

Jarver 1, SWC 30

Although the sidewall guns in this well misfired, all the sidewalls that were collected came from near TD. Sidewall 30 is a conglomerate with clasts of chert, devitrified volcanic and foliated muscovite-rich sandstone in a matrix of shale/mudstone.

Much of the quartz shows indications of derivation from a metamorphic terrain. The chert shows multiple cross veins of later chert as well as recrystallization. There are clasts of fine sandstone displaying a weak foliation and some pyrite cement. The feldspars show some alteration to masses of kaolin (usually those feldspars within rock fragments).

There is no obvious cement in this sample as most of the primary porosity is obscured or filled with original sedimentary matrix.

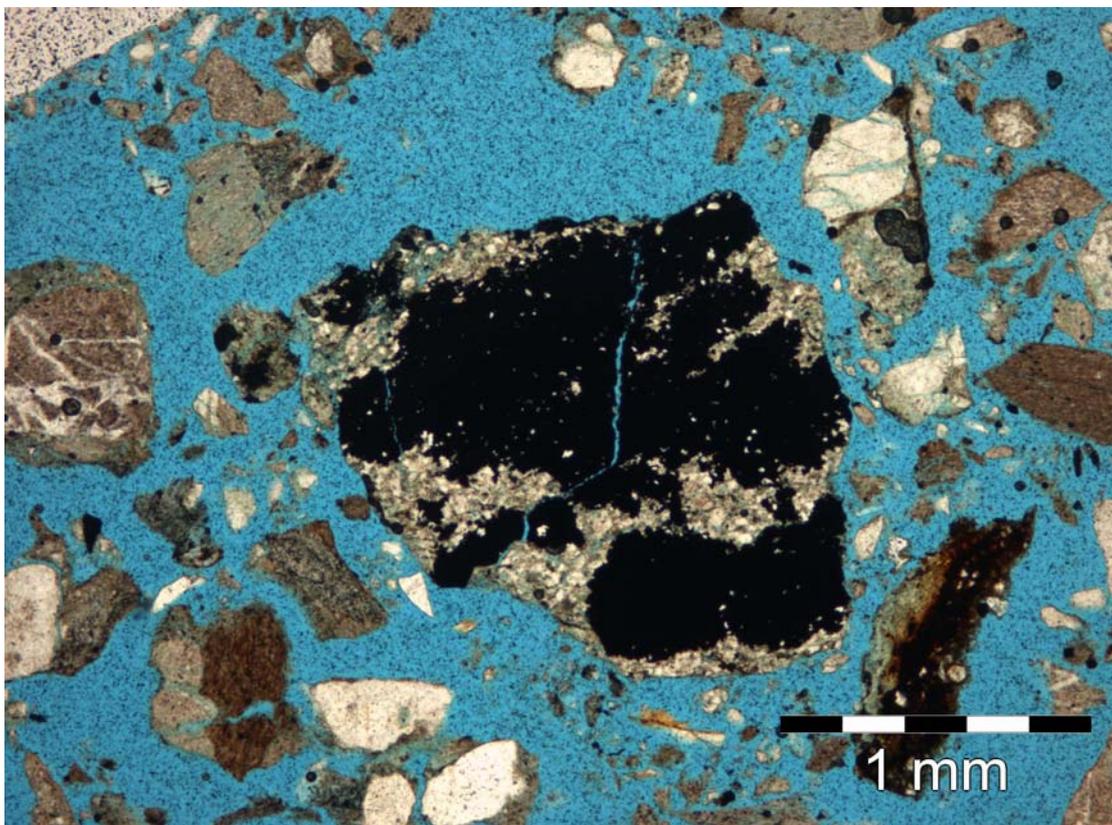


Figure 12. Jarver 1, SWC 30

The large clast in the centre of the image is a foliated meta fine sandstone with extensive replacive pyrite cement. The veined grain at centre left is chert with chert veins.

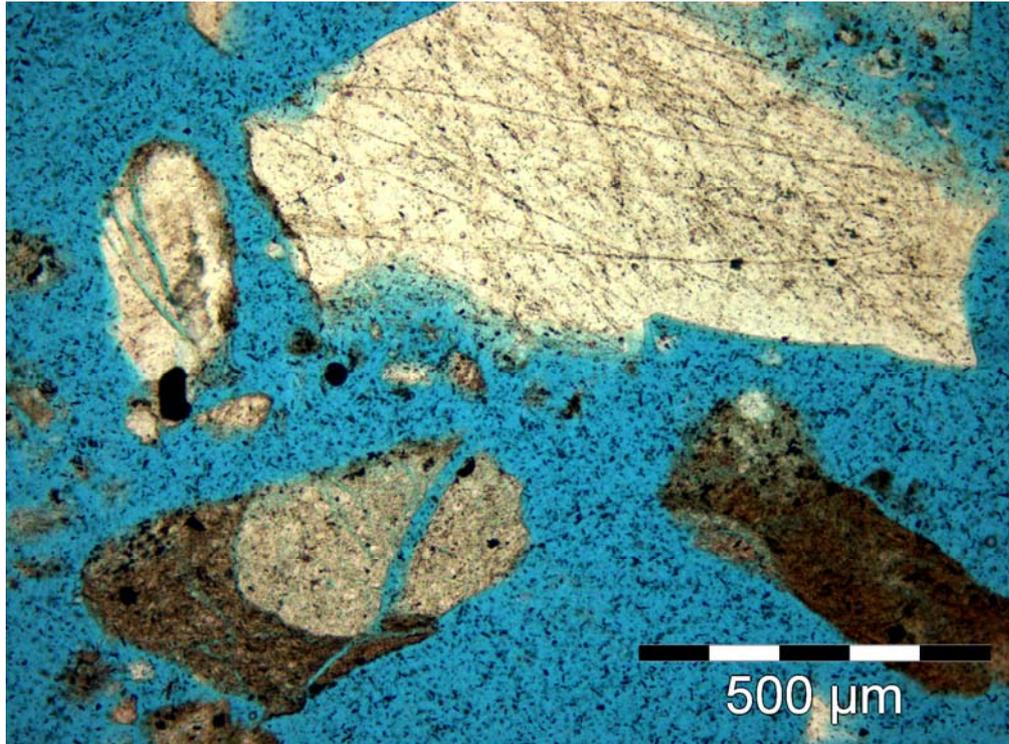


Figure 13A. Jarver 1, SWC 30

The large grain in the upper part of the image is a hydrothermal (fault) quartz full of fluid inclusions. The circled cutting is a rounded chert grain surrounded by muddy matrix.

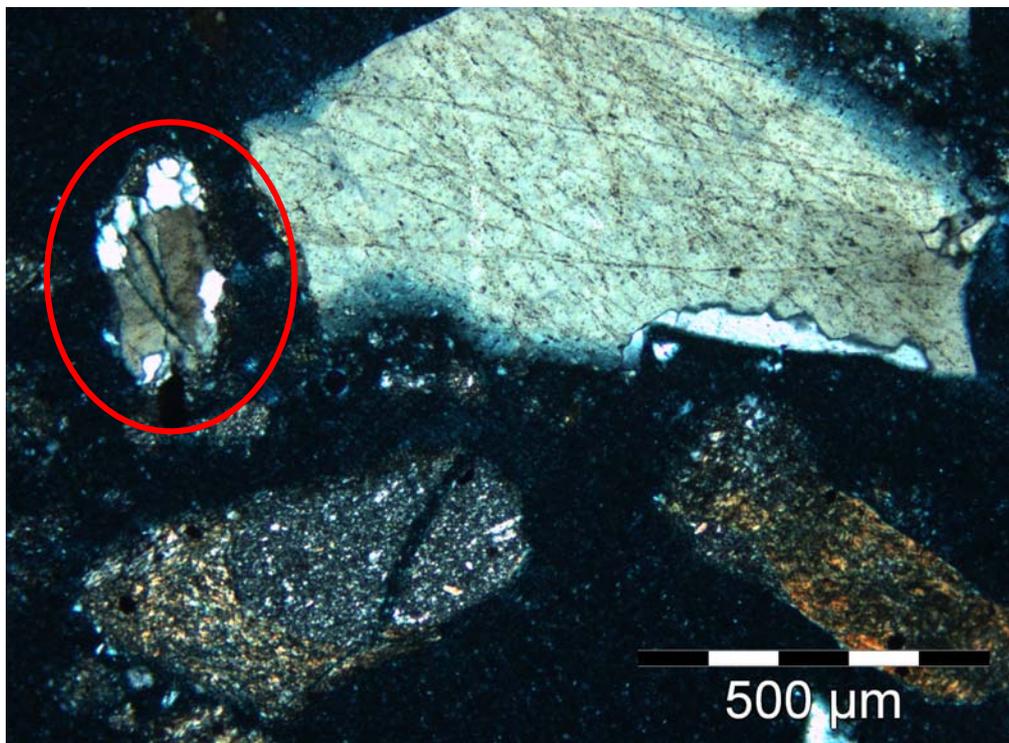


Figure 13B. Jarver 1, SWC 30

The same field of view as Fig. 13A under crossed polars shows the unstrained nature of the hydrothermal quartz but the highly strained, polycrystalline nature of the metamorphic quartz circled. The speckled pattern of the rounded chert grain is characteristic of that mineral.

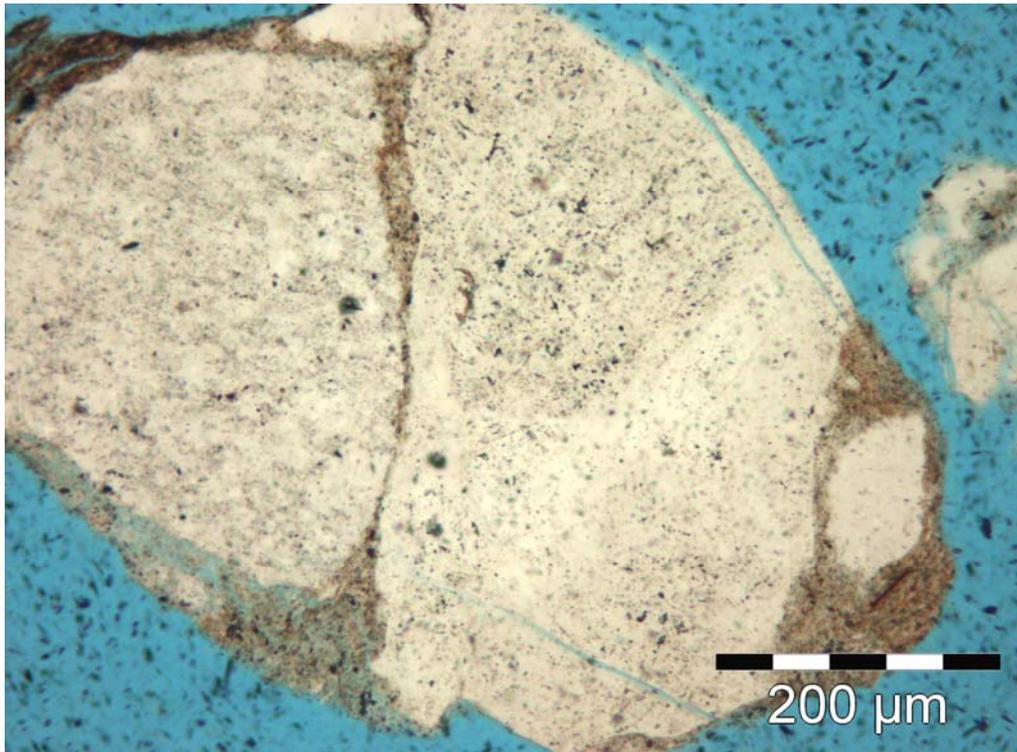


Figure 14A. Jarver 1, SWC 30

A group of silica-rich grains surrounded by thin rims of muddy matrix

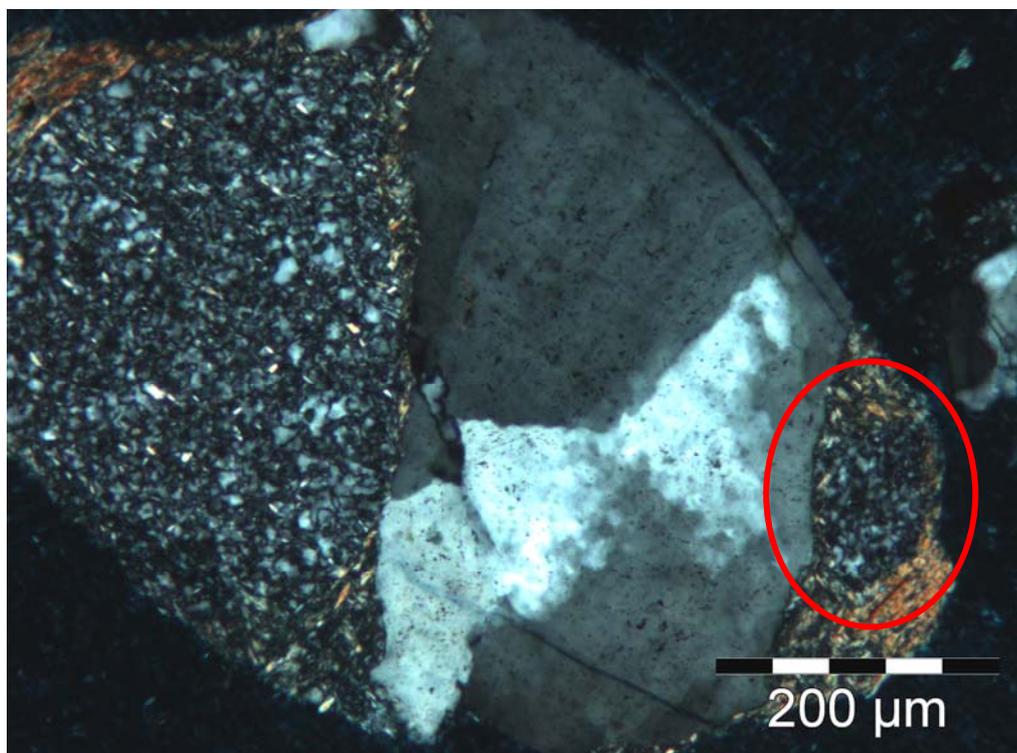


Figure 14B. Jarver 1, SWC 30

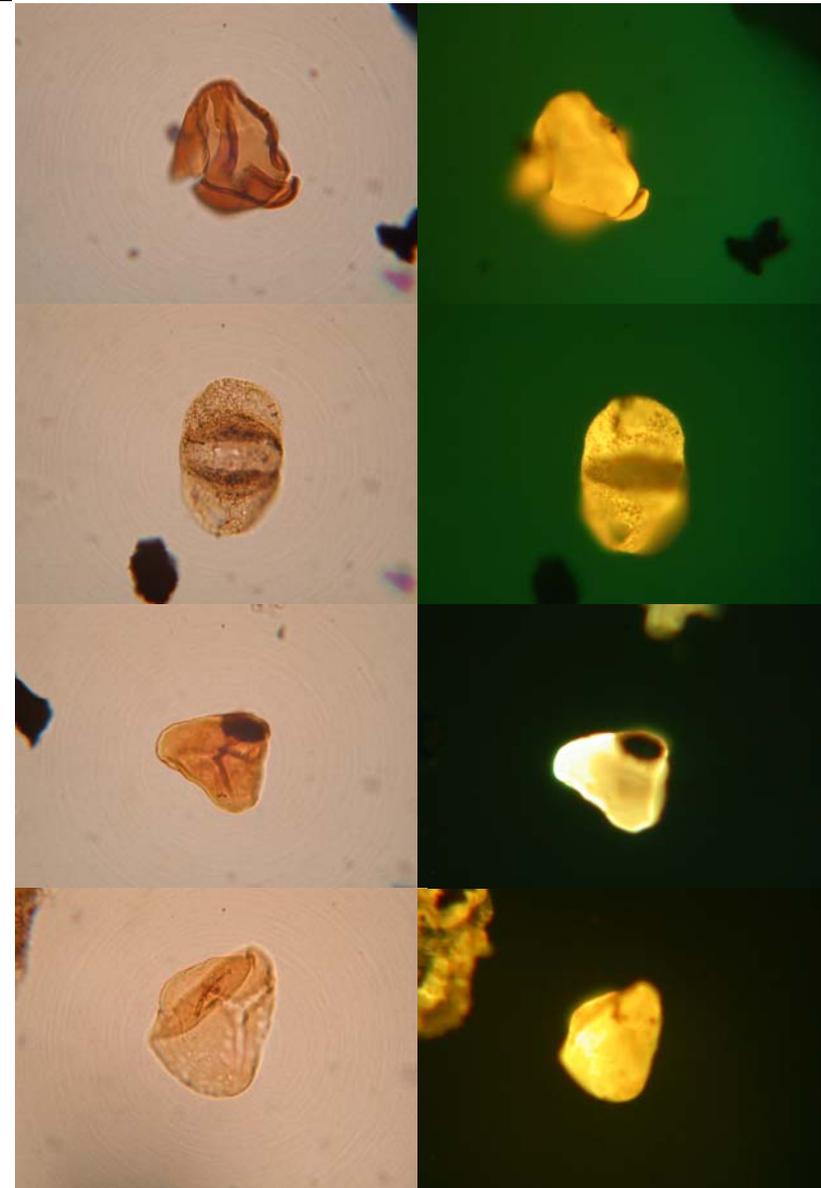
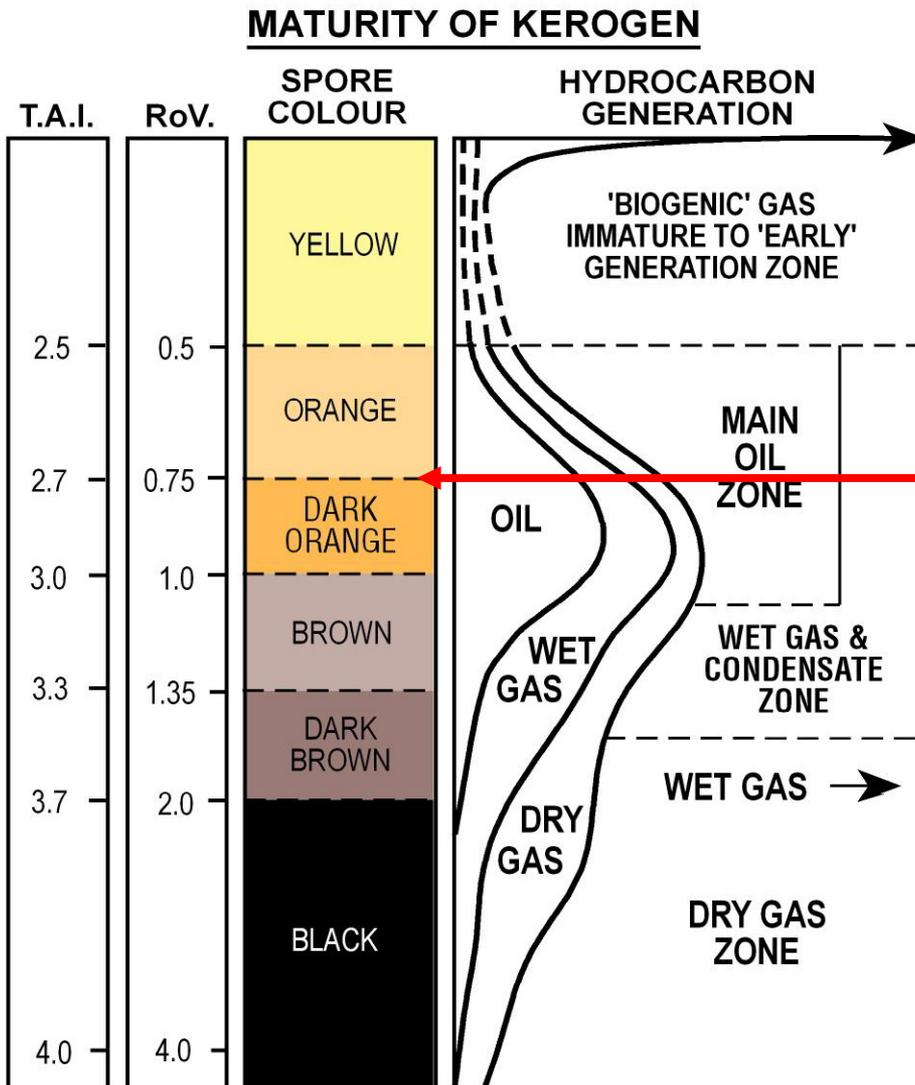
The same field of view as Fig. 14A under crossed polars shows the grain on the left to be chert and the one in the centre is fault quartz. There is a small rounded grain (circled) surrounded by mud matrix.

Jarver-1

Spore Colour Maturity Study

2880 – 2904m

Jarver-1 Spore Colour & Fluorescence Data for 2880 – 2904m indicates near Orange / Dark Orange boundary level of maturity equivalent to approximately 0.75 – 0.8% R_oV (Early to Mid Oil Generation Zone)



THIS IS A GUIDE - VARIATION IN KEROGEN TYPES & OTHER FACTORS WILL CAUSE DIFFERENT GENERATION HISTORIES.

Jarver-1, Otway Basin. Rock Type Assessment of Thylacine Member cutting samples

Claire Behan, June 2008

Introduction

Drill cutting samples were selected for rock type analysis from the Thylacine Member, from samples collected between 2690 – 2780m KB. The main focus of the study was a visual estimation of porosity to complement the petrophysical analysis. The samples were gently washed to remove drilling mud, dried, then microscopically assessed using a Zeiss binocular microscope with x10 magnification. The standard Santos Rock Type assessment spreadsheet was completed and a WES plot produced. A Klingenberg (KOB) and overburden corrected (OB) permeability calculation was not made as Otway Basin well core data has not yet been assessed for the relevant age overburden factors included the General OB and KOB equations.

Assessment

Drill cutting samples from 2682 – 2796m KB, bagged in 6m intervals, were analysed. Five samples were extracted from the set for palynological analysis – 2688-2694m, 2700-2706m, 2766-2772m, 2778-2784m, and 2784-2790m.

All the samples are predominantly argillaceous sandstone, with up to 20% organic shale (2682 – 2700m KB), decreasing with depth to 10% siltstone / 5% organic shale. Grain size over this same top interval is Fine to Very Fine (177-62 micron). The interval 2706 – 2772mKB is Medium – Fine Upper (500-177 micron) fining downwards to Fine (250-125 micron). All samples contain 10 – 20% coarse to very coarse quartz grains, possibly plucked from a younger formation, that occur as loose grains amongst smaller grain size quartz grains and clay clumps. (Figure 1) Iron stained clay and minerals was observed in 1-4% of sandstone and clay aggregates in all sample intervals.



Figure 1. Jarver-1 (2745m KB)

Quartz grains are sub-angular/ sub-rounded, have low relief and dull to moderately bright lustre. Consolidation is poor, due to the high proportion of clay matrix. (Figure 2)



Figure 2. Jarver-1 (2706m KB)

Quartz cemented aggregates are well consolidated but make up only 3-10% of total sandstone aggregates in the interval 2682-2748m KB, and 15 – 25% between 2748-2778m KB. (Figure 3)

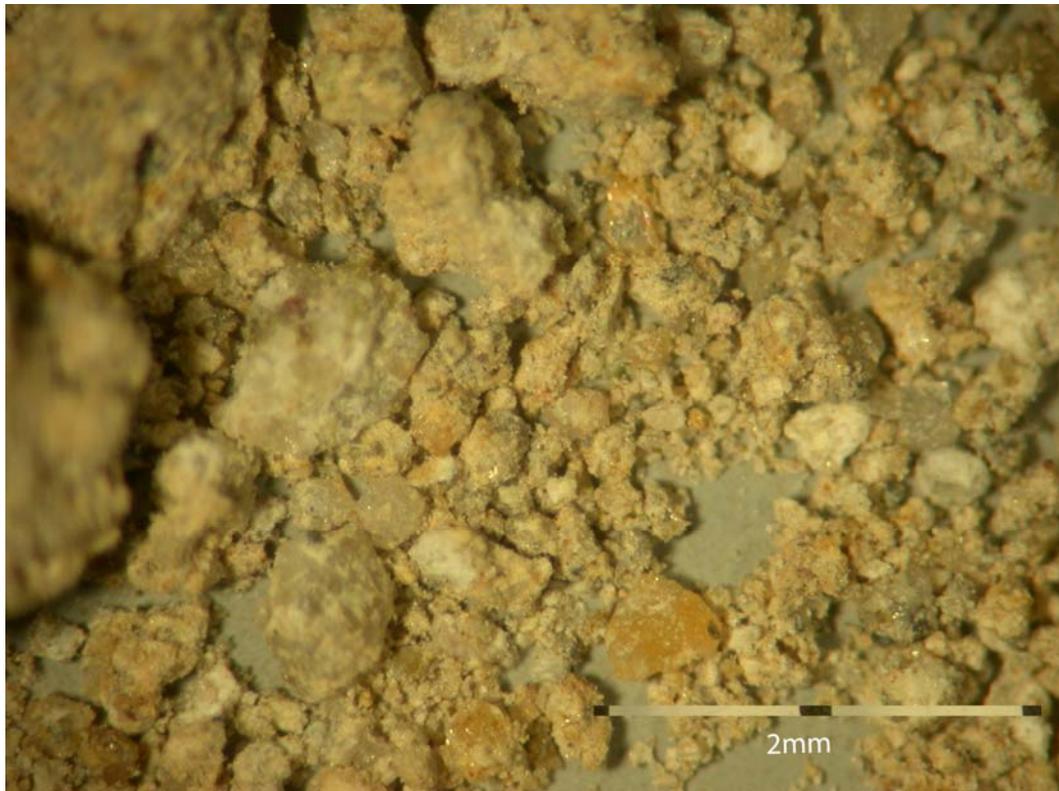


Figure 3. Jarver-1 (2772m KB)

Framework minerals include glauconite, muscovite mica, plagioclase feldspars and/or coal or other dark coloured rock fragments in 1-2% each, the remaining 90+% comprising quartz. (Figure 4) Siderite and pyrite is present, (trace-2%) in some samples. (Figure 5)

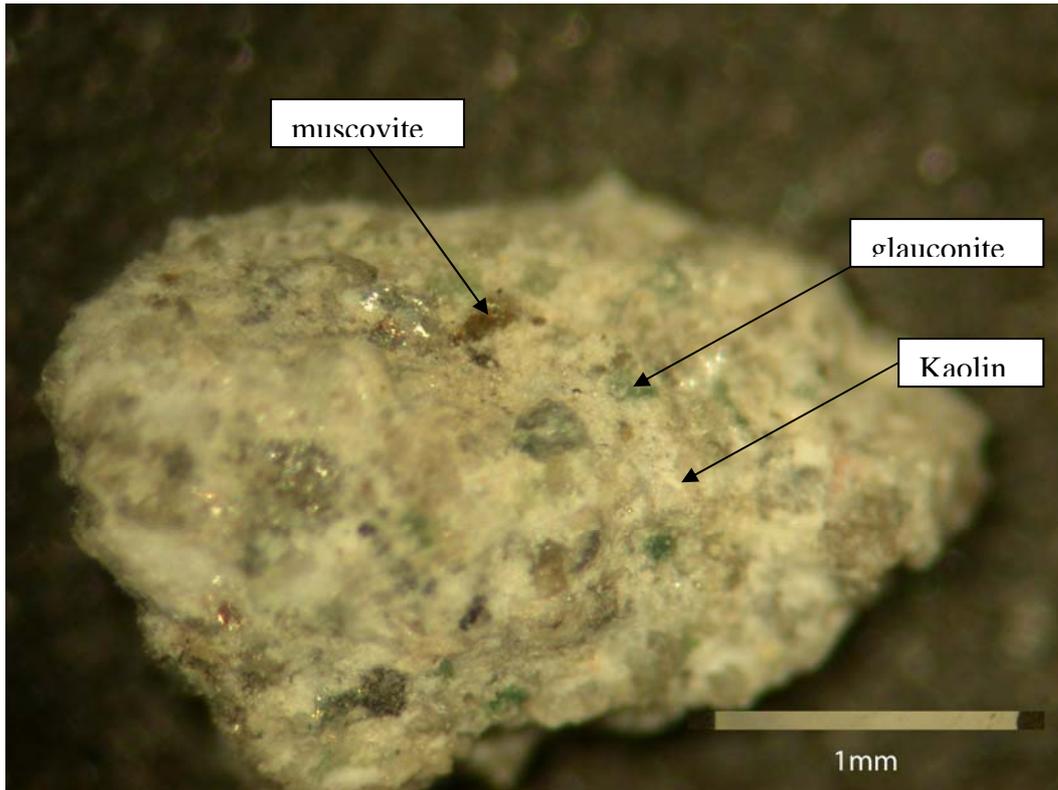


Figure 4. Jarver-1 (2754m KB)

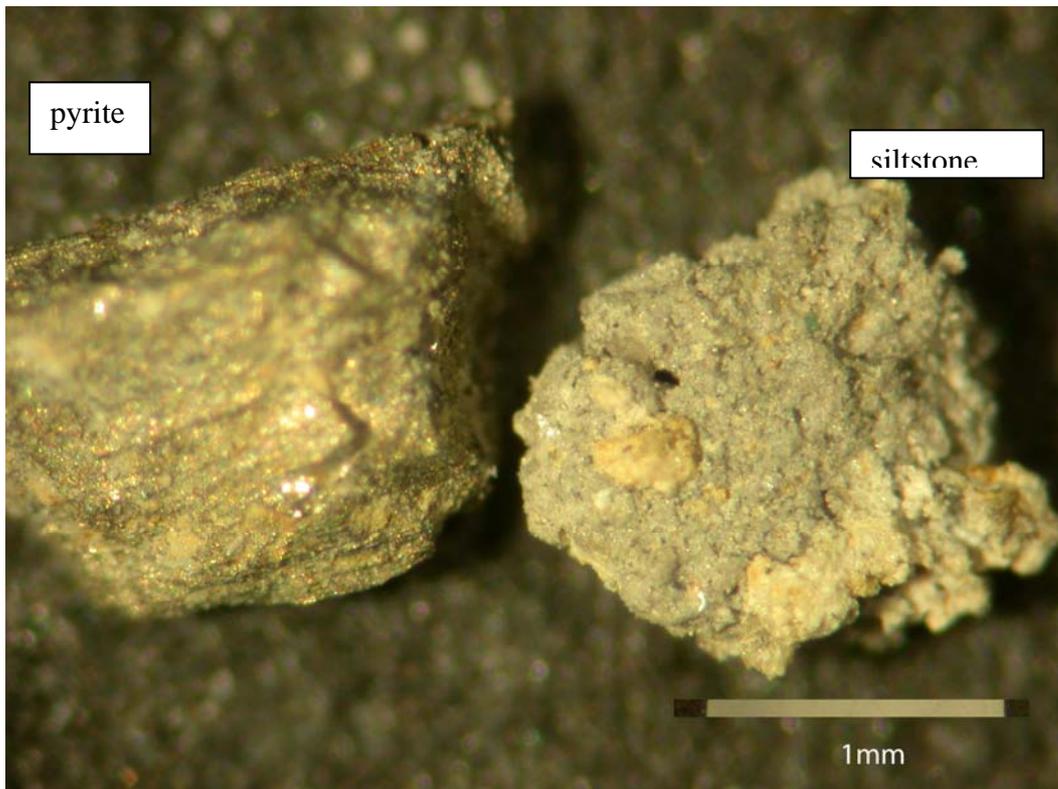


Figure 5 Jarver-1 (2706m KB)

The matrix is characterised by increasing quartz cement with depth in proportion to decreasing macro effective porosity. Kaolin clay occurs as pore filling, feldspar replacement and re-crystallisation from original clays. (Figure 6)

Quartz grains are also coated with white grains too small to identify under the binocular microscope.
Illite may be present, but was not observed at the available microscope resolution.
Identification may also be masked by the abundant kaolin.

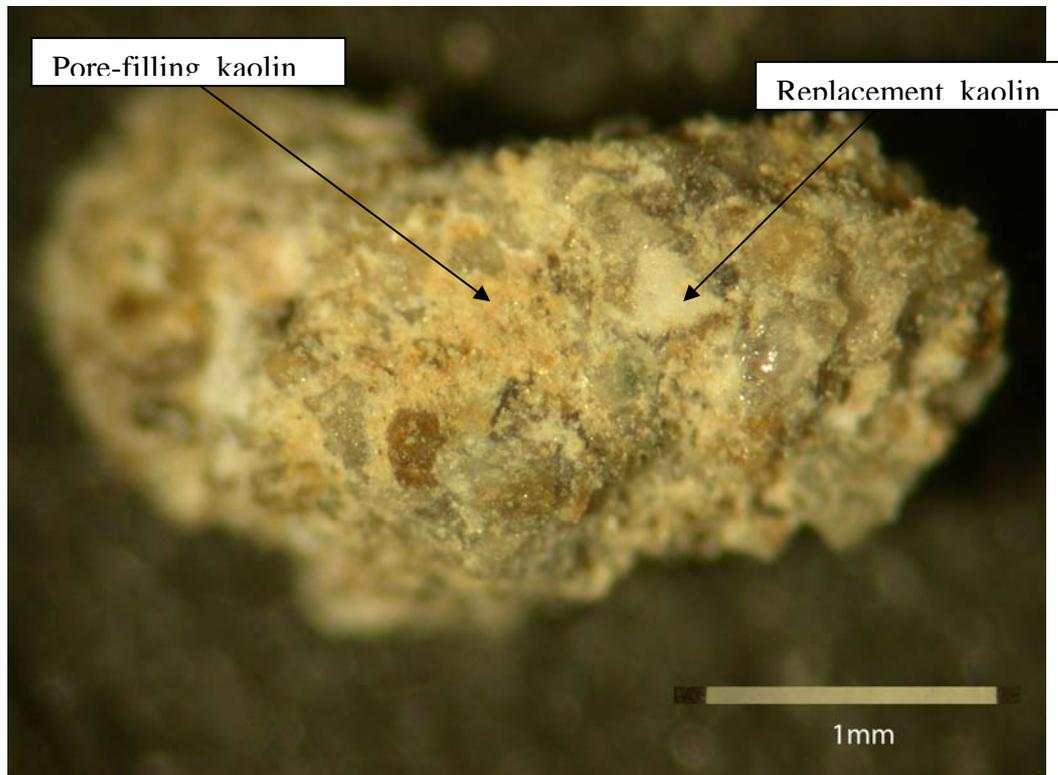


Figure 6 Jarver-1 (2772m KB)

At 2682-2712m KB sandstone aggregates have visible porosity and micro-effective porosity (Figure 1 & 7) in both the consolidated and clay-dominated aggregates. The rock type is assessed as 60-80% Rock Type 1D, 20-40% 1C for the 3 samples. Kaolin from altered feldspar is common, grain coat rare. Micro-effective porosity accounts for approximately 45% of total porosity.



Figure 7 Jarver-1 (2706m KB)

Between 2712-2748m KB clay-rich sandstone aggregates make up 95% of total sandstone aggregates. However, visible porosity decreases, as does kaolin-replaced feldspar, but grain coating clay increases to a maximum of 25% total clay content. Rock type classification for this interval is 40-50% Rock Type 1D, 30-45% Type II, plus a minor proportion of Rock Type 1C and Type III. The proportion of micro-effective porosity is greater than macro-effective porosity. (Refer to Appendices for Rock Type Classification characteristics)

The interval 2748-2778m KB is assessed as Rock Type II (45-55%) with 15-30% Type 1D and III. The proportion of consolidated sandstone aggregates is 15-25% in which pore-filling kaolin predominates, replacement kaolin representing almost 50% total clay and grain coat clay decreasing to 1% total intergranular volume at 2778m KB. Porosity is 60% micro-effective, 40% macro-effective. (Figures 8 - 10)

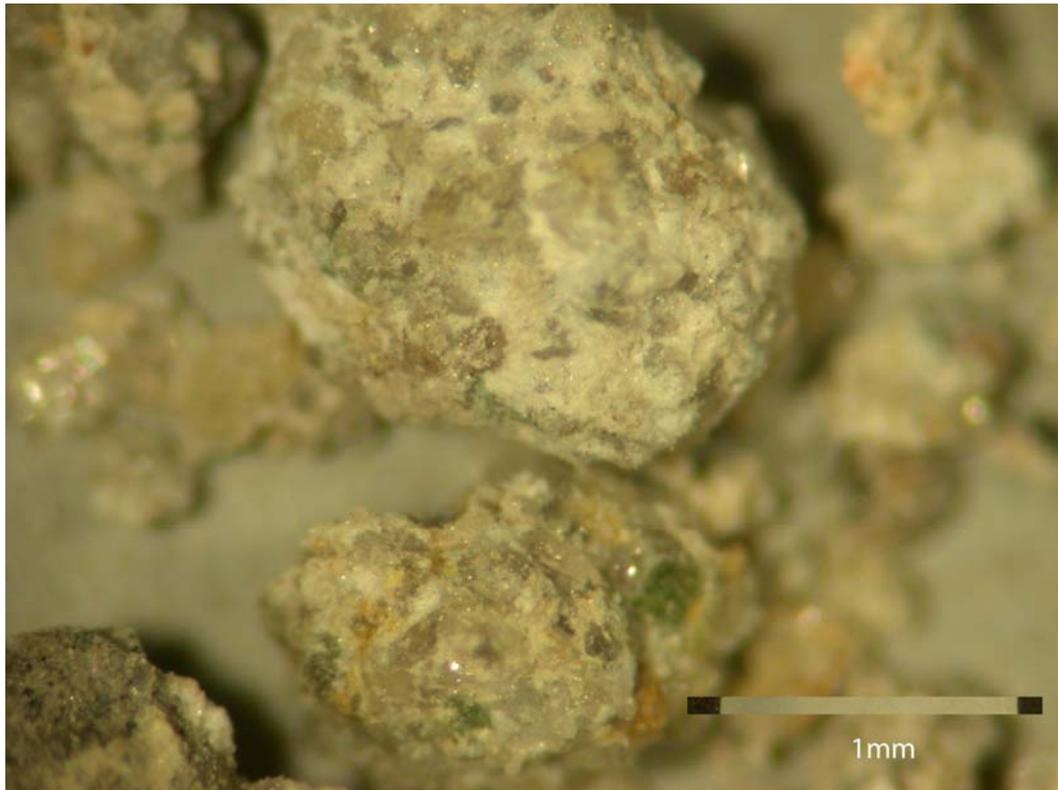


Figure 8 Jarver-1 (2754m KB) Rock Type Classification 1D aggregates



Figure 9 Jarver-1 (2772m KB) Rock Type Classification 1D aggregate



Figure 10 Jarver-1 (2772m KB) Rock Type Classification II aggregate

Unfortunately the sample interval covering basal Thylacine Mbr - top Flaxman Fm was used for palynological analysis.

The drill cutting sample interval 2790-2796mKB was assessed, primarily to check if a depth shift to match wireline was necessary, but also to ascertain the Flaxman Fm lithological characteristics.

In this Flaxman Fm interval of 85% sandstone / 10% siltstone / 5% shale, grainsize is Medium to very Fine (350-88 micron), with 5% larger sized loose quartz grains observed. Grain relief is low, consolidation moderate to well consolidated (90% consolidated aggregates), lustre is dull, grains sub-angular/sub-rounded, and moderately spherical. The framework mineral suite is similar to the Thylacine Mbr, but the matrix comprises less pore-filling kaolin than Thylacine and proportionally more feldspar-replacement kaolin and quartz cement, plus 2% pyrite. (Figure 11)

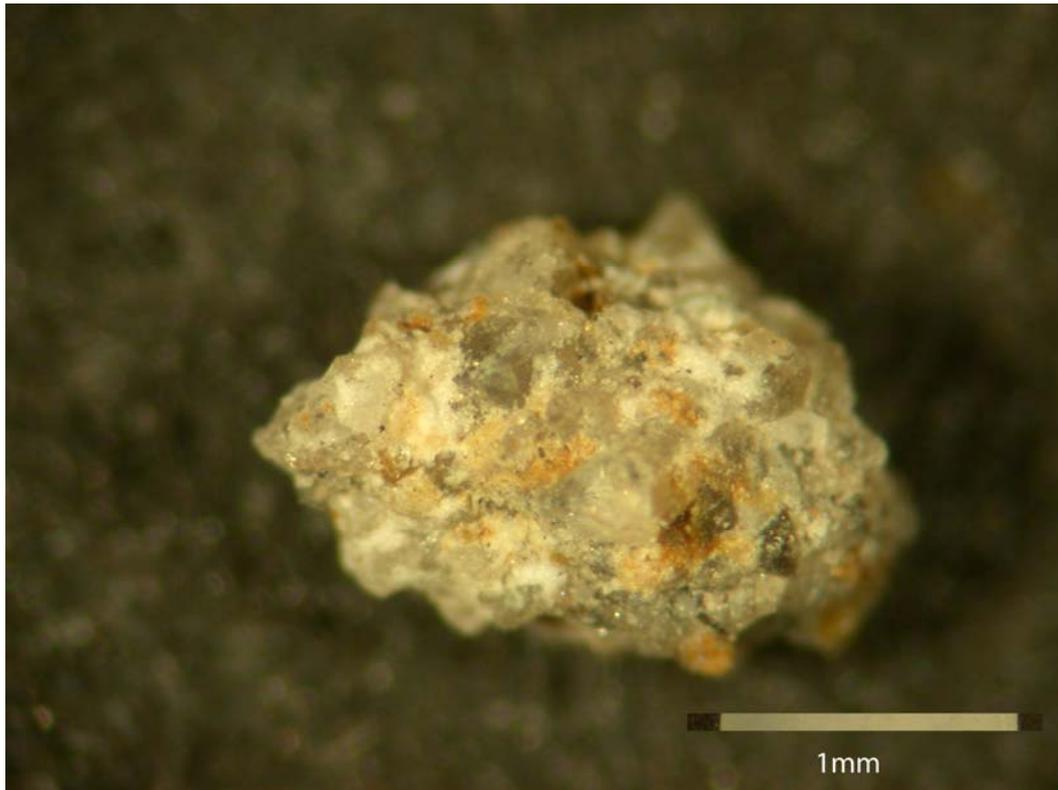


Figure 11 Jarver-1 (2790m KB) Rock Type Classification 1D

Macro-effective porosity is low, most aggregates are well cemented, of Rock type Classification 1D (60%) and II. (35%) (Figure 12, 13, 14)

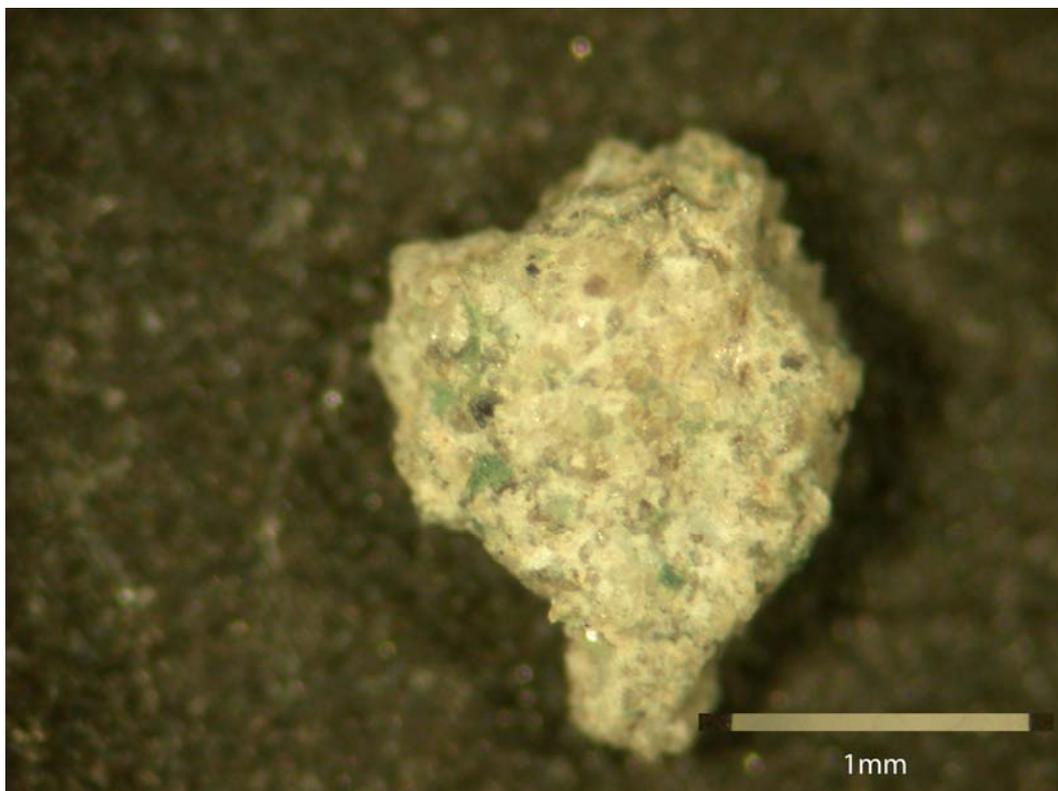


Figure 12 Jarver-1 (2790m KB) Rock Type Classification 1D

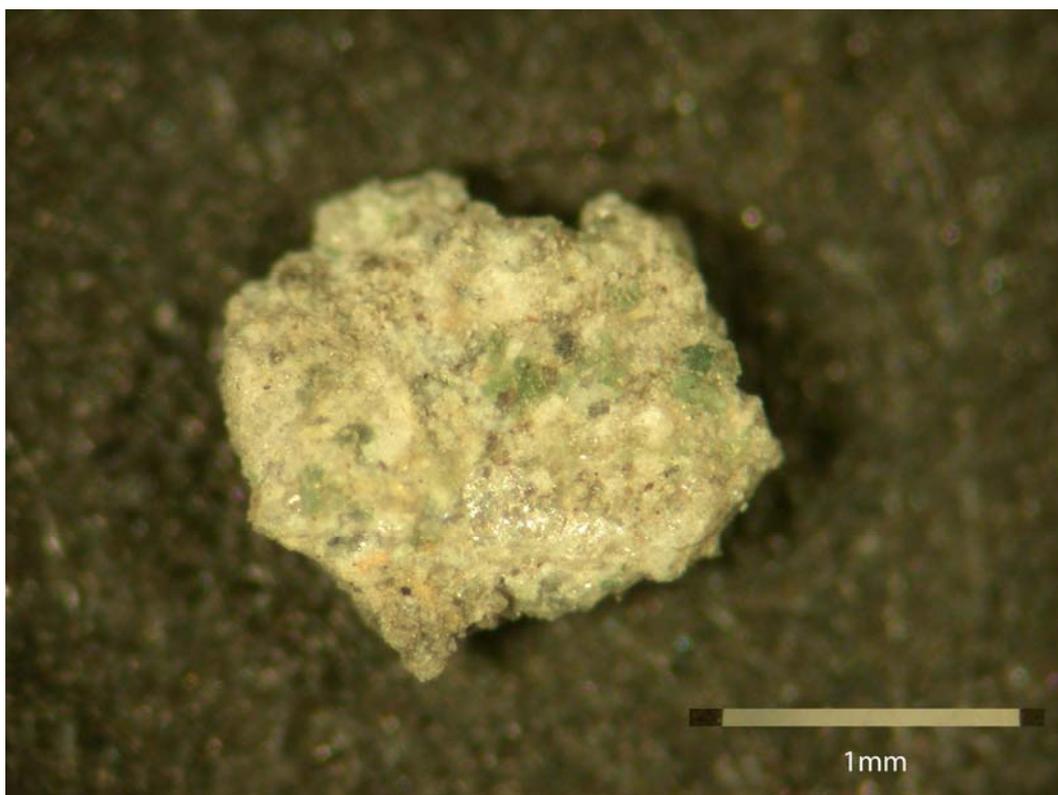


Figure 13 Jarver-1 (2790m KB) Rock Type Classification II



Figure 14 Jarver-1 (2790m KB) Rock Type Classification III

Summary

The Thylacine Member is a medium to fine grained argillaceous sandstone, with a high proportion of kaolin clay as pore-fill, replacement of feldspar, and re-crystallisation from original muds. A deltaic environment of deposition is inferred, where low energy fine grained sand and silt deposition and glauconite formation is interlaminated with muds.

At present depth the unit is fluid-saturated, as evidenced by the extensive clay and feldspar alteration and clay precipitation. No oil smears were observed.

Rock Type Classification results favour the top 2682-2712mKB interval as reasonable reservoir quality rock. Below 2712mKB, rock type classification 1D & II implies poor quality, low permeability and tight reservoir conditions for gas, and the high clay content further decreases the mobility of any hydrocarbons.

Appendix – Rock Type Classification Tables

Rock Type	Air Permeability Range (mD)	Reservoir Type
1A	>100	Conventional
1B	10-100	Conventional
1C	1-10	Conventional
1D	0.5-1	Tight Gas
II	0.07-0.5	Marginal tight gas
III	<0.07	Non-reservoir

Table 1. Santos Cooper Basin Rock Type Classification

Table 1. Pore Type Classification and characteristics, Deep Basin, Canada after Sneider and King (1984)

Type	Characteristics of dry, freshly broken surfaces at 20X magnification	Remarks
I	<ul style="list-style-type: none"> • Visible ϕ—very abundant to common • Pinpoint ϕ—very abundant to common • Pore interconnection is visible on many pores • Needle probe can easily dislodge some grains from rock surface and reveal pore 	<ul style="list-style-type: none"> • Reservoir quality rock for gas without natural and/or artificial fracturing (if thick enough) <p>Permeability, mD</p> <ul style="list-style-type: none"> • 1A >100 • 1B 10–100 • 1C 1–10 • 1D 0.5–1
II	<ul style="list-style-type: none"> • Visible ϕ—scattered • Pinpoint ϕ—abundant to common • Needle probe can only occasionally dislodge a grain from rock surface 	<ul style="list-style-type: none"> • Capable of gas production if inter-layered with Type 1 rock, or has natural open fractures and/or is artificially fractured and is thick enough • Permeability is > 0.07 to 0.5 mD (depending on particle size, sorting and clay mineral content)
III	<ul style="list-style-type: none"> • Visible ϕ—none to very isolated • Pinpoint ϕ—none to few, scattered pores • Usually very well consolidated and/or pore filled with clays or other pore filling material 	<ul style="list-style-type: none"> • Usually too tight to produce at commercial rate with natural or artificial fractures or when inter-layered with Type 1 rock

Table 2. after Sneider & King (1984) Rock Type Classification and Characteristics, Deep Basin, Canada

