

***Routine Core Analysis***  
***Well Thylacine #2***  
***Offshore***  
***Otway Basin***  
***Australia***

Prepared for  
**Woodside Energy Ltd.**

January 2002

File: PRP-01042

Rock Properties  
Core Laboratories  
Perth  
Australia

8<sup>th</sup> January 2002

**Woodside Energy Ltd**

1 Adelaide Tce  
PERTH WA 6000

**Attention : Mr. J. Kelly**

Subject : Routine Core Analysis  
Well : Thylacine #2  
File : PRP-01042

Dear Sir,

Presented herein is the final report of a routine core analysis study conducted on three cores from the above well that arrived at our laboratory in mid September 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 three cores from Thylacine #2 on behalf of Woodside Energy Ltd. (Woodside). A total of 255 horizontal and seventy-five vertical plugs were taken from the cores, the porosities and permeabilities for which were measured at ambient and overburden pressures. Horizontal plug sample porosities, at overburden, range from 4.6 to 24.3%, whilst overburden Klinkenberg permeabilities ( $K_{inf}$ ) range from 0.001 to 4610mD. Sample 243, which does not have a Klinkenberg permeability since it was measured by steady-state, has an air permeability of 8330mD. The mean arithmetic values are 14.9% and 111mD, respectively. Grain density values range from 2.643 to 3.165g/cc, with a mean value of 2.699g/cc. The high grain density values are largely attributed to the presence of siderite and occasional pyrite.

The porosity and permeability cross-plot shows good trends of permeability increasing with porosity. The majority of data points in cores 1 and 2 are fairly tightly packed, whilst those in core 3 are quite spread out. Core 2 samples generally have slightly higher permeabilities than core 1, whilst core 3 sample permeabilities are up to three orders of magnitude higher. The bulk of core 1 and 2 samples have permeabilities between 0.1 and 10mD, whilst core 3 sample permeabilities are fairly evenly spread between 0.001mD and 10,000mD.

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.

On the Integrated Corelog the surface core gamma compares fairly well with the profile permeametry and plug data. The plug permeability data compares very well with the profile permeametry data.

## **INTRODUCTION**

The aluminium core barrels were delivered to Core Lab's premises on the 14<sup>th</sup> September in two steel core baskets.

A preliminary core analysis program was received from Woodside on the 18<sup>th</sup> September. 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 and full diameter samples

The reported data for the above services are presented digitally on a diskette, whilst the digital core photographs are on the CD-Roms, all of which are included with this report.

## **INVENTORY**

Core No.	Depth Range (m)	Core Length (m)
1	2150.00 – 2199.99	49.99
2	2203.50 – 2257.60	54.10
3	2258.50 – 2314.55	56.05
	Total	160.14

## **LABORATORY PROCEDURES**

### **Initial Inventory**

The core barrels, the majority of which were approximately nine metres in length, arrived in two steel core baskets. All barrels were unloaded from the basket and laid out in order. The barrel depths were recorded on an in-house inventory and checked against the supplied manifest. All barrels that were three metres in length, or longer, were then marked and cut into shorter lengths for easier handling. Once cut, end caps were placed on the open ends.

### **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 two people loaded, and two people 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 once each core had been run.

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

### **Laying Out and Marking**

The core was unloaded from the barrels by removing the top cap and sliding the core out onto the lay-out trays. After the core was laid out, the pieces were fitted together and cleaned of drilling fluids. Several core sections were crushed or jammed and required the barrels to be cut open to remove the core. Core depths, a continuous slabbing line, and orientation arrows pointing to the base were marked on the core.

## **Full Diameter Sampling**

Seven 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 and analysis as per the *Sample Preparation, Grain Volume and Grain Density, and Permeability and Porosity* sections below.

## **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.

## **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 1580 point measurements were made, and the preliminary results sent to Woodside as each core was completed. Profile permeametry was not conducted on sections of core that were solely shale. The final permeametry data is presented in tabular form on pages 6 to 44, and graphically on the Integrated Corelog.

## **Core Photography**

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

Ultra-violet light photography was not conducted, as the core exhibited no fluorescence.

### 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.

A CD-Rom with preliminary large format photographs was sent to Woodside and Origin Energy (Origin) on the 22<sup>nd</sup> October. A final set of A4 prints and a CD-Rom containing the large format photographs are scheduled for despatch to Woodside. The large format white light prints and final images also contain the grain density, and ambient porosity and permeability data for the plug samples. A set of CD-Roms containing the small format images was sent to Woodside on the 4 December.

## **Core Description**

Duncan Barr of Core Lab conducted a core description on the slabbed core, the results of which are presented in a separate report.

## **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 the KCl brine solution. 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 255 horizontal and seventy-five vertical plugs were drilled from the core.

The plugs 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 plug 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 volumes were measured on the full diameter samples using a Heise gauge helium porosimeter. Grain density data is calculated from grain volume and sample weight data.

## **Permeability and Porosity**

Permeability and pore volume measurements were made on all plug samples at ambient and overburden pressure in the CMS<sup>TM</sup>300 automated core measurement system. The overburden pressures for each core were calculated by Woodside. A standard check plug was run with every five plug 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. Due to its permeability being outside the range of the CMS-300, sample 243's permeabilities were measured by steady-state method.

The full diameter samples were individually placed in a hydrostatic core holder for pore volume and permeability measurements, at both ambient and overburden pressures. Pore volumes were measured directly by a Heise gauge helium porosimeter, then combined with their grain volumes to obtain porosity data. Permeabilities were measured using a steady-state permeameter.

Preliminary data for the majority of the samples were sent to Woodside as they became available. Porosity, permeability and grain density data for the plug and full diameter samples are tabulated on pages 45 to 64. Plug data is presented graphically on the Integrated Corelog. A cross-plot of overburden porosity versus permeability for the plug samples is on page 65. Cross-plots of horizontal versus vertical plug data are presented on pages 66 to 68.