The diagenetic fingerprint of the Amadeus Basin, NT

Analytical report

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1. Introduction

Petroleum potential and rock properties in the Central Australian Basins are poorly understood. The most comprehensive dataset is from the Amadeus Basin, currently the most hydrocarbon prolific Central Australian Basin. Petroleum exploration however, has been sporadic, largely due to the lack of understanding of these basins. Such frontier basins have great potential for conventional hydrocarbon accumulations, unconventional coal seam and shale gas and sediment-hosted mineralisation.

2. Description of Project

The project will assess the existing data (literature review) of the Amadeus Basin and utilise inexpensive methods (e.g. diagenesis, petrographic studies) that can expand current knowledge. For example, diagenesis plays a crucial role in defining porosity and permeability, giving an understanding of the fluid history of an area. The results of the additional studies will be combined with existing data and interpreted in relation to known petroleum occurrences. Outcomes will be reviewed for their application to adjacent basins.

3. Results

A total of 10 petroleum wells have been sampled between June 2009 and June 2010. All samples were used for petrographic investigations. Semiquantitative XRD was performed on 3 samples from well Tempe Vale 1 and Ooraminna 1.

3.1. Petrographic observations

This chapter provides a petrographic study of 15 out of 19 polished, blue stained thin sections. All figures are thin section overviews taken as a mosaic under transmitted light (except MW1 – transmitted light and polarised).

Table 1. Summary of thin sections.

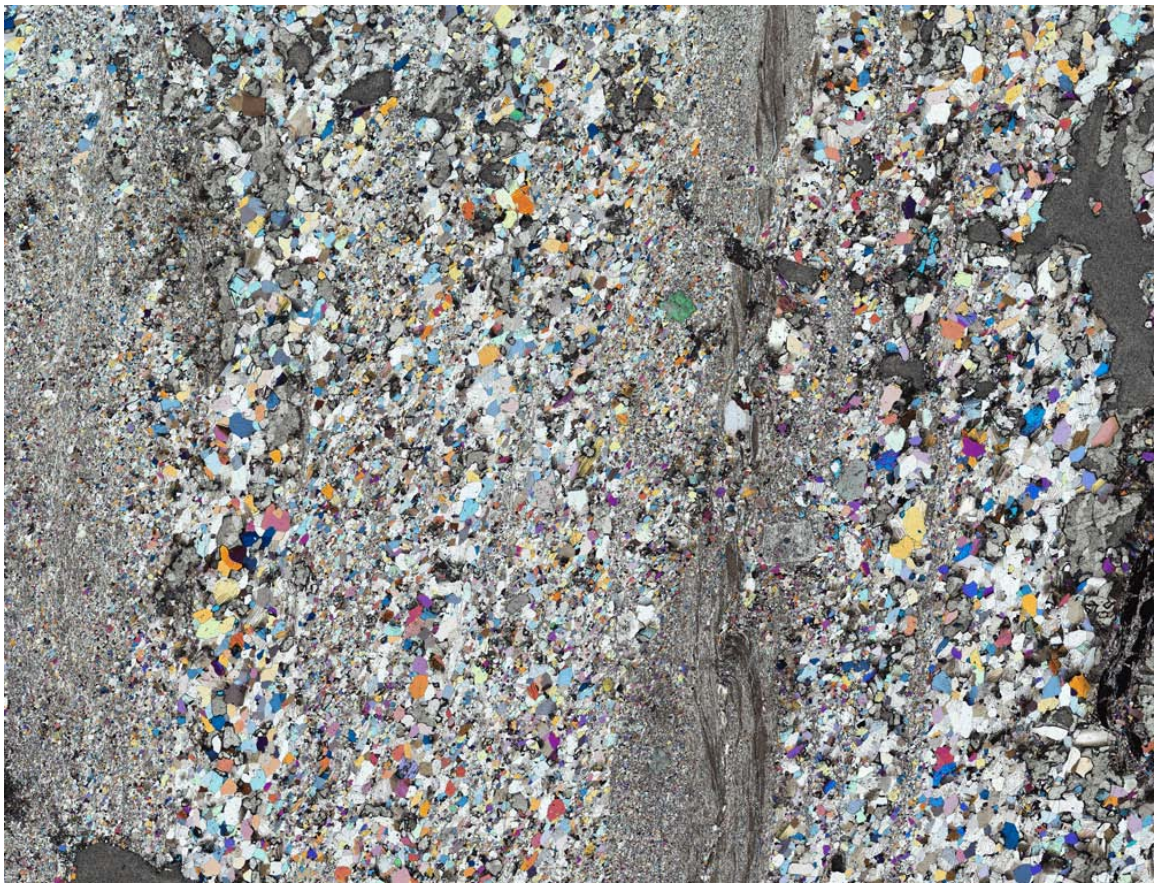
Sample ID	Drill hole	Depth in m	Lithology
ER22	Erldunda	1505	Siltstone
MW1	Mt Winter 1	2191	Evaporite
MW6	Mt Winter 2a	176.2	Sandstone
MW2	Mt Winter 2a	178.5	Sandstone
OO17	Ooraminna 1	414.5	Sandstone, arkosic
OR3	Orange 1	821	Sandstone
OR4	Orange 1	871.7	Sandstone
OR18	Orange 1	2655.4	Sandstone, arkosic
TV19	Tempe Vale 1	351	Sandstone
TV20	Tempe Vale 1	521.3	Sandstone, arkosic
TV21	Tempe Vale 1	737.6	Sandstone
TH26	Tent Hill 1	935	Sandstone, arkosic
TH27	Tent Hill 1	1103	Sandstone
TH28	Tent Hill 1	1225	Sandstone
TH29	Tent Hill 1	1280	Sandstone
TH30	Tent Hill 1	1355	Sandstone
WB24	Wallaby 1	2422	Sandstone
WA25	Wallara 1	713.5	Sandstone
WW23	West Waterhouse 1	1806.4	Sandstone, arkosic

Sample ID: ER22 – Erldunda 1 1505m

Sample type:	Blue stained polished section
Lithology:	Siltstone
Porosity:	Poor
Grain size:	Fine
Sorting:	Well
Roundness:	Subangular to subrounded
Detrital mineralogy:	Quartz, K-feldspar, mica, clay, zircon
Authigenic mineralogy:	K-fsp dissolution, illite replacing K-fsp, kaolinite, quartz overgrowth

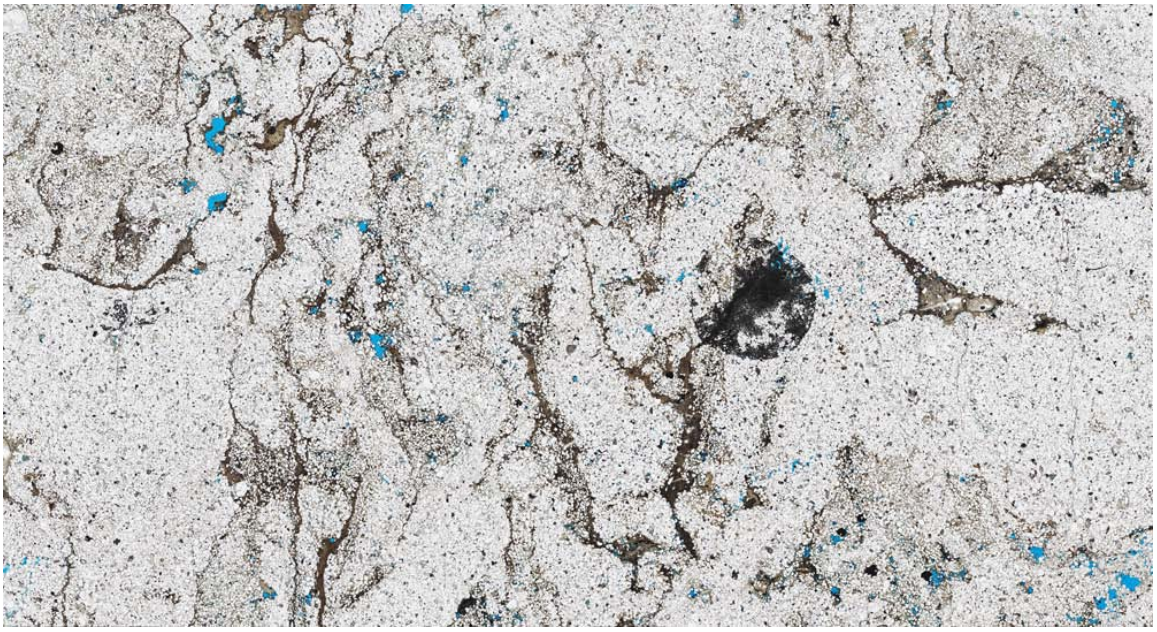
Sample ID: MW1 – Mount Winter 1 2191m

Sample type:	Blue stained polished section
Lithology:	Evaporite
Porosity:	Poor
Grain size:	Very fine
Sorting:	-
Roundness:	Angular
Detrital mineralogy:	Gypsum matrix, minor quartz
Authigenic mineralogy:	Pyrite, dolomite, calcite, gypsum



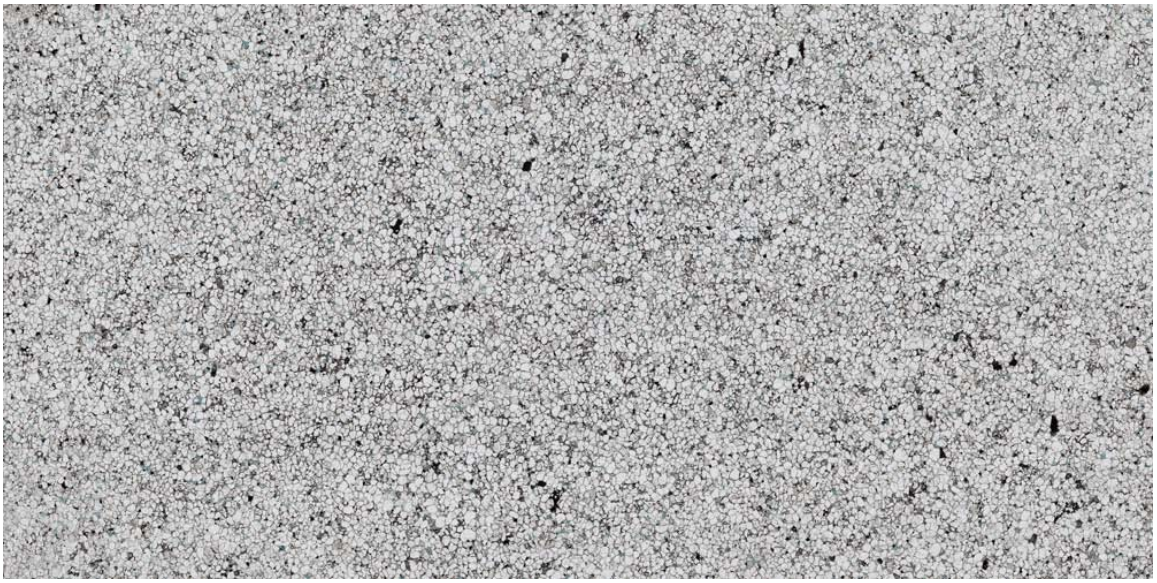
Sample ID: MW6 – Mount Winter 2A 176.2m

Sample type:	Blue stained polished section
Lithology:	Sandstone
Porosity:	-
Grain size:	Medium
Sorting:	Well
Roundness:	Subrounded
Detrital mineralogy:	Quartz, pyrite, clay and minor K-feldspar
Authigenic mineralogy:	Quartz overgrowth, poor grain-to-grain contact, K-feldspar dissolution, apatite growth and dissolution, associated pyrite, hairy illite in pores



Sample ID: MW2 oil – Mount Winter 2A 178.4-178.6m

Sample type:	Blue stained polished section
Lithology:	Sandstone
Porosity:	Poor to moderate
Grain size:	Medium
Sorting:	Well
Roundness:	Subrounded
Detrital mineralogy:	Quartz, K-feldspar
Authigenic mineralogy:	K-fsp dissolution skeletal, K-fsp overgrowth, pyrite, quartz overgrowth, calcite cement pore filling – ferroan, Mn and Mg after K-fsp, secondary calcite dissolution

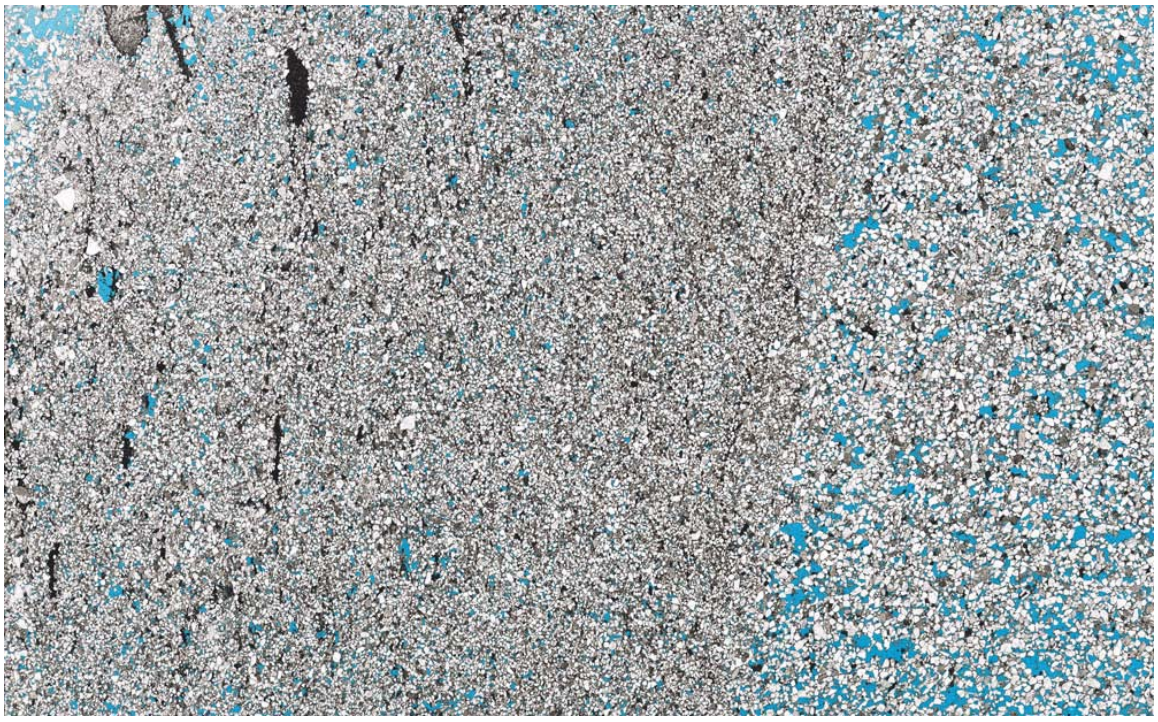


Sample ID: MW2 – Mount Winter 2A 178.4-178.6m

Sample type:	Blue stained polished section
Lithology:	Sandstone
Porosity:	Poor to moderate
Grain size:	Medium
Sorting:	Well
Roundness:	Subrounded
Detrital mineralogy:	Quartz, K-feldspar
Authigenic mineralogy:	Quartz overgrowth, ferroan calcite in pores (pore occluding) and patchy (some Mg and Mn bearing), K-fsp dissolution (skeletal), K-fsp overgrowth, rare clay minerals (illite replacing K-fsp)

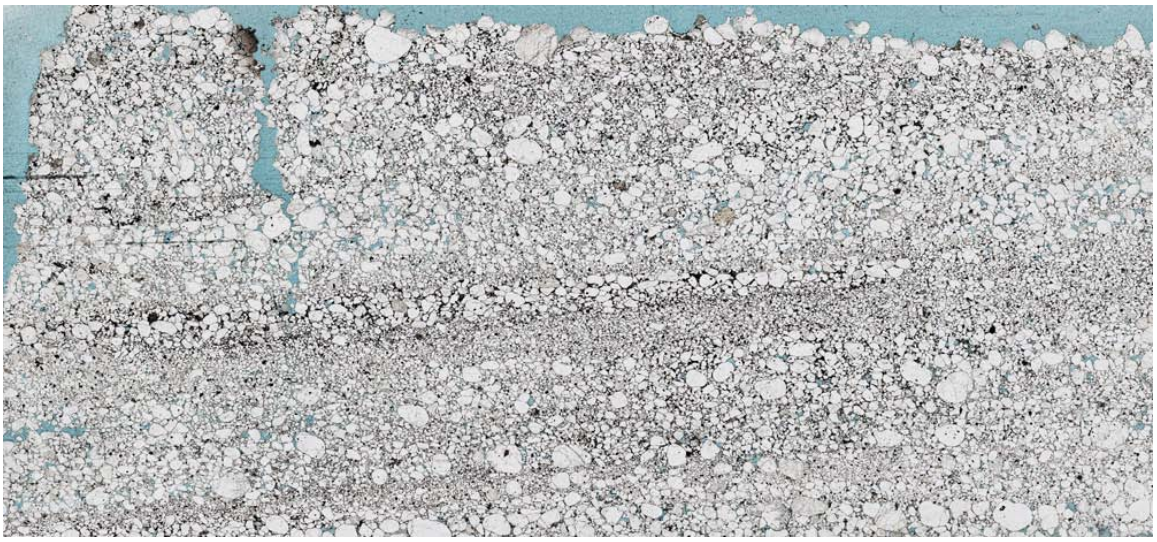
Sample ID: OO17 – Ooraminna 1 414.5m

Sample type:	Blue stained polished section
Lithology:	Sandstone, arkosic
Porosity:	Moderate
Grain size:	Medium grained
Sorting:	Moderate
Roundness:	Subrounded
Detrital mineralogy:	Quartz, K-feldspar, clay, heavy minerals and mica
Authigenic mineralogy:	K-feldspar dissolution, K-feldspar overgrowth, clay and minor quartz overgrowths



Sample ID: OR3 – Orange 1 821m

Sample type:	Blue stained polished section
Lithology:	Sandstone
Porosity:	Poor to moderate
Grain size:	Coarse
Sorting:	Well
Roundness:	Subrounded
Detrital mineralogy:	Quartz, K-feldspar
Authigenic mineralogy:	Quartz overgrowth, quartz pore filling, clay coating (illite), styolites in quartz

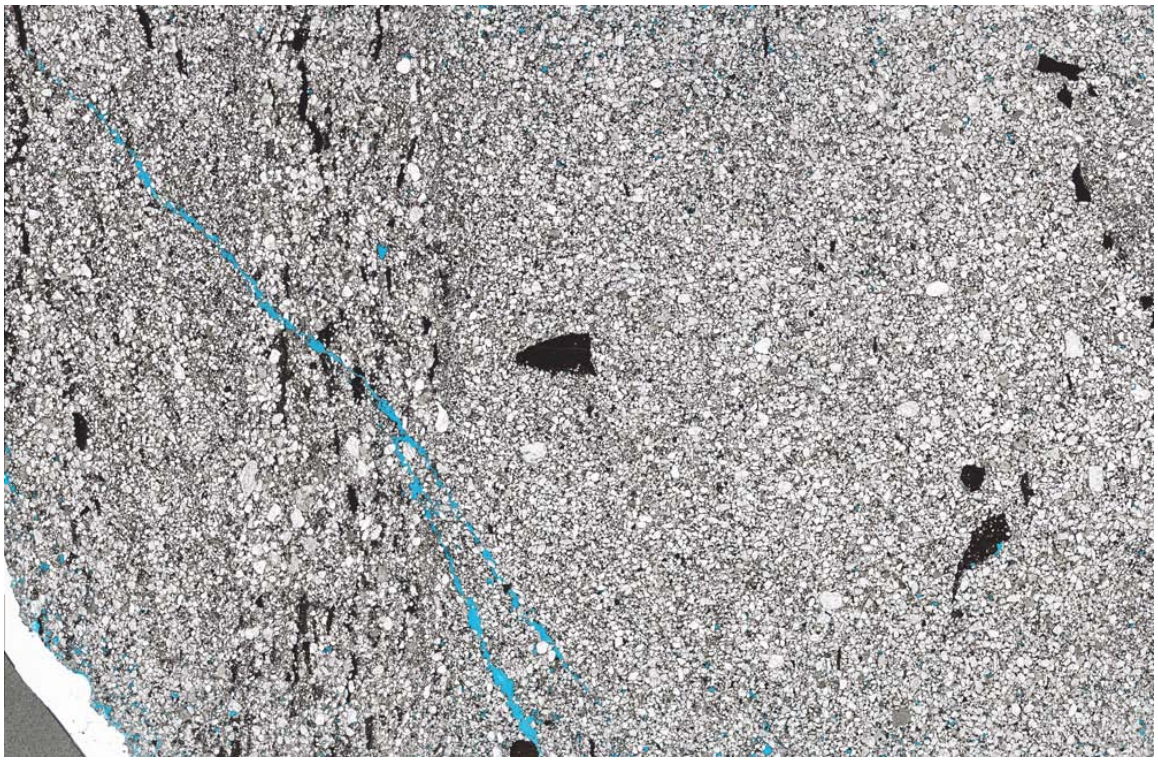


Sample ID: OR4 – Orange 1 871.7m

Sample type:	Blue stained polished section
Lithology:	Sandstone
Porosity:	Poor to moderate
Grain size:	Coarse
Sorting:	Well
Roundness:	Subrounded
Detrital mineralogy:	Quartz, K-feldspar
Authigenic mineralogy:	Apatite nodules, dolomite, quartz overgrowth, microquartz in pores, clay, styolite in quartz, heavily quartz cemented

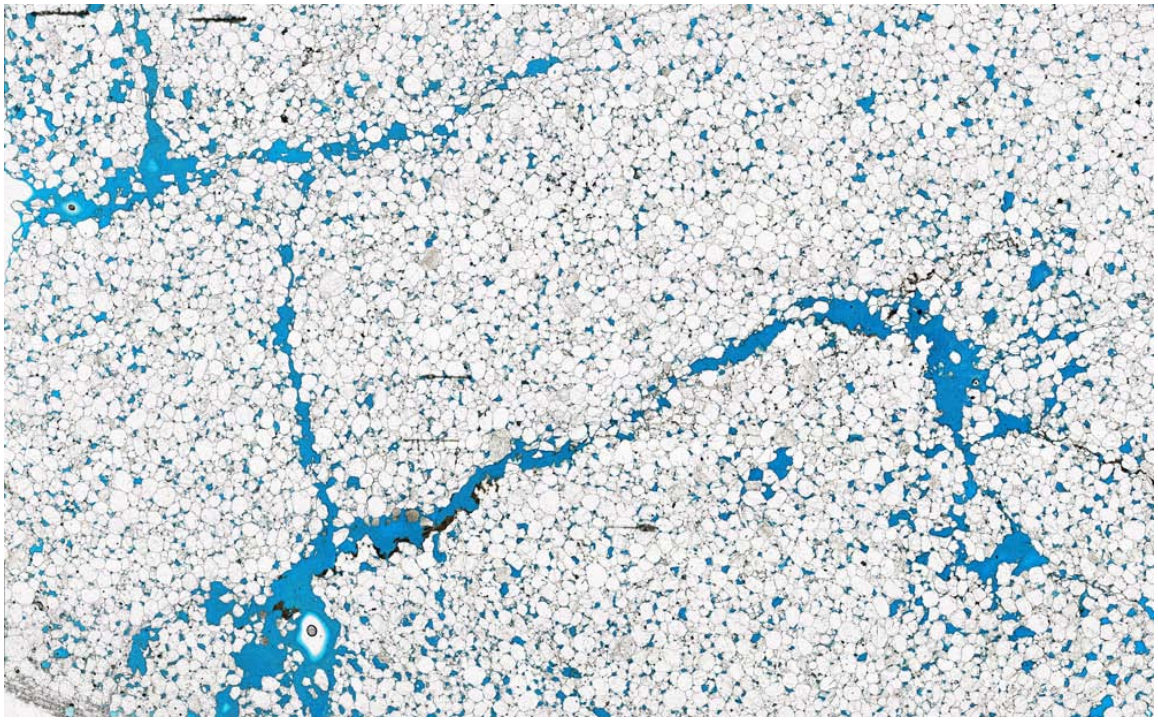
Sample ID: OR18 – Orange 1 2655.4m

Sample type:	Blue stained polished section
Lithology:	Sandstone, arkosic
Porosity:	Poor
Grain size:	Medium to fine grained
Sorting:	Moderate
Roundness:	Subrounded
Detrital mineralogy:	Quartz, K-feldspar, clay matrix, heavy minerals (apatite)
Authigenic mineralogy:	K-feldspar dissolution, quartz overgrowth may be inherited



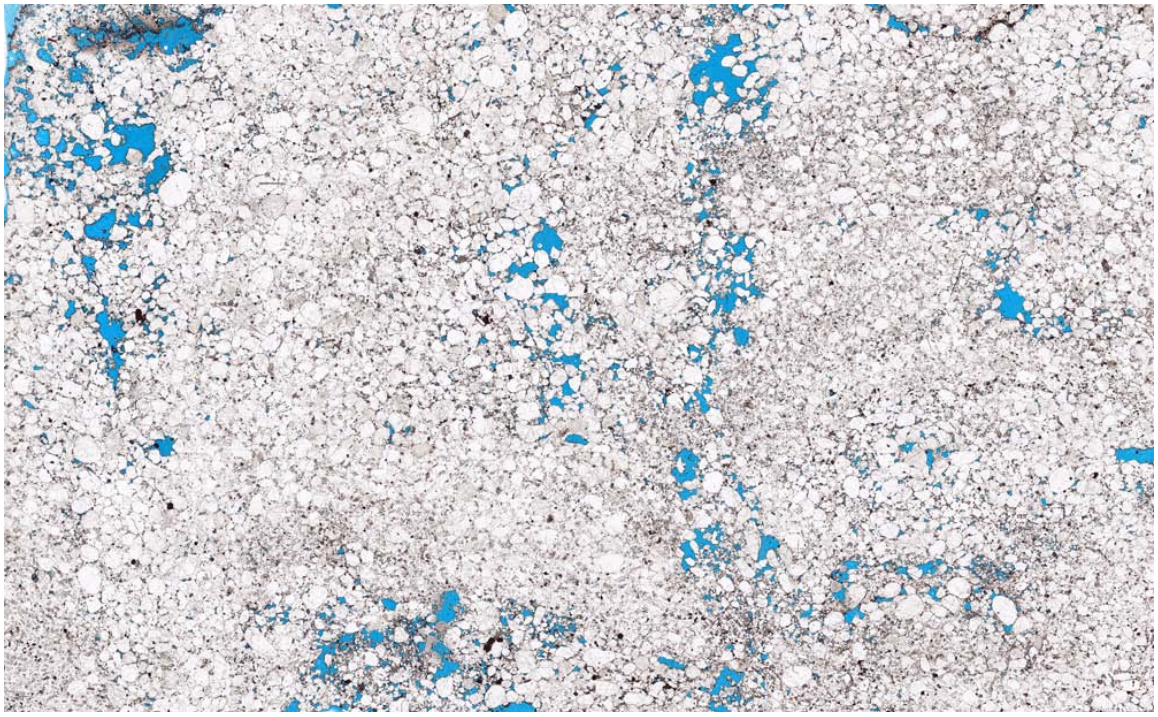
Sample ID: TV19 – Tempe Vale 1 351m

Sample type:	Blue stained polished section
Lithology:	Sandstone
Porosity:	Moderate
Grain size:	Medium to coarse
Sorting:	Well
Rounding:	Subangular to angular
Detrital mineralogy:	Quartz and mica
Authigenic mineralogy:	Quartz overgrowth, illite rare, cubic pyrite in clay, mica alteration to clay



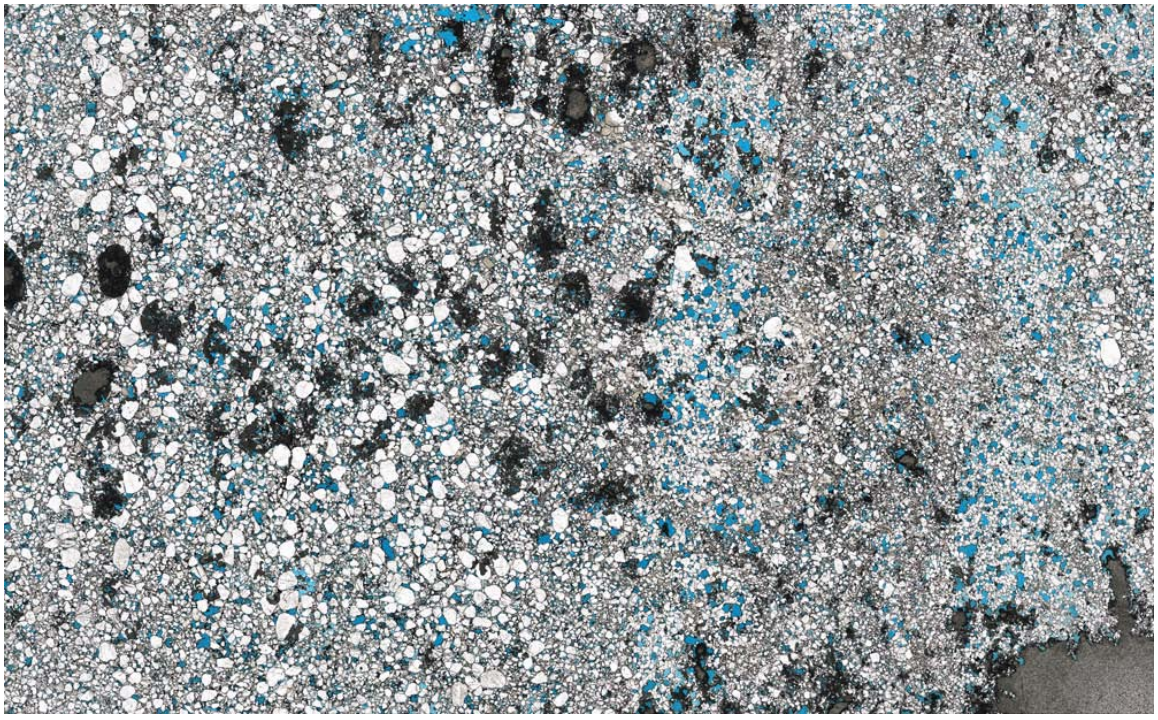
Sample ID: TV20 – Tempe Vale 1 521.3m

Sample type:	Blue stained polished section
Lithology:	Sandstone, arkosic
Porosity:	Poor
Grain size:	Medium
Sorting:	Poor
Rounding:	Subangular
Detrital mineralogy:	Quartz, K-feldspar
Authigenic mineralogy:	Iron oxides, quartz overgrowth, K-fsp dissolution, K-fsp overgrowth, illite replacing K-fsp, late barite infilling pores



Sample ID: TV21 – Tempe Vale 1 737.6m

Sample type:	Blue stained polished section
Lithology:	Sandstone
Porosity:	Good
Grain size:	Medium to coarse
Sorting:	Moderate
Rounding:	Subangular to angular
Detrital mineralogy:	Quartz, rare mica
Authigenic mineralogy:	Kaolinite in pores (booklets), heavy minerals, quartz overgrowth, clay minerals in pores, chlorite, fractured sandstone

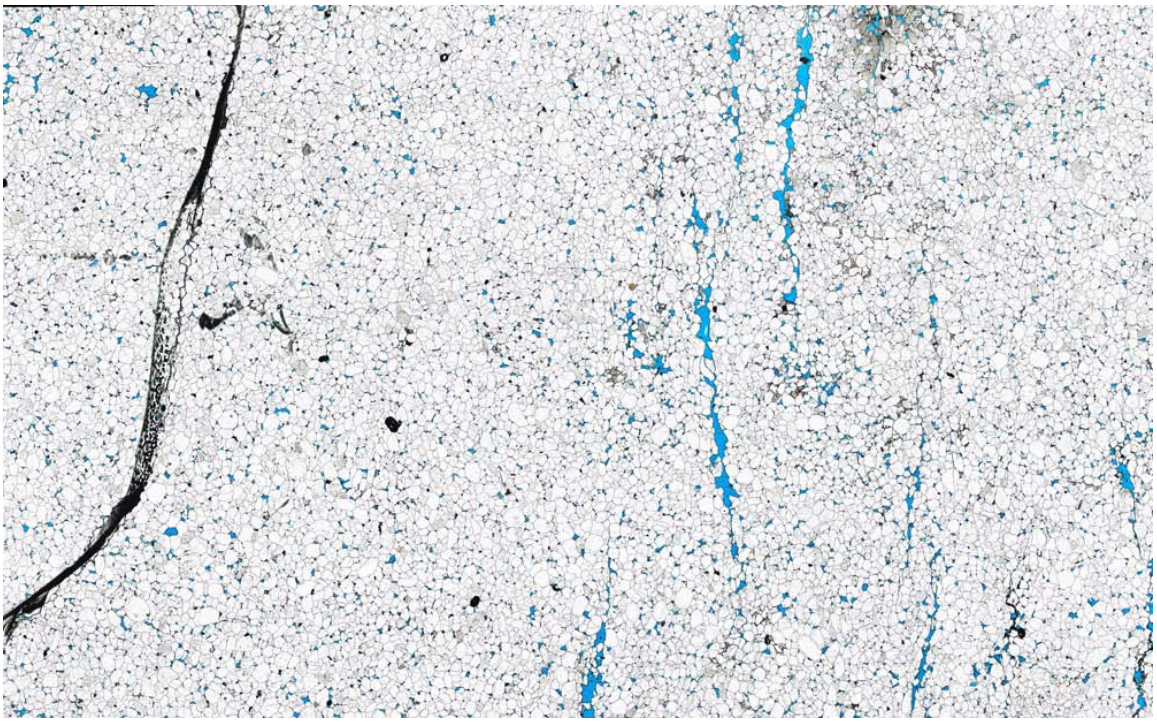


Sample ID: TH26 – Tent Hill 1 935m

Sample type:	Blue stained polished section
Lithology:	Sandstone, arkosic
Porosity:	Poor to moderate
Grain size:	Medium to fine
Sorting:	Moderate
Rounding:	Subangular to angular
Detrital mineralogy:	Quartz, K-feldspar, clay and mica
Authigenic mineralogy:	Quartz overgrowth, dissolution of K-fsp, styolites, pore filling and patchy anhydrite, kaolinite, barite

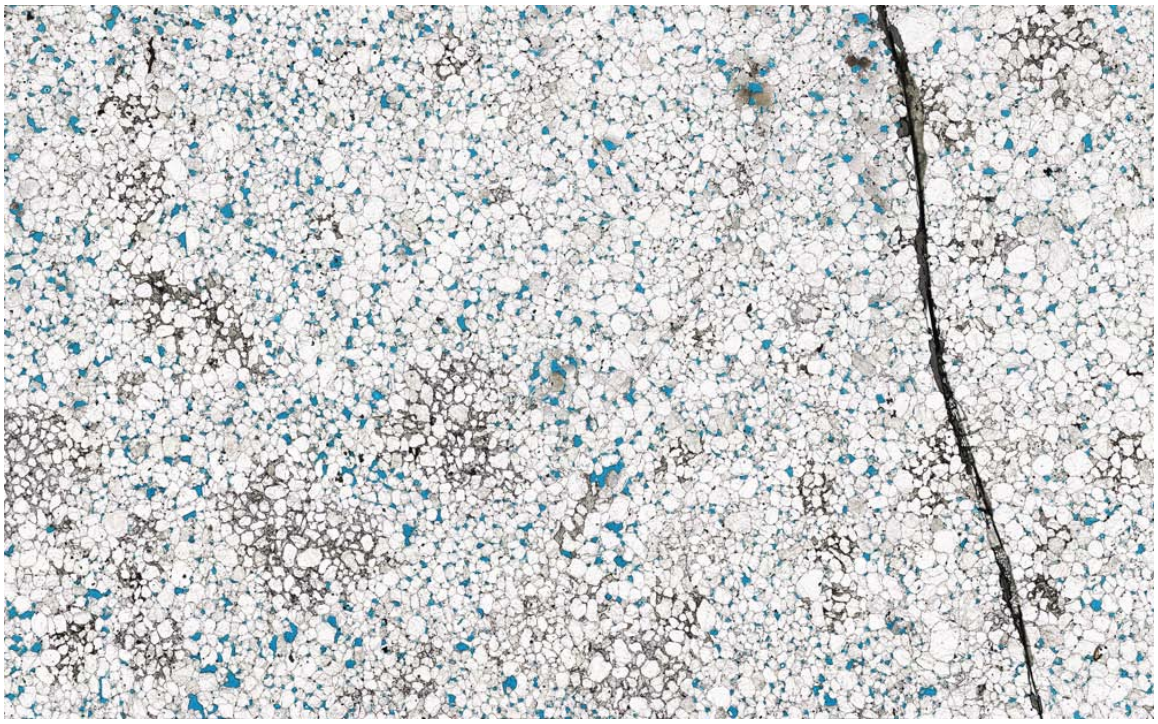
Sample ID: TH27 – Tent Hill 1 1103m

Sample type:	Blue stained polished section
Lithology:	Sandstone
Porosity:	Poor
Grain size:	Medium to coarse
Sorting:	Well
Rounding:	Subangular to subrounded
Detrital mineralogy:	Quartz
Authigenic mineralogy:	Quartz cement, minor clay, pyrite and minor patchy barite infilling pores after quartz cement (leached)



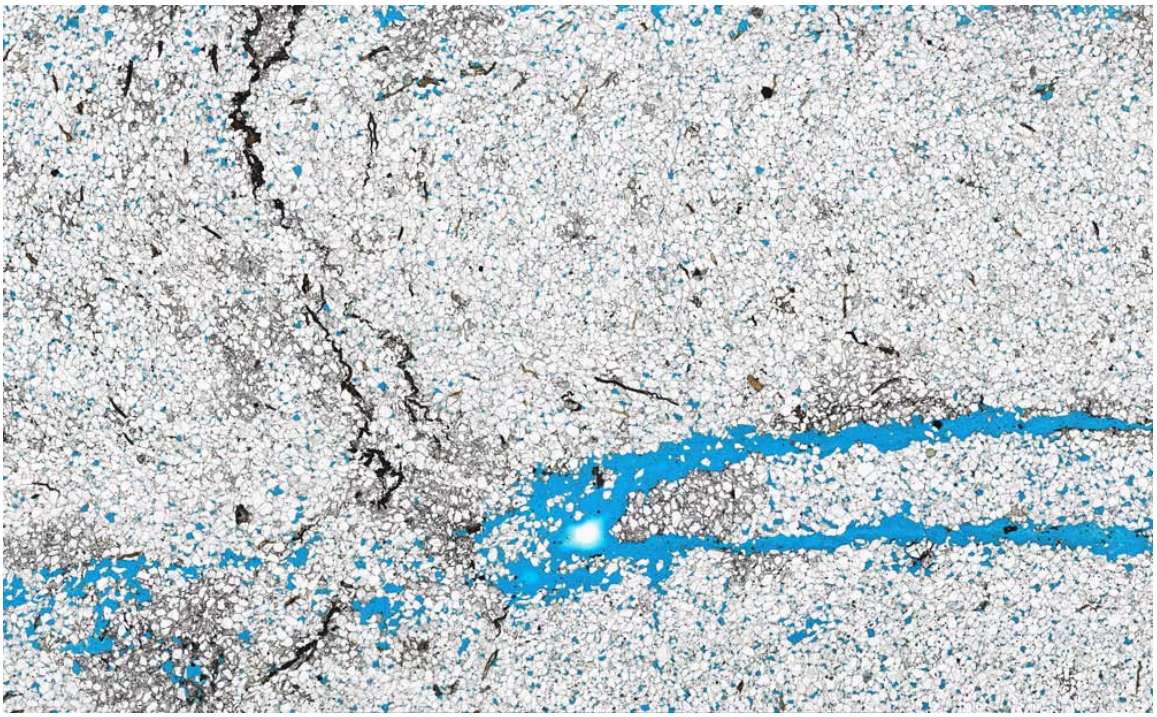
Sample ID: TH28 – Tent Hill 1 1225m

Sample type:	Blue stained polished section
Lithology:	Sandstone
Porosity:	Poor
Grain size:	Medium to coarse
Sorting:	Moderate
Rounding:	Angular to subangular
Detrital mineralogy:	Quartz, trace zircon
Authigenic mineralogy:	Quartz overgrowth into pores, low Fe-calcite infilling pores after quartz cementation, barite infilling pores, rare clay



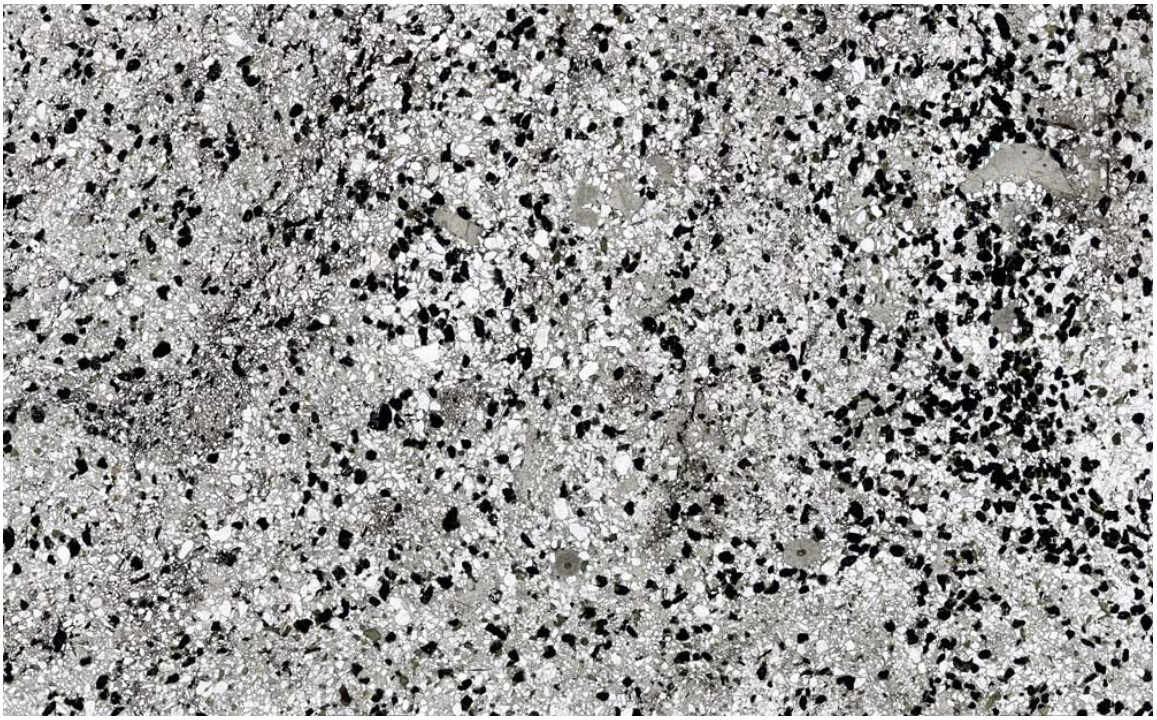
Sample ID: TH29 – Tent Hill 1 1280m

Sample type:	Blue stained polished section
Lithology:	Sandstone
Porosity:	Poor to moderate
Grain size:	Medium to coarse
Sorting:	Well
Rounding:	Angular to subangular
Detrital mineralogy:	Quartz, minor K-feldspar and zircon
Authigenic mineralogy:	Gypsum, ferroan calcite, patchy barite, quartz cement, K-fsp overgrowth on K-fsp, minor clay



Sample ID: TH30 – Tent Hill 1 1355m

Sample type:	Blue stained polished section
Lithology:	Sandstone
Porosity:	Poor
Grain size:	Medium to coarse
Sorting:	Well
Rounding:	Subrounded to subangular
Detrital mineralogy:	Quartz, K-feldspar
Authigenic mineralogy:	Calcite (Mg-Fe) cement, K-fsp cement overgrown by calcite, apatite replacing mica, quartz cement, apatite-pyrite replacing K-fsp

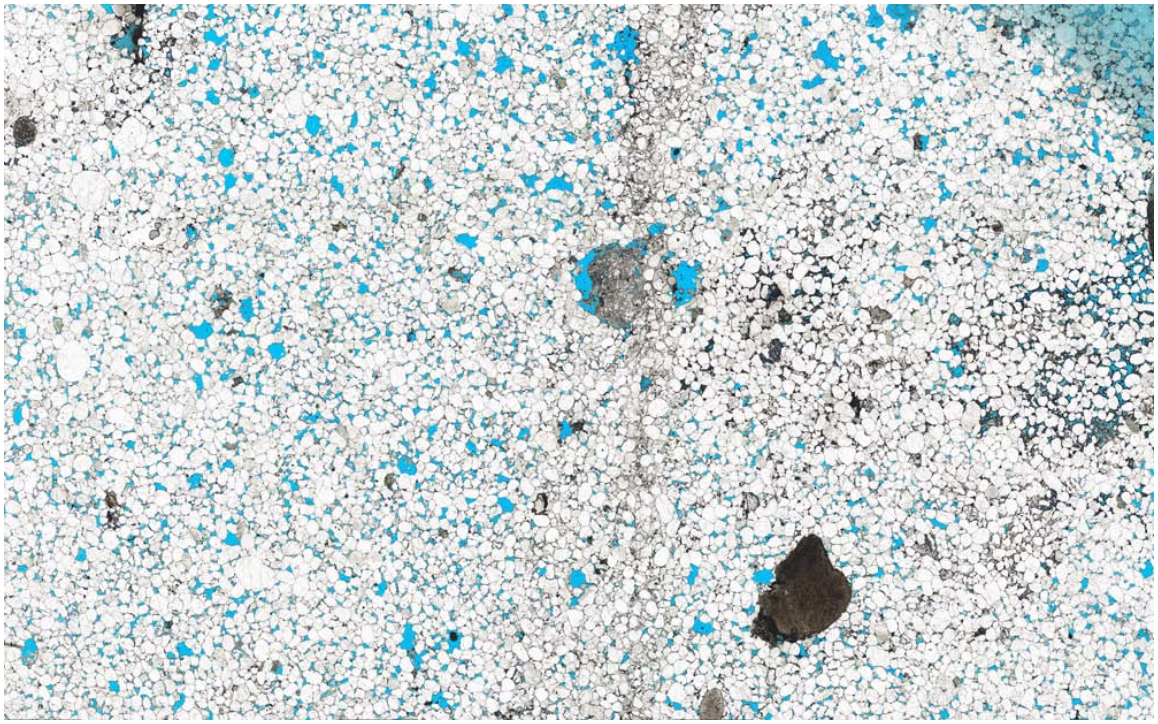


Sample ID: WB24 – Wallaby 1 2422m

Sample type:	Blue stained polished section
Lithology:	Sandstone
Porosity:	Poor
Grain size:	Medium to fine
Sorting:	Moderate to poor
Rounding:	Subrounded to rounded
Detrital mineralogy:	Quartz, K-feldspar, pyrite, clay
Authigenic mineralogy:	Barite associated with K-fsp cement (iron bearing), quartz cement, calcite (Mg-Fe) cement, clay supported sandstone, bands of silica (no grains), clay and heavily calcite cemented

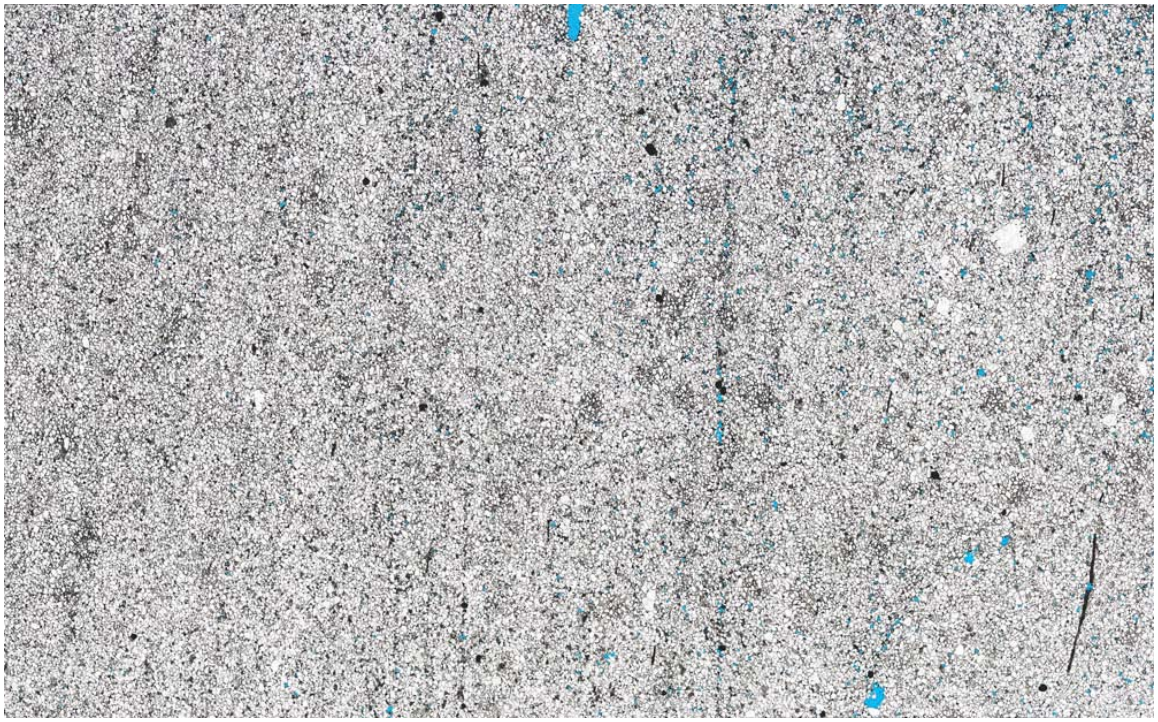
Sample ID: WA25 – Wallara 1 713.5m

Sample type:	Blue stained polished section
Lithology:	Sandstone
Porosity:	Moderate
Grain size:	Medium to coarse
Sorting:	Well
Rounding:	Angular
Detrital mineralogy:	Quartz, rare K-feldspar
Authigenic mineralogy:	Quartz overgrowth, anhydrite, barite, K-fsp dissolution, apatite associated with clay



Sample ID: WW23 – West Waterhouse 1 1806.4m

Sample type:	Blue stained polished section
Lithology:	Sandstone, arkosic
Porosity:	Moderate to poor
Grain size:	Medium
Sorting:	Moderate
Rounding:	Subangular
Detrital mineralogy:	Quartz, K-feldspar, trace zircon
Authigenic mineralogy:	Quartz overgrowth, ferroan calcite cement filling pores, hairy illite replacing K-fsp, euhedral K-fsp cement



3.2. XRD data

XRD data were aquired on sample OO17, TV19 and TV21. All results are shown in the table below.

Table 2. XRD results in percent.

Sample	Quartz	Feldspar	Musc/Illite	Hematite	Kaolinite	Dolomite	Chlorite
OO17	57	30	10	0.5	0	2	0
TV19	99	0	1	0	0	0	0
TV21	97	0	0	1	1.5	0	0

The XRD data show a simple mineralogical composition of a arkosic sandstone OO17 and clean quartz sandstones TV19, TV21.