



Central Analytical
Research Facility

QUT Central Analytical Research Facility Scientific Report

CLIENT	ALS Minerals (SA)
REPORT DATE	21 st September 2017
PREPARED BY	Henry Spratt, David Steele, and Tony Raftery
ANALYSIS REQUESTED	Qualitative XRD
OUR REFERENCE	X17316
YOUR REFERENCE	W and B
QUT CONTACTS	<p>Dr David Steele, Research Officer/Laboratory Manager Ph: 07 3138 2583 email: david.steele@qut.edu.au</p> <p>Mr Tony Raftery, Projects Manager Ph: 07 3138 5122 email: a.raftery@qut.edu.au</p> <p>Dr Henry Spratt, Senior Laboratory Technician Ph: 07 3138 9526 email: henry.spratt@qut.edu.au</p> <p>X-ray and Particles Laboratory enquiries: xandp@qut.edu.au</p>

RESULTS

Phase Identification / Quantification

The powder X-ray diffraction patterns show the presence of crystalline phases. Graphics of the collected diffraction patterns along with the phases identified are included at the end of this report. Below are tables of the phases identified and their concentration estimates. The estimated normalised concentration of the corundum internal standard in the samples is higher than 10 wt%. This means there is an unaccounted for component in the samples (i.e., the samples contain non-diffracting/unidentified material). End-member albite was consistently the best fitting plagioclase phase to all samples. Microcline was consistently the best fitting K-Feldspar to all samples. In sample – both “intermediate” and “maximum” microcline phases were required to obtain a good fit to the collected data. The apatite phase reported was modelled as fluorapatite because the a unit cell parameter refined to $< 9.4 \text{ \AA}$; a a unit cell value $> 9.4 \text{ \AA}$ implies hydroxyapatite.

Although qualitative analysis was requested, it was decided to model the diffraction patterns to ensure the phases in the samples were identified correctly and to determine any low minor phases.

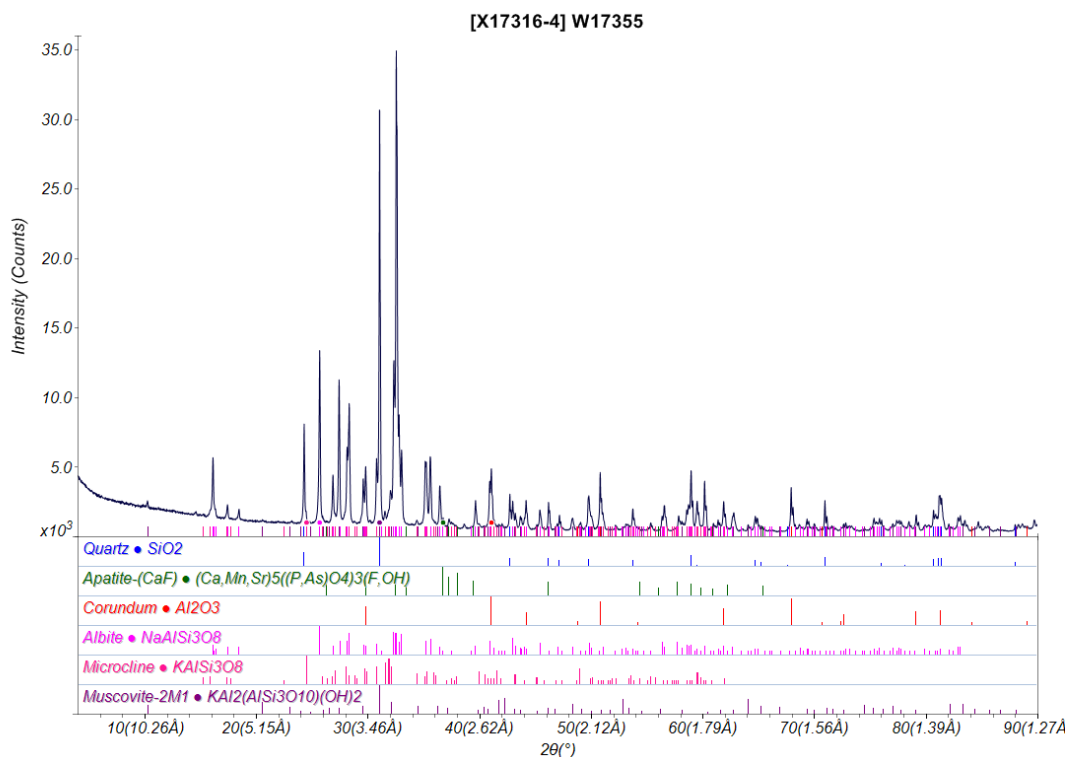
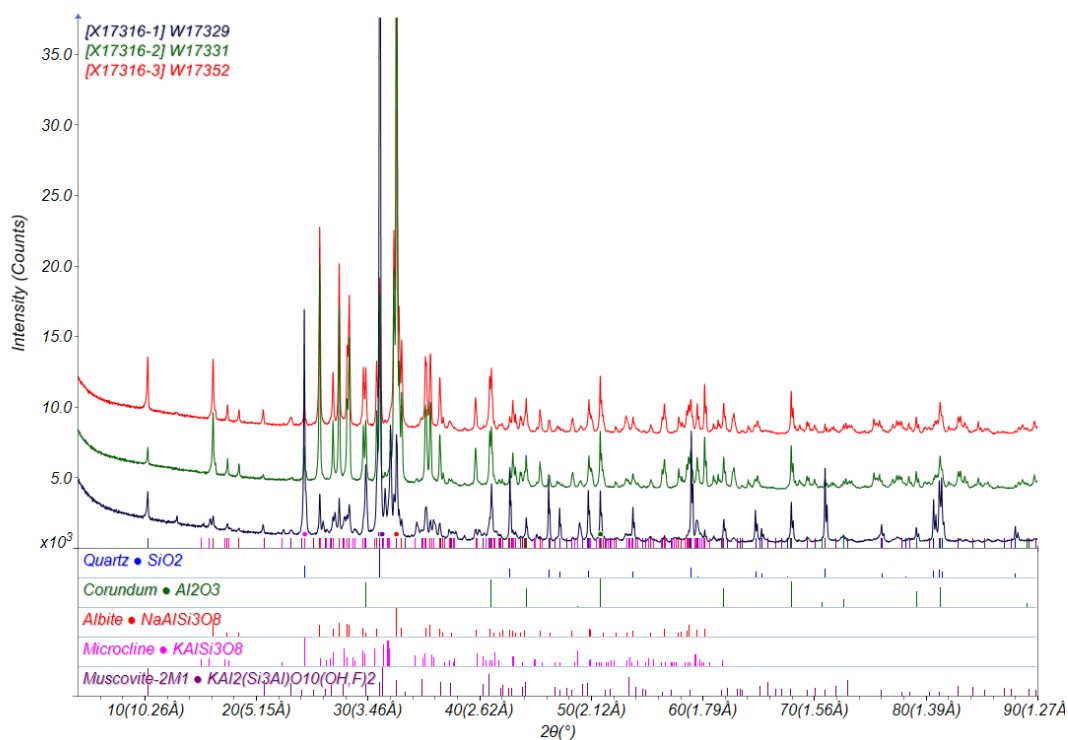
Table of phase concentration estimates (nominal wt%, absolute)

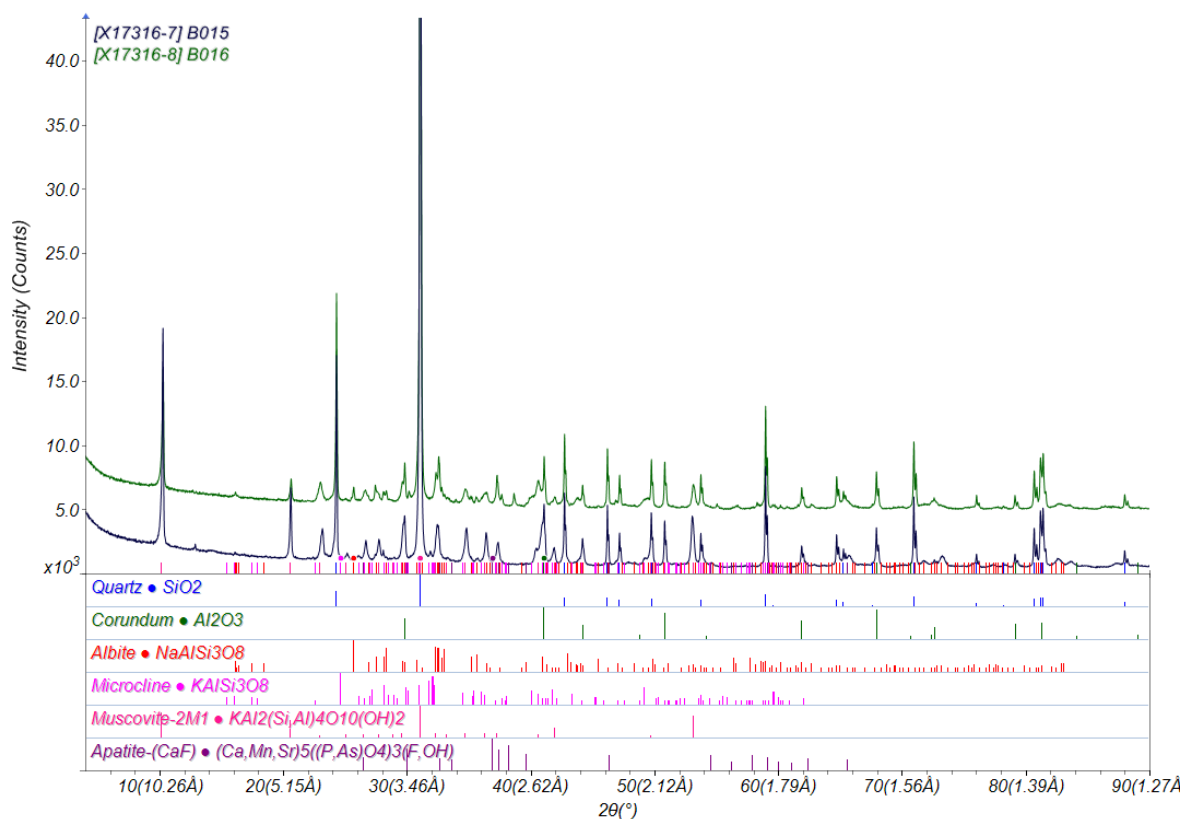
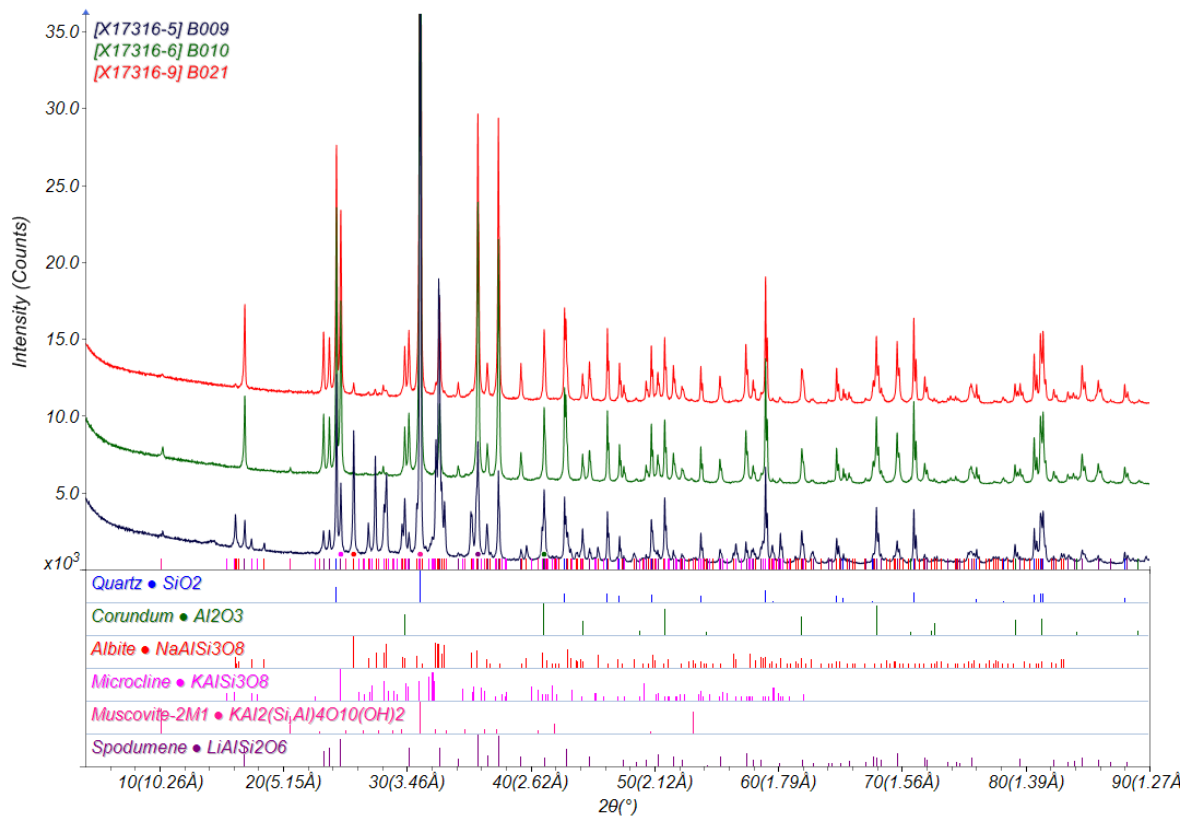
<i>X17316</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>
<i>W and B</i>	<i>W17329</i>	<i>W17331</i>	<i>W17352</i>	<i>W17355</i>	<i>B009</i>	<i>B010</i>
Quartz	41.7	6.3	4.3	15.9	25.7	40.9
Fluorapatite				0.9		
Spodumene					19.2	50.2
Albite	17.9	84.8	79.3	72.3	40.7	
K-Feldspar (microcline)	27.5	5.8	3.3	7.3	3.4	
Mica (muscovite)	5.4	3.0	9.3	1.8	2.4	2.7
Non-diffracting/unidentified	7.5	0.3	3.8	1.9	8.6	6.2

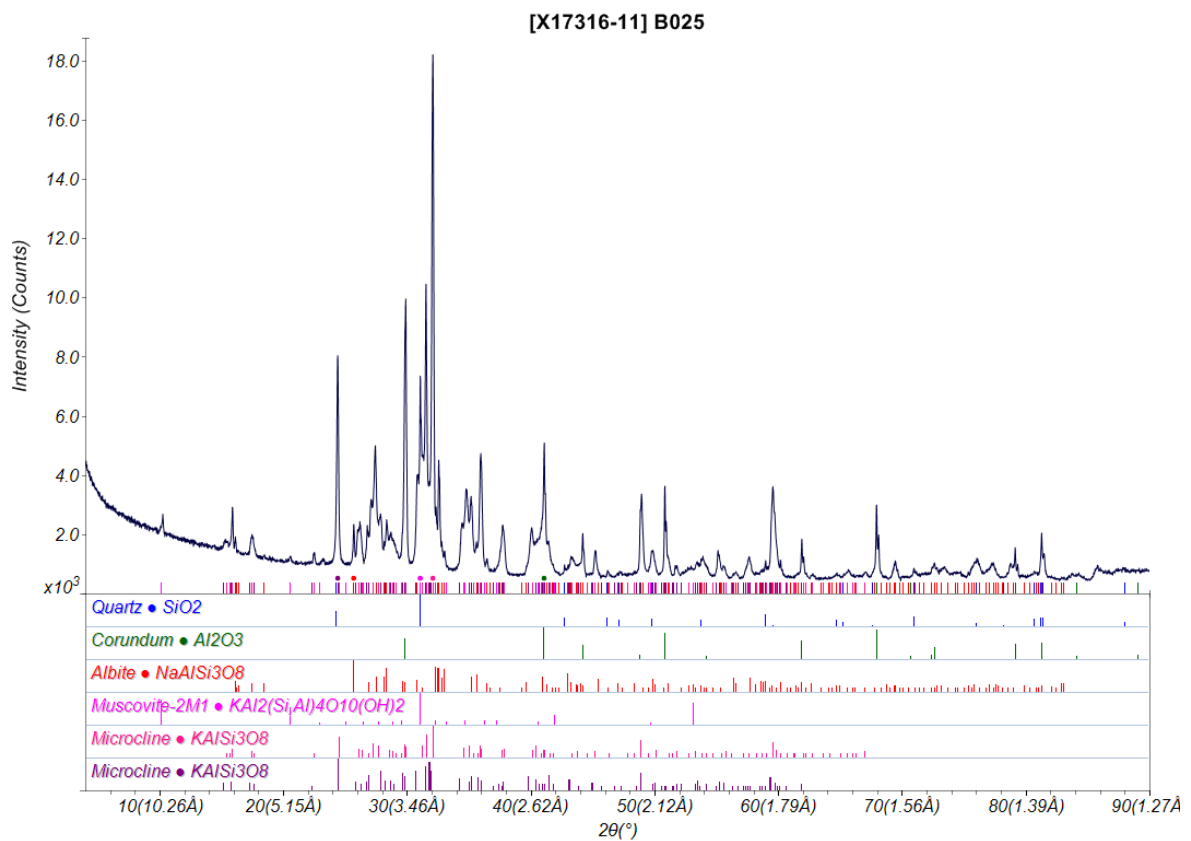
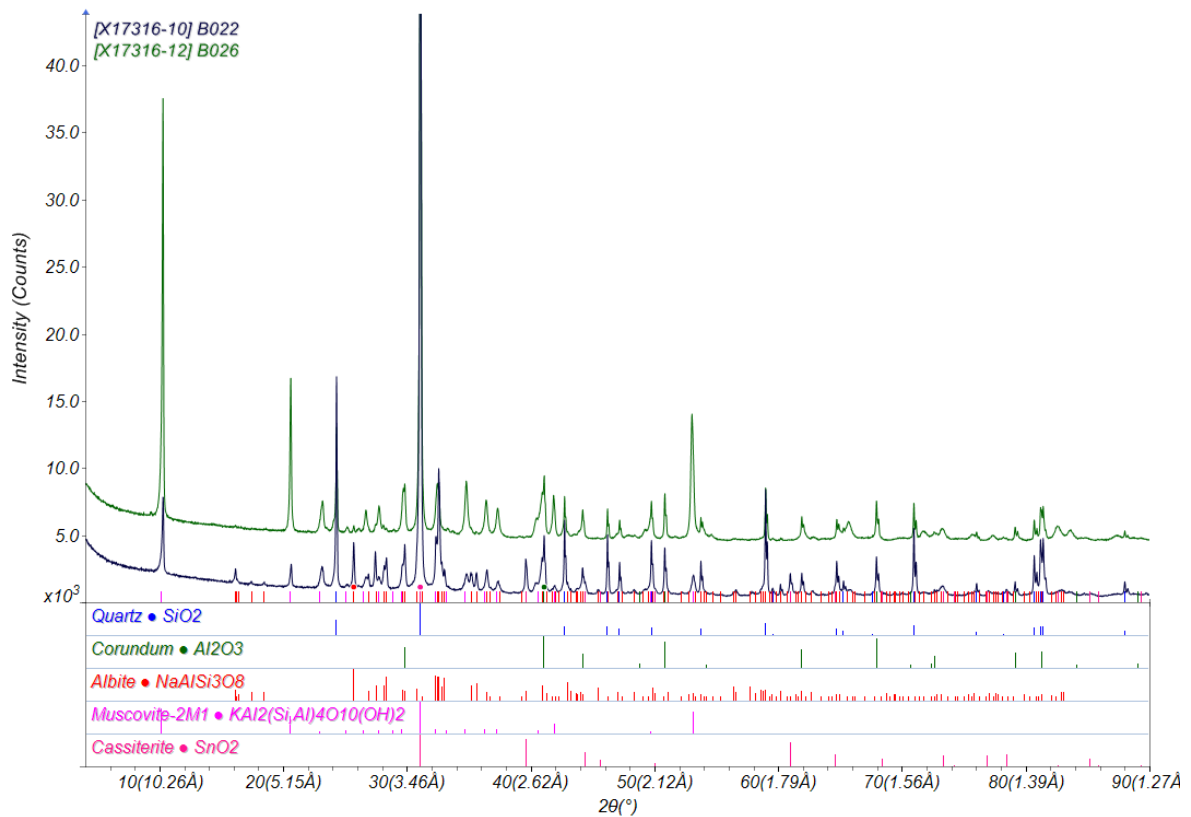
<i>X17316</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>	<i>11</i>	<i>12</i>
<i>W and B</i>	<i>B015</i>	<i>B016</i>	<i>B021</i>	<i>B022</i>	<i>B025</i>	<i>B026</i>
Quartz	38.3	41.5	39.3	41.8	1.5	17.2
Cassiterite				1.4		
Fluorapatite		2.9				
Spodumene			50.7			
Albite	3.5	8.1	2.7	21.4	9.3	5.8
K-Feldspar (microcline)	1.6				78.9	
Mica (muscovite)	39.8	30.3		25.7	2.9	58.7
Non-diffracting/unidentified	16.8	17.2	7.4	9.7	7.5	18.4

APPENDIX 1 – X-RAY DIFFRACTION DATA AND GRAPHICS

Powder X-ray Diffraction Patterns







APPENDIX 2 – ANALYTICAL TECHNIQUES

Sample preparation

Sub-samples (2.7 g) were accurately weighed and specimens prepared for X-ray diffraction analysis by the addition of a corundum (0.3 g, Al_2O_3) internal standard at 10 wt%. The specimens were micronised in a McCrone mill using zirconia beads and ethanol, then dried in an oven overnight at 40 °C. The resultant homogenous powders were back-pressed into sample holders. Note, corundum was added by mistake. Thus, quantitative results are reported but will be invoiced at qualitative price as requested.

Sample analysis

Step scanned X-ray diffraction patterns were collected for half an hour per sample using a PANalytical X'Pert Pro powder diffractometer and cobalt $\text{K}\alpha$ radiation operating in Bragg-Brentano geometry. The collected data was analysed using JADE (V2010, Materials Data Inc.) and X'Pert Highscore Plus (V4, PANalytical) with various reference databases (PDF4+, AMCSD, COD) for phase identification. Rietveld refinement was performed using TOPAS (V5, Bruker) for quantitative phase analysis. The known concentration of added corundum facilitates reporting of absolute phase concentrations for the modelled phases. The sum of the absolute concentrations is subtracted from 100 wt% to obtain a residual (called non-diffracting/unidentified, also known as “amorphous”). The residual represents the unexplained portion of the pattern: it may be non-diffracting content but will also contain unidentified phases or poorly modelled phases. It is not an accurate measure as its error is the sum of the errors of the modelled phases. An absorption contrast correction (Brindley) was made on the basis that the average size of the particles in the specimens is approximately 5 μm . The more absorbing phases will be under estimated if their actual average particle size is greater than 5 μm .

Powder X-ray diffraction is bulk phase analysis, it is not chemical analysis. Phase concentrations may be mis-estimated if an incorrect chemical formula is assigned to a phase. Therefore, the closest matches in the reference phase identification databases were used in the Rietveld refinement model, but other members of the identified mineral groups may be present.