

***Routine Core Analysis***  
***Well Thylacine #1***  
***Offshore***  
***Otway Basin***  
***Australia***

Prepared for  
**Woodside Energy Ltd.**

September 2001

File: PRP-01025

Rock Properties  
Core Laboratories  
Perth  
Australia

11<sup>th</sup> September 2001

**Woodside Energy Ltd**

1 Adelaide Tce  
PERTH WA 6000

**Attention : Mr. J. Kelly**

Subject : Routine Core Analysis  
Well : Thylacine #1  
File : PRP-01025

Dear Sir,

Presented herein is the final report of a routine core analysis study conducted on the single core and MSCT samples from the above well that arrived at our laboratory in late May 2001.

We appreciate the opportunity to present this service to Woodside Energy Ltd. Please contact us should you require any further information or assistance.

Yours sincerely,

**Core Laboratories Australia Pty Ltd**

Darryl Beer  
Senior Core Analyst

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## **SUMMARY**

Core Laboratories Australia Pty Ltd (Core Lab) conducted a routine core analysis study on a single core and twelve MSCT samples from Thylacine #1 on behalf of Woodside Energy Ltd. (Woodside). A total of ninety-eight horizontal and thirty-one vertical plugs were taken from the core, the porosities and permeabilities for which were measured at ambient and overburden pressures, as were the MSCT samples. Horizontal plug sample porosities, at overburden, range from 4.2 to 22.9%, whilst overburden permeabilities ( $K_{inf}$ ) range from less than 0.001 to 13200mD. The mean values are 15.3% and 527mD, respectively. Grain density values range from 2.641 to 3.154g/cc, with a mean value of 2.699g/cc. The high grain density values appear to be largely attributed to the presence of siderite.

The porosity and permeability cross-plot shows a reasonable trend of permeability increasing with porosity. There are two groups beginning to form, a lower (less than 10mD) and higher permeability (greater than 10mD), with the latter group having a greater spread of data points than the lower permeability range. The MSCT samples have slightly higher porosities on average for the same permeability than the plugs.

Cross-plots were made using data generated from horizontal versus corresponding vertical plugs. Deviation from the 1:1 line in the porosity and grain density plots generally indicates lithology variation between the horizontal plugs and their vertical counterparts. When studying the permeability plot, and eliminating the lithological variations indicated by the porosity and grain density data, deviations from the 1:1 line will generally reflect structural features such as bedding and laminations – that is, genuine barriers to vertical flow in the reservoir. In the case of Thylacine #1, the primary cause of variation between horizontal and vertical permeabilities is, indeed, bedding.

On the Integrated Corelog the surface core gamma compares well with the profile permeametry data as well as the plug data. Where peaks in the grain density data correspond with troughs in permeability and porosity data appears to be indicative of the presence of siderite.

## **INTRODUCTION**

The aluminium core barrels were delivered to Core Lab's premises on the 23<sup>rd</sup> May in two wooden boxes. The MSCT samples arrived on the 25<sup>th</sup> May.

A preliminary core analysis program was received from Woodside on the 23<sup>rd</sup> May. Services performed and presented in the report include:

- Total surface gamma
- Profile permeametry on slabbed core
- Core photography on slabbed core and MSCT samples - white light (prints and CD-Rom)
- Permeability, porosity (at ambient and overburden) and grain density measurements on plugs, MSCT's, and full diameter samples

The report data for the above services is presented digitally with the core photographs on the CD-Rom included with this report. On the completion of analyses, the MSCT samples were forwarded to Reservoir Solutions Ltd as requested by Woodside.

## **INVENTORY**

| Core No. | Depth Range (m)   | Core Length (m) |
|----------|-------------------|-----------------|
| 1        | 2165.00 – 2200.63 | 35.63           |
| Total    |                   | 35.63           |

### MSCT's

| Sample No. | Depth (m) | Sample No. | Depth (m) | Sample No. | Depth (m) |
|------------|-----------|------------|-----------|------------|-----------|
| M1         | 2050.0    | M6         | 2092.2    | M11*       | 2153.0    |
| M2         | 2053.0    | M7         | 2094.0    | M12        | 2165.9    |
| M3         | 2055.0    | M8         | 2133.0    | M13        | 2230.0    |
| M4         | 2066.3    | M9         | 2139.1    |            |           |
| M5         | 2076.5    | M10        | 2143.6    |            |           |

\* No recovery

## LABORATORY PROCEDURES

### Initial Inventory

The core barrels, each approximately one metre in length, arrived in two wooden boxes. All barrels were unloaded and laid out in order. The barrel depths were recorded on an in-house inventory and checked against the supplied manifest.

The MSCT samples were unpacked from their box, and the samples numbers and depths noted.

### Surface Core Gamma

The core was logged while still in the core barrels. A zero base-line was established, and a standard calibration tube logged prior to running the core.

During the logging of the core, one observer verified that each barrel passing the detector was in its correct sequence and orientation, whilst one person loaded, and one person offloaded the barrels. As each barrel cleared the detector it was replaced in sequence on the lay out benches ready for the core to be unloaded. The preliminary digitised gamma trace was sent by e-mail to Woodside on the 24<sup>th</sup> May.

The complete core gamma log sequence is presented in this report on the Integrated Corelog.

## **Laying Out and Marking**

Since the core barrels were gypsum injected, two longitudinal cuts were made approximately 180° apart. The top section of each barrel was then carefully removed and the core unloaded on the lay-out trays. After the core was laid out, the pieces were fitted together and cleaned of drilling fluids. A few core sections were crushed and were left in the barrels to preserve their shape. These sections were from 2181.0 to 2182.0m, 2185.1 to 2185.3m, and 2187.2 to 2188.6m. Core depths, a continuous slabbing line, and orientation arrows pointing to the base were marked on the core.

Woodside selected six samples which were sent to Reservoir Solutions Ltd for scanning electron microscopy.

## **Full Diameter Sampling**

Several sections of core were selected in conglomerate zones for full diameter sampling to undergo porosity, permeability and grain density measurements. These sections were trimmed using a brine solution, and marked with sample number, direction arrows and depths, before going for cleaning as per the *Sample Preparation* section below. Seven samples were initially selected, however sample FD1 was too fractured to provide a sample of reasonable length.

## **Core Slabbing**

The request for core slabbing required the core to be cut into one-third, two-third sections. The one-third section was then to be cut in half for the state and federal government storage agencies.

The core was slabbed, using a KCl brine solution as lubricant, to show the maximum dip of any bedding features. After slabbing, the cut faces of both sections were washed free of fines using the solution, and the depths and orientation arrows were remarked on all core sections. The two-third section was left to surface dry for profile permeametry.

## **Core Description**

Peter Arditto of Sedstrat Pty Ltd conducted a core description on the slabbed core, the results of which are presented in a separate report. A brief lithological (hand specimen) description was conducted on the MSCT samples by Patrick Clews of Core Lab, and is presented in the appendix of this report.

## **Profile Permeametry**

Profile permeametry was conducted on the cut face of the two-third core section using the PDPK™300 profile permeameter. Measurements were made approximately every ten centimetres. A total of 361 point measurements were made, and the preliminary results sent to Woodside on the 1<sup>st</sup> June. The final permeametry data is presented in tabular form on pages 6 to 14, and graphically on the Integrated Corelog.

## **Core Photography**

### **i) Ultra-violet (UV) Light**

UV light photography was not conducted, as there was no fluorescence observed in the core.

### **ii) White Light**

White light photography was performed in both large (four metres per frame) and small (25cm per frame) formats. The core was surface wet in both formats to give better detail. White light photography was also performed on all MSCT samples.

A CD-Rom with preliminary large format photographs was sent to Woodside and Origin Energy (Origin) on the 25<sup>th</sup> June. A final set of A4 prints of the large format photographs and a CD-Rom, containing both the large and small format images, are included with this report. The large format white light prints and images also contain the grain density, and ambient porosity and permeability data for the plug samples.

## **Sample Preparation**

Horizontal plug sample points were marked at approximately every thirty centimetres, and vertical plug sample points were selected at approximately every third horizontal plug point.

Once identified, 1½ inch diameter core plugs were drilled using a brine solution. A few sample locations required 1 inch diameter plugs be obtained due to insufficient suitable material to obtain a 1½ inch diameter plug. After drilling, the core plugs were trimmed and the ends placed in labelled snap-lock plastic bags for possible future analysis. The samples were washed of fines (using the same brine solution), numbered, and their respective plug holes in the core identified with numbered markers. A total of ninety-eight horizontal and thirty-one vertical plugs were drilled from the core.

Sample 49 required lead sleeving because of its friable nature. Lead sleeving involved wrapping the plug in lead foil with one fine and one coarse screen at each end of the sample to allow analyses to be conducted on the sample. It was then put into a core holder and pressured to about 800psi to seal the lead around the sample. The sample was removed from the core holder and its number engraved on the lead foil.

The plugs, MSCT's and full diameter samples were placed in hot refluxing methanol to remove the salt residue in the pore spaces. Complete salt removal was indicated by the methanol, in which the samples were immersed, producing a negative reaction to silver nitrate.

When cleaned of salts the samples were removed from the soxhlet, air-dried to expel the excess methanol and hot oven dried at 90°C overnight. The samples were then removed from the oven, and placed in desiccators to cool to room temperature.

### **Grain Volume and Grain Density**

The weight, diameter and length of all samples were measured before they were processed through the Ultrapore™ porosimeter to determine grain volume. As a standard quality control measure, a calibration check plug was run after every ten samples. Grain density data is calculated from grain volume and sample weight data. The weight and grain volume data for sample 49 was corrected for the lead sleeve and screens.

### **Permeability and Porosity**

Permeability and pore volume measurements were made on all samples at ambient and overburden pressure in the CMS™300 automated core measurement system. The overburden pressure of 1910psig was calculated for the plugs and full diameter samples using an average core depth. Overburden pressures for the MSCT samples were calculated individually because of the spread of depths. A standard check plug was run with every five plug and MSCT samples.

Klinkenberg permeability ( $K_{inf}$ ) values are obtained directly from the CMS-300, since it operates by unsteady-state principles. Porosity data was obtained by combining pore volumes from the CMS-300 data with grain volumes from the Ultrapore porosimeter. Porosity and permeability data for sample 49 was corrected for the lead and screens.

Preliminary data for the majority of the samples was sent to Woodside as it became available. Porosity, permeability and grain density data are tabulated on pages 15 to 23. Plug data is presented graphically on the Integrated Corelog. A cross-plot of overburden porosity versus permeability for the plug and MSCT samples is on page 24. Cross-plots of horizontal versus vertical plug data are presented on pages 25 to 27.

## **APPENDIX**

### **MSCT Descriptions**

#### **M1 - 2050.0m**

Sandstone. Lithic Arkose. Light grey, very fine to lower medium, dominantly upper fine, moderately sorted, angular to subrounded, faintly laminated with occasional coarse laminae, occasional coarse shale clasts and few coal fragments, possibly kaolinitic. Poor visible porosity, nil fluorescence.

#### **M2 - 2053.0m**

Sandstone. Lithic Arkose. Light grey, very fine to lower medium, dominantly upper fine, moderately sorted, angular to subrounded, faintly laminated, rare thin coaly streaks, possibly kaolinitic. Poor to fair visible porosity, nil fluorescence.

#### **M3 - 2055.0m**

Sandstone. Lithic Arkose. Light grey, very fine to lower medium, dominantly upper fine, moderately sorted, angular to subrounded, faintly laminated, occasional mica and small rip-up clasts, possibly kaolinitic. Poor visible porosity, nil fluorescence.

#### **M4 - 2066.3m**

Sandstone. Lithic Arkose. Light grey, very fine to lower medium, dominantly upper fine, poorly sorted, angular to subrounded, faintly laminated, slightly calcareous, rare small clay-lined burrows (Paleophycos), possibly kaolinitic. Poor visible porosity, nil fluorescence.

#### **M5 - 2076.5m**

Sandstone. Lithic Arkose. Medium grey, very fine to upper fine, dominantly lower fine, poorly sorted, angular to subrounded, poorly laminated, argillaceous, partly bioturbated, possibly sideritic, slightly carbonaceous, possibly kaolinitic. Negligible visible porosity, nil fluorescence.

#### **M6 - 2092.2m**

Sandstone. Lithic Arkose. Light grey, very fine to upper medium, dominantly upper fine with occasional lower medium laminae, moderately sorted, angular to subrounded, faintly laminated, few faint burrow structures with minor clay, possibly kaolinitic, occasional volcanic rock fragments. Poor to fair visible porosity, nil fluorescence.

#### **M7 - 2094.0m**

Sandstone. Lithic Arkose. Light to medium grey, lower to upper fine, dominantly lower fine, moderately well sorted, angular to subrounded, faintly laminated, occasional coarse kaolinitic shale fragments and coal clasts on uneven bedding surface, possibly kaolinitic. Poor visible porosity, nil fluorescence.

#### **M8 - 2133.0m**

Sandstone. Lithic Arkose. Light grey, very fine to lower medium, dominantly upper fine, moderately sorted, angular to subrounded, massive, rare pyrite. Poor visible porosity, nil fluorescence.

**M9 - 2139.1m**

Sandstone. Lithic Arkose. Light grey, very fine to lower medium, dominantly upper fine, moderately sorted, angular to subrounded, very faintly laminated, occasional mica and thin coaly streaks, possibly kaolinitic. Poor visible porosity, nil fluorescence.

**M10 - 2143.6m**

Sandstone. Lithic Arkose. Light grey, very fine to lower medium, dominantly upper fine, poorly sorted, angular to subrounded, faintly laminated, well indurated, faint mottling possibly bioturbation. Poor visible porosity, nil fluorescence.

**M12 - 2165.9m**

Sandstone. Lithic Arkose. Light grey, very fine to upper coarse, dominantly upper medium, poorly sorted, angular to subrounded, massive, possibly kaolinitic. Fair visible porosity, nil fluorescence.

**M13 - 2230.0m**

Sandstone. Lithic Arkose. Light grey, lower very fine to upper fine, dominantly lower fine, moderately sorted, angular to subangular, moderately laminated with common irregular clay laminae up to 3 mm locally disrupted by bioturbation, occasional coal clasts concentrated on laminae. Poor visible porosity, nil fluorescence.