

APPENDIX A (i)

CORE DESCRIPTIONS

by R.L. Pemberton

ALICE NO. 1 WELLCORE DESCRIPTIONSCore No. 1: 520' - 530' recovered 10'

Coring Times: 7, 6, 7, 7, 6, 8, 7, 8, 9, 9 min./ft.

520' - 524' Sandstone, red, poorly consolidated, soft red ferruginous cement, argillaceous and silty; white calcareous material; poorly sorted very fine to coarse grained, angular to sub-rounded quartz and minor dark mineral and rock grains; slightly arkosic and micaceous (white and black mica). Rock crumbles in fingers when wet but becomes more consolidated when dry; massive with faint current bedding; poor intergranular porosity.

Dip -  $0^{\circ}$  to  $8^{\circ}$ .

524' - 526' Shale - top 4", red, calcareous very soft, sticky when wet with irregular sandy patches and scattered rounded pebbles, with a thin pebbly streak at the base; grading into Sandstone, red, speckled, black, very fine to fine grained, calcareous, silty, very micaceous (black and white) grading almost to Siltstone; thin-bedded.

526' - 530' Sandstone as from 520' - 524'.

Oil and Gas indications - nil.

Note: This core was cut to check for a suitable casing seat. Due to the poor consolidation of the sand it was decided to drill ahead before setting surface casing.

Core No. 2: 820' - 830' recovered 10'

Coring Times: 4, 4, 4, 5, 7, 7, 6, 7, 6, 7 min./ft.

Sandstone, rusty orange-red, very calcareous, well consolidated, friable, very fine to medium grained, rounded to sub-angular quartz and minor rock grains, arkosic, some feldspars have altered to kaolin. Cement is argillaceous and calcareous. This sand is very homogeneous throughout with only minor variations in grain size. The core breaks into plates  $\frac{1}{4}$ " to 6" thick indicating thin to medium bedding - slightly current-bedded; poor to fair intergranular porosity.

Dip  $0^{\circ}$  to  $5^{\circ}$ .

Oil and Gas indications - nil.

Core No. 3: 1,124' - 1,131' recovered 4'8"

Coring Times: 5, 5, 6, 5, 5, 5, 5, min./ft.

Sandstone, light rusty red, calcareous clay matrix, very fine to fine, well sorted, sub-angular to sub-rounded, slightly arkosic (partly altered to white kaolin), micaceous, very poorly consolidated, crumbly when wet. Poor to fair intergranular porosity. Core breaks along thin argillaceous partings, thin, bedded.

Dip - flat, with minor wavy current-bedding.

Oil and Gas indications - nil.

Core No. 4: 1428' - 1438' recovered 6'4"

Coring Times: 5,3,4,6,5,5,6,5,5,5 min./ft.

Sandstone, light yellowish red-brown, with light brown streaks, slightly to very calcareous, very fine to fine grained, well sorted, rounded to sub-rounded, arkosic (most feldspar has altered to white kaolin), traces of dark mineral grains; poorly cemented with silty, quartzose matrix, giving fair to poor intergranular porosity - very friable to crumbly; local scattered soft black unidentified inclusions (carbonaceous?); thin bedded appearance with many silty, ferruginous partings.

Dip - flat with some strong cross-bedding up to 60°.

Oil and Gas indications - nil.

Core No. 5: 1760' - 1770' recovered 7'2"

Coring Times: 4,5,3,4,6,8,9,10,8,8 min./ft.

Sandstone, medium rusty brown, very fine to fine grained, sub-angular to rounded, well sorted, very poorly cemented with silty quartzose cement - very soft and crumbly. Poor to fair intergranular porosity.

Dip - apparently flat, but strong current-bedding; massive.

4'4" Sandstone, red, iron stained, very fine to fine, well sorted, sub-angular to rounded, calcareous silty quartzose matrix. Fairly well cemented, slightly friable, traces of poor intergranular porosity; scattered beds 1" - 6" of white Sandstone of similar texture and white matrix. Bedding is generally flat, but much thin wavy current-bedding. Scattered small yellow limonitic patches, and some minor yellow mottling.

1'4" Sandstone, as in top 1'6", with very strong cross-bedding and thin silty streaks.

Oil and Gas indications - nil.

Core No. 6: 2153' - 2163' recovered 10'

Coring Times: 20,19,21,15,20,12,9,11,10,6 min./ft.

2" Sandstone, purple, very fine to medium grained sub-rounded to sub-angular, calcareous silty cement. Scattered white calcite patches, with concentric bands on outside, crystalline interior - may be after fossils. Small flecks of soft black carbonaceous(?) material. Abundant small inclusions of brown sandstone at bottom.

2'2" Sandstone, light rusty brown, very fine to medium grained, sub-rounded to sub-angular slightly arkosic (and kaolinitic). Scattered fine soft black carbonaceous(?) flecks; calcareous silty cement, friable, massive, current-bedded; scattered bands of flow breccia(?); brown sandstone fragments in calcareous sand matrix, dark red with yellow limonite mottling, with small white calcite patches, possibly after fossils; breccia has a faint wavy bedded appearance.

2'2" Sandstone, purple, white crystalline calcite and silt matrix, well banded, hard, fine to medium grained to locally slightly coarse grained, sub-angular to rounded. Abundant small white crystalline calcite patches, and red, purple, sandy calcite zones; sandstone is locally brecciated with light red brown sandstone fragments in purple sand matrix,

with wavy flow pattern; scattered red and yellow ferruginous streaks and patches.

4'4" Sandstone, light-medium rusty brown, red and yellowish brown, generally poorly sorted very fine to coarse grained, with some graded current bedding, rounded to angular, cemented with white crystalline calcite and silt; variably friable, massive, current-bedded. Calcite locally makes up to  $\pm 25\%$  of rock. Scattered white calcite patches. Current-bedding.

Dip -  $0^{\circ}$  to  $20^{\circ}$

1'2" Sandstone, medium rusty brown, very fine to very coarse grained, sub-angular to rounded; silty, slightly calcareous matrix, poorly cemented, very friable, massive, slight intergranular porosity.

Oil and Gas indications - nil.

Core No. 7: 2710' - 2716' recovered 3'4"

Coring Times: 19,22,19,25,16,18 min./ft.

Quartz Sandstone, clean, white, partly stained light red, very fine to medium with coarse grained streaks, generally sub-angular. Some quartz recrystallization is evident; cemented with white siliceous, silty, and light red silty argillaceous material. Cementing is fair to good, rock is hard, slightly friable; locally slightly arkosic and kaolinitic; rare patches are slightly calcareous; few scattered irregular patches of red and green, soft micaceous shale.

At 2610'6" a  $\frac{1}{2}$ " bed of Siltstone, red, silty and argillaceous.

At 2711' - 2711'6" especially, many Scolithid worm tubes (filled in with sand) in all attitudes from vertical to parallel to bedding planes; strongly current-bedded.

Dip - varies from  $0^{\circ}$  to  $25^{\circ}$

Oil and Gas indications - nil.

Core No. 8: 2977' - 2982' recovered 1'6"

Coring Times: 40,27,22,27,24 min./ft.

2" Sandstone, light red, very fine to fine grained, silty cemented, moderately friable. 3" Sandstone, purple, very fine to very coarse grained, sub-rounded to sub-angular, silty, argillaceous, slightly calcareous cement; hard, tight; patches of white crystalline Calcite.

1' Sandstone, light red, very fine to fine grained, well sorted, few scattered black mineral grains, silty matrix, moderately friable. Extreme cross-bedding.

Dip -  $0^{\circ}$  to  $30^{\circ}$

1" Sandstone, becoming very poorly sorted, very fine to very coarse grained, argillaceous, silty matrix, dark red; with red-brown micaceous Shale inclusions and few flat-lying Scolithid worm tubes.

Oil and Gas indications - nil.

Core No. 9: 3125' - 3130' recovered 4'6"

Coring Times: 23,20,17,18,27 min./ft.

Dolomite, sandy, glauconitic, light grey-brown, predominately a coarse mosaic of white and grey dolomite crystals, sub-rounded quartz grains, and varying amounts of green to almost black glauconite grains. Glauconite is present in varying amounts from  $\oplus$  25% to traces. In places it occurs as fine to coarse irregular pelletoid grains embedded in Dolomite. The Dolomite becomes locally fine crystalline in irregular streaks and patches. Rare accumulations of well-preserved but badly broken up dolomitized shell fragments in a coarse matrix occur. Sand grain content is generally high and Dolomite grades rarely to dolomitic Sandstone. Shale occurs as a few thin laminal and fine irregular partings; dark grey and brown, slightly micaceous. Shale stringers rarely become stylolitic. Shaly zones contain apparent flat-lying worm burrows. Porosity - a few small vuggy patches are present in the coarse-grained rock.

Dip -  $0^{\circ}$  to  $5^{\circ}$

Oil and Gas indications - nil.

Core No. 10: 3410' - 3415' recovered 4'

Coring Times: 20,23,27,23,24 min./ft.

4" Sandstone, dolomitic, light brown, very fine to fine grained, silty, micaceous, hard and tight, with irregular black Shale partings containing worm burrows - flat lying.

1'9" Shale, dark green to very dark grey, almost black, micromicaceous - with thin wavy streaks and laminations of Dolomite, grey, sandy, and dense; Sandstone, light brown, dolomitic and silty, current-bedded.

14" Sandstone and Shale - irregular interbeds from  $\frac{1}{2}$ " to paper thin laminae of Sandstone (approx. 80%), fine grained, brown, partly argillaceous, silty, glauconitic and dolomitic; Shale (20%) black to green, micaceous. Entire section shows strong current-bedding. One interface of truncated bedding is apparently an erosional surface.

5" Dolomite, grey, very sandy, micaceous, very fine crystalline, dense, fine banded at base.

4" Shale, black, micaceous, with approximately 40% of streaks and lenses of strongly cross-bedded Sandstone; calcareous, micaceous, fine-grained, and many sand-filled tubes, often very irregular, probably worm burrows.

Dip - variable from  $0^{\circ}$  -  $10^{\circ}$

Oil and Gas indications - nil.

Core No. 11: 3573' - 3596' recovered 22'5"

Coring Times: 13,10,8,11,11,19,20,25,17,17,14,16,20,  
16,22,27,32,19,19,17,16,16,15 min./ft.

Note - Traces of dull yellow fluorescence were observed in the cuttings during coring.

8' Interbedded Shale (60%), very dark grey and green-grey to black, micaceous, brittle; Sandstone (40%) light grey, very fine to fine-grained, sub-angular to angular, micaceous, silty

calcareous cement, hard and tight. Beds are from very fine laminae to 6" thick, current-bedded, wavy and irregular, often contorted, appear deformed, locally fragmental and reworked during deposition. Sandstone is often lenticular in Shale, and vice-versa.

7'8" Sandstone, light grey, fine to medium grained, sub-angular to sub-rounded, generally fair sorting, with poorly sorted streaks, micaceous, scattered dark mineral grains; silty, slightly calcareous cement, well cemented, tough, fair to poor porosity, water-flushed. Few Shale streaks, dark grey to black, micaceous; in thin wavy beds and laminae, also a few rounded to angular Shale fragments within the sand. At 3787' - an 8" bed of Sandstone is very fine, silty, extremely micaceous, dark grey. Sandstone is generally massive current-bedded.

6'9" Interbedded Shale (40%) very dark grey to black; Sandstone, light grey, fine to very fine grained, tight, calcareous silty cement - all current-bedded, thin laminated to thin-bedded. Many sand stringers in Shale, possibly infilled shrinkage cracks, compressed and deformed during compaction of mud. At 3590' a 1" bed of Dolomite, medium grey, silty and sandy, oolitic (oolites to 1 m.m. diameter) very fine crystalline.

Dip - varies from generally flat to  $10^{\circ}$ , irregular due to current-bedding (hole deviation is  $5\frac{1}{4}^{\circ}$ ).

Oil and Gas indications - nil.

Core No. 12: 3885' - 3891' recovered 5'6"

Coring Times: 28,23,18,21,26,23 min./ft.

1' Dolomite, silty, sandy, green, hard and tight, with thin streaks, lenses and laminations of Sandstone, light grey, calcareous, micaceous, very fine grained, partly recrystallized, cross-bedded; Shale very dark grey-green, silty, very micaceous; also micaceous streaks.

6" Limestone, dark grey brown, slightly dolomitic and argillaceous, crypto-crystalline with small medium to coarse crystalline patches, appears to be possibly biofragmental, also fine oolites throughout. Scattered individual fine to very coarse rounded to subrounded quartz grains. Scattered lenticular patches of dense grey crypto-crystalline limestone. Rare very thin argillaceous partings, partly stylolitic.  
4" Dolomite, medium green, as in top 1 foot.

3'8" Limestone partly silty and sandy, light grey, crypto-crystalline, dense, tight, grading to Sandstone at bottom.

Approximately 5% fine irregular Shale streaks, veins and patches, occasionally stylolitic, scattered throughout. Rare small patches of fine crystalline Galena.

Dip - irregular and variable  $0^{\circ}$  and  $5^{\circ}$

Oil and Gas indications - nil.

Core No. 13: 4157' - 4159' - no recovery

Core No. 14: 4191' - 4196' recovered 2'9"

Coring Times: 50,30,30,33,22 min./ft.

6" Limestone, bioclastic, medium dark brown, crypto-micro-crystalline, oolitic, coarse crystalline recrystallized fossil(?) fragments, well developed stylolites.

1' Thin beds and lenses of Dolomite, silty, sandy, green-grey and brown, grading to Siltstone, dolomitic; Limestone, brown and grey crypto-crystalline, partly argillaceous; Shale grey and green, micaceous. Top of interval is broken up by contemporaneous deformation.

7" Limestone, light grey-brown, bioclastic, pelletoid, oolitic (90%) tightly packed oolites and large pellets, also grey sandy inclusions. Few faint outlines of apparent shell fragments and other possible fossil debris; generally crypto-crystalline, black stylolitic partings. Grades with intervals above and below. Good yellow mineral fluorescence throughout.

8" Limestone, oolitic, much as above, light-medium brown, composed almost entirely of oolites. Few thin argillaceous, silty, and sandy streaks, stylolitic.

Dip  $0^{\circ}$  -  $5^{\circ}$

Oil and Gas indications - nil.

Core No. 15: 4525' - 4530' recovered 4'

Coring Times: 25,25,40,29,23 min./ft.

8" Shale, very dark grey and green to black, very micaceous, silty, platy, brittle, with silty dolomitic streaks and lenses.

6" Dolomite medium grey, silty, calcareous, very fine to medium crystalline, hard, dense and massive. Top of interval is a thin dark argillaceous, micaceous, fragmental streak, with possible fossil fragments.

1" Limestone, light grey-brown, crypto-crystalline, dense, with coarse crystalline inclusions,  $\pm 1/32"$  x  $\frac{1}{4}"$  scattered throughout; few fine stylolitic; shaly streaks at top and bottom of interval.

1'10" Interbedded Shale, very dark grey and green, micaceous; Sandstone, light grey, calcareous, silty, micaceous, very fine to fine grained, tight; Dolomite, dark grey, silty, argillaceous. Bedding is irregular and wavy, beds from fine laminae to 2" thick. Dip is irregular, generally  $\pm 5^{\circ}$ . Some high dips at base of core due to current-bedding or contemporaneous deformation.

Oil and Gas indications - nil.

Core No. 16: 4843' - 4850' recovered 5'

Coring Times: 34,26,33,26,23,24,27 min./ft.

Note:- It appears that the top 2 feet of the core were lost.

2" Limestone, dark brown, argillaceous, micro-to-crypto-crystalline, dense, stylolitic - trace coarse crystalline patches.

10" Dolomite, medium grey, very silty, hard, dense and massive, crypto-to-micro-crystalline; few argillaceous and micaceous partings. One fine vertical stylolite runs the length of the interval.

4' Limestone, medium brown, crypto-to-micro-crystalline, rare coarse patches, dense, tight, massive. Small pyrite patches are disseminated throughout. Fine stylolitic argillaceous partings are at random angles and do not indicate bedding. There is no visible dip.

Oil and Gas indications - nil.

Core No. 17: 5165' - 5174' recovered 9'

Coring Times: 20,21,21,21,19,17,17,18,16 min./ft.

7'2" Shale rusty red-brown, silty, trace calcareous, very micaceous, hard, brittle, small patches of white crystalline gypsum scattered throughout. No distinct bedding visible but core breaks indicating a generally flat dip. Locally small very silty patches and zones of small contorted compaction structures. Bottom  $\frac{1}{2}$ " grades from brown to dark grey, overlying the limestone.

1'10" Limestone, light grey, very dolomitic, very slightly silty, algal, dense, tight and massive, micro to very fine crystalline; granular. Algal growth is indicated by fine light grey to black concentric lamellar structures throughout, undulating in vertical section and a ragged concentric pattern in plan section resembling grain of knotty piece of wood. Strong mineral fluorescence is common.

Dip - roughly horizontal.

Oil and Gas indications - nil.

Core No. 18: 5449' - 5456' recovered 7'

Coring Times: 40,47,40,41,45,35,40

Shale, dark rusty brown, silty, generally very micaceous. Gypsum occurs as fine nodules and patches to large irregular streaks, is white to bluish, fine to medium crystalline, scattered throughout core. Few thin light grey streaks, very dolomitic, grading to Dolomite, silty, and apparently slightly siliceous in part. Bedding, as indicated by dolomitic streaks, appears flat.

Oil and Gas indications - nil.

Core No. 19: 5723' - 5728' recovered 3'6"

Coring Times: 31,26,27,25,29 min./ft.

18" Shale, dark rusty red-brown, very silty, grading to Siltstone in fine laminations, extremely micaceous, very slightly calcareous, hard and brittle. Thin greyish dolomitic and micaceous streaks show fine wavy, but flat dip. Locally very gypsiferous, gypsum occurs as small pellet-like aggregates, large irregular patches and as well crystallized fracture filling in a few fine fractures.

6" Dolomite, medium grey and brown, silty, slightly argillaceous and locally micaceous, crypto-micro-crystalline, dense, partly fine laminated with black and dark grey argillaceous, silty streaks. Several thin wavy and contorted red silty Shale streaks throughout, indicates deformation during compaction.

18" Shale/Siltstone as above, slightly gypsiferous.



Dip - flat,  $+5\frac{1}{2}^{\circ}$  hole deviation.

Oil and Gas indications - nil.

Core No. 20: 6062' - 6066' recovered 4'

Coring Times: 76,67,98,78 min./ft.

6" Dolomite, dark brown, argillaceous, crypto-micro-crystalline with coarse crystalline patches, dense and tight. Fine concentric laminations suggest algal growth. Small amount of white crystalline gypsum scattered throughout in small patches.

3' Dolomite, dark grey, very argillaceous, slightly silty, crypto-to-micro-crystalline, dense and tight with thin very dark grey Shale streaks; also, thin streaks of dark brown Dolomite as in top 6". White crystalline gypsum occurs as streaks and inclusions of varying sizes.

6" Shale, very dark green, brittle, splintery, with traces of brown crystalline gypsum in small patches throughout.

Dip  $\pm 5^{\circ}$

Oil and Gas indications - nil.

Core No. 21: 6096' - 6101' recovered 3'2"

Coring Times: 25,40,60,81,55 min./ft.

7" Dolomite and Shale interbedded and intergrading. Dolomite is medium dark grey-green, crypto-micro-crystalline, argillaceous hard and dense; Shale is dark grey-green, dolomitic, hard and brittle. Gypsum occurs as white sugary inclusions and fine infillings in very fine fractures and along minor slickensiding.

1'5" Dolomite, medium dark brown, slightly argillaceous, crypto-crystalline, dense, locally slightly siliceous, small amounts of white gypsum inclusions - locally faint bituminous odour on fresh surface.

1'2" Dolomite, dark greyish green, argillaceous, very slightly micaceous and scattered gypsum inclusions. Locally fine strongly contorted laminations suggest algal growth.

Dip  $\pm 0^{\circ}$

Oil and Gas indications - nil - except for traces of bituminous odour.

Core No. 22: 6116' - 6119' recovered 3'

Coring Times: 32,32,24 min./ft.

1' Dolomite, laminations and thin beds, wavy streaks of very dark grey-green argillaceous. Dolomite and dark brown crypto-crystalline, almost lithic Dolomite, all very hard and tight; some streaks shaly, very fine horizontal fracture 7" from top with slight bleeding of brown oil, yellow fluorescence.

8" Dolomite, dark brown, crypto-to- slightly micro-crystalline, argillaceous, overall very dense and tight but rare very fine vugs, irregular very dark grey and brown wavy, distorted laminations suggest possible algal growth; rare small coarse crystalline patches. Few very fine fractures at random angles from nearly horizontal to nearly vertical, with oil bleeding from fractures. Oil is dark brown, with a strong odour, fluoresces brilliant yellow. Oil is estimated at  $\pm 40^{\circ}$  A.P.I. gravity. Large light tan irregular Chert inclusions at base of interval.

1'4" Dolomite, argillaceous, dark brownish grey, crypto-to fine crystalline, hard, dense and tight; few small patches of fine crystalline gypsum, massive no bedding visible. Bedding of core is indistinct but the cores break generally horizontal.

Oil and Gas indications - a maximum of 2 units of gas was recorded during coring and shows of oil as listed above.

Core No. 23: 6119' - 6137' recovered 16'

6119' - 6122'2" Dolomite, argillaceous, very dark green-grey, crypto-to-micro-crystalline dense; medium brown micro-crystalline, sub-lithographic. Scattered patches of brown to white crystalline gypsum; black shaly stringers and few stylolitic partings. Gypsum also occurs as fracture filling. Bedding is wavy and indistinct, partly brecciated indicating contemporaneous deformation.

6122'2" - 6128'5" - This interval was sealed for analysis shortly after pulling and was therefore not examined in detail. Dolomite, argillaceous, medium brown to medium grey, crypto-to-micro-crystalline, few black shaly laminations, often wavy suggesting algal growth. Porosity - few very fine vugs visible, apparent very poor intercrystalline porosity or micro-regular porosity; also, few fine fractures at random angles. Entire interval bleeding dark brown oil which fluoresces brilliant yellow and has a strong petroliferous odour.

6128'5" - 6129'5" Dolomite, argillaceous, very dark grey-green and brown, crypto-crystalline, dense with black argillaceous streaks grading into shale below.

6129'5" - 6131'3" Shale, very dark green and very dark grey, micro-micaceous, hard and brittle, slightly dolomitic, grading with Dolomite above.

6131'3" - 6134'3" Dolomite, argillaceous, very dark greenish grey and brown, crypto-crystalline, dense, no distinct bedding, often irregular and wavy. Appears partly clastic with zones of fine fragments possibly shell debris. Small brown gypsum inclusions; lower part of interval is partly brecciated due to slumping or other movement. Thin black shaly partings at base.

6134'3" - 6135' Dolomite, medium brown, crypto-to-micro-crystalline, very slightly siliceous, hard and dense with fine black argillaceous streaks and partings; few patches of white gypsum. Fine irregular banding appears partly cross-bedded.

Dip - roughly horizontal.

Oil and Gas indications - as listed above.

Core No. 24: 6443' - 6446' recovered 2'8"

Coring Times: 36,33,38 min./ft.

10" Dolomite, light grey, green and red mottled, slightly argillaceous and calcareous, crypto-crystalline, dense; no bedding visible, core has a partly conglomeratic-brecciated appearance with rounded to angular fragments of one colour embedded in the other, probably due to contemporaneous deformation, slumping, etc.. Few black stylolitic partings and few small patches of pink gypsum.

1'10" Dolomite, light, medium green, brown, light grey, crypto-to-micro-crystalline, locally siliceous, dense and tight. A thin streak containing angular fragments of reddish chert occurs at top of the interval. No good bedding is evident; local fine contorted laminations suggest possible algal growth. Core commonly is shattered, brecciated as in above interval. Many patches of white to pink gypsum are scattered throughout. Bottom 1 foot of interval comprises 40% gypsum, white to bluish, sparry - becoming partly anhydrite. Slight fetid odour on fresh broken core.

Oil and Gas indications - nil.

Core No. 25: 6758' - 6764' recovered 5'3"

Coring Times: 14,11,18,16,16,19 min./ft.

30" Mudstone and Shale light grey, soft, massive, crumbly to platy, very calcareous, slightly silty, trace micaceous. Clear sparry gypsum crystals and patches disseminated throughout; some slickensiding is evident. Shaly cleavage indicates bedding at  $0^{\circ}$  -  $10^{\circ}$ .

33" Shale rusty red-brown, slightly silty, micromicaceous, brittle - small patches of pink crystalline gypsum scattered throughout. In part of interval core breaks in plates indicating bedding almost flat.

Oil and Gas indications - nil.

Core No. 26: 6876' - 6898' recovered 9'7"

Rock Salt (Halite), clear, transparent, partly slightly stained brownish, massive, extremely coarse crystalline, no bedding or structure is evident. Approximately 10% of Core consists of inclusions along Shale fractures, rusty red-brown, silty and very minor Dolomite grey, crypto-crystalline, dense, mottled, occurring as patchy, often feathery masses.

Oil and Gas indications - nil.

Core No. 27: 7305' - 7307' recovered 2'

Interbedded Siltstone and Sandstone; Siltstone rusty red-brown, very sandy, micaceous, calcareous, hard and dense; Sandstone, light brown, grey and white; fine to coarse-grained in fairly well-sorted streaks, sub-rounded to rounded, minor dark mineral grains. Cement is siliceous, also minor silty and calcareous; extremely hard, dense and abrasive.

Dip - flat, wavy in part.

Oil and Gas indications - nil.

Core No. 28: 7513' - 7518' recovered 2'5"

Coring Times: 28,22,20,23,24 min./ft.

Siltstone, dark rusty red-brown, ferruginous, argillaceous, micaceous, very sandy and quartzose, trace calcareous, very hard and brittle. Thin partings of red-brown and green Shale, fuchoid structures developed on some bedding planes. Frequent Sandstone laminations, very fine to granular, sub-rounded to rounded, poorly sorted, silty quartzose cement bedding is wavy partly lenticular, partly laminated, dip approximately flat.

Oil and Gas indications - nil.

Note: The interval of Core 28 has been adjusted five feet up to agree with pipe measurements taken after coring.

APPENDIX A (ii)

CORE ANALYSIS RESULTS

By Core Laboratories Inc.

# CORE LABORATORIES AUSTRALIA (VIC) LTD.

*Petroleum Reservoir Engineering*

BRISBANE, AUSTRALIA

October 14, 1963

G.P.O. BOX 664K  
CABLE: CORELAB  
PHONE: 55-1315

EXOIL (N.T.) PTY. LTD.,  
1st Floor, Perry House,  
Elizabeth & Albert Sts.,  
BRISBANE. QUEENSLAND.

Attention: Mr. Roger Planalp

SUBJECT: Core, Mud and Cuttings Analysis  
Alice No. 1 Well,  
Wildcat,  
Deep Well Station,  
Northern Territory, Australia.

Gentlemen :

A Core Laboratories Australia (Vic) Ltd. combination drill cuttings and mud analysis unit was present at the site of the subject well during drilling operations from surface to the total depth of 7518 feet. Using standard equipment plus a Programmed Hydrocarbon Detector (rapid sampling gas chromatograph) the drilling fluid was monitored continuously for hydrocarbon content and the drill cuttings were checked at regular intervals for gas and oil content and lithology. The results of these operations are shown on the accompanying Grapholog. A lithologic description of cores recovered is given on pages 3 through 10 and Core Analysis Results are reported on page 11.

## HYDROCARBON SHOWS:

Oil fluorescence was observed at several intervals. The first two; from 3505 to 3555 feet and from 3635 to 3660 feet, presented dull gold fluorescence due to black viscous asphaltic oil. Occasional blebs of oil could be observed on the surface of the cuttings as well as in their pores. A small amount of methane accompanied the higher of these two intervals; however, no gas could be extracted from the cuttings. A drill stem test from 3481 to 3530 feet recovered muddy fresh water (chloride = 300 ppm). Evaluation of electric logs indicated that this water probably came from a porous zone above that containing the fluorescence.

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October 14, 1963

The third and fourth fluorescent intervals extended from 6090 to 6095 feet and from 6110 to 6165 feet. Cores taken from these intervals had bright yellow fluorescence and bleeding oil was noted at various zones. Small amounts of gas accompanied the fluorescent zones. The gas was predominately methane with minor amounts of ethane, propane and butane. Moderate amounts of gas were extracted from cuttings at local intervals. Two drill stem tests of these zones yielded small amounts of drilling mud.

The fifth fluorescent interval extended from 6855 to 6870 feet. Pale to dull yellow fluorescence was observed in dolomite. The moderate amount of gas accompanying this fluorescent zone was predominately methane with lesser amounts of ethane, propane and butane. This thin dolomite zone occurred in a relatively thick, salt bed. No gas could be extracted from the small quantity of cuttings recovered from this zone. Drill stem tests yielded drilling fluid and salt water only.

CORES :

Samples of cores 22 and 23 were analyzed by conventional procedures. Oil saturations were very high; however, porosities and permeabilities were very low and the zone was considered non-productive. The retorted oil was clear and light brown with API gravity of 43°.

We sincerely appreciate the opportunity to have been of service and trust that the information furnished in the report and during drilling operations has assisted in the evaluation of this well.

Yours very truly,  
CORE LABORATORIES AUSTRALIA (VIC) LTD.



Joe B. McAdams  
Resident Manager

## CORE LABORATORIES, INC.

Petroleum Research Engineering

DALLAS TEXAS

Company EXOIL (N.T.) PTY.LTD.

Well ALICE NO.1

Field WILDCAT

XXXX N. TERRITORY XXXX AUSTRALIA

Location

Formation

Cores

Drilling Fluid

Elevation

Remarks

CONVENTIONAL

WATER BASE

Page

File

Date Report

Analyst

of

FL 152-2L

20 JAN 64

JBM

## CORE ANALYSIS RESULTS

Figures in parentheses refer to analytical remarks

SAMPLE NUMBER	DEPTH FEET	PERMEABILITY MILLIDARREYS		PORE VOLUME PERCENT	WATER SAT. % (107)		TOTAL WATER CORE	FORMABLE PRODUCTION	REMARKS
		FOR INITIAL	VERTICAL		% SOLVENT	% CORE			
1	6125.2	<0.1	-	3.2	1.3	40.2	40.2	(3)	
2	6125.8	0.1	-	8.7	3.2	36.7	8.2	(3)	
3	6126.2	0.1	-	6.5	1.9	29.8	14.2	(3)	
4	6126.8	<0.1	-	4.4	1.4	32.2	20.2	(3)	
5	6127.2	<0.1	-	3.2	1.3	39.6	28.4	(3)	
6	6117.0	<0.1	-	2.4	0.4	17.1	22.9	(3)	
7	6118.0	<0.1	-	2.1	0.4	18.4	39.0	(3)	
8	821.0	515.0	141.0	23.7	-	-	-	(3)	
9	1126.0	49.0	0.4	17.5	-	-	-	(3)	
10	1430.0	13.0	1.3	22.1	-	-	-	(3)	
11	1765.0	13.0	4.2	18.5	-	-	-	(3)	
12	1770.0	217.0	26.5	19.7	-	-	-	(3)	
13	2162.0	24.0	23.0	17.4	-	-	-	(3)	
14	2716.0	53.0	11.0	31.5	-	-	-	(3)	
15	2979.0	4.3	4.2	10.7	-	-	-	(3)	
16	3127.0	0.6	<0.1	5.3	-	-	-	(3)	
17	3583.0	0.1	0.1	10.1	-	-	-	(3)	
18	3585.0	0.1	<0.1	9.7	-	-	-	(3)	
19	6763.0	0.1	<0.1	17.1	-	-	-	(3)	
20	7306.0	0.1	<0.1	2.3	-	-	-	(3)	

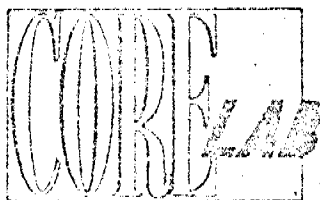
## NOTE

\* REFER TO ATTACHED LETTER

① INCOMPLETE CORE ANALYSIS - INTERPRETATION RESERVED

(3) INTERPRETATION AND ANALYSIS OF RESULTS

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CORE LABORATORIES, INC.

Petroleum Reservoir Engineering

COMPANY EXOIL N.L.

DATE ON 22/8/63

FILE NO. 152-2L

WELL ALION No. 1

DATE OFF 22/8/63

ENGRS. JEM &amp; AGR

FIELD WILDCAT

FORMATION

ELEV. 1753.4 KB

COUNTY STATE N.T.

DRLG. FLD.

CORES

LOCATION

REMARKS

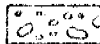
SAND



LIMESTONE



CONGLOMERATE



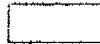
CHERT



SHALE



DOLOMITE



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## COMPLETION COREGRAPH

PERMEABILITY O—O

TOTAL WATER O—O

## TABULAR DATA and INTERPRETATION

POROSITY X—X

OIL SATURATION X—X

SAMPLE NUMBER	DEPTH FEET	PERM MD	Y-Score	MEDIA SATURATION % PORE SPACE		POROSITY X—X	OIL SATURATION X—X
				OIL	TOTAL WATER		
6	6117.0	<0.1	2.4	17.1	22.9		
7	6118.0	<0.1	2.1	18.4	39.0		
1	6125.2	<0.1	3.2	40.2	40.2		
2	6125.8	0.1	8.7	36.7	8.2		
3	6126.2	0.1	6.5	29.8	14.2		
4	6126.8	<0.1	4.4	32.2	20.2		
5	6127.2	<0.1	3.2	39.6	28.4		



APPENDIX B

PETROGRAPHIC DESCRIPTIONS OF CORES

By W.B. Bryan

ALICE NO. 1 WELLPETROGRAPHIC DESCRIPTIONS OF CORES

by W. B. Bryan

Core 1

527'      Calcareous lithic sandstone  
             (Red friable sandstone)

The sample is composed of well rounded sand grains (0.4 - 0.6 mm) in a matrix of calcite and angular quartz silt. The sand-sized material is composed of the following, in order of decreasing importance: quartz, quartzite or quartz siltstone, limestone and shale, microcline. Many of the grains have a reddish stain or coating, presumably iron oxide. An approximate modal estimate is as follows: quartz, 60%, as sand and silt-sized grains; lithic fragments and feldspar, 20%; calcite, 20%. Since some of the lithic fragments are limestone, the total carbonate content may be as high as 30%. Biotite, chlorite, and tourmaline are present in minor amounts.

Most of the quartz is strained and/or extensively fractured. Sorting is relatively poor. Porosity cannot be judged because there is considerable plucking in the section; however, some of the primary porosity has clearly been filled by calcite.

Core 2

826'      Calcareous sandstone  
             (Brown friable sandstone)

Angular to well rounded quartz grains (0.3 - 0.4 mm diameter) make up about 70% of the sample. Lithic fragments of shale and quartzite (7%), microcline (3%), and tourmaline (one grain) make up the rest of the sand fraction. The rest of the sample consists of carbonate cement (5%?) and pore space. The relatively high porosity evident in thin section is confirmed by the ready absorption of water by the hand specimen.

Core 3

1,125'      Calcareous sandstone  
             (Buff coloured friable sandstone)

This is nearly identical to the previous sample (Core 2) except that the average grain size is about 0.2 mm. Heavy accessory minerals include tourmaline and corundum, and there is a small amount of muscovite. The same comments as to porosity apply.

Core 4

1,431'      Sandstone

The sample is composed of sub-angular to well rounded quartz grains .2 - .3 mm in diameter. There is a small amount of microcline, shale and chert fragments. Bedding is expressed by a slight variation in grain size. Apatite is the only accessory mineral identified. Black specks

and interstitial black patches appear metallic and may be manganese oxide.

Porosity appears high.

Core 5

1,760' Calcareous sandstone  
(Reddish-brown friable sandstone)

Well rounded quartz grains 0.3 - 0.5 mm in diameter are loosely cemented by calcite. There is a small amount of silt-sized quartz. There is virtually no feldspar or lithic debris. Rutile (?) appears as a network of acicular crystals in one of the quartz grains. Tourmaline, apatite, and zircon are present.

Bedding is vaguely expressed by variation in grain size. Porosity appears to be fairly high.

1,763' Sandstone  
(White friable sandstone)

The sample is composed of sub-angular to well rounded quartz sand 0.2 - 0.3 mm in diameter. There are a few grains of feldspar and a small amount of calcite cement. Zircon and tourmaline occur as accessory minerals.

Porosity appears very high, although some of this may be due to plucking.

Core 6

2,155' Calcareous sandstone  
(Pinkish grey sandstone)

The sample is composed largely of quartz, well rounded but of irregular shape and low sphericity. Grain size is variable, from 0.1 to 0.4 mm. Microcline, plagioclase, and lithic fragments of chert and hornfels (?) make up about 2-3% of the sand fraction. Green tourmaline is conspicuous as pleochroic sand-sized grains. Apatite is also a conspicuous accessory mineral.

Calcite cement forms a matrix which fills most of the pore space and constitutes 20-30% of the rock. Many of the quartz grains are traversed by a network of fractures. These fractures are best developed in the larger grains and tend to be concentrated toward the centre of the grains.

2,161' Sandstone  
(Pink sandstone)

This sample is very similar in composition to the sandstone at 2,155' except that the grains are more closely packed, with welded or sutured boundaries. Some grains show development of secondary overgrowths. Average grain size is about 0.2 mm. Calcite forms about 5% of the sample, occurring as individual subhedral and anhedral grains similar in size to the quartz grains. Hematite coatings are present on some of the quartz. A few fragments of collophane are present.

Intergranular porosity appears low to moderate, consisting mainly of polygonal openings .02 - .03 mm in diameter between the quartz grains.

Core 7

2,713' Calcareous sandstone  
(Mottled pink and white sandstone)

Angular to sub-angular fine quartz sand (.05 - 0.1 mm) including a small amount of feldspar makes up about 60% of the sample. Subspherical quartz grains 0.1 - 0.5 mm in diameter are randomly scattered throughout the sample. These larger grains tend to have a well developed network of internal fractures, although a few are almost free of fracturing. These larger grains make up about 20% of the sample.

Calcite forms a very fine grained matrix averaging about 20% over the whole sample, though in detail the proportion of calcite varies from about 5% to nearly 50% in limey lenses and patches. These patches enclose representatives of all the clastic grains occurring elsewhere in the sample, and are gradational into more normal sandstone. This suggests that they are primary carbonate, precipitated along with the sand grains. Some of the enclosed sand grains are rimmed with radial carbonate overgrowths suggestive of an incipient oolite development. Bedding is vaguely delineated by variation in the sand-carbonate ratio.

Zircon, tourmaline, and leucoxene (?) are prominent accessory minerals. There are a few fragments of collophane, some of which appear to have a definite bone structure. Rutile (?) appears as minute acicular crystals in some of the quartz grains.

Porosity is low, due to the extensive calcite cement.

Core 8

2,978' Sandstone  
(Massive pink sandstone)

This is a nearly pure quartz sandstone with a very small amount of microcline. Grain size is varied from about 0.1 mm to 0.5 mm. Most of the grains are firmly compacted and interpenetrating, with some secondary overgrowths and a tendency toward sutured boundaries.

Accessory minerals include zircon and tourmaline. There are a few fragments of collophane. There are thick hematite coatings on some of the quartz grains. Rutile (?) is enclosed by some of the quartz.

Porosity is probably low due to compaction and overgrowths. However small (.01 - .02 mm) pores are abundant and are free of carbonate cement.

Core 9

Sandy glauconitic limestone (dolomitic)  
(Speckled grey-green limestone with grey limestone pebbles)  
(Thin section includes matrix and limestone pebble)

The speckled matrix is composed of glauconite pellets (30%), calcite (50%), and angular to sub-angular quartz sand (20%). The glauconite pellets are cryptocrystalline, coloured a bright green, and are elliptical or spherical in form, averaging about .5 mm in diameter. The carbonate

forms large anhedral crystals greater than 1.0 mm in diameter which enclose glauconite and quartz. It reacts only slightly with acid and takes a stain with difficulty. This suggests a high dolomite content. The sand grains average about 0.3 mm in diameter and are randomly distributed throughout the sample.

The limestone inclusion, or pebble, is much finer grained and enclosed silt-sized quartz, mica, and feldspar which are concentrated in bands and lenses. Glauconite is present only as a few silt-sized rounded fragments. There are several irregular patches of pyrite 1.5 - 3.0 mm in length.

A few fragments of collophane are present. These have a curved form and layered structure suggestive of shell fragments. The hand specimen contains a circular structure about 3 mm in diameter which appears to be the cross section of a crinoid stem.

#### Core 10

3,412'        Shale  
              (Black shale with silty partings)

Graded bedding units 1.0 - 2.0 mm thick show a gradual transition from quartz-muscovite-microcline silt to pure clay. The clay shows aggregate extinction parallel to the bedding. The clay makes up about 75% of the sample.

Minor constituents include chlorite and tourmaline.

3,414'        Silty limestone  
              (Grey limestone with shaly partings)

The sample is variable in composition, consisting of broken fragments of what is probably very fine grained calcareous limestone in a coarser matrix of angular quartz silt (with minor amounts of microcline) which is in turn suspended in fine grained carbonate.

The limestone inclusions are finely bedded and are composed mainly of calcite .01 mm in diameter. They are virtually free of silt.

The ratio of silt to carbonate in the coarser portion of the limestone is close to 1:1. Much of the carbonate has an incipient oolitic structure, growing radially or concentrically around quartz or coarser carbonate as a nucleus.

The average grain size of the silt is about .03 mm, of the carbonate about .01 mm. The carbonate stains readily and is probably calcite.

Minor constituents include tourmaline and muscovite.

#### Core 11

3,574'        Calcareous siltstone  
              (Grey siltstone with shaly partings)

Individual beds range in composition from shale to siltstone, the latter predominating. The silt is composed of the following minerals: Quartz, 60%; Microcline, 20%;

Muscovite, 5%; Calcite cement, 15%. The grains are angular to sub-angular, and secondary overgrowths are common on both quartz and feldspar. The carbonate is interstitial.

The shaly bands differ only in the much greater amount (about 50%) of calcareous clay matrix, the remainder being composed of silt-sized fragments of quartz, feldspar, and mica.

Dark wisps and patches of material in both lithologies are highly reflective and thus must be ferruginous clay and iron oxides.

3,586'        Calcareous sandstone  
              (Grey sandstone)

The principal mineral is quartz (75%) with minor amounts of microcline (10%), and calcite (15%). "Heavy" accessories include a distinctive blue-green tourmaline, pink apatite, and zircon. Acicular crystals in some quartz grains may be rutile.

Quartz occurs as sub-angular to moderately well rounded grains .2 - .8 mm in diameter. The largest grains are most perfectly rounded. There is a slight secondary overgrowth on some of the grains. Feldspar resembles the quartz in shape, but is restricted to the smaller sizes and lacks overgrowths.

Calcite occurs as tiny (.01 - .02 mm) rhombohedra along grain boundaries, and as coarser patches, lenses, and granules enclosed by the sandstone. Some of these are 2 - 3 mm in diameter and appear to be inclusions of silty limestone.

Porosity appears high, but this may be due in part to plucking of quartz and calcite during grinding of the thin section.

3,588'        Oolitic limestone (dolomitic)  
              (Oolitic grey limestone)

Oolites make up 70-80% of the rock. Crystalline calcite cement fills most of the interstitial spaces. There are a few small fragments of a biaxial positive mineral of low birefringence, this probably being gypsum. A trace of pyrite is present in the hand specimen.

The oolites are almost perfectly spherical, averaging about .8 mm in diameter. Most are cryptocrystalline in part, with a radial structure observable in polarized light. Fine concentric banding is commonly present. Carbonate rhombs .01 - .02 mm in diameter are scattered through the oolites. The coarser crystals tend to be concentrated toward the centres. Most have solid cores and no obvious nucleus; a few have a small fragment of gypsum (?) at the core. The oolites fail to take a stain and are virtually insoluble in dilute acid.

The interstitial carbonate is coarsely crystallized (.3 - .5 mm) and is readily stained and attacked by acid. Euhedral rhombs attached to the surface of the oolites and projecting into the interstitial spaces fail to stain or react.

The oolites and associated crystalline carbonate appear to be composed predominantly of dolomite, while the interstitial carbonate is largely calcite. There appears to be two generations of dolomite, the first forming the oolites; and the second, the coarser crystals growing on the surface of the oolites. The calcite may be a secondary mineral. The gypsum (?) is probably primary, as it appears in the centres of some of the oolites.

Core 12

3,886' Silty dolomite  
(Grey limestone with shaly partings)

The sample is composed primarily of tiny (.01 - .02 mm) subhedral rhombs of dolomite. Sub-angular silt-sized fragments composed of quartz with some microcline and muscovite are concentrated along bedding planes. A trace of green tourmaline is present in the silty beds. The silt constitutes about 15% of the sample. Patches and wisps of opaque material .02 - .03 mm in length are highly reflective and are probably iron oxide.

3,887' Oolitic limestone.  
(Dark grey massive limestone)

Calcite is the predominant mineral, composing both the oolites and the interstitial cement, as indicated by uniform staining. Some of the crystals are more than .5 mm in diameter, but most occur as discrete rhombs .1 - .2 mm in diameter in the centres of oolites or as fibrous, radiating crystals .05 - .08 mm long around the margins of oolites. Many of the oolites contain an intermediate zone of cryptocrystalline carbonate, and a few are made up of a single large, rounded crystal of calcite. The average diameter of the oolites is about .8 mm. Most are nearly spherical, but some are very much elongated.

Sand-sized (.1 - .8 mm) quartz grains are scattered through the sample, the largest being about the same size and shape as the oolites, and the smaller being less well rounded and more irregular in shape.

Spaces between oolites are completely filled by the radial outgrowths from the oolites. There is no visible porosity.

Opaque material is locally concentrated in the centres of oolites and along stylolitic partings. Some of it is distinctly metallic and brassy, probably pyrite.

3,889' Silty limestone  
(Grey mottled limestone with stylolitic partings).

Mineralogically, this sample is similar to that at 3,886', except that the carbonate is predominantly calcite. The silt is present as irregular lenses and patches in the carbonate. Grain size is less than .05 mm, except for a few coarser patches of calcite ranging up to 1 mm. There are scattered tiny grains of pyrite, and some leucoxene (?).

Core 14

4,192' Oolitic limestone.

Texturally this sample is very similar to that at

3,887'. Spherical and elliptical oolites averaging about .6 mm in diameter are distinctly outlined by a thin shell of cryptocrystalline calcite. Within the shell, calcite rhombs up to .1 - .2 mm are common, while the core of the oolite may be again composed of cryptocrystalline calcite. In a few cases a single calcite grain fills the whole oolite. Quartz grains form the core of a few of the oolites. Radial calcite overgrowths are less pronounced than at 3,887', the spaces between oolites being primarily filled with a fine mosaic of calcite averaging about .02 mm grain diameter.

Anhydrite occurs as porphyroblastic patches up to 2 mm in diameter. These contain relict traces of oolite outlines and are clearly a secondary replacement of the oolitic limestone. The anhydrite makes up 10-15% of the sample.

A stylolitic parting passes through the centre of the thin section. Oolites on either side of the stylolite are abruptly truncated by it. This appears to be excellent evidence of the pressure-solution origin of stylolites.

A final feature of interest is the nodules of pellets of fine-grained oolitic limestone which are scattered through the sample. These may be several times larger than the oolites, and some contain a considerable amount of silt-sized quartz.

#### Core 15

4,525' Silty dolomite  
(Grey-green dolomite with shaly partings)

The principal minerals are dolomite, as subhedral rhombs and irregular grains .05 - .01 mm in diameter. Next in importance is a dark clay matrix which is distributed in patches from .1 to 1.0 mm in diameter. Silt-sized quartz and mica make up about 10% of the sample. The quartz is angular to sub-angular, and the mica flakes parallel the vaguely defined bedding.

Very weak reaction with acid indicates a small amount of calcite.

Porosity appears very low, due to the fine clay matrix, and the disseminated nature of the coarser clastics.

4,526' Oolitic (?) limestone with anhydrite

Calcite is the predominant mineral, as indicated by uniform staining. The rock is made up of numerous cryptocrystalline carbonate pellets or oolites about .05 mm in diameter, surrounded by radial crystals of calcite (or aragonite?) .02 - .03 mm in length. These coalesce, filling most of the space between pellets, and the remaining space is filled with a mosaic of fine calcite (.01 - .02 mm in diameter.) Angular silt-sized grains of quartz and feldspar are scattered through the rock, to the extent of 1-2% of the volume. Anhydrite occurs as large (2 - 3 mm length) subhedral porphyroblasts containing relict limestone textures (pellets, quartz, carbonate rhombs) and are clearly secondary. They constitute 4 - 5% of the rock.



Porosity appears very low.

Core 16

4,846' Silty limestone  
(Mottled brown limestone)

Very fine grained calcite (.02 mm) is the predominant mineral. Localized veins and patches of coarser calcite (.1 - .3 mm) are common. Silt-sized quartz, white mica, and some feldspar are scattered through the limestone and are locally concentrated in irregular patches 2 - 3 mm in diameter. The mica is randomly oriented and there is no suggestion of bedding.

Pyrite occurs as irregular patches and subhedral crystals up to 1 mm in longest dimension. Uniform staining of the carbonate indicates the absence of dolomite. No sulphate appears in the thin section.

Porosity appears low.

Core 17

5,166' Ferruginous siltstone  
(Dark reddish-brown micaceous siltstone)

Angular to sub-angular quartz less than .03 mm in diameter is the predominant mineral. White mica is abundant, and there is a small amount of chlorite and green tourmaline. There seems to be very little clay. Red iron oxide is the principal cementing agent. Tiny dark granules are highly reflective and are probably iron oxide.

Bedding is distinct but contorted.

5,173' Dolomite  
(Buff coloured bedded dolomite)

Dolomite occurs as euhedral to subhedral rhombs .02 - .03 mm in diameter and also as cryptocrystalline matrix material. Cryptocrystalline pellets are present, about .1 - .2 mm in diameter. Anhydrite makes up about 8% of the sample and is present as patches .1 - .2 mm in diameter interstitial to the dolomite rhombs. Staining indicates that calcite is present only as sparsely disseminated patches interstitial to the dolomite.

Bedding is extremely contorted and indistinct. Primary porosity was probably high but is considerably reduced by anhydrite infilling. There is little or no evidence of actual replacement of carbonate by anhydrite in this sample.

Core 18

5,451' Argillaceous siltstone  
(Reddish-brown argillite with green inclusions)

The sample is composed of about 50% silt-sized material, composed mainly of angular quartz with minor amounts of mica and feldspar. The matrix is a red ferruginous clay. There are also lenses and patches of grey clay .2 - 1.0 mm in diameter. Bedding is vaguely defined by oriented mica flakes and elongated clay lenses.

Core 19

5,726'      Calcareous argillite

The sample is composed of about 20% silt-sized quartz, chlorite, and mica set in a matrix of carbonate and clay. The matrix is moderately reactive with dilute acid, suggesting a dolomitic calcite. The ratio of carbonate to clay is difficult to estimate, but they appear to be about equal in amount. There is about 1% of a minute ( $< .01\text{mm}$ ) clear mineral containing a brown zone and a clear outer zone. This may be iron-stained quartz or feldspar with a secondary overgrowth.

Bedding is expressed by linear darkening of the clay by iron oxide. The iron content, however, appears to be much lower than in the sample at 5,451'.

Core 20

6,062'      Dolomitic limestone with anhydrite  
(Brown limestone with salt-covered fracture)

The sample is composed almost entirely of fine-grained (.01 - .02 mm) calcite and dolomite. Dark, non-reflective material is concentrated in stylolites along one end of the sample. It is probably bituminous. There are a few scattered silt-sized grains of quartz. Bedding is expressed by slight variations in grain size. The bedding is displaced about .5 mm by several oblique micro-faults.

Anhydrite has replaced the calcite along bedding planes and fractures. It forms individual porphyroblasts up to 2 mm in length. The salt-covered fractures in the hand specimen parallel the micro-faults in the thin section. The salt is normal anhydrite, with  $B = 1.576$ ,  $L = 1.570$ .

Porosity is difficult to assess, since there is some plucking in the thin section. It is probably low due to infilling by anhydrite. The importance of the fracturing and stylolitic parting cannot be assessed from a small sample.

The sample takes a stain only with difficulty, suggesting a high dolomite content. Because of the very fine grain size it is not possible to distinguish the two carbonates accurately.

A small sample dissolved in HCl left a bituminous residue in the beaker.

6,064'      Silty dolomite  
(Grey brittle dolomite)

Most of the sample is extremely fine-grained, almost cryptocrystalline. It is slowly attacked by cold, dilute acid, indicating that most of this material is carbonate, probably calcite in part. About 20% of the sample is composed of silt-sized material, most of this being angular quartz with some mica. The silt is concentrated along bedding planes, some of which show graded bedding.

Anhydrite makes up about 15% of the sample. It occurs as tabular crystals up to .2 mm in length. Some

of these are in lenses or rounded clusters .3 - 2.0 mm in diameter; the rest are scattered through the rock. The habit of the crystals is that of gypsum. This was probably a primary precipitate of gypsum which has been dehydrated.

Core 21

6,097' Dolomitic limestone with anhydrite  
(Mottled brown limestone with anhydrite crystals)

The sample is composed of almost equal amounts of very fine grained carbonate and porphyroblastic anhydrite. The carbonate is mainly calcite as indicated by staining, and occurs as sub-hedral to anhedral crystals .01 - .02 mm in diameter. Dolomite occurs as larger rhombs .05 - .06 mm in diameter, associated with the anhydrite. The anhydrite porphyroblasts average 2 - 3 mm in their longer dimension and make up at least 50% of the sample. The anhydrite crystals are extremely irregular in form and appear to have developed initially along porous zones in the limestone, although they have grown subsequently by replacement of calcite.

The sample is permeated with a brownish stain which is evidently a bituminous substance.

Preliminary Report on Limestones in the Interval  
3,588' - 6,097'

A brief examination has been made of thin sections from all cores between the footages indicated. Limestone and dolomite are the predominant lithologies. Reports on individual samples will be submitted as soon as possible. The following summary outlines the most important features bearing upon the environment of deposition.

5,173' - 6,097': These samples are dominantly dolomite, with varying amounts of anhydrite and gypsum, the sulphates being especially prominent at 6,097'. The carbonate is very fine-grained and very pure. There is no evidence of organic debris of any type.

4,192' - 5,173': These samples are composed largely of calcite, in the form of fine-grained pellets, oolites, and interstitial cement. Porphyroblasts of secondary (?) anhydrite are sparingly present. Oolites are best developed at 4,192'. The cores of the oolites are relatively insoluble and do not take a stain, and thus must be dolomitic. A small amount of pyrite is present at 4,846'. No organic material is in evidence.

3,588' - 4,192': These samples are dominantly calcite, except that very fine-grained dolomite occurs at 3,886'. Oolites are prominently developed at 3,588', and oolites or pelletal deposition is evident at 3,887' and 3,889'. Small amounts of quartz, mica and clay occur in these samples, and there are also small amounts of anhydrite and gypsum (?). No organic structures are present.

It does not appear that any firm conclusion can be drawn from these samples as to proximity to a reef. The lack of any fossil fragments and the suggestion of a predominantly chemical deposition of the carbonate can be related to a shallow shelf environment. Oolites

may form in reef lagoons, as in the Bahamas or may be absent, as in the case of the Great Barrier Reef. The sulphates appear primary at least in part, and suggest deposition in a restricted lagoon, but there is no direct evidence that this restriction was caused by a reef. The overall sequence suggests a gradual transition from a shallow evaporite basin to an open shelf environment.

Core 21 (Contd.)

6,099'      Argillaceous limestone with anhydrite  
              (Grey massive dolomite limestone)

The sample is composed predominantly of very fine grained, almost cryptocrystalline carbonate and clay. Silt-sized angular quartz and muscovite are scattered through the fine matrix and total possibly 10% of the rock. Anhydrite is present as minute prismatic crystals .02 - .05 mm in length. These are locally concentrated into feathery aggregates up to 1 mm in diameter.

A coarser grained lens about 2 mm in diameter contains pellets of carbonate .1 - .2 mm in diameter, tabular anhydrite crystals .05 - .1 mm in length, and a cryptocrystalline carbonate matrix. A network of fractures traverses the sample and these appear to have localized dolomitization of the carbonate matrix. Staining indicates that calcite is the principal carbonate except within .03 mm of the centres of these fractures. The exact proportions of clay, calcite, dolomite, and anhydrite cannot be determined because of the very fine grain size.

Porosity appears low.

Core 22

6,118'      Argillaceous limestone with anhydrite.  
              (Grey argillaceous limestone)

The sample is composed of about 50% anhydrite and 50% clay silt, and cryptocrystalline carbonate. The anhydrite occurs as fibrous crystals .1 - .2 mm in length and as feathery aggregates and patches up to 2.0 mm in diameter. Most of the crystals have the optical properties of anhydrite - a few have low birefringence and inclined extinction typical of gypsum.

The carbonate is probably calcite in part as it reacts with the dilute acid. It is too fine grained for staining to be effective. The clay content is also in doubt, though it is sufficient to make the fine matrix nearly opaque in some areas. Bedding is clearly defined by linear variation in opacity and by alignment of anhydrite crystals. Swirls and dislocations of the bedding are common, especially around anhydrite aggregates.

The silt consists of very fine quartz and some mica, probably equalling less than 10% of the sample by volume.

The sulphate is evidently primary, due to lack of

porphyroblastic development or appreciable development along veins, and its general conformance in size and orientation with other clastic material in the sample. The fibrous habit suggests that it was originally gypsum, although fibrous "primary" anhydrite is not unknown.

Core 23

6,122' Dolomitic limestone with anhydrite  
(Brown limestone with bituminous stylolitic parting)

The sample is composed of very fine grained carbonate with streaks and patches of interstitial bituminous material. Anhydrite occurs along veins and bedding planes and as irregular porphyroblastic crystals up to 2 mm long. It constitutes 10-15% of the sample.

The carbonate appears to be about 70% calcite as indicated by staining. Dolomite occurs as isolated anhedral crystals disseminated through the limestone. It is not obviously associated with the anhydrite. Most of the carbonate is almost cryptocrystalline. Local coarsening of grain size to .02 - .1 mm is associated with vuggy openings .03 - .05 mm in diameter. Anhydrite often encloses similar relatively coarse crystals and has probably been introduced in vuggy areas. Porosity is fairly low due to the sealing effect of the anhydrite.

A small sample dissolved in acid leaves an oily residue with a petroliferous odour. The bituminous material is concentrated along stylolitic partings.

6,130' Shale  
(Grey argillite or shale with anhydrite)

The sample is composed mainly of cryptocrystalline brown clay with an aggregate extinction parallel to the bedding. There are scattered silt-sized quartz fragments, and there are streaks and patches of a colourless, very fine grained mineral which could be anhydrite. These patches are elongated parallel to the bedding. Pyrite occurs as a porphyroblastic grain 1.0 mm in length replacing part of one of these elongated white patches. There is a trace of non-reflective brown material, probably organic.

This sample appears to represent mildly reducing, slightly restricted conditions.

Core 24

6,445' Limestone with anhydrite  
(Bluish-grey limestone with pink anhydrite nodules)

The sample consists of cryptocrystalline carbonate matrix containing disseminated minute (<.01 mm) crystals of anhydrite, and coarser grained (>.1 mm) swirls, streaks and patches of anhydrite crystals. Some of the patches exceed 4.0 mm in maximum diameter. A small amount of silt-sized quartz is disseminated through the sample. The coarser silt grains are associated with the coarser anhydrite crystals.

Staining indicates that the carbonate is almost entirely calcite. No gypsum was detected.

Bedding is clearly defined by slight variation in grain size and composition. Some of it appears graded, with coarser anhydrite followed by finer anhydrite and finally by cryptocrystalline calcite.

Porosity is probably low, due to the very fine grain size and lack of visible pore space or vugs.

Core 25

6,760' Silty argillaceous limestone  
(Light grey argillaceous limestone)

The sample is composed of cryptocrystalline calcite, clay, and angular quartz-muscovite silt in approximately equal proportions. The silt tends to be concentrated in patches .5 - 1.0 mm in diameter. Some of these are bedded and may represent lithic fragments of siltstone. The clay-carbonate matrix is almost opaque. Locally it has been replaced by irregular clear cherty patches which enclose quartz silt and a few small flakes of mica. A few dolomite rhombs are also enclosed by the chert. Some of the "chert" granules have high birefringence and may be very fine grained dolomite, as they do not take a stain.

Anhydrite appears to fracture surfaces in the hand specimen but does not appear in thin section.

6,762' Silty argillite (calcareous)  
(Calcareous red argillite)

A red argillaceous matrix encloses angular to sub-angular quartz, microcline, and muscovite silt. A few rounded grains of quartz .2 - .5 mm are also present. The silt makes up possibly 25% of the sample, with quartz being the principal mineral. Subhedral to anhedral carbonate grains .05 - .08 mm in diameter make up about 5% of the rock. Very fine carbonate may also be mixed with the red clay matrix. Reaction with acid suggests that the carbonate is calcite. Staining is not effective because of the strong red colour of the sample.

There is no clearly defined bedding evident in the thin section, although swirls and patches of varying proportions of silt and clay are visible.

Anhydrite appears along fractures in the thin section and hand specimen. There are authigenic overgrowths on the silt-sized quartz and microcline.

Core 26

6,890' Halite with argillaceous inclusions.

The salt is halite, with  $N = 1.544 \pm .002$ . The argillaceous material consists of a cryptocrystalline brown matrix with angular silt-sized quartz grains, some mica, and a few tiny flakes of anhydrite.

Core 27

7,305' Ferruginous siltstone

Angular to sub-angular quartz is the predominant

mineral, with smaller amounts of microcline, and mica. A ferruginous clay matrix makes up about 10% of the sample. The clay is concentrated in discontinuous and slightly disoriented beds and patches. Mica tends to be strongly oriented parallel to the bedding. A few nearly spherical quartz sand grains .25 - .50 mm in diameter are scattered through the sample.

Chlorite, biotite, and apatite can be recognized as minor constituents.

Core 28

7,518          Calcareous siltstone

The sample is about 80% silt and 20% carbonate. The silt is predominantly angular quartz, with white mica, biotite, chlorite, and microcline in decreasing order of prominence. The micas total about 10% of the rock and are strongly aligned, providing the main expression of the bedding. Tourmaline and apatite are present in accessory amounts.

The carbonate does not react with acid and thus must be dolomite. Ferruginous clay is present only in very minor amounts, probably less than 5%.