



C&R CONSULTING

Geochemical & Hydrobiological Solutions Pty Ltd

ABN 72 077 518 784

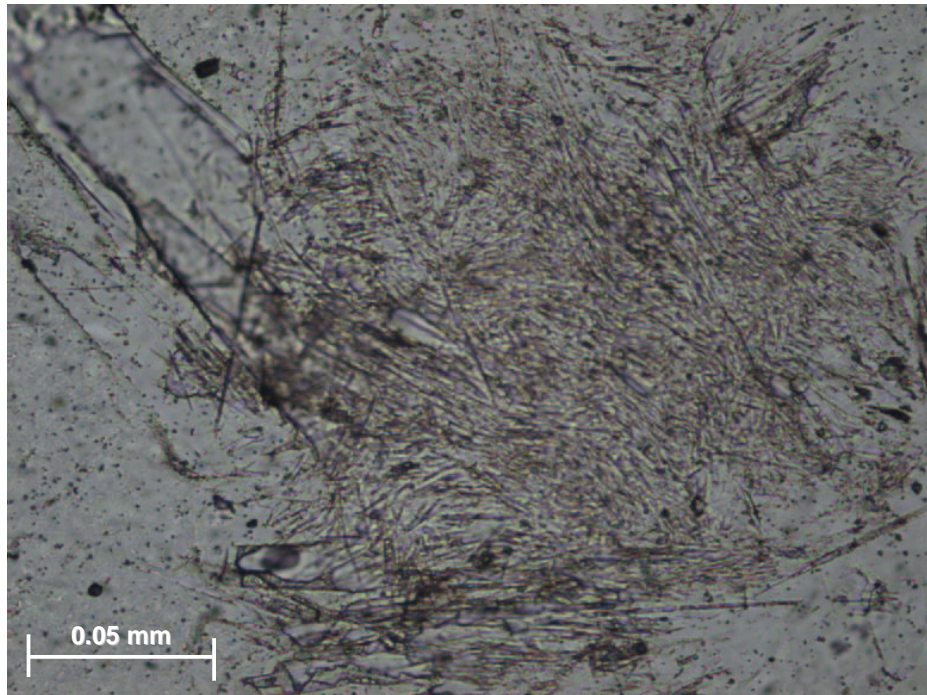
*Underground Coal Gasification / Coal Seam Gas Investigations
Mineralogical, Geological, Petrographic and Soils Services
Hydrogeomorphic and Palaeogeomorphic Evaluations
Terrestrial and Aquatic Fauna and Flora Surveys
Climate History and Extreme Events Analysis
Contaminated Site and Mine Water Analysis
Environmental Compliance and Monitoring
Estuarine and Marine Water Assessments
Surface and Groundwater Investigations*

PO Box 1777
Thuringowa, Qld, 4817, AUSTRALIA

Tel: +61 (0) 7 4725 3751
Mob: +61 (0) 417 635 032

info@candrconsulting.com.au
www.candrconsulting.com.au

MOUNT CHARLOTTE EVAPORITE MINERALOGY INVESTIGATION



Micrograph of thin section C&R1 displaying fibrous polyhalite within halite matrix
[plane polarised light, 500x magnification with field of view 0.3mm]

Report on Mineralogical Analyses of four Core Samples

PREPARED FOR:

TELLUS HOLDINGS PTY LTD

Date: 24th October 2011

CLIENT: TELLUS HOLDINGS PTY LTD
PROJECT: Mt. Charlotte Mineralogy Investigation
REPORT: Report on Mineralogical Analyses
DATE: 24th October 2011



IMPORTANT NOTE

No part of this document may be reproduced without written permission from the Clients and C&R Consulting Pty Ltd. If this report is to form part of a larger study, or is a response to a "Request for Additional Information" from a Compliance Agency, this report must be included as an Appendix within the full report without any additions, deletions or amendments.

C&R Consulting Pty Ltd do not accept any responsibility in relation to any financial and/or business decisions made for any other property or development other than that for which this information has been provided.

Handwritten signature of Dr Chris Cuff in black ink.

Dr Chris Cuff
Director

24th October 2011

Date

Handwritten signature of Dr Cecily Rasmussen in black ink.

Dr Cecily Rasmussen
Director

24th October 2011

Date

CLIENT: TELLUS HOLDINGS PTY LTD
PROJECT: Mt. Charlotte Mineralogy Investigation
REPORT: Report on Mineralogical Analyses
DATE: 24th October 2011



SUMMARY OF RELEVANT INFORMATION

Project Title	Mt. Charlotte Mineralogy
Project Purpose	Determine mineralogy of evaporite drill core samples
Applicants Details	
Nominated Representative	Mr. Duncan van der Merwe
Title/Position	Managing Director
Company	Tellus Holdings Pty Ltd
Postal Address	Level 57, MLC Centre, 19-29 Martin Place, Sydney NSW 2000
Telephone	02 92387631
Fax:	02 92387633
Email	duncan@tellusholdings.com.au
Investigation Undertaken by:	Dr. C. Cuff, Dr. K. Camuti, Mr. S. Wegner



TABLE OF CONTENTS

1. INTRODUCTION	5
2. PETROGRAPHIC ANALYSIS.....	7
2.1 MINERALS IDENTIFIED & PROPORTIONS	7
2.2 MINERAL CHARACTERISTICS & RELATIONSHIPS.....	8
2.3 POROSITY & EVAPORITE RELATIONSHIPS	10
3. X-RAY ANALYSIS	11
3.1 X-RAY DIFFRACTION	11
3.2 FURTHER XRF INTERPRETATION.....	14
4. SUMMARY & RECOMMENDATIONS	15

LIST OF FIGURES

Figure 1	Vertically offset XRD scans	12
Figure 2	Vertically offset XRD Scans with expanded horizontal scale	13

LIST OF TABLES

Table 1	Sample Identification Table	6
Table 2	Summary Table of Petrographic Results	7
Table 5	Summary of Minerals identified in X-ray Diffraction analyses	11
Table 3	Summary Major Element Semi-Quantitative XRF results	14
Table 4	Summary Minor and Trace Element Semi-Quantitative XRF results	14

LIST OF APPENDICES

Appendix 1 – PETROGRAPHIC ANALYSES.....	16
Appendix 2 – QUT XRD ANALYSES	17
Appendix 3 – AAC XRF ANALYSES.....	18



1. INTRODUCTION

Tellus Holding Pty Ltd (the client) through Terra Search Pty Ltd Townsville, commissioned C&R Consulting Pty Ltd (C&R) to undertake mineralogical analysis of four drill core samples.

Minerals of interest in the specimens were halite, potash (and its variants particularly sylvite), and petalite (lithium bearing).

The analyses proposed for the investigation, comprised X-Ray Diffraction (XRD) combined X-Ray Fluorescence (XRF) along with petrographic analysis to evaluate textural and mineralogical relationships.

Four sub-sample pairs of the drill core were selected and provided to C&R by Terra Search. One corresponding sample each for petrography and XRD/XRF.

The samples were dominated by coarse rock salt of varying colours with differing proportions of sediment and other sedimentary / evaporite banding textures.

(FJC2801) – Chandler Formation

C&R 1 – 5042003A - Translucent to clear, pale yellowish brown coarse salt

C&R 2 – 5042003B - Sandy (quartz) reddish brown, medium grained salt-dominated rock

(FJC2802) – Gillen Member

C&R 3 – 5042004A - Translucent to clear, pale brown coarse salt

C&R 4 – 5042004B – Banded black sediments within dark grey coarse salt

Note: the sample pairs are similar but not identical, with some variation in proportion of salts and sedimentary layering.

The surfaces of all samples were notably affected by atmospheric dissolution of the salts.

The four petrographic samples were submitted to Northern Petrographics Townsville for production of polished (standard size) thin sections. All care was taken to ensure the specimens did not come into contact with water during production by using high grade kerosene as a lubricant.

Petrographic Analyses were conducted by C&R Consulting and the results are attached in Appendix 1.

The corresponding four subsamples were forwarded to the X-Ray Analysis Facility at the Queensland University of Technology, Brisbane for XRD analysis. The results of these analyses, with some interpretation, are provided in Appendix 2.

Note: the interpretation in the raw XRD analyses is advanced upon by Dr. K. Camuti and Dr. C. Cuff who are specialists in mineral XRD interpretation.

The remaining milled subsamples were returned from QUT and forwarded to the Advanced Analytical Center, James Cook University Townsville, for Semi-Quantitative XRF analysis to assist mineralogical evaluation. The XRF results are provided in Appendix 3.

CLIENT: TELLUS HOLDINGS PTY LTD
PROJECT: Mt. Charlotte Mineralogy Investigation
REPORT: Report on Mineralogical Analyses
DATE: 24th October 2011



Table 1 Sample Identification Table

Terra Search ID	Petrographic #	QUT – XRD #	AAC – XRF #
5042003A	C&R 1	6968-01	10317-01
5042003B	C&R 2	6968-02	10317-02
5042004A	C&R 3	6968-03	10317-03
5042004B	C&R 4	6968-04	10317-04



2. PETROGRAPHIC ANALYSIS

The petrographic analyses were conducted on a research quality Lieca DMLP microscope, with a range of objectives up to 500x magnification; with reflected light assembly.

2.1 MINERALS IDENTIFIED & PROPORTIONS

The following table summarises the range of minerals identified in thin section; their estimated proportions and maximum grainsize.

Note: Mineral proportions are visual estimates using modal analysis charts. The microscope under transmitted light can resolve clay sized grains down to 1µm (micron) at 500x magnification. However, confidence in identifying mineral species below 10µm in size (0.01mm) is increasingly diminished due to limitations in optical techniques resulting from interference by other minerals in the 30µm thick light path of the rock section.

Table 2 Summary Table of Petrographic Results

MINERAL	C&R 1		C&R 2		C&R 3		C&R 4	
	%	mm	%	mm	%	mm	%	mm
Halite	99	0.01	92	0.01	99	0.005	30	0.01
Anhydrite			1	0.1			50	1.4
Carbonate			3	0.05	<1	0.006	20	0.15
Gypsum	<1	0.04	<1	0.1	<1	0.01	<1	0.005
Polyhalite	1	0.25			<1	0.25		
Quartz			2	0.06				
Feldspar			<1	0.05				
Mica			1	0.05				
Detrital Clay			<1	<0.001				
Glauconite			<1	0.004				
Iron Oxide			<1	0.001	<1	<0.001	<1	<0.001
Unknown	<1	0.02						

These mineral proportions are visual estimates that can range in error up to plus or minus 5% for the larger area estimates while values <1% are considered trace abundance.

It must be noted that thin sections C&R 1 and C&R 3 (and to a lesser extent C&R 2) all suffered from loss of sample in the final phase of polishing; ranging up to 20% loss by area. As such, the mineral proportions across these sections contain additional error.



2.2 MINERAL CHARACTERISTICS

Halite [NaCl]

Halite is the dominant mineral for all but section C&R 4. The halite is similar in all sections, observed as fine grained (0.01mm) massive to slightly granular to polycrystalline with isotropic character.

The surface of the salt after polishing varies considerably between slides with varying depths of pitting and relief. This surface variation maybe a result of variations in crystallinity, mineralogy (minor variants that may include trace levels of potassium, fluorine, calcium, magnesium) but is more likely to be a function of the quality of polishing.

It is not apparent that the pitting represents internal original porosity.

Broken edges of the salt in most hand specimens, display coarse crystallinity with what appears to be slightly irregular cleavage planes up to 10mm wide. As such it is deduced that the salt has undergone fine recrystallisation with further changes in diagenesis.

It cannot be discounted that some level of deformation in the salt may have occurred when cutting, grinding and polishing; to provide the massive textures observed under section. In examples where detrital sediment or coarse anhydrite is present, the surface of the soft halite has dropped at least 2 microns in relief.

In isolated patches, crystalline cubic forms of halite are observed at the surface, ranging up to 0.01mm in size. The random orientation of the cubes in what appears to be a massive matrix, suggest original textures.

Disseminated throughout the halite in some sections are small (<0.002mm) circular inclusions that appear to be fluid inclusions. In other examples, the dominant inclusions are distinct crystalline particles up to 0.001mm with trace birefringence (possibly gypsum).

No discernable salt variants other than halite and possibly trace polyhalite were observed under the microscope.

Polyhalite [2CaSO₄.MgSO₄.K₂SO₄.2H₂O]

Rare masses of fine grained (0.25mm) fibrous to lamellar inclusions within halite are proposed to be polyhalite (Micrograph on front page of report).

Whilst possibly a form of anhydrite where more tabular, the fibrous form of the mineral is more characteristic of polyhalite.

Where the acicular grains grade to lamellar or tabular forms, it appears the larger grains are in fact dissolved and removed. This is evident in one section where the crystals intersect the slide surface and provide distinct cavities. The cavities within the salt provide optical effects (pale grey ghost grains) within the otherwise isotropic halite matrix.

Anhydrite [CaSO₄]

Commonly coarse grained (<1.4mm) euhedral tabular grains aligned in bedding-like bands with possibly some evidence of differential compaction and disruption to bedding.

Distinctly high (second order) birefringence and mostly clear crystals with either intergranular halite or carbonate.

Gypsum [CaSO₄.2H₂O]

Minor small (<0.1mm) isolated subhedral grains either in halite or carbonate. The crystals are generally clear and display first order grey to yellow birefringence. In limited cases of



radial growth within carbonate concretions, the gypsum has been stained with red iron oxide (submicroscopic). The gypsum crystals in the concretions are possibly original grains that have been protected from later diagenesis to anhydrite.

Carbonate {Dolomite} [CaMg(CO₃)₂]

Although not a diagnostic property in section, the unusual extreme dark brownish-pink birefringence of many carbonate grains (particularly the smaller examples) suggest dolomite composition.

Relatively large (0.15mm) isolated subhedral grains of carbonate persist, intergranular to coarse anhydrite. Some of these coarser grains of carbonate display more typical pale calcite birefringence with rhombohedra shapes.

Sedimentary bands of granular to subhedral carbonate occur in one section.

Minor small carbonate concretions also occur; near submicroscopic growth, inter-grown with gypsum and displaying some iron staining. The high relief of this carbonate to the gypsum, slight brown colouration suggest also the possibility of minor siderite.

The well defined concretions are proposed to be early diagenetic in origin, prior to significant burial and compaction.

Detrital sediment Quartz, Feldspar and Mica

Very minor to trace levels of fine (<0.06mm) sediment were observed in section C&R 2 as discontinuous thin beds within the halite.

The quartz occurs as clear isolated sub-angular grains, moderately strained, and of probable igneous intrusive origin with mild regional deformation.

Minor small sub-angular grains of relatively fresh microcline and albite were observed.

The micas consist of muscovite, fox-brown biotite and distinctive bright green glauconite. The glauconite is observed as a replacement of unknown rounded lithic fragments.

The same section contained minor brown submicroscopic clay of likely detrital origin, intergranular to detrital quartz and mica.

Iron Oxide / Hydroxide

Mostly submicroscopic red or yellow minor or staining of grains. Notably in some carbonate concretions, where both the carbonate matrix and gypsum grains are stained. Rare small patches of near submicroscopic red iron oxide also occurs within the halite matrix; most probably a very late phase.

Unknown Mineral

Trace (<1%) small (<0.02mm) high relief green to blue grains within matrix halite of section C&R 1 could not be identified. They were neither, polishing grit (aluminium oxide) or contamination such as corundum powder. The grains had strong first order yellow to pink birefringence, no pleochroism, and angular (possibly equant prismatic) shape. The unknown may possibly represent isolated anhydrite with impurities but the grainsize is too small to confirm.



2.3 POROSITY & EVAPORITE RELATIONSHIPS

Portions of the polished surface to most slides display coarse pitting and topology that most likely represents quality of polishing {the contrast of hard and soft beds of differing mineralogy make the grinding and polishing process very difficult}. These pits and surface textures display no sign of extending into the specimen with depth and therefore do not represent inherent porosity to the salt.

Where it is clear the specimen displays a high quality polish, the surface of the halite is smooth and texture free with the exception of minor patches of fine cubic halite structure. It is not clear if the cubic surface texture represents individual crystals with intergranular porosity of a more soluble species.

It is deduced overall that there is no significant porosity remaining within the salt, either primary or secondary after loss of more soluble species.

No definitive evidence for sylvite or any other salt species could be identified in section.

There is the possibility that the halite matrix has been modified by the sectioning process, thus potentially losing structural evidence of former sylvite. Examination of freshly broken fragments of specimens under the electron microscope should resolve any such structures.

The textural sequence for evaporite precipitation appears to fit the experimental observations, with carbonate (calcite diagenetically modified to dolomite) followed by gypsum (diagenetically modified to anhydrite), then trace acicular polyhalite followed by intergranular halite.

The textures of the carbonate and gypsum beds are not clear, and may represent salt flow structures or differential compaction. In either case, halite is observed as a massive intergranular phase to both carbonate and sulphate species.

The precipitation of minor polyhalite is significant, as it indicates that any potassium in the evolving fluid reacts with all probably to the gypsum (or the anhydrite) to form polyhalite. This reaction would limit the concentration of both Mg and K in the evolving brine and thus inhibits the crystallisation of soluble K and Mg salts including sylvite.

The release of 6H₂O in the reaction also inhibits the concentration increasingly for sylvite precipitation being achieved:



The lithium mineral Petalite [disilicate - LiAl(Si₂O₅)₂] was not identified in thin section or XRD as hoped by the client. However, this mineral is not expected of evaporite systems unless overprinted by hydrothermal fluids; either associated with scapolites in carbonate environments or fluids resulting in zeolite/tourmaline/spodumene/quartz type assemblages. Petalite is usually formed in pegmatites although if late stage related fluids react with evaporites then petalite may form.

There is no evidence of secondary hydrothermal alteration or thermal metamorphism in the specimens provided.



3. X-RAY ANALYSIS

3.1 X-RAY DIFFRACTION

This section summarises the mineralogy interpreted from XRD analyses of the four Mt Charlotte evaporite samples. The XRD are summarized in the table below, and scans from the samples are included as Figures 1 and 2 (over page).

The mineralogy of all four samples is dominated by halite, with variable quantities of anhydrite, dolomite and quartz.

Sample 5042003B (C&R 2) produces several XRD peaks consistent with the presence of mica minerals. The semi-quantitative XRF results for this sample also had the highest K (1.2%) and Al (1.08%) contents, which is consistent with the presence of mica.

A very small and poorly resolved XRD peak in 5042003B may indicate a trace of sylvite, but this is a speculative interpretation as there are insufficient peaks to make a confident identification.

The estimated abundances of minerals in sample 5042004B are very approximate, as there were difficulties correlating the mineral abundances with the XRF results.

Table 3 Summary of Minerals identified in X-ray Diffraction analyses

Minerals Identified	Estimated Mineral Abundances wt%** from X-ray Diffraction			
	5042003A	5042003B	5042004A	5042004B
	XRD No 6968-01	XRD No 6968-02	XRD No 6968-03	XRD No 6968-04
Quartz	< 1	~ 3	< 1	~ 1
Halite	~ 95	~ 80	~ 95	45 - 55
Dolomite	~ 1	~ 8	~ 2	5 - 10?
Anhydrite	1 – 2	1 – 2	~ 2	30 - 40
Mica		5 – 10?		
Sylvite?		trace ~ 1?		
Goethite?		trace ~ 1?		

**Relative mineral abundances were estimated from the QUT Siroquant results and the semi-quantitative XRF results.

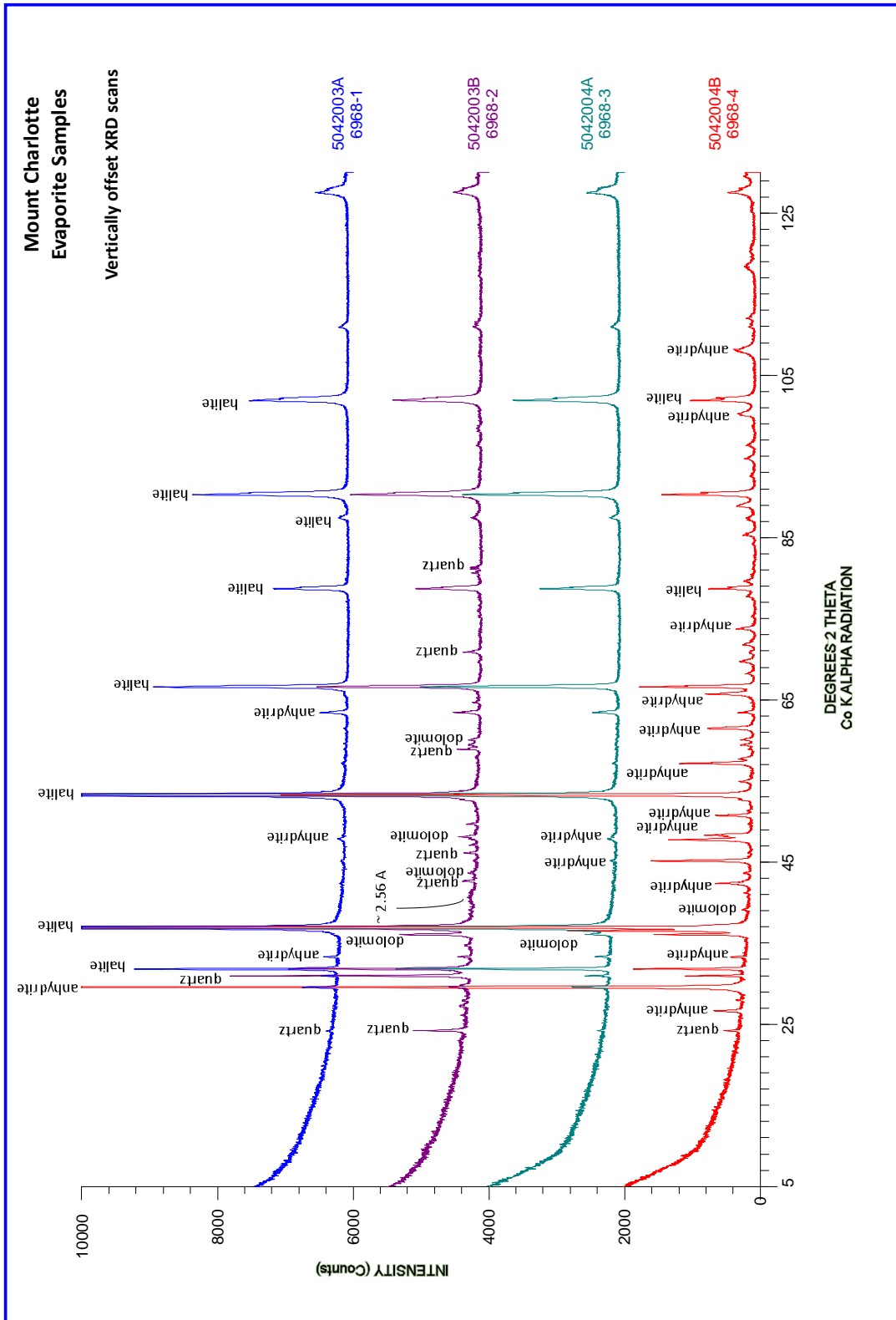


Figure 1 Vertically offset XRD scans

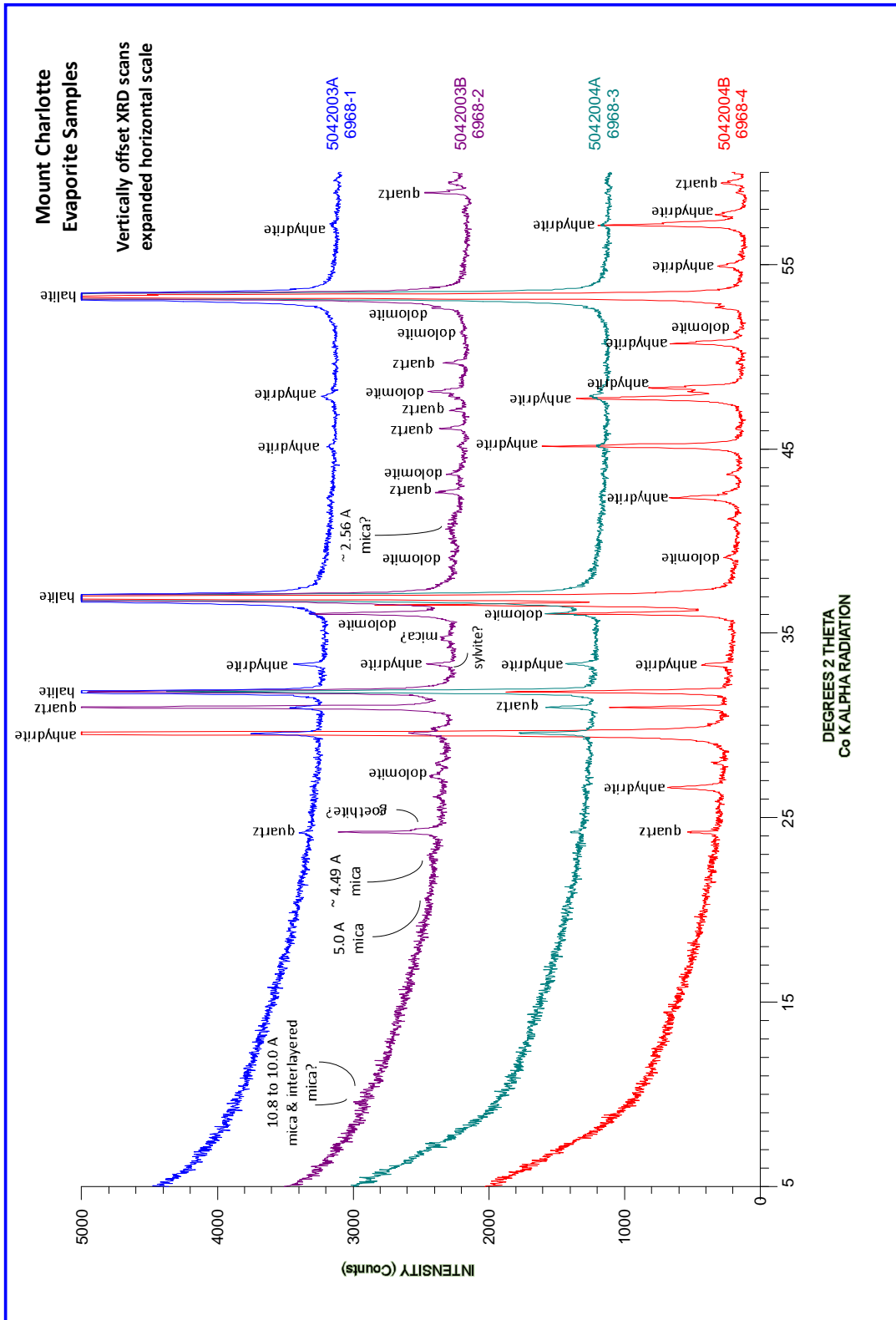


Figure 2 Vertically offset XRD Scans with expanded horizontal scale



3.2 FURTHER XRF INTERPRETATION

The range of semi-quantitative X-Ray Fluorescence detection is from the elements with atomic number greater than Beryllium through to Uranium (minus the Nobel gases). The analysis is therefore unable to detect Lithium as it has a lower atomic number to beryllium which is the X-Ray vacuum barrier to the instrument.

Potash analysis results have not been provided; therefore it must be deduced without evidence for lithium based minerals that lithium is below trace abundance.

From the XRF results it is seen that sodium and chloride are in roughly correct proportions amenable to halite (Table 4).

Calcium varies predominantly in accordance with the proportion of carbonate (calcite) versus sulphate minerals (gypsum, anhydrite) and magnesium for dolomite.

Aluminium, silica and potassium are mostly linked to detrital minerals of clays, micas and quartz (trace feldspar).

Minor iron is proposed to be taken up with iron oxides and hydroxides as observed in section.

Table 4 Summary Major Element Semi-Quantitative XRF results

Sample	Na (%)	Mg (%)	Al (%)	Si (%)	S (%)	Cl (%)	K (%)	Ca (%)	Fe (%)
C&R 1	38.98	0.124	0.111	0.22	0.484	70.78	0.036	0.869	0.009
C&R 2	34.35	1.072	1.076	3.793	0.308	61.35	1.201	2.13	0.677
C&R 3	39.45	0.235	0.11	0.241	0.489	70.08	0.091	1.05	0.022
C&R 4	35.27	0.518	0.23	0.531	5.807	54.74	0.106	12.78	0.134

Many of the trace elements (e.g. Ti, Cr, Mn, Zr) are likely associated with the detrital minerals although phosphorus could be evaporite related as trace phosphorite and bromine will be associated with halite (Table 5).

The trace rubidium and strontium maybe preferentially located within either the carbonates or sulphates.

Table 5 Summary Minor and Trace Element Semi-Quantitative XRF results

Sample	P (%)	Ti (%)	Cr (%)	Mn (%)	Br (%)	Rb (%)	Sr (%)	Zr (%)
C&R 1	0	0	0	0	0.014	0	0.006	0
C&R 2	0.011	0.068	0.024	0.009	0.013	0.003	0.044	0.004
C&R 3	0	0	0	0	0.02	0	0	0
C&R 4	0	0	0	0	0.013	0	0.069	0



4. SUMMARY & RECOMMENDATIONS

1. The results of petrographic and X-Ray analyses show the samples provided are dominated by halite.
2. Sample C&R 2 (5042003A) contains discontinuous thin beds of detrital sediment, namely minor quartz, muscovite, biotite, trace feldspar and clay.
3. Sample C&R 4 (5042004B) contains appreciable anhydrite and dolomite in evaporite / bedding structures.
4. Trace gypsum is observed in both the halite matrix and some carbonate nodules.
5. Minor iron hydroxide as poorly crystalline goethite is present as late submicroscopic staining of halite, carbonate and sulphates, along with trace patches of barely visible red haematite (oxide) grains.
6. Trace sylvite may have been identified within the XRD trace of C&R 2, however, no petrographic evidence was observed.
7. Minor fibrous polyhalite was observed in C&R 1 & C&R 3. The existence of polyhalite indicates the brine waters in both beds may not have attained sufficient concentrations of potassium to support the growth of sylvite.
8. To evaluate the possibility of porosity after dissolution of more soluble salts such as sylvite, it is recommended that fresh samples be examined both in covered (non-polished) section and under the scanning electron microscope.

CLIENT: TELLUS HOLDINGS PTY LTD
PROJECT: Mt. Charlotte Mineralogy Investigation
REPORT: Report on Mineralogical Analyses
DATE: 24th October 2011



APPENDIX 1 – PETROGRAPHIC ANALYSES



PETROGRAPHIC ANALYSES

CLIENT – Tellus Holdings Pty Ltd
PROJECT – Mt. Charlotte Evaporites
DATE – 21st October 2011

Sample History & Purpose

Hand specimen samples of evaporite drill core (dominated by coarse salts) provided to C&R Consulting by Terra Search Pty Ltd for the purpose of petrographic analysis to determine visible mineralogy and textures in conjunction with X-Ray Diffraction / X-Ray Fluorescence analysis.

C&R sample numbers to corresponding Terra Search numbers:

C&R 1 – 5042003A (FJC2801)
C&R 2 – 5042003B
C&R 3 – 5042004A (FJC2802)
C&R 4 – 5042004B

LIMITATIONS: The following mineral proportions are visual estimates using modal analysis charts. The microscope under transmitted light can resolve clay sized grains down to 1µm (micron) at 500x magnification. However, confidence in identifying mineral species below 10µm in size (0.01mm) is increasingly diminished due to limitations in optical techniques resulting from interference by other minerals in the 30µm thick light path of the rock section.

SAMPLE – C&R 1 (5042003A)





Hand Specimen Description

The sample consists of translucent pale yellow rock salt displaying coarse crystallinity (cleavage and probable crystal faces) ranging up to 5mm in broken edges of the specimen. Minor coarse to medium grained quartz sand is observed in the outer margins of the specimen.

The outer morphology suggests some degree of atmospheric dissolution of the salt has occurred.

Microscopic Description [standard polished section]

PRIMARY MINERALS (100%)

- | | | | |
|---------------|---|----------------|--------------------------------------|
| 99% | Halite | 0.01 mm | Euhedral to massive |
| | Crystalline cubic halite observed in small patches across the slide; within a matrix of submicroscopic (?) massive halite. Round inclusions (<0.002mm) within massive salt matrix observed under high relief conditions, suggest possibly fluid inclusions. | | |
| 1% | Lamellar Unknown | 0.25 mm | Acicular to lamellar cavities |
| | Clusters of unknown acicular to thin tabular (lamellar) cavities occur where an unknown mineral has been removed. The tabular cavities provide a grey ghost birefringence effect under crossed polarized light within the halite. Polyhalite is the most likely species for the acicular grains but gypsum (selenite) cannot be discounted for the coarser tabular phase. | | |
| <1% | Gypsum | 0.04 mm | Tabular to cubic |
| | Isolated grains of medium relief tabular (to fragmental?) grains within salt matrix. First order grey to yellow birefringence. | | |
| <1% | Unknown grains | 0.02 mm | Angular |
| | Trace very high relief pale green to pale blue angular grains within salt matrix. Strong first order yellow to pink birefringence; non-pleochroic. Possibly anhydrite. | | |

General Petrographic Observations & Interpretations

Two phases of halite with differing crystallinity are observed in the specimen. The first is massive, isotropic, with no discernable texture. The second consists of well defined cubic crystals up to 0.01mm (Micrograph 1); growing as minor clusters within the massive halite matrix. Under crossed polarized light, the cubic crystals are highlighted on the margins by a near sub-microscopic unknown mineral displaying faint birefringence up to first order yellow (possibly gypsum).

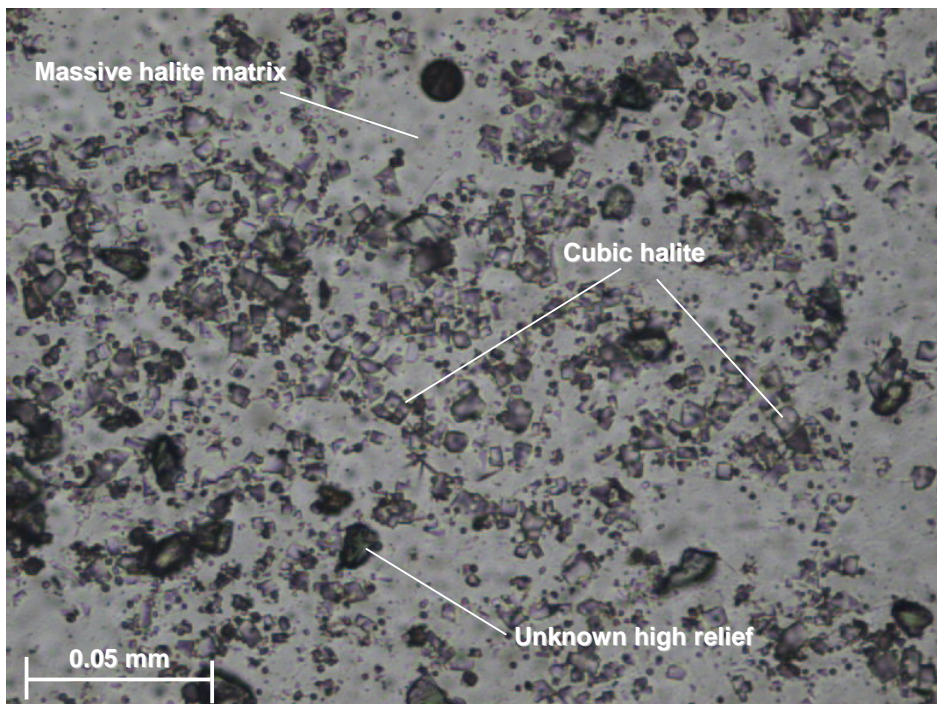
The lamellar to acicular phase within the halite is likely polyhalite although a more definitive sulphate species is likely responsible for the more tabular inclusions (Micrograph 2).

With maximum closure of the sub-stage diaphragm, the massive matrix displays very little granularity although a high density of circular inclusions exist (possibly fluid inclusions), ranging up to 0.002mm.

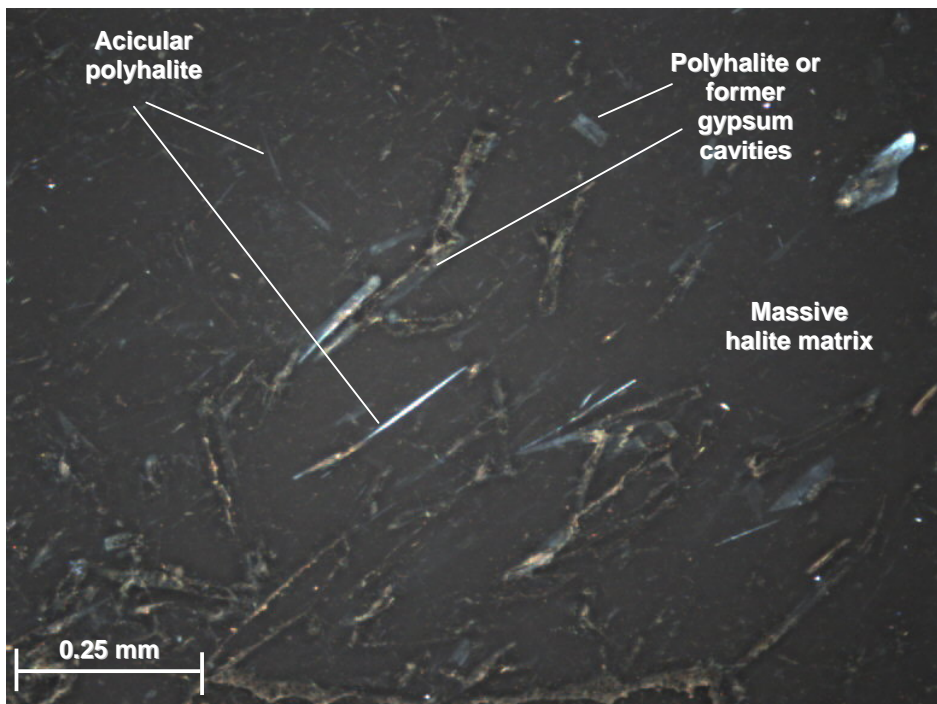
Approximately 20% of the sample area has been removed from the slide with over polishing. Additional to this physical removal, is the possibility of reaction with phases of salt and the glue such that adhesion to the glass slide appears to be lost in places.

CLASSIFICATION

Halite with minor polyhalite and trace gypsum (Evaporite)



Micrograph 1. Thin Section C&R1 - plane polarized light [500x Mag. F.O.V. 0.3mm]
Cubic crystalline halite in a massive halite matrix along with unknown high relief mineral phase.



Micrograph 2. Thin Section C&R1 - crossed polarized light [100x Mag. F.O.V. 1.6mm]
Acicular to lamellar / tabular moulds; likely representing dissolution of polyhalite within isotropic halite matrix.

SAMPLE – C&R 2 (5042003B)



Hand Specimen Description

The sample consists of pale reddish-brown partly translucent coarse rock salt with small amounts of fine sand on its margins.

The outer morphology of the specimen indicates some degree of atmospheric dissolution of the salt has occurred.

Microscopic Description

[standard polished section]

PRIMARY MINERALS (100%)

92%	Halite	0.01 mm	Euhedral to massive
	Dominantly structureless, finely granular to massive halite ranging up to 0.004mm. Some small areas of crystalline salt displaying cubic forms.. The majority of the surface is otherwise greatly pitted although not considered natural porosity.		
3%	Carbonate	0.05 mm	Granular to subhedral
	Very fine (0.006mm) granular matrix of carbonate in patches of detrital fine quartz sand. Grains are likely chemical precipitation but could represent detrital origins (isolated grains up to 0.05mm). Some areas of the fine carbonate display a pale brown colouration that may result from iron staining. Uncertain if calcite or dolomite.		
2%	Quartz	0.06 mm	Angular
	Detrital fragments of quartz sand in isolated discontinuous beds. Grains are individual, clear of inclusions and display moderate strain (undulose extinction).		
1%	Detrital Micas	0.05 mm	Subhedral



Detrital flakes of clear to strongly pleochroic dark brown mica (biotite) with poorly defined birefringence. Similar sized grains and proportions of clear high birefringent muscovite are also present. These grains found only within carbonate bearing detrital fine quartz sand.

- | | | | |
|-----|---|---------------------|-----------------------------------|
| 1% | Anhydrite | 0.1 mm | Tabular |
| | Crystalline tabular grains of anhydrite within detrital fine sand beds. Second order birefringence colours (up to red). Isolated rare elongated prismatic grains in the halite matrix appear to be sulphate (anhydrite) replaced by halite. | | |
| <1% | Gypsum | 0.1 mm | Tabular |
| | Crystalline tabular grains of medium relief gypsum and slightly higher relief to anhydrite within detrital fine sand beds. First order grey to yellow birefringence for gypsum. Isolated rare elongated prismatic ghost grains in the halite matrix appear to be sulphate replaced by halite or cavities. | | |
| <1% | Detrital Clays | <0.001 mm | Dusting |
| | Dusting of submicroscopic brown detrital clay intergranular to fine carbonate / quartz sand. | | |
| <1% | Feldspar | 0.05 mm | Angular |
| | Limited detrital grains of feldspar, notably microcline, with no significant alteration. | | |
| <1% | Glauconite | 0.004 mm | Submicroscopic replacement |
| | Unknown detrital grains (0.06mm) replaced by submicroscopic to barely visible fine grains of glauconitic mica. | | |
| <1% | Haematite/Goethite | 0.001 mm | Granular to submicroscopic |
| | Very fine grained irregular patches of red iron oxide grading to submicroscopic yellow staining both within massive salt and detrital beds. | | |

General Petrographic Observations & Interpretations

Quartz grains (whilst very fine sand size) display characteristics of moderately strained (weak regionally deformed) intrusive igneous origin. The high angularity of grain morphology is likely influenced by small grain size but may indicate limited transport distance.

There is a significant fall in polish surface height (1-2um) from the patches of detrital very fine sand to the halite. The polished surface of the halite displays a marked difference to specimen C&R1 in that it is more granular and pitted with holes up to 0.02mm diameter but only 1 or 2 microns deep. This likely represents polishing or grinding influence but could suggest a different granularity to the matrix halite. The pitting does not appear to represent internal porosity.

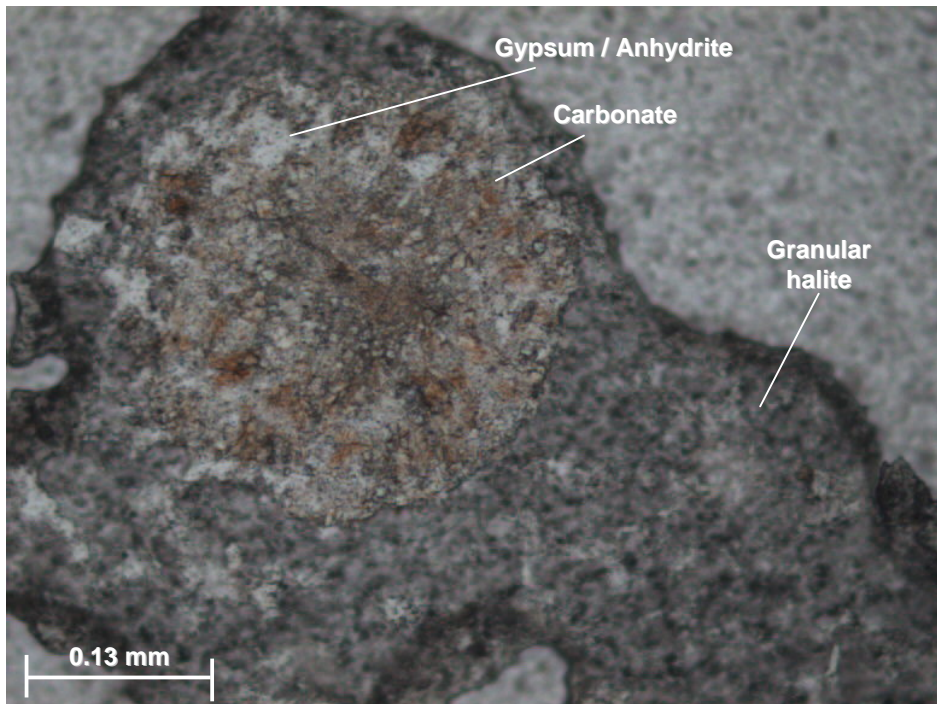
Individual grains of crystalline halite were identified only in the polish shadows of the fine sand patches showing the grinding and polishing greatly modifies the salt surface across much of the slide.

A distinct spherical concretion (0.3mm diameter) composed of a mixture of radiating intergrowth of carbonate and gypsum was observed in the halite matrix (Micrographs 3&4). It is possible some of the very fine grained detrital beds are cemented in a similar manner.

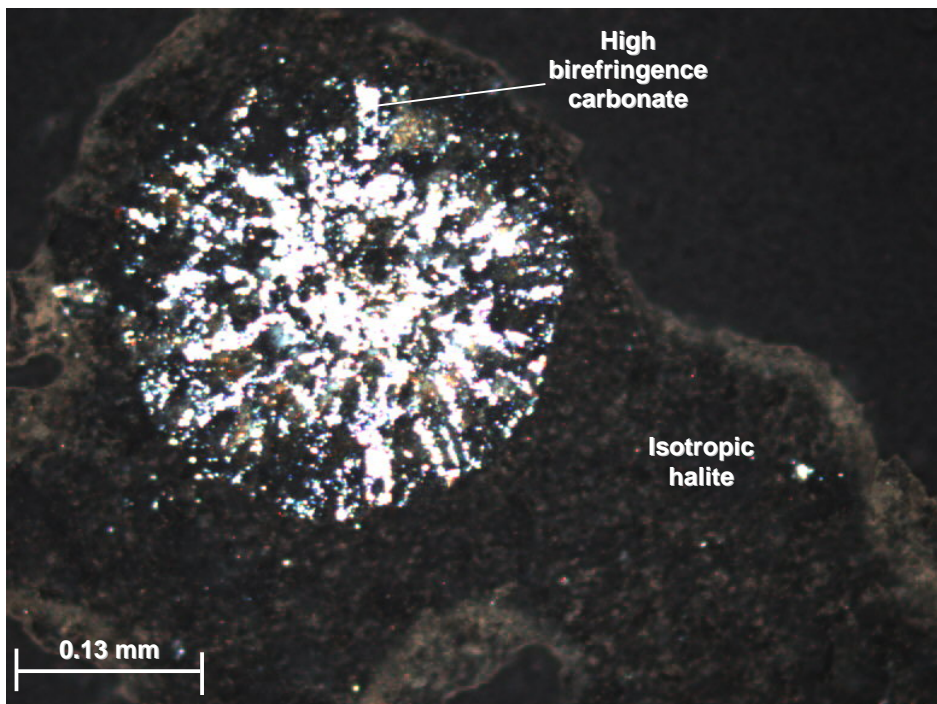
Rare small (0.1mm long) ghost grains of elongated prismatic shape within the halite matrix appear to be either isolated polyhalite or possibly anhydrite replaced by halite.

CLASSIFICATION

**Halite with minor detrital fine sands cemented by carbonate and gypsum
(Evaporite)**



Micrograph 3. Thin Section C&R 2 - plane polarized light [200x Mag. F.O.V. 0.8mm]
Radiating carbonate and gypsum concretion within matrix halite. Some gypsum crystals are iron stained red.



Micrograph 4. Thin Section C&R 2 - crossed polarized light [200x Mag. F.O.V. 0.8mm]
Carbonate has high birefringence compared to radiating gypsum crystals that are lower first order.

SAMPLE – C&R 3 (5042004A)



Hand Specimen Description

The sample consists of dark red to brown partly translucent coarse rock salt.

The outer morphology of the specimen indicates some degree of atmospheric dissolution of the salt has occurred.

Microscopic Description

[standard polished section]

PRIMARY MINERALS (100%)

99%	Halite Dominantly massive structureless to granular halite.	0.005 mm	Massive to granular
<1%	Carbonate Minor patches of very fine granular carbonate within halite. Uncertain if calcite or dolomite.	0.006 mm	Granular
<1%	Gypsum Rare isolated grains of gypsum with first order grey to yellow birefringence.	0.01 mm	Tabular
<1%	Haematite/Goethite Minor submicroscopic red iron oxide staining of the halite in places.	<0.001 mm	Submicroscopic
<1%	Polyhalite (?) Rare euhedral ghost crystals within the halite, up to 0.04mm wide (tabular) and now completely removed (moulds) suggest sulphate. More prevalent intense patches of acicular grains indicate a polyhalite phase.	0.25 mm	Lamellar to acicular



General Petrographic Observations & Interpretations

The majority of the slide was over ground / polished with only trace thickness of halite remaining. Whilst not the correct thickness, it was readily observed that the sample was greatly dominated by halite.

Trace minerals other than halite include carbonate and gypsum with some iron oxide staining.

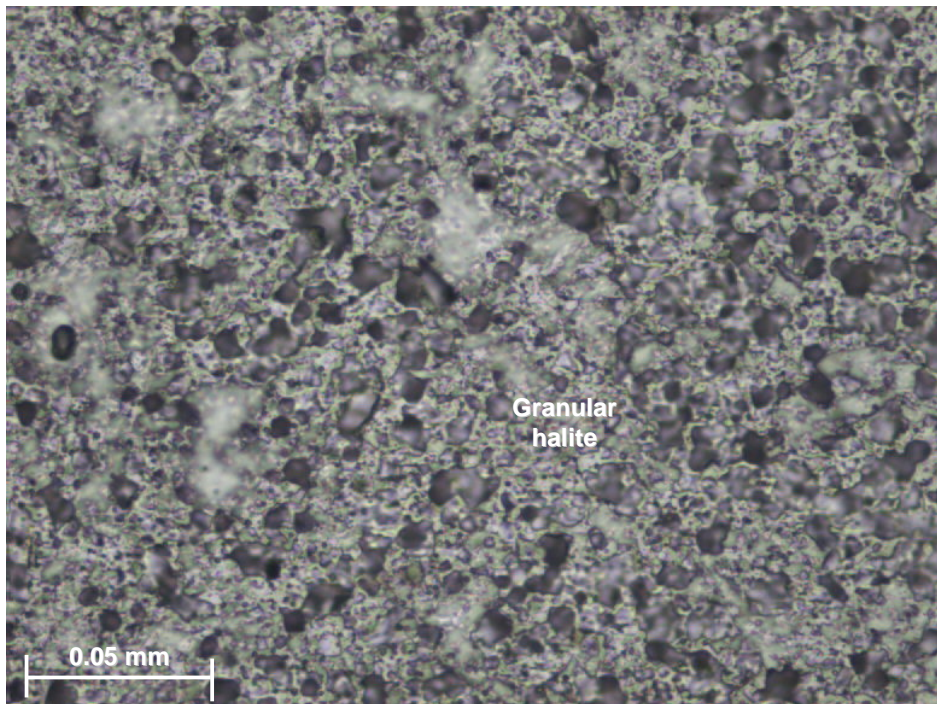
No crystalline halite was observed rather a fine granular surface predominated (Micrograph 5); possibly a function of polishing quality of the slide or deformation in the soft halite surface during grinding.

An unknown tabular/ lamellar euhedral ghost mineral phase occurs in trace levels up to 0.25mm long within the halite. It appears to represent thin voids within the salt that may result from the loss of a more soluble sulphate phase such as polyhalite (acicular) or gypsum (tabular).

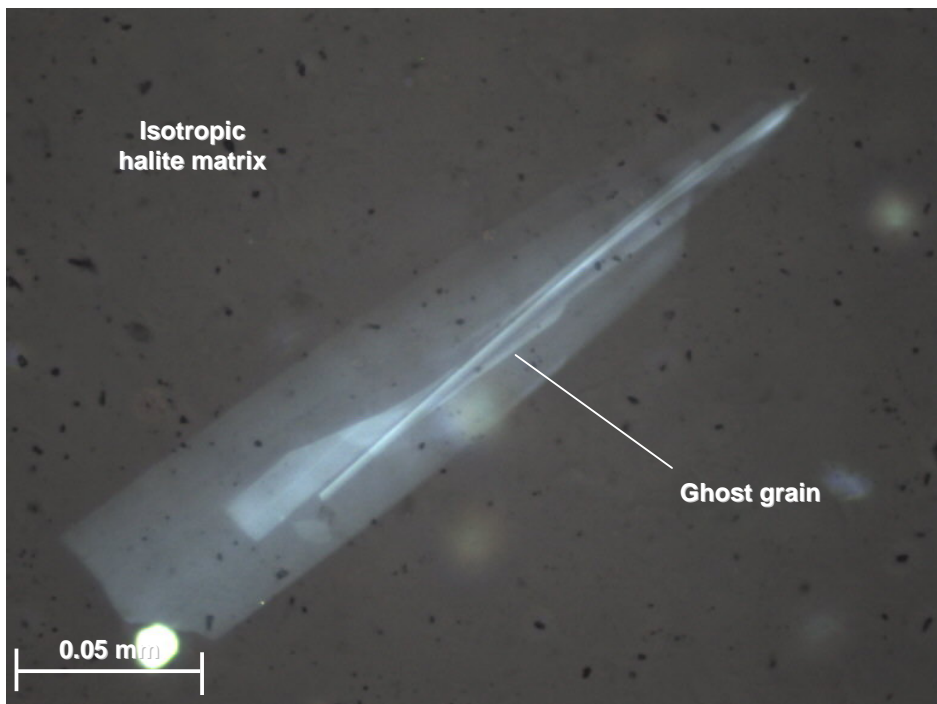
Some of the ghost grains appear to represent internal reflections either from slight parting along cleavage or crystal contacts (Micrograph 6). The regular extinction of the ghost grains and similar optical properties suggest possibly a polyhalite phase which cannot be confirmed optically.

CLASSIFICATION

Halite with trace carbonate, gypsum and possibly polyhalite (Evaporite)



Micrograph 5. Thin Section C&R 3 - plane polarized light [500x Mag. F.O.V. 0.3mm]
Granular texture in halite is possibly a function of grinding deformation or poor polish.



Micrograph 6. Thin Section C&R 3 - crossed polarized light [500x Mag. F.O.V. 0.3mm]
Lamellar ghost grain of polyhalite or gypsum within halite matrix (or possibly just an internal reflection).

SAMPLE – C&R 4 (5042004B)



Hand Specimen Description

The sample consists of dark brown to black sedimentary bands of evaporite minerals within partly translucent yellow to brown coarse rock salt.

The outer morphology of the specimen indicates atmospheric dissolution of the surface.

Microscopic Description

[standard polished section]

PRIMARY MINERALS (100%)

- | | | | |
|------------|--|----------------|-------------------------------|
| 50% | Anhydrite | 1.4 mm | Tabular to granular |
| | Clear subhedral to euhedral crystals with prominent cleavage and birefringence ranging up to 2 nd order pink (δ 0.037). Crystals are aligned in wavy patterns reflecting differential compaction or halite flow. | | |
| 30% | Halite | 0.01 mm | Massive to crystalline |
| | Typically clear fine grained massive to faintly granular and strongly pitted on the surface. Surface textures are possibly the result of surface deformation with section production and or poor polish. Minor areas of fine cubic crystalline halite are observed but are possibly also polish dependant. The halite contains considerable density of fine 0.002mm circular inclusions (possibly fluid inclusions). | | |
| 20% | Carbonate | 0.15 mm | Subhedral to granular |
| | Beds of fine to medium grained pale brown granular carbonate inter-grown with anhydrite along with isolated large coarse clear crystalline carbonate (with some birefringence characteristics of dolomite) also inter-grown with anhydrite. Minor very fine grained pale | | |



brown carbonate matrix associated with strongly iron stained isolated sedimentary structures (modified concretions?) are inter-grown with first order grey to yellow gypsum.

- <1% **Gypsum** **0.005 mm** **Subhedral**
Crystals within isolated minor fine carbonate-related sedimentary structures. Display only first order birefringence and are mostly iron stained red.
- <1% **Haematite/Goethite** **<0.001 mm** **Submicroscopic**
Minor submicroscopic red iron oxide staining in places of fine carbonate growth.

General Petrographic Observations & Interpretations

Irregular banding (possibly representing differential compaction) between dominantly carbonate or anhydrite and halite occur across the slide. The anhydrite in particular is often strongly aligned with this layering (Micrographs 7 & 8).

The beds of carbonate are mostly granular and fine to medium grained with intergrowths of lesser medium grained anhydrite. Within the coarse anhydrite layers, the carbonate is also coarse grained and subhedral to rhombohedral (possibly calcite).

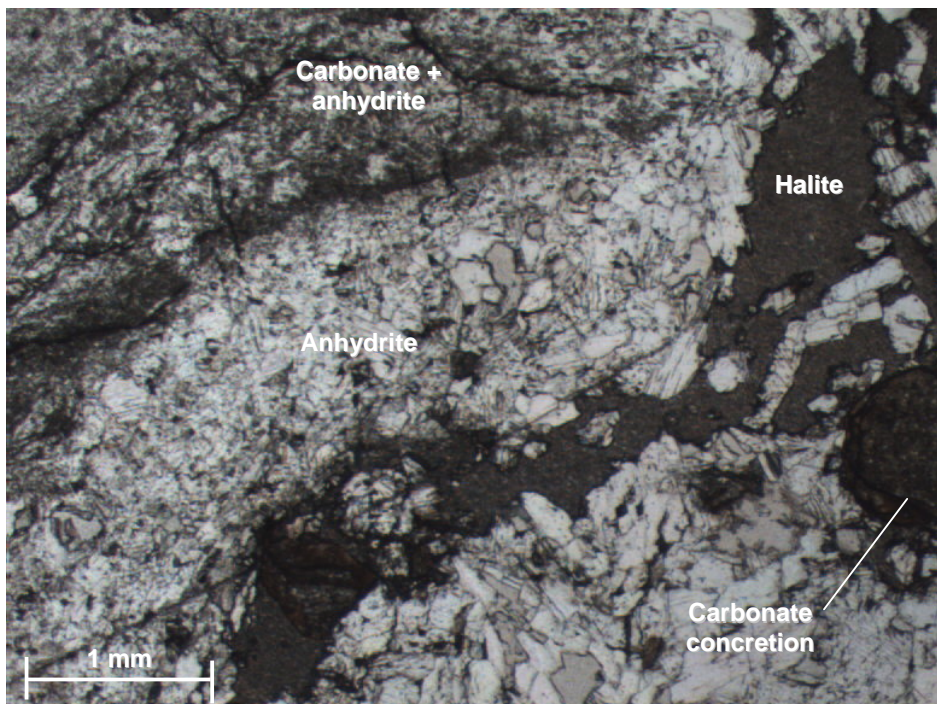
The finer grained carbonate presents extreme birefringence with a particular dark brown to pink colouration that is partly characteristic of dolomite.

The salt is predominantly massive in texture with minor examples of cubic crystallinity, likely enhanced by the polish. The lack of coarse halite cleavage and large crystals as observed in hand specimen is possibly a result of deformation during thin section production or indicates fine grained recrystallisation of earlier coarse grains.

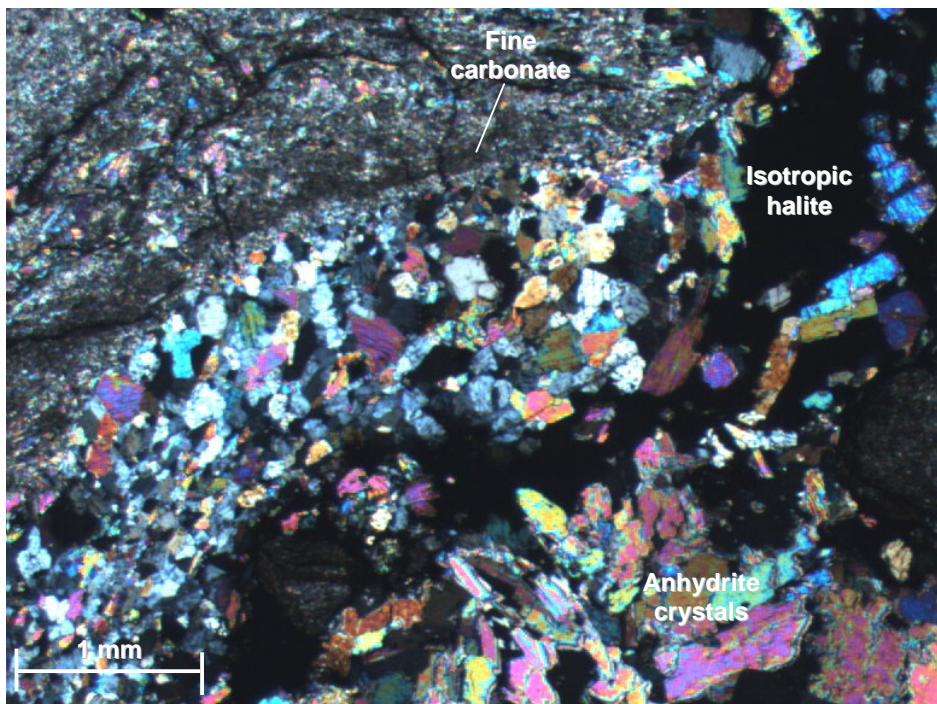
Minor gypsum is observed in irregular iron stained carbonate dominated structures possibly representing modified concretions.

CLASSIFICATION

Banded Anhydrite, Carbonate & Halite (Evaporite)



Micrograph 7. Thin Section C&R 4 - plane polarized light [25x Mag. F.O.V. 6.4mm]
Bands of dominantly fine grained halite, coarse anhydrite and medium to fine grained carbonate; plus carbonate concretion.



Micrograph 8. Thin Section C&R 4 - crossed polarized light [25x Mag. F.O.V. 6.4mm]
Isotropic halite with coarse brightly coloured (high birefringence) anhydrite and fine carbonate.

CLIENT: TELLUS HOLDINGS PTY LTD
PROJECT: Mt. Charlotte Mineralogy Investigation
REPORT: Report on Mineralogical Analyses
DATE: 24th October 2011



APPENDIX 2 – QUT XRD ANALYSES



POWDER X-RAY DIFFRACTION ANALYSIS OF SUBMITTED SAMPLES

QUT Reference: XAF6968
Your Reference: 5042003A, 5042003B, 5042004A, 5042004B
Date: 6 September 2011

INTRODUCTION

The four (4) samples were sent by Stephen Wegner of C&R Consulting for powder x-ray diffraction analysis to determine the identity and nominal concentrations of compounds present. The samples were received on 31 August 2011.

PROCEDURE

The samples broken in half and one half crushed (with one half set aside for return) except 5042004B were the entire sample was crushed in a swing mill. A 2g sub-sample was split off and micronized using a McCrone mill with agate beads and hexane as a fluid. The samples were dried overnight at 40C to evaporate the fluid. Step-scanned diffraction patterns were collected using a Panalytical vertical diffractometer, cobalt K α radiation and the usual conditions. The powder x-ray diffraction data was analysed using Jade (V9.0, Materials Data Inc.) for phase identification and SiroQuant (V3, Sietronics Pty Ltd) for quantitative analysis using a Rietveld technique.

RESULTS

Tabulated phase concentrations are in the table below. The results are relative and normalised – they represent a ratio of concentrations. Any error in modelling of a phase will influence its estimated concentration. These results are nominal.

Powder XRD diffraction is phase analysis and is not chemical analysis. XRD and chemical analysis results may be able to be resolved if other information is available such as the chemical formula of the phases present or the polymorph (variant of crystal structure). The closest matches in the reference database were used in the modelling, but other members of the respective mineral groups may be present in the samples. Phase concentrations may be mis-estimated if an incorrect chemical formula is assigned to a phase or an inappropriate structure used in the modelling. There may be minor unidentified phases in the samples.

Included are the diffraction data in graphical format. The phases identified are indicated on the graphics.

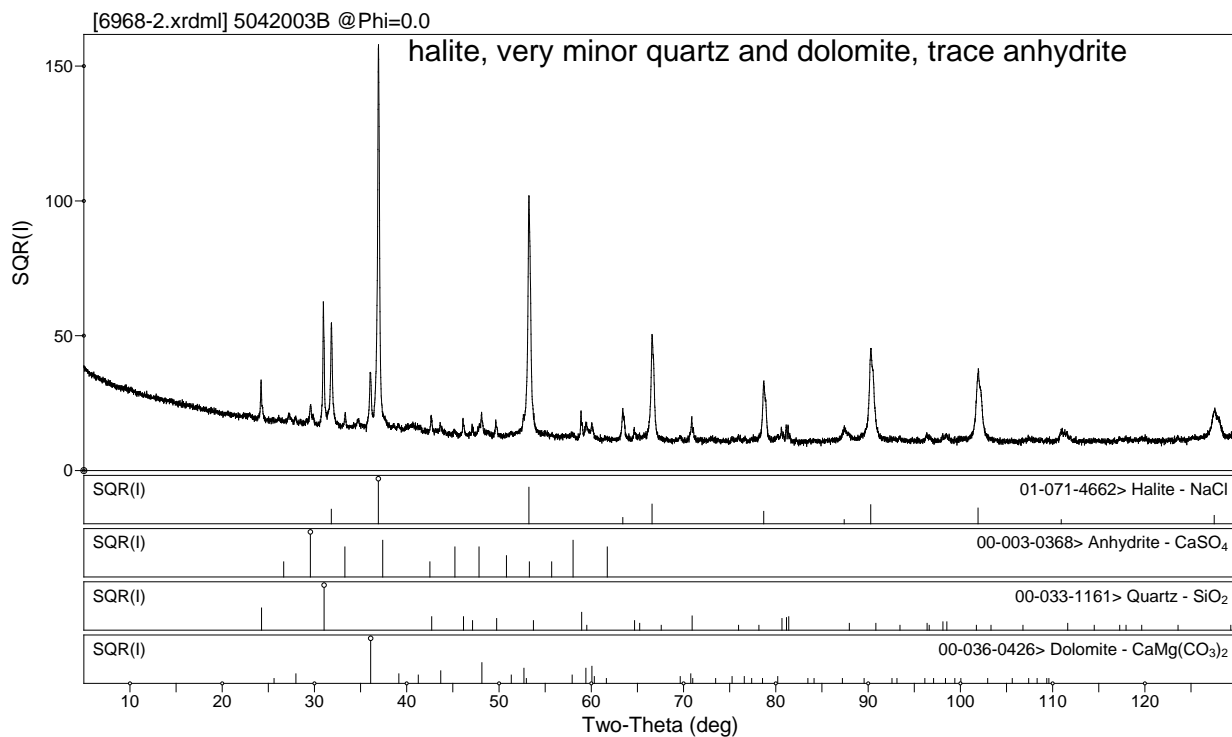
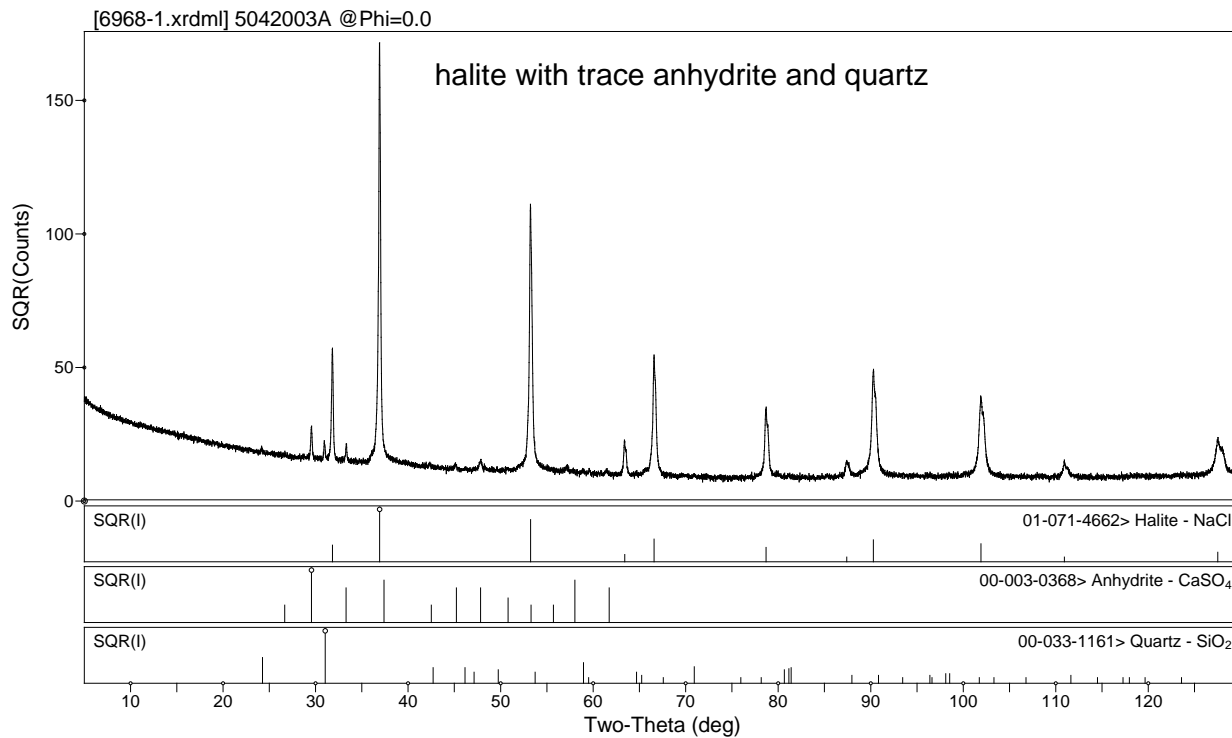
Phase concentrations (nominal, relative) wt%

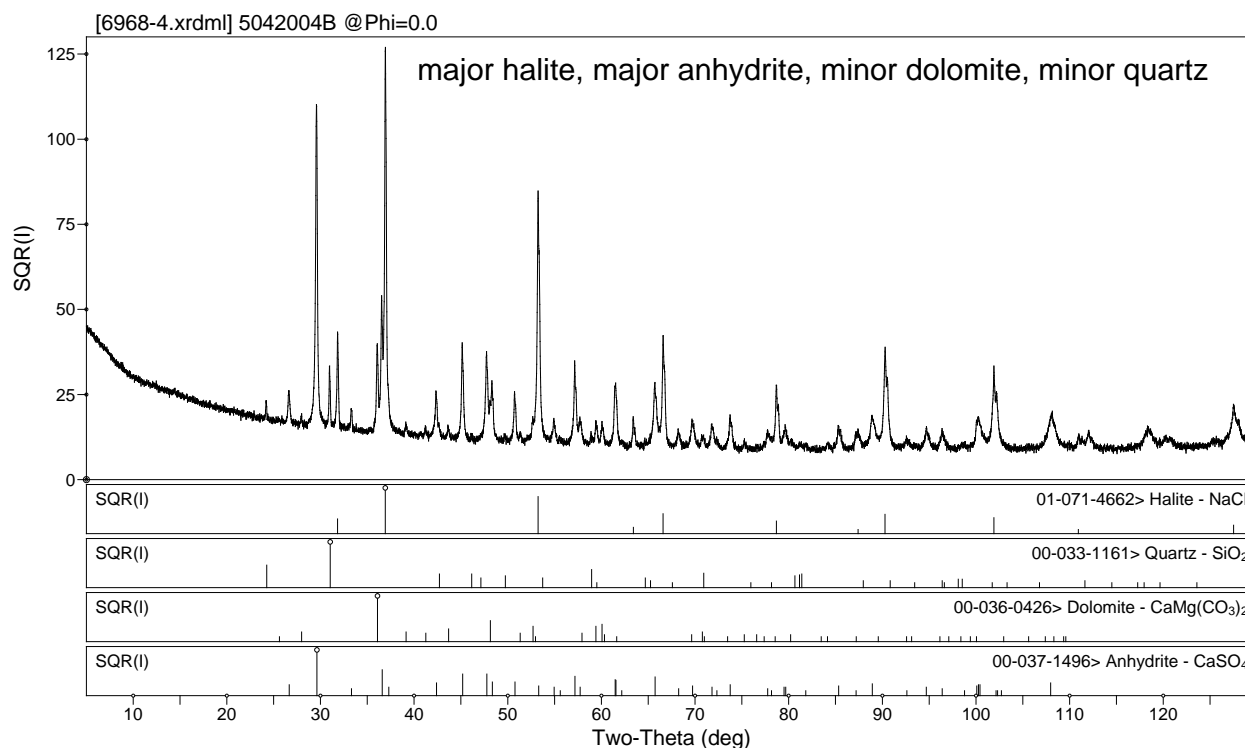
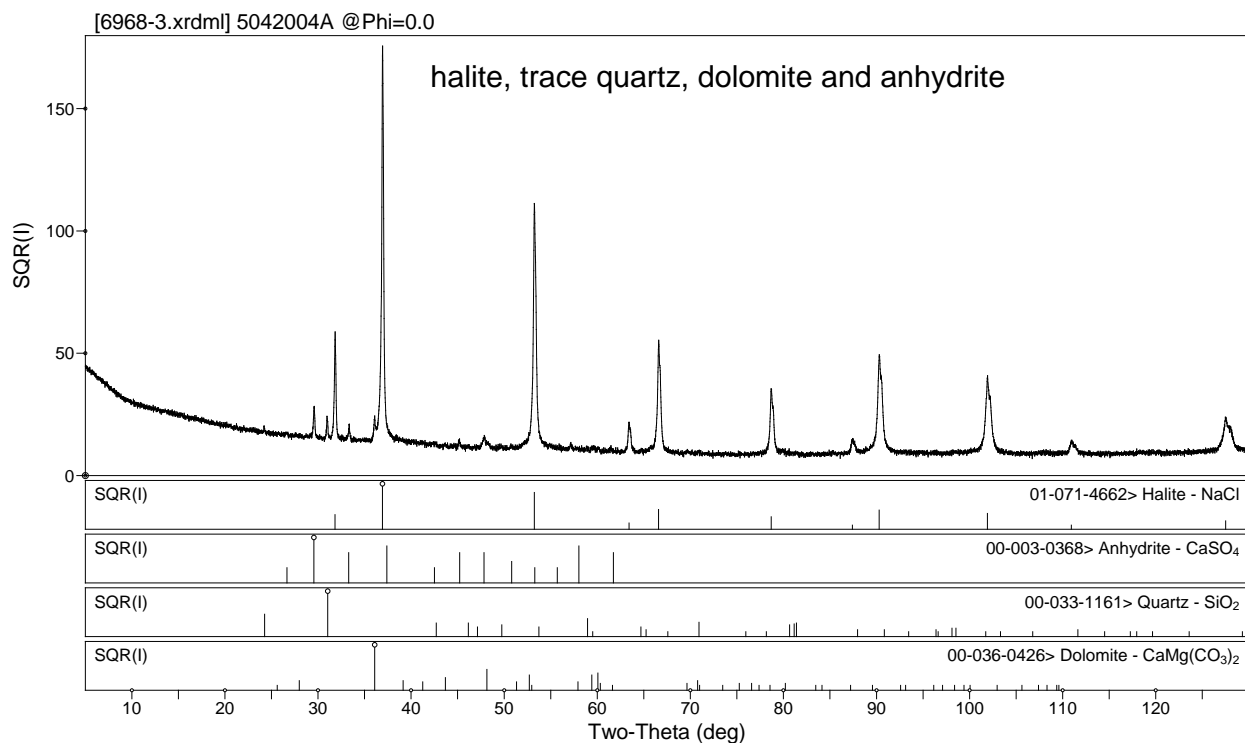
XAF	6968-1	6968-2	6968-3	6968-4
C&R	5042003A	5042003B	5042004A	5042004B
Halite	95.5	80.9	94	44.4
Dolomite	0.1	7	2	7.9
Quartz	1.2	10.3	1.1	2.3
Anhydrite	3.3	1.9	2.9	45.4

Tony Raftery

Tony Raftery
Senior Technologist

Powder XRD patterns





CLIENT: TELLUS HOLDINGS PTY LTD
PROJECT: Mt. Charlotte Mineralogy Investigation
REPORT: Report on Mineralogical Analyses
DATE: 24th October 2011



APPENDIX 3 – AAC XRF ANALYSES



Advanced Analytical Centre
James Cook University
Townsville
Queensland 4811
Australia

Telephone (07) 4781 4599
International Telephone 61 7 4781 4599
Facsimile (07) 4781 5550
International Facsimile 61 7 4781 5550

SUBJECT OF REPORT

Semi-Quantitative XRF Analysis

CONFIDENTIAL

Report 10317-R01 is prepared for: Mr Stephen Wegner

stephen@candrconsulting.com.au

Samples Received 16-Sep-2011
Samples Analysed 16-Sep-2011
Sampling: The Advanced Analytical Centre took no part in sampling of this material

Written by:	Dr Shane Askew	Date:	19-Sep-2011
Checked by:	Dr Kevin Blake	Job No:	10317-11
Approved by:	Dr Kevin Blake	Facility:	Xray
Position:	Director -AAC		



Advanced Analytical Centre
James Cook University
Townsville
Queensland 4811
Australia

Telephone (07) 4781 4599
International Telephone 61 7 4781 4599
Facsimile (07) 4781 5550
International Facsimile 61 7 4781 5550

Semi-Quantitative Analysis Report

Job No. 10317-11
Sample No. 10317-01
Description 6968-1
Sample Preparation Solid
Sample Received 16-Sep-2011
Sample Analysed 16/09/2011 4:45:27 PM
Sampling The AAC took no part in sampling of this material
Client Mr Stephen Wegner

O	F	Na 39.0	Mg 0.124	Al 0.111	Si 0.220	P	S 0.484
Cl 70.8	K 0.036	Ca 0.869	Sc	Ti	V	Cr	Mn
Fe 0.009	Co	Ni	Cu	Zn	Ga	Ge	As
Se	Br 0.014	Rb	Sr 0.006	Y	Zr	Nb	Mo
Ag	Cd	In	Sn	Sb	Te	I	Cs
Ba	La	Ce	Hf	Ta	W	Hg	Tl
Pb	Bi	Th	U				Total 100.0

The analysis method is semi-quantitative and results should be used only as an indication of concentration.
All results are expressed as weight%. Liquid and loose powder samples can not be analysed for the elements H - F inclusive.
All elements with blank have been analysed but are below detection.
Rare earth elements and platinum group are excluded from routine analysis.



Advanced Analytical Centre
 James Cook University
 Townsville
 Queensland 4811
 Australia

Telephone (07) 4781 4599
 International Telephone 61 7 4781 4599
 Facsimile (07) 4781 5550
 International Facsimile 61 7 4781 5550

Semi-Quantitative Analysis Report

Job No. 10317-11
 Sample No. 10317-02
 Description 6968-2
 Sample Preparation Solid
 Sample Received 16-Sep-2011
 Sample Analysed 16/09/2011 4:58:06 PM
 Sampling The AAC took no part in sampling of this material
 Client Mr Stephen Wegner

O	F	Na 34.4	Mg 1.07	Al 1.08	Si 3.79	P 0.011	S 0.308
Cl 61.3	K 1.20	Ca 2.13	Sc	Ti 0.068	V	Cr 0.024	Mn 0.009
Fe 0.677	Co	Ni	Cu	Zn	Ga	Ge	As
Se	Br 0.013	Rb 0.003	Sr 0.044	Y	Zr 0.004	Nb	Mo
Ag	Cd	In	Sn	Sb	Te	I	Cs
Ba	La	Ce	Hf	Ta	W	Hg	Tl
Pb	Bi	Th	U				Total 100.0

The analysis method is semi-quantitative and results should be used only as an indication of concentration.
 All results are expressed as weight%. Liquid and loose powder samples can not be analysed for the elements H - F inclusive.
 All elements with blank have been analysed but are below detection.
 Rare earth elements and platinum group are excluded from routine analysis.



Advanced Analytical Centre
James Cook University
Townsville
Queensland 4811
Australia

Telephone (07) 4781 4599
International Telephone 61 7 4781 4599
Facsimile (07) 4781 5550
International Facsimile 61 7 4781 5550

Semi-Quantitative Analysis Report

Job No. 10317-11
Sample No. 10317-03
Description 6968-3
Sample Preparation Solid
Sample Received 16-Sep-2011
Sample Analysed 16/09/2011 5:10:44 PM
Sampling The AAC took no part in sampling of this material
Client Mr Stephen Wegner

O	F	Na 39.5	Mg 0.235	Al 0.110	Si 0.241	P	S 0.489
Cl 70.1	K 0.091	Ca 1.05	Sc	Ti	V	Cr	Mn
Fe 0.022	Co	Ni	Cu	Zn	Ga	Ge	As
Se	Br 0.020	Rb	Sr	Y	Zr	Nb	Mo
Ag	Cd	In	Sn	Sb	Te	I	Cs
Ba	La	Ce	Hf	Ta	W	Hg	Tl
Pb	Bi	Th	U				Total 100.0

The analysis method is semi-quantitative and results should be used only as an indication of concentration.
All results are expressed as weight%. Liquid and loose powder samples can not be analysed for the elements H - F inclusive.
All elements with blank have been analysed but are below detection.
Rare earth elements and platinum group are excluded from routine analysis.



Advanced Analytical Centre
James Cook University
Townsville
Queensland 4811
Australia

Telephone (07) 4781 4599
International Telephone 61 7 4781 4599
Facsimile (07) 4781 5550
International Facsimile 61 7 4781 5550

Semi-Quantitative Analysis Report

Job No. 10317-11
Sample No. 10317-04
Description 6968-4
Sample Preparation Solid
Sample Received 16-Sep-2011
Sample Analysed 16/09/2011 5:23:25 PM
Sampling The AAC took no part in sampling of this material
Client Mr Stephen Wegner

O	F	Na 35.3	Mg 0.518	Al 0.230	Si 0.531	P	S 5.81
Cl 54.7	K 0.106	Ca 12.8	Sc	Ti	V	Cr	Mn
Fe 0.134	Co	Ni	Cu	Zn	Ga	Ge	As
Se	Br 0.013	Rb	Sr 0.069	Y	Zr	Nb	Mo
Ag	Cd	In	Sn	Sb	Te	I	Cs
Ba	La	Ce	Hf	Ta	W	Hg	Tl
Pb	Bi	Th	U				Total 100.0

The analysis method is semi-quantitative and results should be used only as an indication of concentration.
All results are expressed as weight%. Liquid and loose powder samples can not be analysed for the elements H - F inclusive.
All elements with blank have been analysed but are below detection.
Rare earth elements and platinum group are excluded from routine analysis.

REPORT CONDITIONS ENDORSEMENT

- 1 The work for and preparation of this report are governed by standard conditions (“Standard Report Conditions”) of James Cook University (“JCU”). The Standard Report Conditions also govern use and reproduction of this report and any extract of it. This endorsement highlights some of the Standard Report Conditions but does not override or vary them. A complete copy of the Standard Report Conditions can be obtained from the *Advanced Analytical Centre* (“Centre”) at JCU.
- 2 The report must not be used or referred to in any marketing, publicity, media release or legal proceedings without written authority from JCU. No reference to JCU or the Centre in connection with the work or the report may be made without written authority from JCU.

The analytical methods and procedures used in carrying out the work are summarised in the report.

- 3 Any interpretations of data are also identified as such in the report. JCU accepts no responsibility for any further or other interpretations. Any questions relating to the work or the report or about inferences to be drawn from them, should be referred to the Director of the Centre.
- 4 The report must only be used for the purpose notified to JCU as its intended use at the time of preparation of the report.
- 5 The report must not be disseminated in any way which is likely to mislead or deceive any person, including by disseminating an extract of the report without including relevant qualifications contained in the report.
- 6 These Standard Report Conditions cannot be varied or waived except with the written agreement of the Director of the Centre. No other person has authority on behalf of JCU to do so.
- 7 The work and this report are subject to indemnity, exclusion and liability limiting provisions set out in the Standard Report Conditions.
- 8 Every copy of this report which is made must include this JCU approved report conditions endorsement in a clearly legible form.