

**Mineral Resources Tasmania**

**Mineralogical/Petrology Report**

**LJN2014-137**

# **XRD ANALYSES: DRILLCORE, NORTHERN TERRITORY**

An unpublished Mineral Resources Tasmania report for  
**NT Geological Survey**

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## SUMMARY

The XRD results generally confirm the presence of many of the mineral groups indicated by the IR methods, but in many cases the exact species cannot be determined. In some cases the Hylogger results have missed or misidentified some major minerals.

## INTRODUCTION & BACKGROUND

The Hylogger IR spectroscopic analyses of drillcore being conducted by various Geological Surveys in Australia routinely return analyses indicating various minerals that often cannot be readily confirmed in the hand specimens, and require XRD (X-ray diffraction) or other methods for confirmation.

The objective of this study is mostly to determine the presence or absence of various minerals, or their more specific identity, in samples from these drillholes in the Northern Territory.

## SAMPLES

The details of the eleven drillhole sample, submitted for XRD by Belinda Smith, Northern Territory Geological Survey (NTGS), are given in Table 1 below.

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Table 1: Sample details

Client ID	TSG File Name	HyLogger Sample #	Depth (m)	Description
AS14BRS001	13BARCD038	000449	105.8	Mainly carbonate; shows as hornblende/amphibole in SWIR; edenite / pyroxene / microcline in TIR. Edenite is probably amphibole; please confirm no edenite (minimal chlorite if any).
AS14BRS002	13BARCD038	000508	106.23	Matches to phlogopite/ankerite in SWIR; calcite/biotite/forsterite in TIR. Not sure about phlogopite? Is there any amphibole present? Forsterite is incorrect but hole not yet processed.
AS14BRS003	13BARCD038	001405	113.63	matches to calcite and montmorillonite in both TIR and SWIR. Is this right?
AS14BRS004	13BARCD038	0003902	131.86	epidote in SWIR; quartz, epidote and diopside in TIR. Is diopside present? Anything else?
AS14BRS005	13BARCD038	004207	133.9	plots as epidote in SWIR; 80% grossular and 20% epidote in TIR. Confirm grossular and epidote please. Anything else?
AS14BRS006	13BARCD038	004405	135.23	Same site as petrophysics measurement. Plots as FeMg chlorite, phlogopite in SWIR; microcline in TIR. Is this right?
AS14BRS007	13BARCD038	004894	138.72	serpentine, calcite in SWIR. Siderite, calcite and hornblende in TIR. Serpentine probably spurious?
AS14BRS008	13BARCD038	005818	145.24	Vein/ selvedge material (?) SWIR. Serpentine-dolomite in SWIR; dolomite in TIR, maybe some siderite, hornblende (??)
HU14BRS001	J13	012163	141.02	plots as andradite 80% quartz 20%. Can you tell if it's andradite, rather than just 'garnet'? Petrography indicates andradite too
HU14BRS002	J13	013489	151.33	plots as spessartine, NULL in SWIR. Can you please confirm that it is spessartine (not just garnet?)
HU14BRS003	J13	013523	151.61	plots as apatite with lesser spessartine, possible kaolinite.

The 13BARCD038 drillhole is from the Black Angus prospect, Eastern Arunta Block, southern Northern Territory.

The J13 drillhole is from the Jervois prospect, Arunta Orogenic Domain, southern Northern Territory.

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## ANALYTICAL TECHNIQUES

The samples were all prepared, examined and analysed by XRD, chemical techniques and low power microscopy in the Mineral Resources Tasmania (MRT) laboratories, Rosny Park, Tasmania.

### XRD

The samples were prepared, examined and analysed in the MRT laboratories, Rosny Park, Tasmania. They were run on an automated Philips X-Ray diffractometer system: PW 1729 generator, PW 1050 goniometer and PW 1710 microprocessor with nickel-filtered copper radiation at 35kV/25mA, a graphite monochromator (PW1752), sample spinner and a proportional detector (sealed gas filled PW1711). Our typical step-size is 0.02 degrees, and the standard scanning speed is 0.02 degrees/second. The PW1710 system is presently driven by the CSIRO XRD software: "VisualXRD", "PW1710 for Windows" and "XPLOT for Windows". Interpretation and quantification is largely manual, using a series of prepared standards of the more common minerals to enable some semi-quantitative analysis. Quartz, if present, is used as an internal standard; and if not present, it is often added to the sample for a supplementary scan. Our semi-quantitative results are calculated using single-peak calibration factors derived from scans of known mixtures of minerals.

### RESULTS

The XRD results are attached in Appendix 1 and are summarised in Table 2, with comparison to the Hylogger results. The results are discussed further below.

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**Table 2: Results summary**

Drillhole	Depth (m)	Expected mineralogy	Main XRD Results	Comments
13BARCD038	105.8	Mainly carbonate; shows as hornblende/amphibole in SWIR; edenite/pyroxene / microcline in TIR. Edenite is probably amphibole; please confirm no edenite (minimal chlorite if any).	K-Feldspar (35%-50%), Clinopyroxene (15%-25%), Scapolite (10%-15%), Amphibole (5%-10%), Calcite (2%-5%),	Edenite and hornblende are amphiboles but impossible to specify species without chemical analyses. Kspar is probably Orthoclase rather than microcline. Much more carbonate found by XRD than expected.
13BARCD038	106.23	Matches to phlogopite/ankerite in SWIR; calcite/biotite/forsterite in TIR. Not sure about phlogopite? Is there any amphibole present? Forsterite is incorrect but hole not yet processed.	Calcite (35%-50%), Mica (25%-35%), Dolomite (10%-15%), Serpentine (10%-15%), Clinopyroxene (2%-5%),	Mica is of biotite-phlogopite type, cannot specify without chemistry. Carbonate is calcite not ankerite. No forsterite or amphiboles found.
13BARCD038	113.63	Matches to calcite and montmorillonite in both TIR and SWIR. Is this right?	Calcite (50%-65%), Smectite (10%-15%), mixed-layer mineral (5%-10%),	Smectite may be the montmorillonite species; chemistry is needed. Mixed layer clay may have similar composition and IR properties.
13BARCD038	131.86	Epidote in SWIR; quartz, epidote and diopside in TIR. Is diopside present? Anything else?	Quartz (35%-50%), Epidote (15%-25%), Calcite (10%-15%), Clinopyroxene (5%-10%), Grossular (5%-10%), Scapolite (2%-5%),	Clinopyroxene may be diopside species, chemistry needed. Calcite not detected by IR.
13BARCD038	133.9	Plots as epidote in SWIR; 80% grossular and 20% epidote in TIR. Confirm grossular and epidote please. Anything else?	Grossular (50%-65%), Epidote (15%-25%), Quartz (5%-10%), Calcite (5%-10%),	Reasonable ID matches but minor quartz and calcite not detected.
13BARCD038	135.23	Same site as petrophysics measurement. Plots as FeMg chlorite, phlogopite in SWIR; microcline in TIR. Is this right?	K-Feldspar (50%-65%), Mica (25%-35%), Quartz (5%-10%), Calcite (2%-5%), Chlorite (<2%),	Only trace chlorite found by XRD. Mica is of biotite-phlogopite type. The Kspar is of uncertain type.
13BARCD038	138.72	Serpentine, calcite in SWIR. Siderite, calcite and hornblende in TIR. Serpentine probably spurious?	Calcite (50%-65%), Serpentine (15%-25%), Dolomite (5%-10%), Smectite (5%-10%),	No siderite or hornblende found by XRD; serpentine is correct.
13BARCD038	145.24	Vein/ selvedge material (?) SWIR. Serpentine-dolomite in SWIR; dolomite in TIR, maybe some siderite, hornblende(?)	Dolomite (35%-50%), Serpentine (15%-25%), Calcite (15%-25%), Mica (5%-10%), Chlorite (2%-5%), Clinopyroxene (2%-5%), Amphibole (<2%)	The second carbonate is calcite not siderite. There is only faint trace amphibole by XRD so the hornblende reported by IR may be due to the other minerals.

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J13	141.02	Plots as andradite 80% quartz 20%. Can you tell if it's andradite, rather than just 'garnet'? Petrography indicates andradite too	Garnet (50%-65%), Quartz (10%-15%), Chlorite (2%-5%), Amphibole (2%-5%), Stilpnomelane (2%-5%)	The garnet is consistent with a mixed species, probably about 50/50 andradite and grossular, but other compositions (e.g. Mn-rich) are possible; chemistry is needed to confirm the species.
J13	151.33	Plots as spessartine, NULL in SWIR. Can you please confirm that it is spessartine (not just garnet?)	Spessartine (50%-65%), Magnetite (10%-15%), Chlorite (10%-15%), Quartz (5%-10%), Plagioclase (2%-5%), Apatite (2%-5%), Chalcocopyrite (2%-5%), Mica (<2%)	The garnet is consistent with a spessartine, but other compositions (e.g. Mn-rich) are possible: chemistry is needed.
J13	151.61	Plots as apatite with lesser spessartine, possible kaolinite.	Apatite (35%-50%), Spessartine (25%-35%), Magnetite (15%-25%), Chlorite (5%-10%),	The garnet is consistent with a spessartine, but other compositions (e.g. Mn-rich) are possible: chemistry is needed. No kaolinite detected by XRD – possible interference by chlorite?

The XRD results confirm the presence of many of the mineral groups indicated by the IR methods, but in many cases the exact species cannot be determined without chemical analyses, especially with amphiboles, micas, smectites and garnets which can have many species with extremely variable and commonly intermediate compositions between theoretical end-members.

The K-feldspar can often be determined very accurately by XRD, but in one case above (13BARCD038/135.23) peak overlaps precluded this. In sample 13BARCD038/105.8, XRD indicates that the Kspar is probably orthoclase rather than microcline.

In some cases the Hylogger results have missed or misidentified some major minerals. For example in no forsterite or amphiboles were found by XRD in 13BARCD038/106.23; in 13BARCD038/131.86 no calcite was detected by IR; in 13BARCD038/138.72 no siderite or hornblende was found by XRD; in 13BARCD038/145.24 the second carbonate is calcite not siderite. It is possible that some of these discrepancies are due to inhomogeneity of the rock samples tested but in most of these cases we would have expected to see some trace of the minerals identified by IR.

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## Mineral Resources Tasmania Laboratory Report

**Client:** B. Smith, NTGS

**MRT Job Number:** MPR2014/137

**Analysis:** Approximate Mineralogy

**Method:** X-Ray Diffraction

**Results:** (approx wt %)

<i>TSG File</i>	<i>ID</i>	<i>HyLogger No.</i>	<i>Depth (m)</i>	<i>Minerals Identified</i>
13BARCD038	AS14BRS001	000449	105.80	K-Feldspar <sup>1</sup> (35%-50%), Clinopyroxene (15%-25%), Scapolite (10%-15%), Amphibole (5%-10%), Calcite (5%), Mica (<2%)
13BARCD038	AS14BRS002	000508	106.23	Calcite <sup>2</sup> (35%-50%), Mica <sup>B</sup> (25%-35%), Dolomite (10%-15%), Serpentine (10%-15%), Clinopyroxene (2%-5%), Chlorite (<2%)
13BARCD038	AS14BRS003	001405	113.63	Calcite (63%), Smectite <sup>3</sup> (10%-15%), Mixed-layer mineral <sup>4</sup> (5%-10%), Chlorite <sup>5</sup> (2%-5%), Quartz (2%-5%), K-Feldspar (2%-5%), Mica (<2%), Goethite (<2%)
13BARCD038	AS14BRS004	003902	131.86	Quartz (35%-50%), Epidote (15%-25%), Calcite (13%), Clinopyroxene (5%-10%), Grossular <sup>6</sup> (5%-10%), Scapolite (2%-5%), Smectite (2%-5%), ? <sup>7</sup> (2%-5%)
13BARCD038	AS14BRS005	004207	133.90	Grossular (50%-65%), Epidote (15%-25%), Quartz (5%-10%), Calcite (7%), Smectite (2%-5%), K-Feldspar (<2%)
13BARCD038	AS14BRS006	004405	135.23	K-Feldspar <sup>8</sup> (50%-65%), Mica <sup>B</sup> (25%-35%), Quartz (5%-10%), Calcite <sup>9</sup> (5%), Chlorite (<2%), Amphibole (<2%)



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13BARCD038	AS14BRS007	004894	138.72	Calcite <sup>9</sup> (50%-65%), Serpentine (15%-25%), Dolomite (5%-10%), Smectite (5%-10%), Mica <sup>B</sup> (2%-5%), Chlorite (<2%)
<i>TSG File</i>	<i>ID</i>	<i>HyLogger No.</i>	<i>Depth (m)</i>	<i>Minerals Identified</i>
13BARCD038	AS14BRS008	005818	145.24	Dolomite (35%-50%), Serpentine (15%-25%), Calcite <sup>2</sup> (15%-25%), Mica <sup>B</sup> (5%-10%), Chlorite (2%-5%), Clinopyroxene (2%-5%), Amphibole (<2%)
J13	HU14BRS001	012163	141.02	Garnet <sup>10</sup> (50%-65%), Quartz (10%-15%), Galena (10%-15%), Sphalerite (2%-5%), Chlorite (2%-5%), Amphibole (2%-5%), Stilpnomelane (2%-5%)
J13	HU14BRS002	013489	151.33	Spessartine (50%-65%), Magnetite (10%-15%), Chlorite (10%-15%), Quartz (5%-10%), Plagioclase (2%-5%) Apatite (2%-5%), Chalcocopyrite (2%-5%), Mica (<2%), ? <sup>11</sup> (<2%)
J13	HU14BRS003	013523	151.61	Apatite (35%-50%), Spessartine (25%-35%), Magnetite (15%-25%), Chlorite (5%-10%), Mica (<2%)

## Supplementary Scan (outside target area):

13BARCD038	AS14BRS001	000449	105.80	Mica <sup>B</sup> (50%-65%), Tourmaline (15%-25%), Clinopyroxene (10%-15%), Calcite (5%-10%), K-Feldspar (2%-5%), Amphibole (<2%), Serpentine (<2%)
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## Weight loss after treatment with HCl:

Sample	Wt. % Loss
AS14BRS001	4.6%
AS14BRS002	60.4%
AS14BRS003	62.8%

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AS14BRS004	12.6%
AS14BRS005	6.7%
AS14BRS006	4.8%
AS14BRS007	62.7%
AS14BRS008	68.4%

**Analyst:** R N Woolley  
**Date:** 23 December 2014



## XRD Notes:

Peak overlap (e.g. K-Feldspar and Clinopyroxene) may interfere with identification and quantitative calculations

Amorphous material (e.g. some hydrous iron oxides, organic matter) and minerals present in trace amounts may not be detected.

<sup>B</sup> Biotite type

<sup>1</sup> hand-picked clear crystals yielded peaks at 6.63, 6.48, 5.87, 4.58, 4.22, 3.95, 3.84, 3.77, 3.61, 3.55, 3.47, 3.31, 3.29, 3.24, 2.99, 2.90, 2.77, 2.60, 2.56 ... 2.162 ... 1.802; probably Orthoclase

<sup>2</sup> main peak at 3.024Å-3.025Å (Calcite = 3.035Å); some replacement of Ca by Fe/Mg/Mn

<sup>3</sup> main peak at 15.1Å; expands to 16.8Å when glycolated

<sup>4</sup> peaks at 24.4Å and 12.2Å; collapses to 12.0Å and/or 9.9Å (this peak may be produced by Smectite) when heated to 575°C; unaffected by glycolation; possible mixed-layer Chlorite-Mica?

<sup>5</sup> confirmed by heating to 600°C (collapse of normal structure and formation of 13.9Å peak)

<sup>6</sup> peaks at 2.970, 2.658, 2.532, 2.426, 2.330, 2.168, 1.928, 1.716, 1.649, 1.588 (Grossular = 2.962, 2.650, 2.526, 2.418, 2.323, 2.163, 1.922, 1.710, 1.643, 1.583); some very minor Fe substitution?

<sup>7</sup> some very small unassigned peaks; possibly two other minerals present in trace amounts, one with a peak at 3.15Å, and another with peaks at 4.05Å and 2.87Å

<sup>8</sup> uncertain species

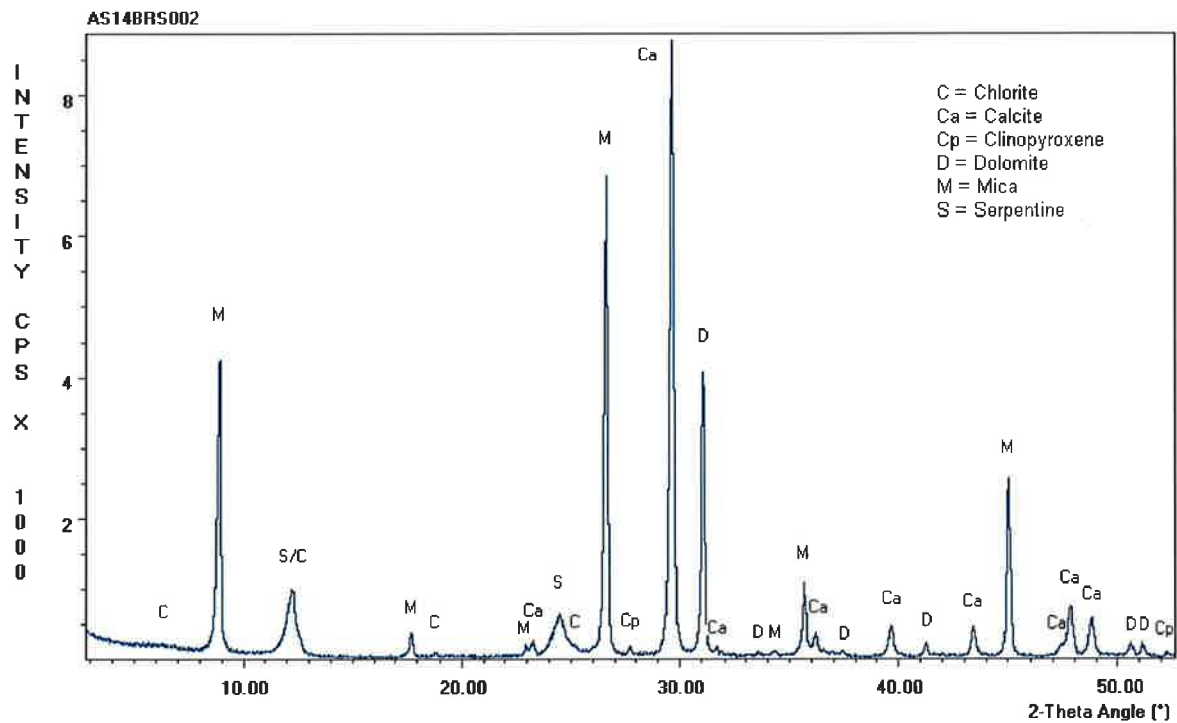
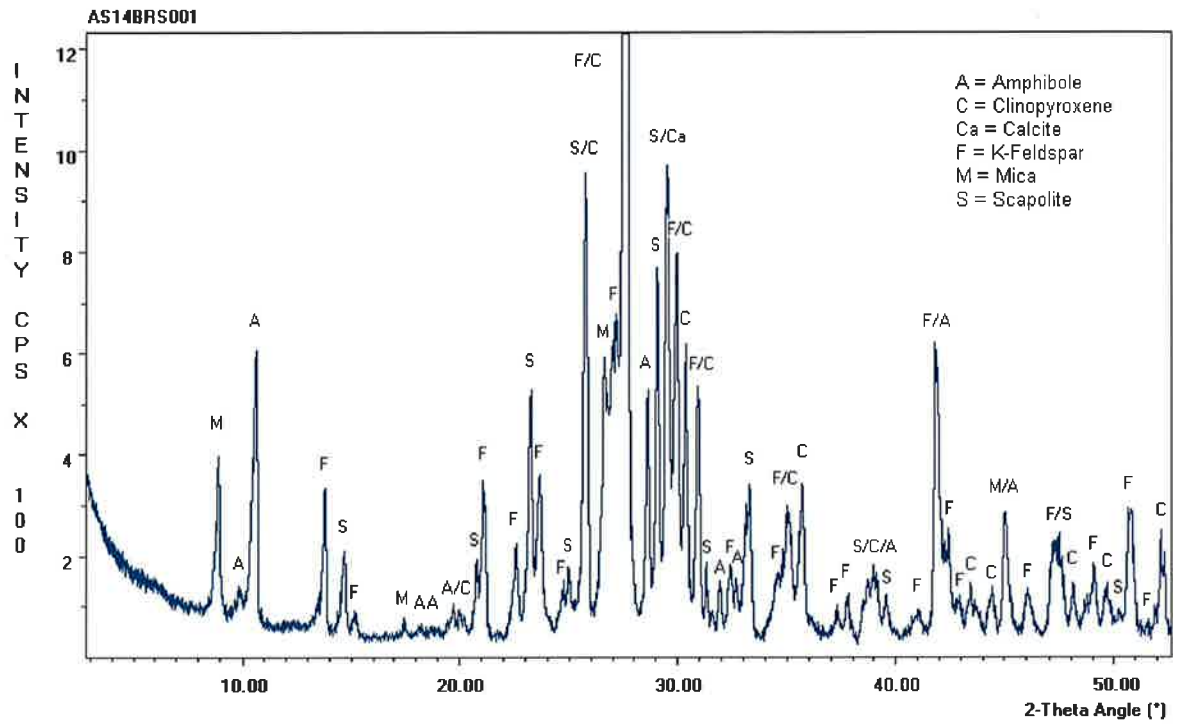
<sup>9</sup> main peak at 3.029Å-3.031Å (Calcite = 3.035Å); possibly some replacement of Ca by Fe/Mg/Mn

<sup>10</sup> peaks at [4.25, overlapped], 2.989, 2.676, 2.550, 2.442, 2.347, 2.185, 1.940, 1.892, 1.726, 1.660, 1.599; while Uvarovite (4.24, 2.999, 2.684, 2.557, 2.449, 2.352, 2.191, 1.946, 1.896, 1.732, 1.664, 1.603) is nominally the closest match. This mineral is probably an intermediate between Andradite (4.263, 3.015, 2.696, 2.571, 2.462, 2.365, 2.203, 1.956, 1.907, 1.741, 1.673, 1.611) and Grossular (4.189, 2.962, 2.650, 2.526, 2.418, 2.323, 2.163, 1.922, 1.872, , 1.710, 1.643, 1.583)

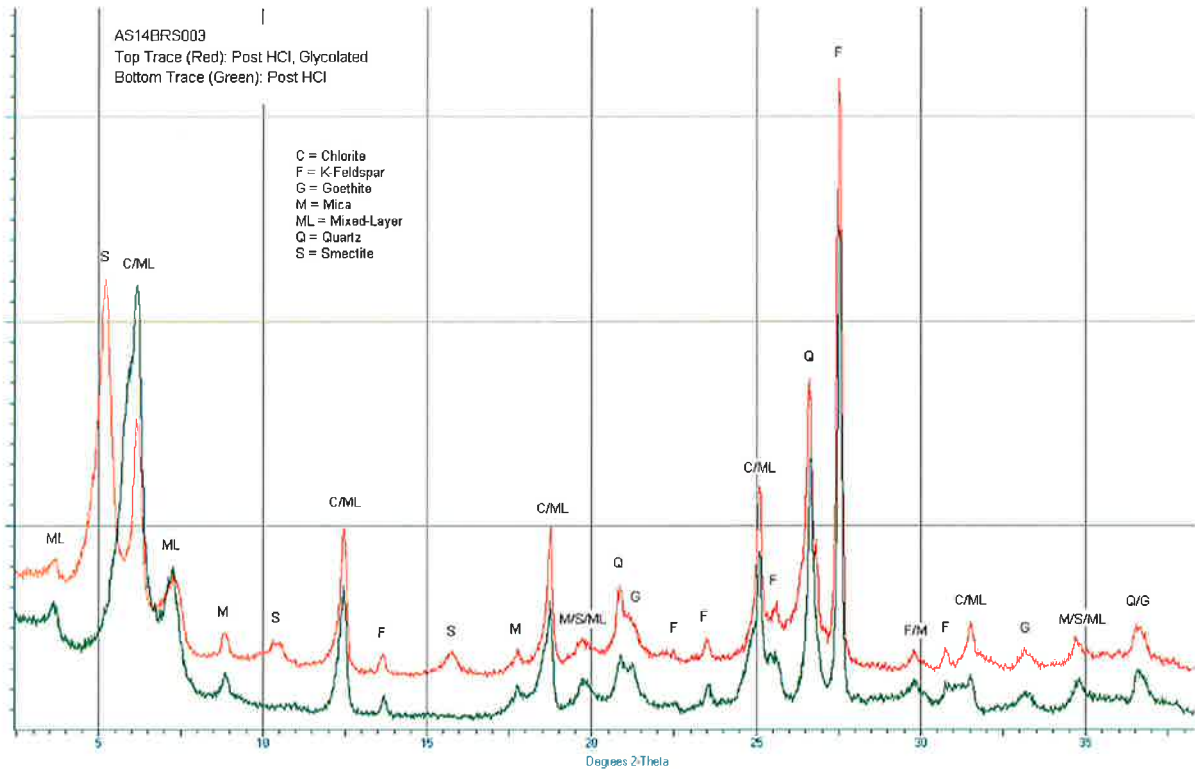
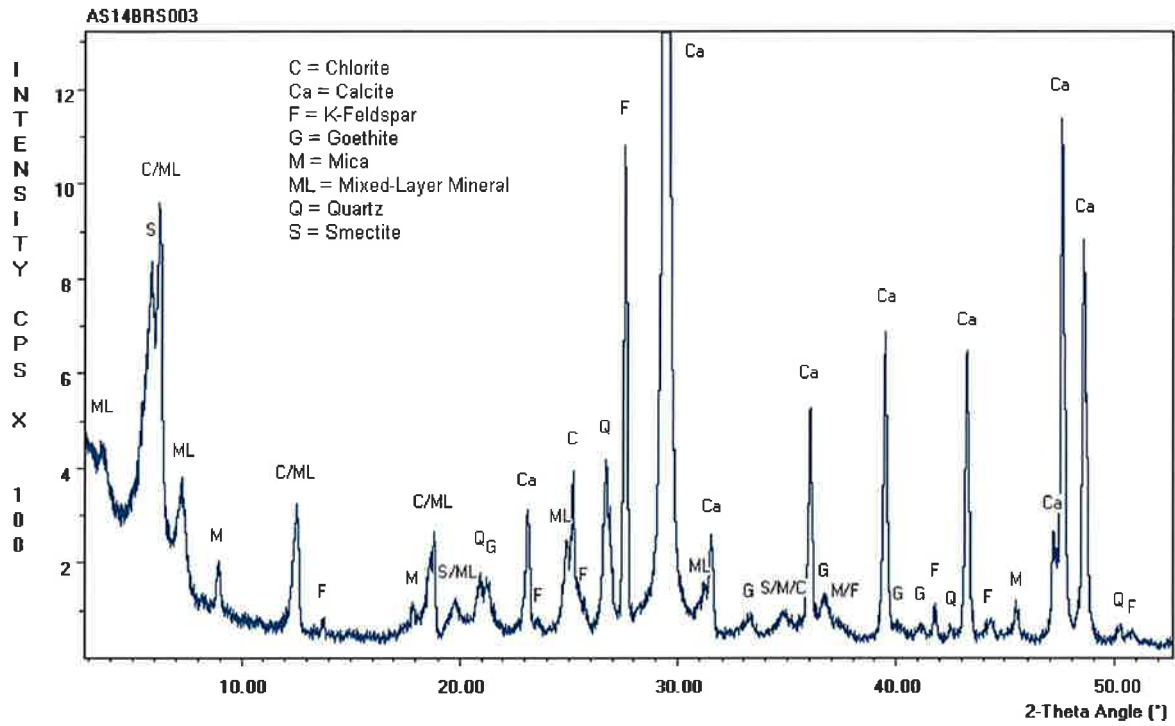
<sup>11</sup> small broad peak at 12.1Å; possible Stilpnomelane or a mixed-layer mineral

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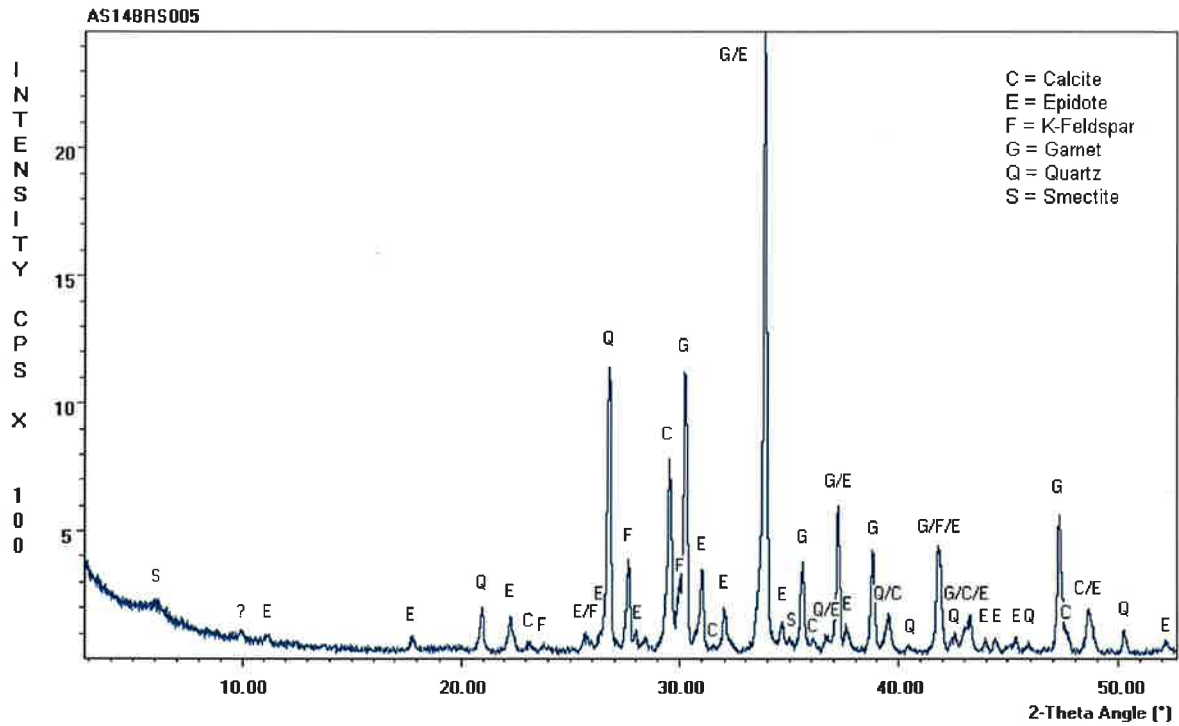
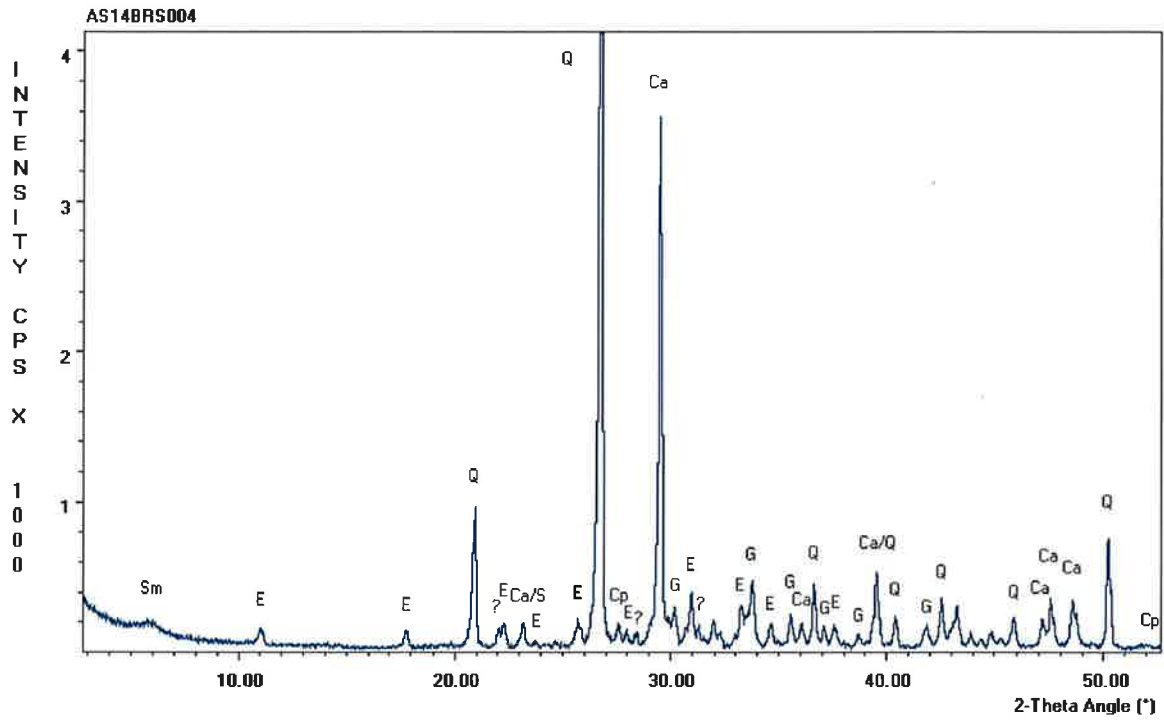
## XRD Scans



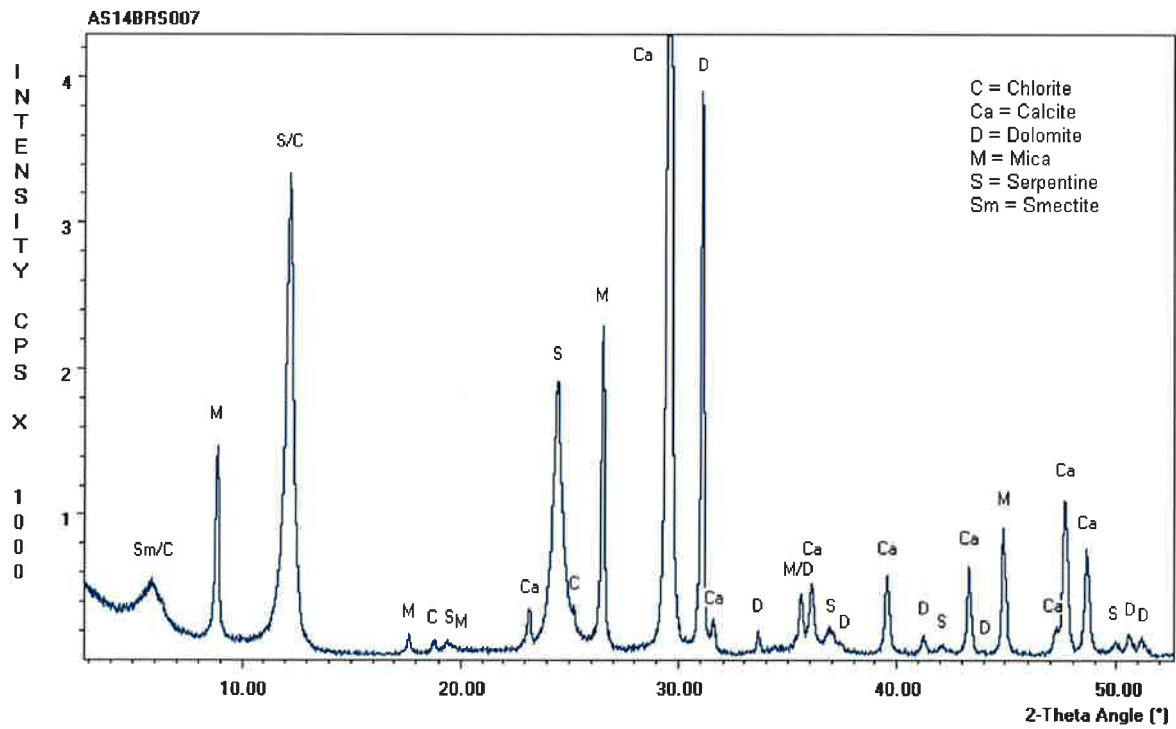
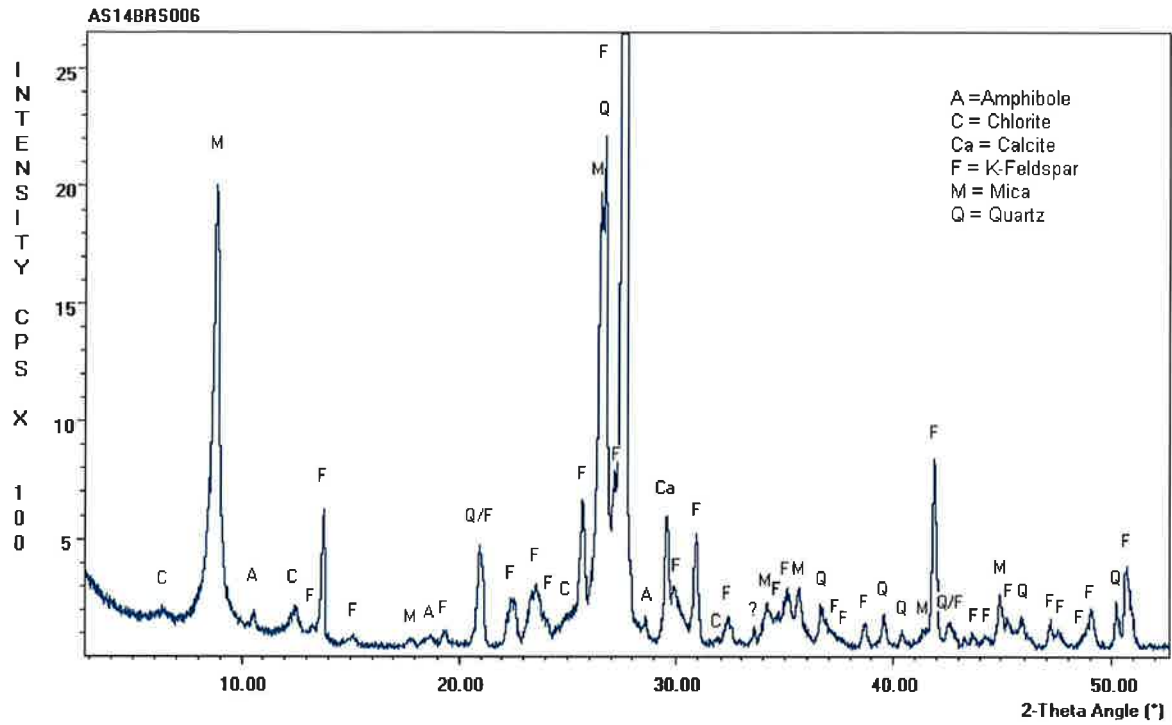
# Mineral Resources Tasmania



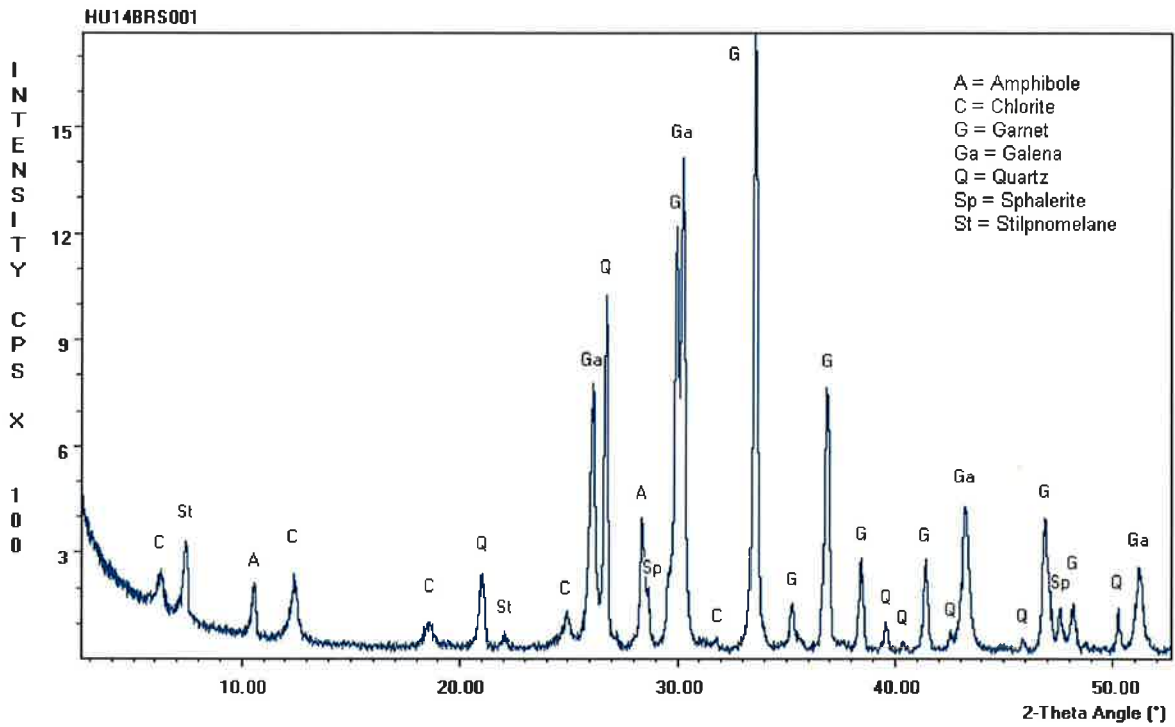
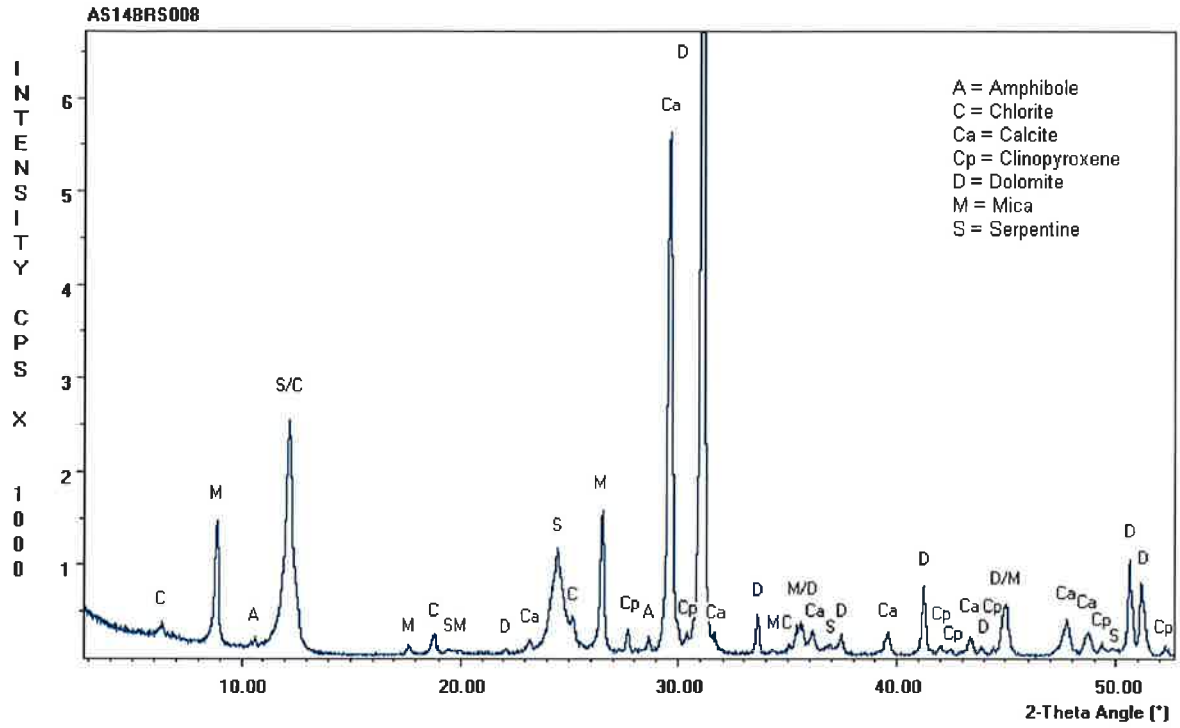
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