



Central Analytical  
Research Facility

# QUT Central Analytical Research Facility

## Scientific Report

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CLIENT	Amy Hoppenbrouwers ALS Minerals WA
REPORT DATE	9 <sup>th</sup> January 2018
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ANALYSIS REQUESTED	Quantitative XRD
OUR REFERENCE	X17462
YOUR REFERENCE	PH581637 – Todd River
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## 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 phase 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).

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

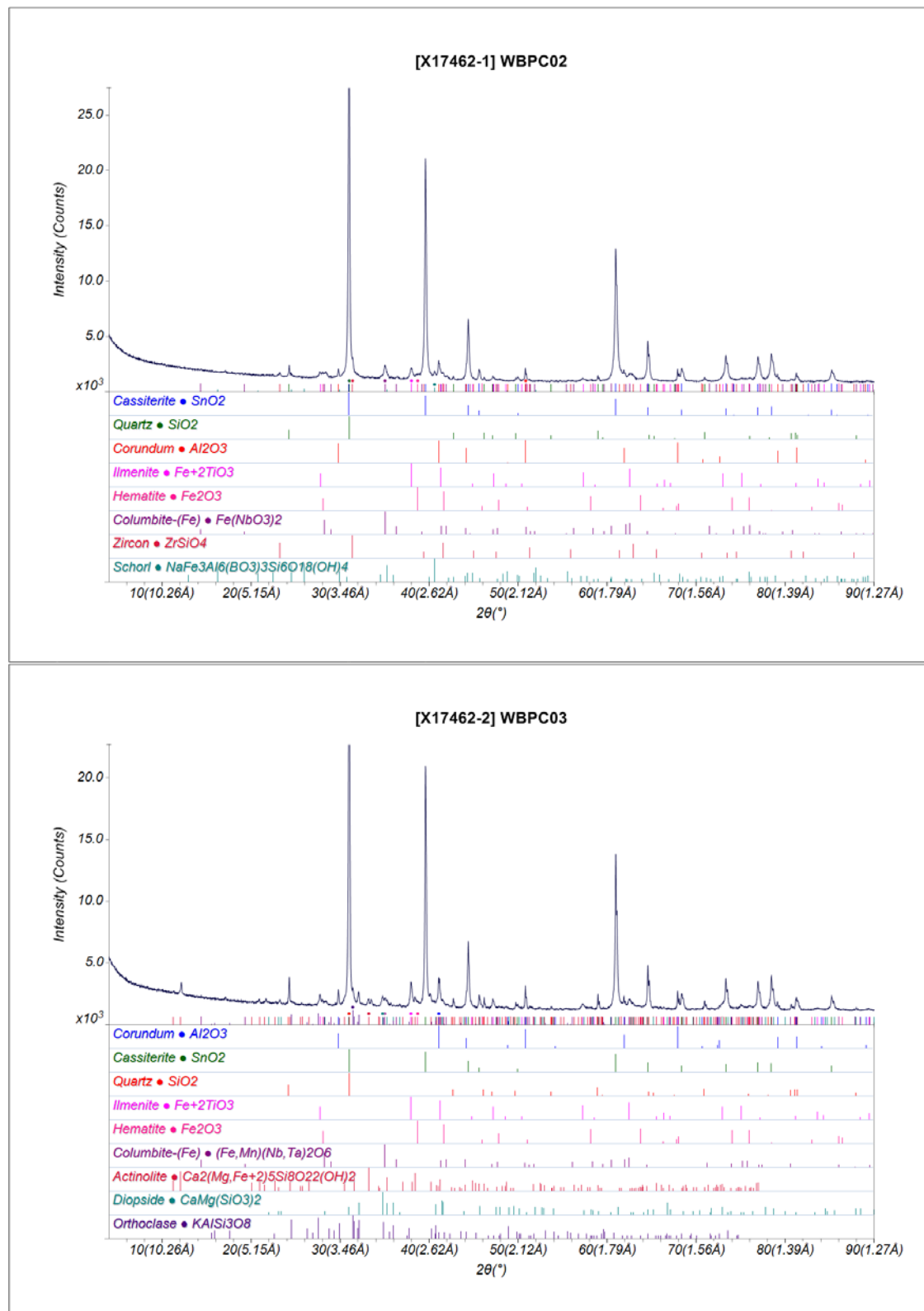
<i>X17462</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>
<i>Todd River</i>	<i>WBPC02</i>	<i>WBPC03</i>	<i>WBPC04</i>	<i>WBPC06</i>
Quartz	10.8	13.8	30.8	11.3
Cassiterite	47.3	25.9	12.4	45.0
Ilmenite	10.5	8.9	7.2	21.7
Hematite	3.1	2.2	2.6	5.2
Columbite-Fe	4.2	2.0	1.2	
Amphibole (actinolite)		10.5	16.1	
Clinopyroxene (diopside)		1.4	2.4	
Zircon	3.1			4.2
Tourmaline (schorl)	4.2			
Albite			3.7	
K-Feldspar		6.0	4.8	3.8
Non-diffracting/unidentified	16.9	29.3	18.8	8.9

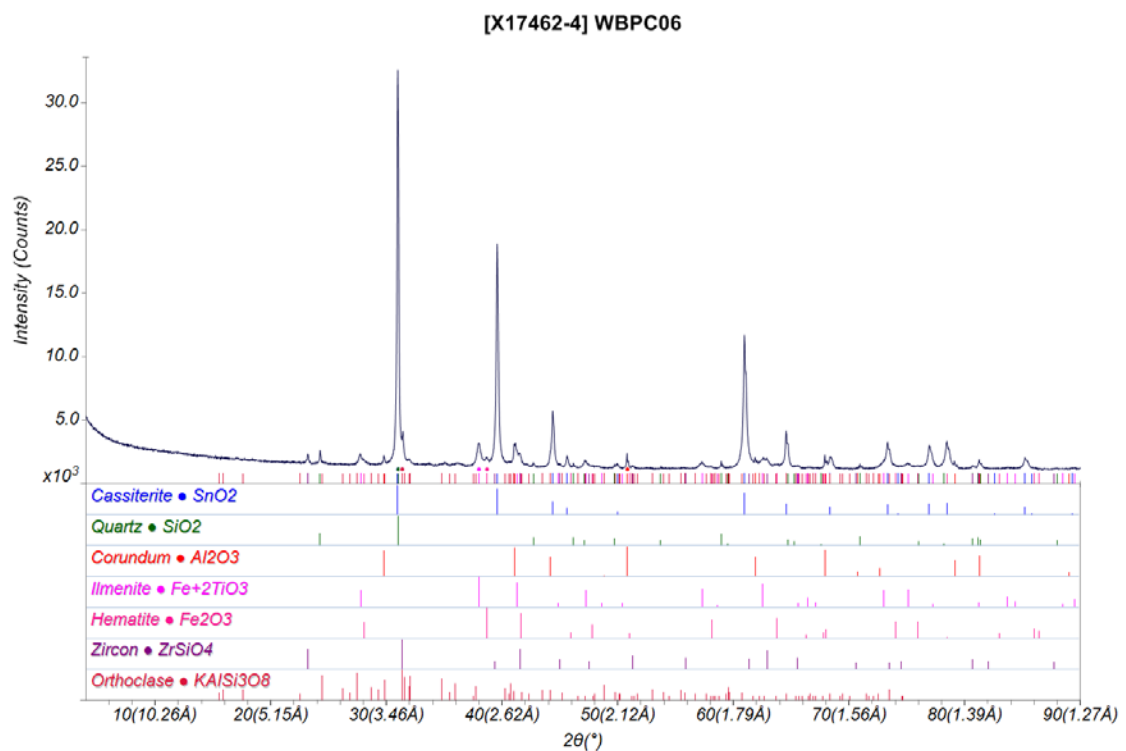
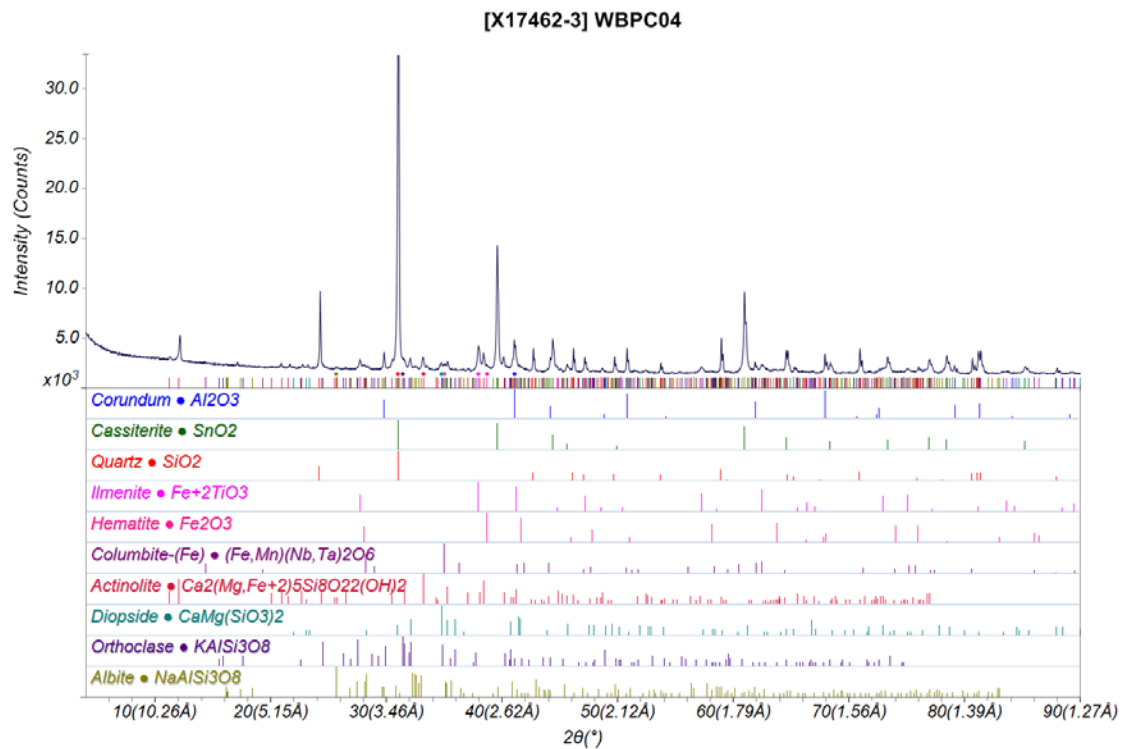
In general the mineral parageneses of the samples tabulated above are consistent with an origin possibly from a fractionated granite-pegmatite source.

However, the amphibole and clinopyroxene quantified in samples WBPC03 and WBPC04 are inconsistent with the other phases present in the sample suite and are inconsistent with the suggested granite-pegmatite origin. Attempts were made to match more geologically-consistent granite-pegmatite phases to the peaks assigned to amphibole and cpx but without success. The modelled amphibole and clinopyroxene fit best to the measured XRD patterns.

## APPENDIX 1 – X-RAY DIFFRACTION DATA AND GRAPHICS

### Powder X-ray Diffraction Patterns





## APPENDIX 2 – ANALYTICAL TECHNIQUES

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### 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,  $\text{Al}_2\text{O}_3$ ) 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.

### 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+, AMCS, 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  $\mu\text{m}$ . The more absorbing phases will be under estimated if their actual average particle size is greater than 5  $\mu\text{m}$ . The estimated uncertainties in the reported phase concentrations are 10 wt% relative or better for every modelled phase. Due to propagation of errors the uncertainty in the amorphous (non-diffracting/unidentified) content is estimated at 30 wt% relative.

Powder X-ray diffraction is bulk phase analysis. Phase abundances may be mis-estimated if an inappropriate chemical formula is assigned to a phase. The closest matches in the reference phase identification databases were used in the phase quantification Rietveld refinement modelling, but other members of an assigned mineral group may be present. It should be noted that a well-fitted Rietveld model does not necessarily indicate the derivative phase quantification is ‘correct’ or realistic.

A degree of confidence in the QXRD data modelling can be obtained by comparing a reliable measured bulk chemical composition with a bulk composition calculated using the QXRD phase abundances. However caution must be exercised in the process as assumptions HAVE to be made, including:

- 1) The chemical formula (compositions) of ALL individual phases must be reliably known.
- 2) The Rietveld phase modelling must be reliable, including having all major phases accurately identified.
- 3) The estimate of the amorphous content must be reliable, but is subject to analytical uncertainty and is affected by the modelling of the quantified phase abundances (#2).
- 4) The measured bulk chemical analysis itself must be reliable and include all major elements or oxides.