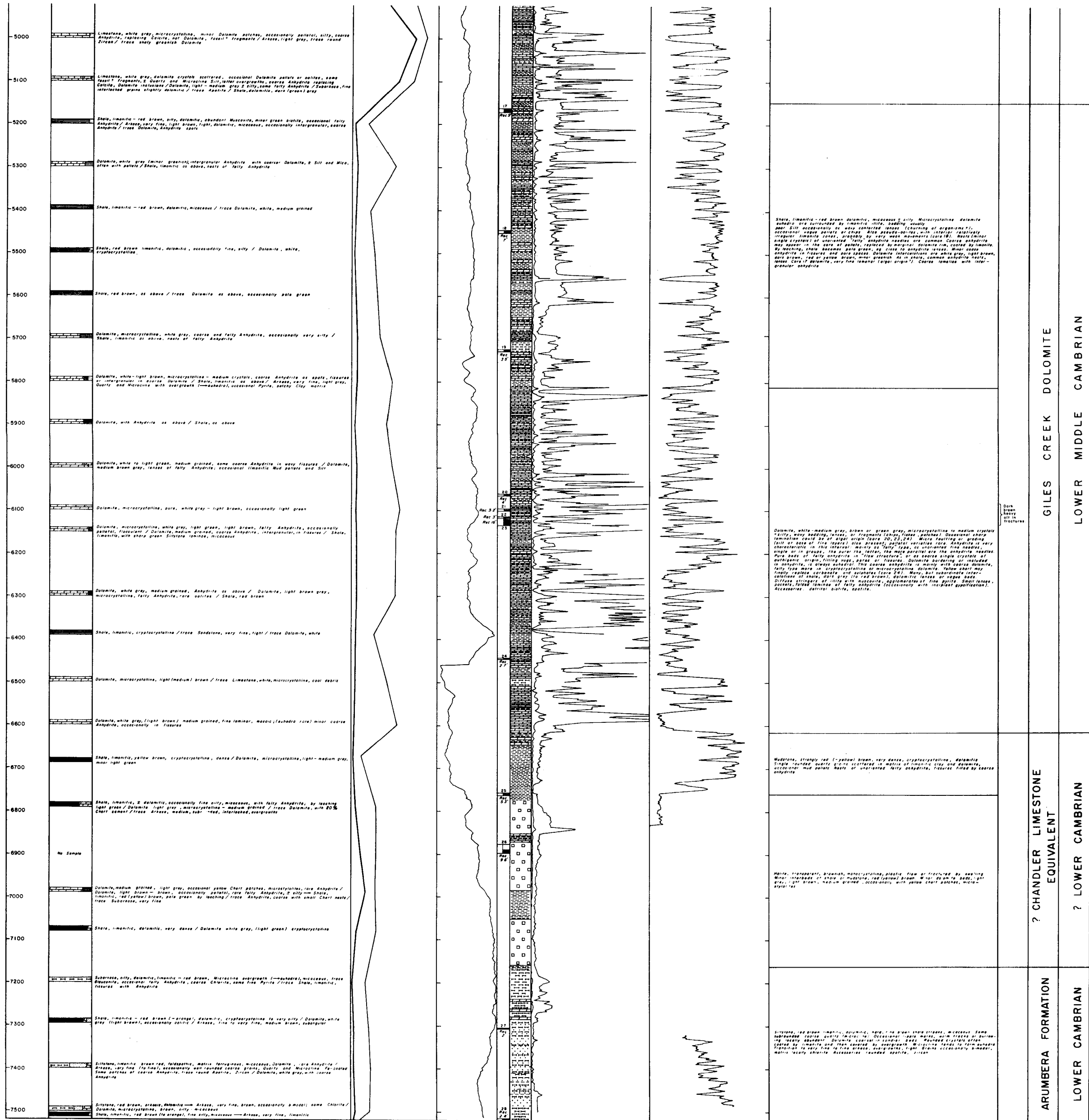
SHANNON FORMATION

PACCOOTA SANDSTONE

UPPER CAMBRIAN

MIDDLE CAMBRIAN

Some heavy block oil



Sheet at scale 1 inch to 100 feet available on request.

TD 7510

To accompany Record 1966/5

Geologist - A. Fehr I.F.P.

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