XRD ANALYSES:
DRILLCORE,
NORTHERN TERRITORY

An unpublished Mineral Resources Tasmania report for
NT Geological Survey

by R S Bottrill and R N Woolley

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SUMMARY

The XRD results generally confirm the presence of most of the minerals indicated by the Hylogger/IR methods. There are very few significant misidentifications or misses in the Hylogger results. In some cases the Hylogger results have misidentified some minerals, e.g. the TIR seems to identify Fe-serpentinite as montmorillonite. The Hylogger has identified two feldspars and two pyroxenes, but XRD shows only one of each.

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.
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SAMPLES

The details of the five drillhole sample, submitted for XRD by Belinda Smith, Northern Territory Geological Survey (NTGS), are given in Table 1 below. The eight drill core samples were all from the Arnhem area, on the Alligator River, NT.

Table 1: Sample details

<table>
<thead>
<tr>
<th>Client ID</th>
<th>TSG DDH File Name</th>
<th>HyLogger Sample #</th>
<th>Hole Depth (m)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AL15BRS001</td>
<td>OBRD14-127/194.05</td>
<td>000305</td>
<td>194.05</td>
<td>aspects tale in SWIR; augite, oligoclase in TIR. CLS shows augite, hedenbergite, labradorite, prehnite, biotite, montmorillonite, muscovite.</td>
</tr>
<tr>
<td>AL15BRS002</td>
<td>OBRD14-127/203.78</td>
<td>001728</td>
<td>203.78</td>
<td>Aspects tale in SWIR, Labradorite, augite, oligoclase, montmorillonite, prehnite</td>
</tr>
<tr>
<td>AL15BRS003*</td>
<td>OBRD14-127/219.97</td>
<td>004155</td>
<td>219.97</td>
<td>Mg chlorite in SWIR. Chlorite, augite, oligoclase in TIR</td>
</tr>
<tr>
<td>AL15BRS004</td>
<td>OBRD14-127/225.1</td>
<td>004950</td>
<td>225.10</td>
<td>chlorite, illitic phengite in SWIR. Quartz, illite in TIR.</td>
</tr>
<tr>
<td>AL15BRS005</td>
<td>OBRD14-127/272.6</td>
<td>012070</td>
<td>272.60</td>
<td>Phengite, Mg chlorite in SWIR. Quartz, muscovite in TIR</td>
</tr>
</tbody>
</table>

* Not submitted

ANALYTICAL TECHNIQUES

The samples were all prepared, examined and analysed by XRD and chemical techniques 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
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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.

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

Table 2: Summary of Main Results, discrepancies highlighted

<table>
<thead>
<tr>
<th>TSG DDH File Name</th>
<th>Client ID</th>
<th>IR mineralogy (NTGS)</th>
<th>Main XRD mineralogy</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>OBRD14-127 /189.05</td>
<td>AL15BRS001</td>
<td>Aspectral in SWIR; augite, oligoclase in TIR. CLS shows augite, oligoclase, hedenbergite, labradorite, prehnite, biotite, montmorillonite, muscovite.</td>
<td>Ca-Na Plagioclase, Clinopyroxene, Quartz, Mica (biotite), Fe-Serpentine</td>
<td>Fair. Only one plagioclase (Ca&gt;Na) and Ca-pyroxene found; no montmorillonite or prehnite. Maybe two micas</td>
</tr>
<tr>
<td>OBRD14-127 /217.78</td>
<td>AL15BRS002</td>
<td>Aspectral in SWIR, Labradorite, augite, oligoclase, montmorillonite, Fe-Serpentine</td>
<td>Ca-Na Plagioclase, Clinopyroxene, Mica (biotite), Fe-Serpentine</td>
<td>Fair. Only one plagioclase (Ca&gt;Na) and Ca-pyroxene found; no montmorillonite or prehnite. Maybe two micas</td>
</tr>
<tr>
<td>OBRD14-127 /217.97</td>
<td>AL15BRS003</td>
<td>Mg chlorite in SWIR. Chlorite, Mg-chlorite in TIR.</td>
<td>Not submitted</td>
<td></td>
</tr>
<tr>
<td>OBRD14-127 /228.1</td>
<td>AL15BRS004</td>
<td>Chlorite, illitic phengite in SWIR. Quartz, illite in TIR.</td>
<td>Quartz Mica (Phengitic muscovite?), Chlorite</td>
<td>Good</td>
</tr>
<tr>
<td>OBRD14-127 /272.6</td>
<td>AL15BRS005</td>
<td>Phengite, Mg chlorite in SWIR. Quartz, muscovite in TIR.</td>
<td>Quartz Mica (Phengitic muscovite?), Chlorite</td>
<td>Good</td>
</tr>
</tbody>
</table>
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SUMMARY AND DISCUSSION

The XRD results generally confirm the presence of most of the minerals indicated by the Hylogger/IR methods. There are very few significant misidentifications or misses in the Hylogger results. The Hylogger results shown in Table 2 are classified here as:

- **Good**: Two or more main minerals identified, subordinates detected correctly.
- **Fair**: One main mineral confirmed, and/or only one incorrectly identified; some subordinates detected correctly.
- **Poor**: Main phases not detected, some subordinates detected correctly.
- **Very poor**: No phases detected correctly.

The results thus vary from fair to good, and overall the results are generally quite good.

Notable XRD results and possible issues include that:

1. In two samples the feldspar was identified by Hylogger as both Labradorite and oligoclase but XRD indicated just a Na-anorthite (Labradorite?). XRD cannot precisely identify the plagioclase composition.

2. In two samples the pyroxene was identified by Hylogger as both augite and hedenbergite but XRD indicated just clinopyroxene. XRD cannot precisely identify the pyroxene composition.

3. The Hylogger only missed some minor constituents like Fe-serpentine (greenalite/berthierine?) and talc.

4. The mica is mostly trioctahedral (biotite?) in two samples and dioctahedral (phengitic muscovite?) in two others but there is insufficient to be more precise.

5. Only minor probable false positives came from the Hylogger, for minor montmorillonite and prehnite.
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This and other data collected in MRT laboratories may enter the MRT databases but every attempt will be made to ensure it remains closed file and not be available externally, unless at your request.
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APPENDIX 1: MINERAL RESOURCES TASMANIA LABORATORY REPORT

MINERAL RESOURCES TASMANIA

Client: B. Smith, NTGS
Sample Source:
MRT Job Number: LJM2015/147
Analysis: Approximate Mineralogy
Method: X-Ray Diffraction

Results:

<table>
<thead>
<tr>
<th>Sample</th>
<th>AL15BRS001</th>
<th>AL15BRS002</th>
<th>AL15BRS004</th>
<th>AL15BRS005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth</td>
<td>194.05m</td>
<td>203.78m</td>
<td>225.1m</td>
<td>272.6m</td>
</tr>
<tr>
<td>Hylogger #</td>
<td>000305</td>
<td>001728</td>
<td>004950</td>
<td>012070</td>
</tr>
<tr>
<td>Abundance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;80%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>65%-80%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50%-65%</td>
<td></td>
<td></td>
<td>Quartz</td>
<td>Quartz</td>
</tr>
<tr>
<td>35%-50%</td>
<td>Ca-Na Plagioclase</td>
<td>Ca-Na Plagioclase</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25%-35%</td>
<td>Clinopyroxene</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15%-25%</td>
<td>Clinopyroxene</td>
<td>Mica(^6), Chlorite</td>
<td>Mica(^6), Chlorite</td>
<td></td>
</tr>
<tr>
<td>10%-15%</td>
<td></td>
<td>Mica(^2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5%-10%</td>
<td>Quartz, Mica(^2), Fe-Serpentine(^3)</td>
<td>Fe-Serpentine(^3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2%-5%</td>
<td>Talc</td>
<td>Quartz, Talc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;2%</td>
<td>Amphibole, Chlorite(^8), Smectite(^6), ? (^6)</td>
<td>Amphibole, Prehnite, Pumpellyite, ? (^7)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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NOTES

1. Peaks at 6.43, 4.68, 4.04, 3.90, 3.76, 3.64, 3.47, 3.37, (3.24, overlapped), 3.21, 3.18, 3.13, 3.02, 2.95, (2.93), (2.91), 2.84, 2.82, 2.65, 2.52, etc – probably Na-Anorthite

2. Trioctahedral; removed by warm HCl; too much overlapping to accurately determine (060) peak; very small peaks at 10Å and 5.0Å in residue after acid treatment may indicate that a trace of dioctahedral Mica is also present

3. Peaks at 7.15Å-7.18Å, 3.55Å-3.57Å and 2.74Å-2.75Å; destroyed by heating to 580°C; soluble in warm HCl; similar to Greenalite/Berthierine

4. Confirmed by transformation of small peak at 14.3Å to 13.9Å after heating to 580°C

5. Confirmed by glycolation (14.3Å peak splits to form 16.7Å and 14.2Å peaks)

6. Trace amounts of Prehnite and Pumpellyite may also be present

7. Trace amounts of Chlorite may be present (barely detectable peaks at 14.0Å and, after heating, 13.9Å)

8. Dioctahedral; (060) peak at 1.503Å; probably Muscovite

Analyst: R N Woolley
Date: 20 January 2016
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AL150RS001

A = Amphibole
C = Chlorite
Cp = Clinopyroxene
M = Mica
P = Plagioclase
Q = Quartz
S = Serpentine
Sm = Smectite
T = Talc

AL150RS001 Post-HCl (warm)

A = Amphibole
Cp = Clinopyroxene
P = Plagioclase
Q = Quartz
T = Talc
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A = Amphibole  
Cp = Clinopyroxene  
M = Mica  
P = Plagioclase  
Q = Quartz  
S = Serpentine  
T = Talc

AL1SBS002

AL1SBS004

C = Chlorite  
M = Mica  
Q = Quartz
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C = Chlorite
M = Mica
Q = Quartz