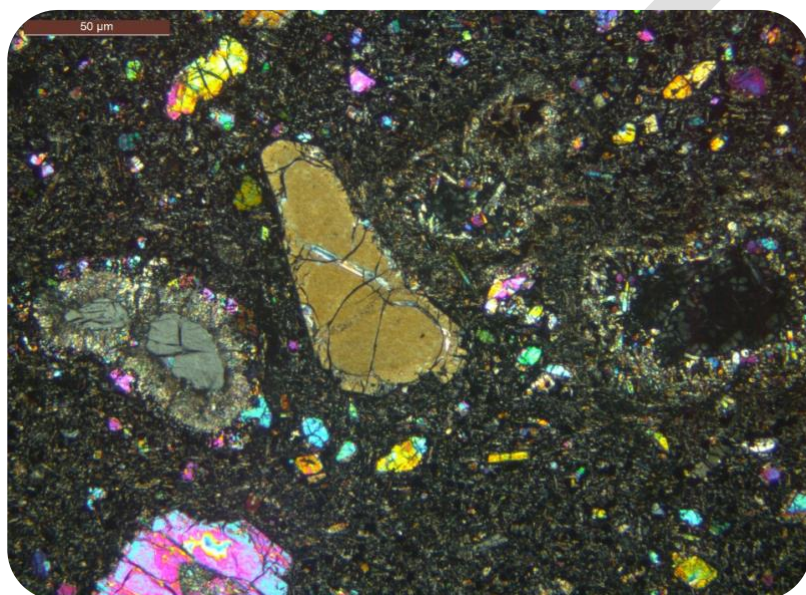


Petrological and Mineralogical Analyses, for Hylogger Project: Rock Assemblage Library



An unpublished Mineral
Resources Tasmania Report for:

J Moltzen,

**Geological Survey
of NSW**

By: R S Bottrill, L Unwin & T
Coyte

Date: 8 March 2020

Mineral Resources Tasmania

SUMMARY

The Hylogger, XRD, XRF, SEM/EDS and optical petrology were used to determine the mineralogy of 20 samples of Tasmanian igneous rocks. Most of these give reasonably consistent results between the methods, though there are some discrepancies, perhaps due to the fine grained and highly altered nature of some of the rocks. No single method seems capable of giving the full mineralogy of most of these samples without supportive studies. Many samples were found to have significantly different lithologies to their provided names.

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 was to confirm the mineralogy of some samples of Tasmanian igneous rocks, mostly from the Cambrian Mt Read Volcanics, by XRD, XRF and by microscopic petrology, to validate Hylogger results, particularly for phyllosilicates.

SAMPLES

The details of the samples submitted are given in Table 1 below (but note their original descriptions are inaccurate in many cases). They are sub-sampled from rocks collected over many years by MRT geologists and stored in the MRT corestore in Mornington. About half are from the Mid-Cambrian Mt Read volcanic sequences, part of the MRVP subset of the TIGER samples and geochemistry database.

Mineral Resources Tasmania

Table 1: Sample details

MRT Reg. No.	RAL No.	Location	Description supplied
R010760	RAL1	Pyengana	Granodiorite (dolerite)
G401107	RAL2	Pieman Rd	Lava (dacite)
R010856	RAL3	Medeas Cove, St Helens	Granite
G401102	RAL4	Murchison Dam Rd	Granodiorite
G401103	RAL5	Murchison Dam Rd	Granodiorite
G401082	RAL6	Bradshaws Rd	Phyric volcanic (andesite)
G401054	RAL7	Anthony road	Phyric volcanic (andesite)
G401057	RAL8	Murchison Dam Rd	Phyric volcanic (rhyolite)
R010754	RAL9	Hogans Road	Gabbro
G401398	RAL10	Beulah: Dasher River	Volcanic rock (basalt)
G401085	RAL11	Bradshaws Rd	Autobrecciated, phyric andesitic-rock (andesite)
G401339	RAL12	Murchison Hwy	Gabbro
G401388	RAL13	Mt Agnew	Adamellite
G401340	RAL14	Savage River Rd	Granite
G401069	RAL15	Bradshaws Rd	Porphyritic, spherulitic volcanic (rhyolite)
R005508	RAL16	Llewellyn	Hawaiite (basalt)
G401010	RAL17	Murchison Hwy	Amygdaloidal, phyric volcanic (dacite)
G401016	RAL18	Elliott Bay	Phyric, schistose volcanic (dacite)
R004131	RAL19	E of St Columba Hotel	Granodiorite
R004475	RAL20	Haleys New Country	Diorite

SAMPLE TREATMENT

The samples were prepared, and analysed in the MRT Hylogger laboratories, Mornington, Tasmania. They were run using Short-wave IR spectrometers and Thermal IR, using various methods including dCLST and sTSAT (Table 2).

They were also analysed by XRD and XRF methods, plus examination by Optical (polarised light) petrography in the MRT laboratories, Rosny. Thin and polished sections were prepared in both the MRT and University of Tasmania - Sandy Bay Geology laboratories. SEM/EDS analyses were conducted on the polished samples at the CSL Laboratories, University of Tasmania, Sandy Bay. The data was all combined into the MINSQ program to refine the mineralogical interpretations (Herrmann and Berry, 2002).

Mineral Resources Tasmania

SAMPLE DESCRIPTION & PETROLOGY

The samples were all described in hand specimen and in cross and plane-polarised transmitted light. Many samples were renamed differently to the original descriptions based on their petrology, and also their chemistry. The images are shown in Figures 1-21 (showing mixed normal and transmitted polarised light images).



Fig. 1 Hand specimens. FOV ~600 mm.

Mineral Resources Tasmania

R010760 RAL1 Pyengana Granodiorite

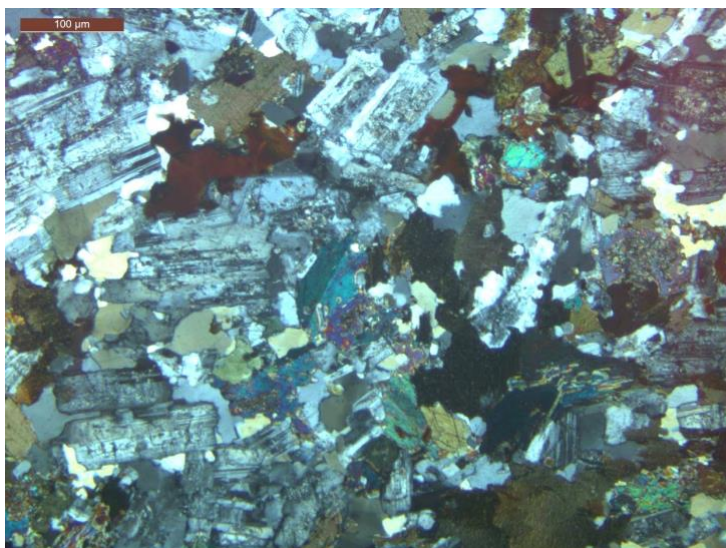
The rock is a medium grained, dark grey igneous rock in hand specimen; it is a weakly altered, clinopyroxene bearing hornblende+biotite rich granodiorite.



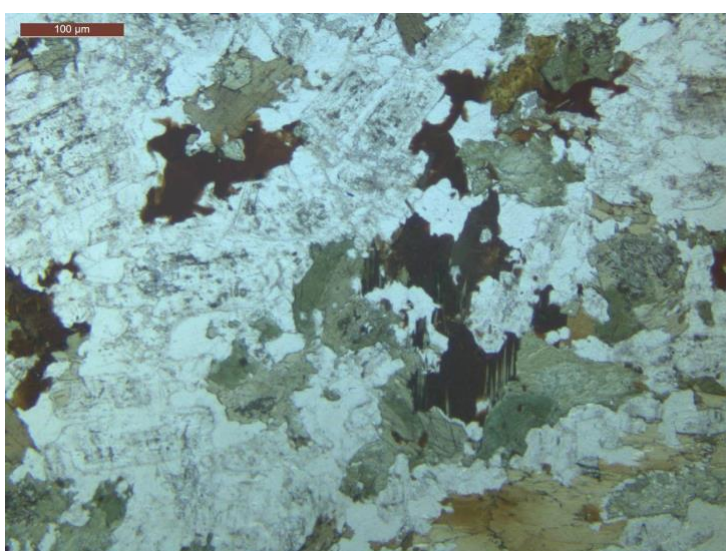
2a



2b



2c



2d

Fig. 2a-d. R010760 RAL1 Pyengana Hornblende-Biotite granodiorite (Images in both incident and polarised light).

Mineral Resources Tasmania

G401107 RAL2 Pieman Rd Dacite

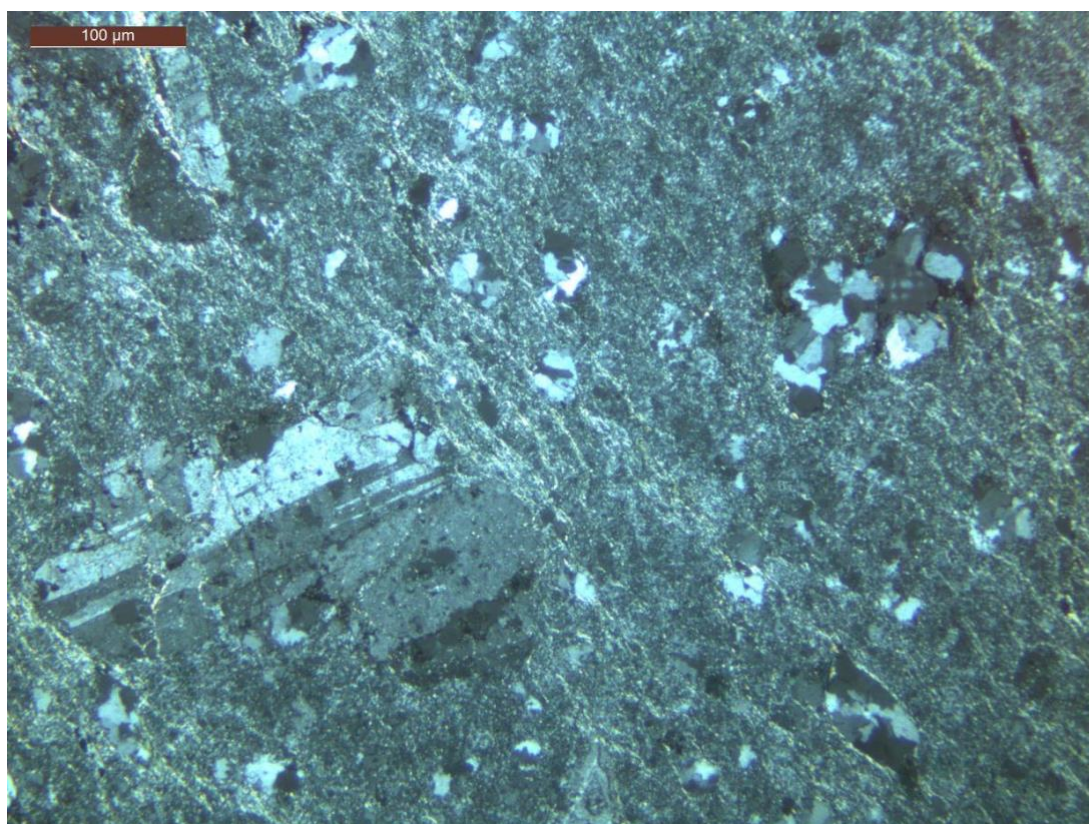
The rock is a fine grained, mottled pink and grey volcanic rock in hand specimen; it is a very highly altered (sericite-kaolinite-chlorite), quartz and feldspar-phyric dacite.



3a



3b



3c

Fig. 3a-c. G401107 RAL2 Pieman Rd Plagioclase-phyric dacite

Mineral Resources Tasmania

R010856 RAL3 Medeas Cove, St Helens Granite

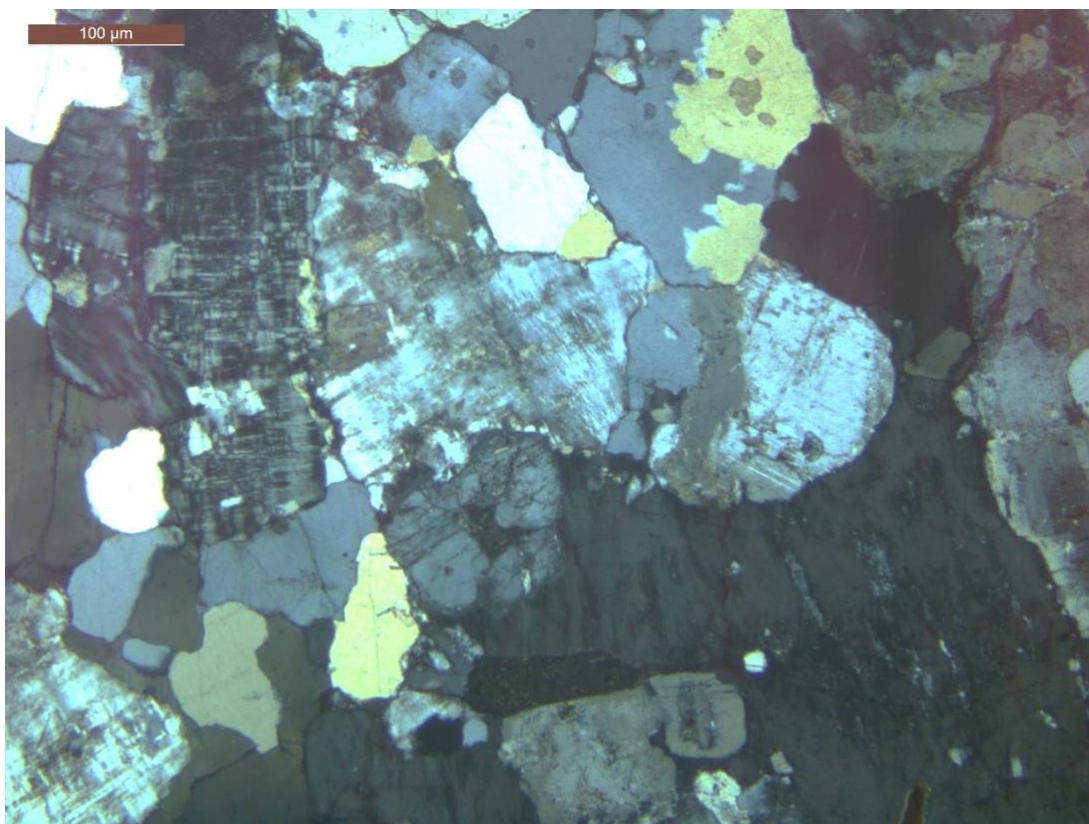
This rock is a medium grained, equigranular mottled pink/white/black granitic rock: a hematite-altered, microcline-biotite monzogranite.



4a



4b



4c

Fig. 4a-c. R010856 RAL3 Medeas Cove, St Helens Microcline Granite

Mineral Resources Tasmania

G401102 RAL4 Murchison Dam Rd Monzogranite

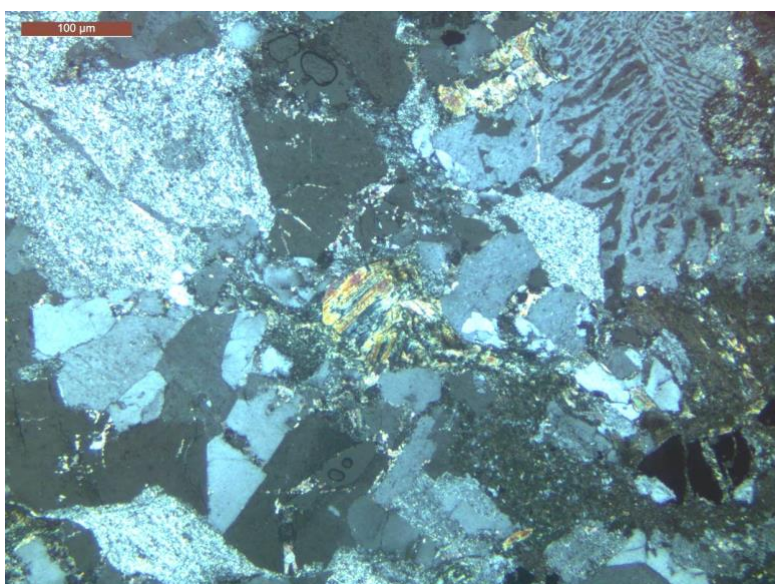
This rock is an equigranular, mottled red/white/black granitic rock. It is a highly altered (sericite-chlorite), granophyric, biotite micro-monzogranite.



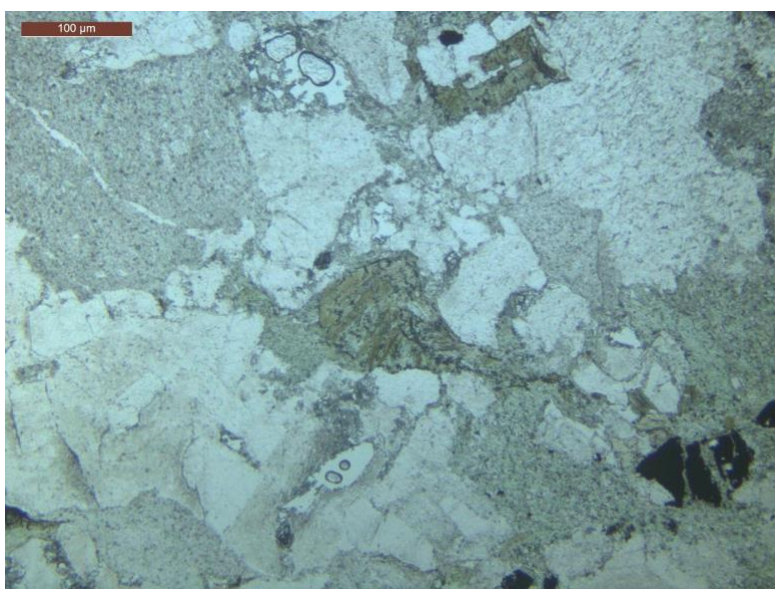
5a



5b



5c



5d

Fig. 5a-d. G401102 RAL4 Murchison Dam Rd Biotite monzogranite

Mineral Resources Tasmania

G401103 RAL5 Murchison Dam Rd Monzogranite

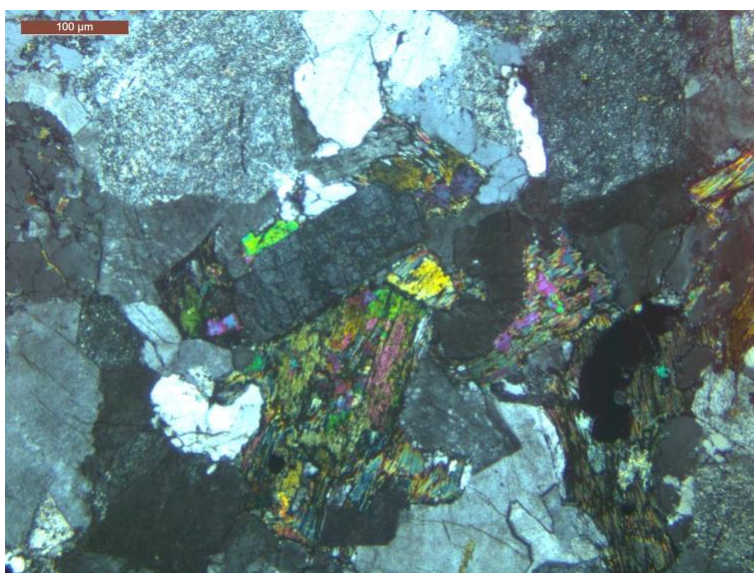
This rock is a mottled pink/white/black granitic rock. It is an altered (chlorite) hornblende-biotite micro-monzogranite.



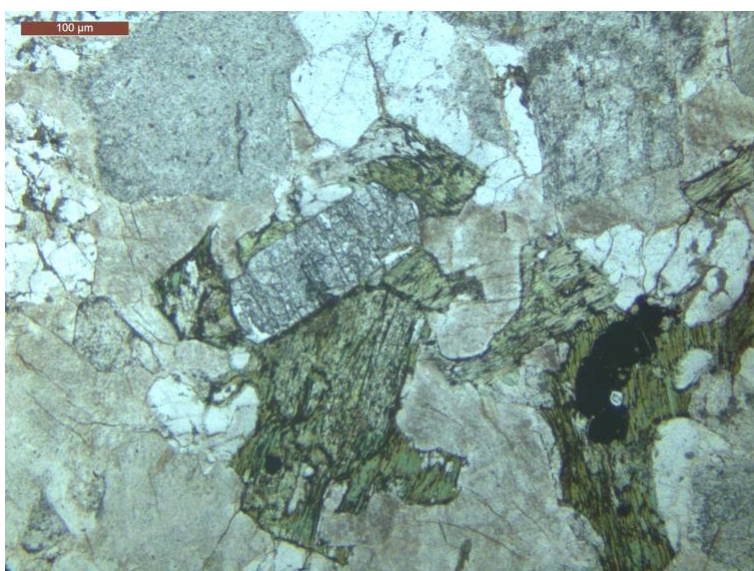
6a



6b



6c



6d

Fig. 6a-d. G401103 RAL5 Murchison Dam Rd Hornblende-biotite microgranodiorite

Mineral Resources Tasmania

G401082 RAL6 Bradshaws Rd Dacite

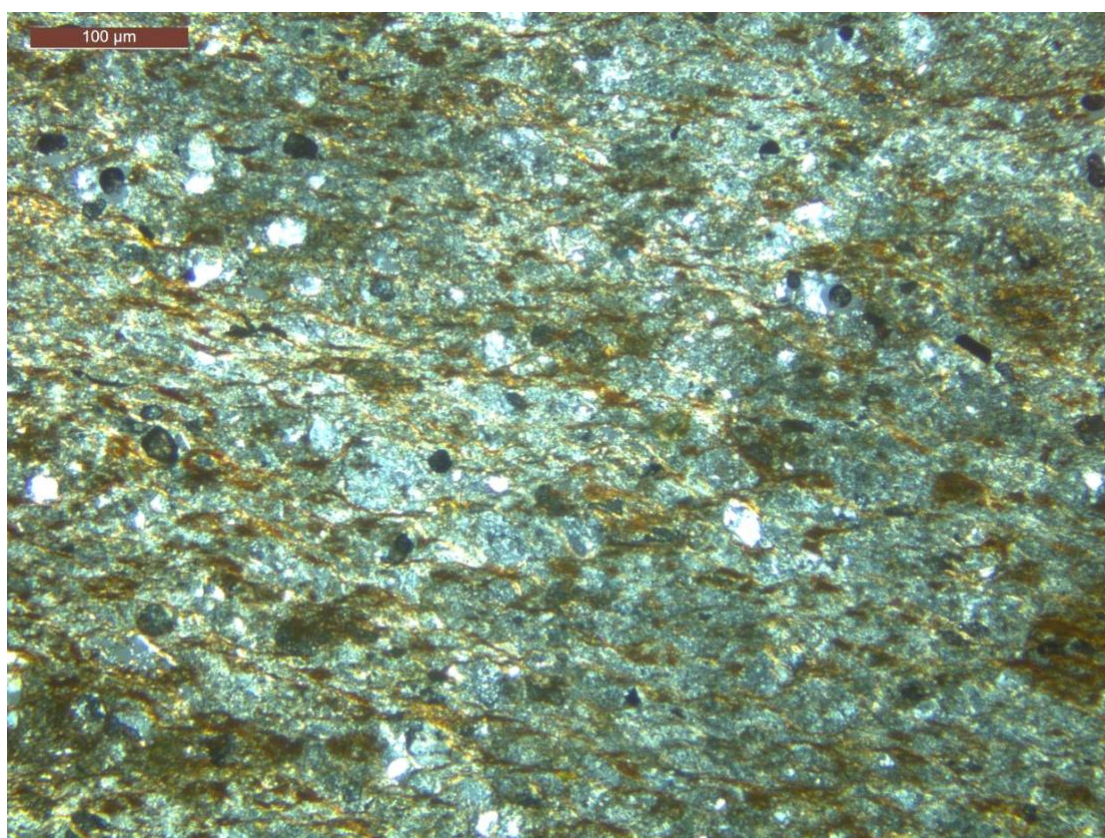
The rock is a fine grained, mottled pink and grey volcanic rock in hand specimen; it is a sheared and very highly altered (sericite-kaolinite-chlorite), finely quartz and feldspar-phyric dacite.



7a



7b



7c

Fig. 7. G401082 RAL6 Bradshaws Rd Altered dacite

Mineral Resources Tasmania

G401054 RAL7 Anthony road Rhyodacite

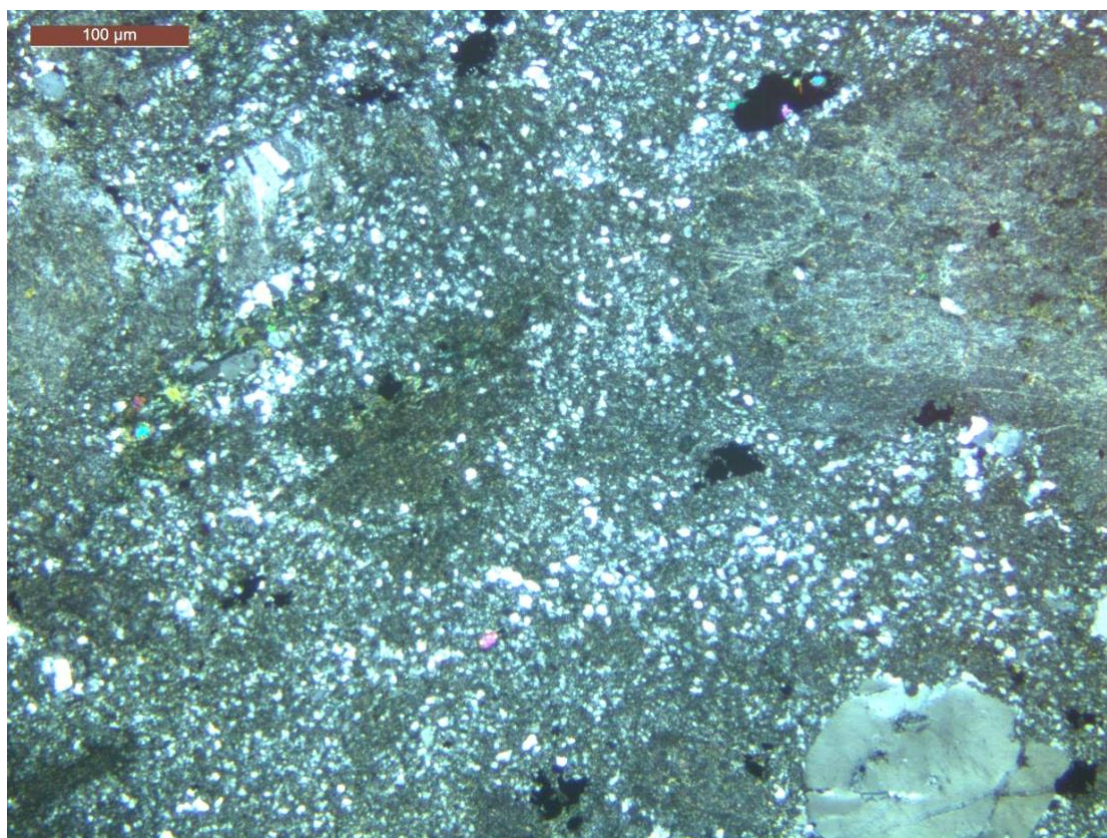
The rock is a fine grained, mottled pink and grey volcanic rock in hand specimen; it is a very highly altered (kaolinite-chlorite), coarsely quartz and feldspar-phyrlic rhyodacite.



8a



8b



8c

Fig. 8a-c. G401054 RAL7 Anthony road, Altered quartz-feldspar phyrlic rhyodacite

Mineral Resources Tasmania

G401057 RAL8 Murchison Dam Rd Dacite

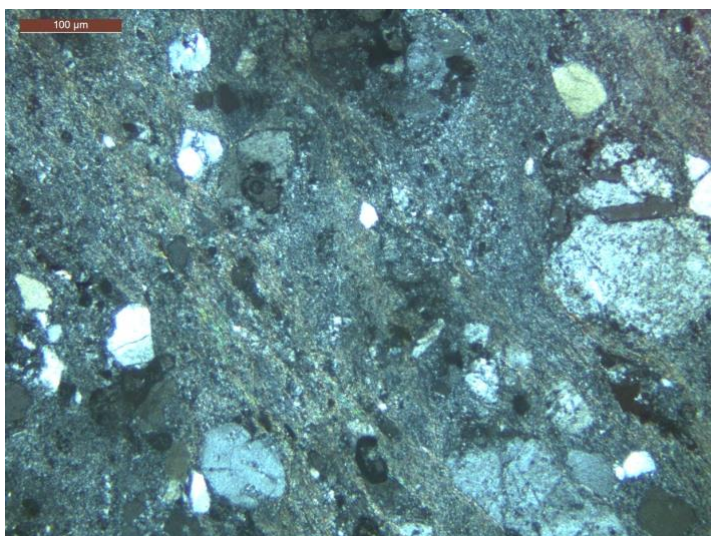
The rock is a fine grained, mottled pink and grey volcanic rock in hand specimen; it is a very highly altered (sericite-chlorite), weakly quartz and feldspar-phyric dacite.



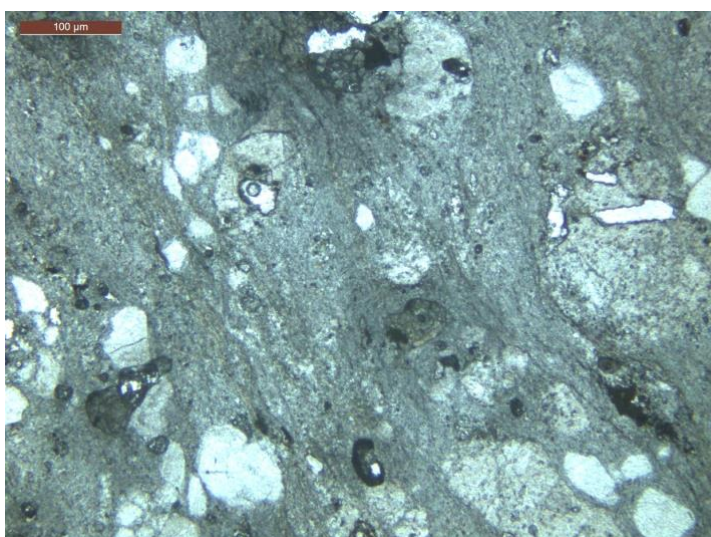
9a



9b



9c



9d

Fig. 9a-d. G401057 RAL8 Murchison Dam Rd Altered quartz-feldspar phyric dacite.

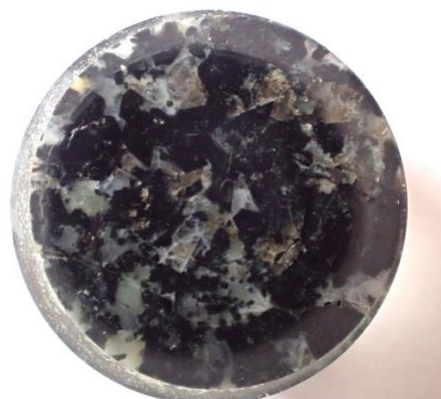
Mineral Resources Tasmania

R010754 RAL9 Hogans Road Tonalite

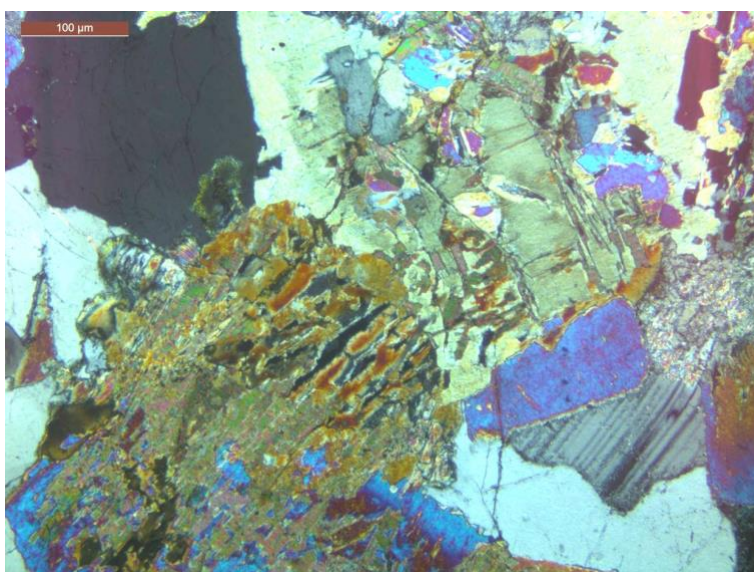
This rock is a mottled, coarse grey/black gabbroic rock. It is an altered (chlorite-prehnite- sericite), equigranular hornblende-biotite Tonalite



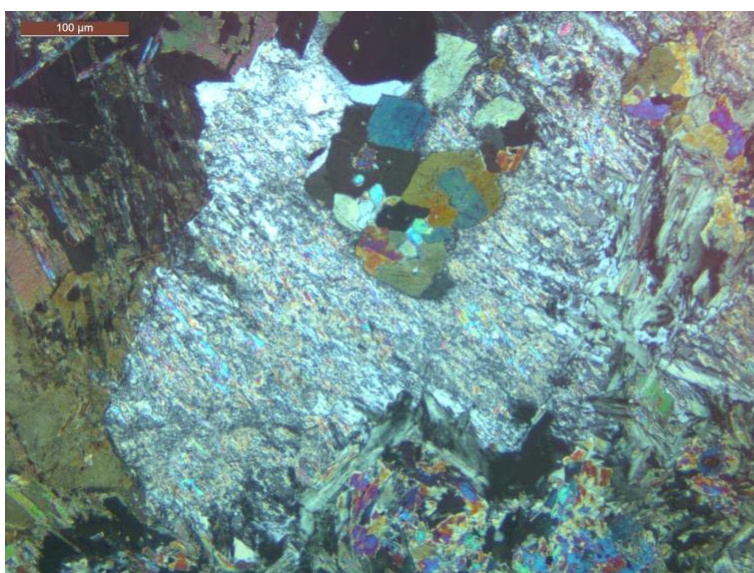
10a



10b



10c



10d

Fig. 10a-d. R010754 RAL9 Hogans Road Altered Tonalite

Mineral Resources Tasmania

G401398 RAL10 Beulah: Dasher River Andesitic rock

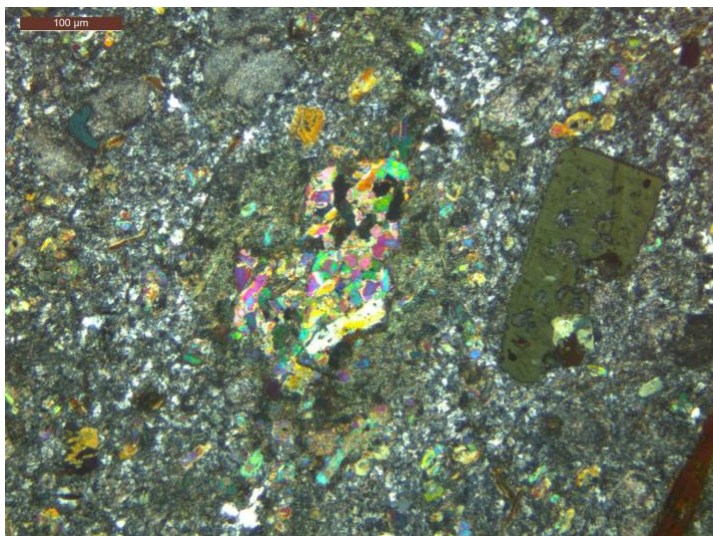
This rock is a white-spotted, fine grained black volcanic rock. It is a highly altered (chlorite-epidote-sericite) hornblende-biotite-feldspar phyric andesite/plagidacite.



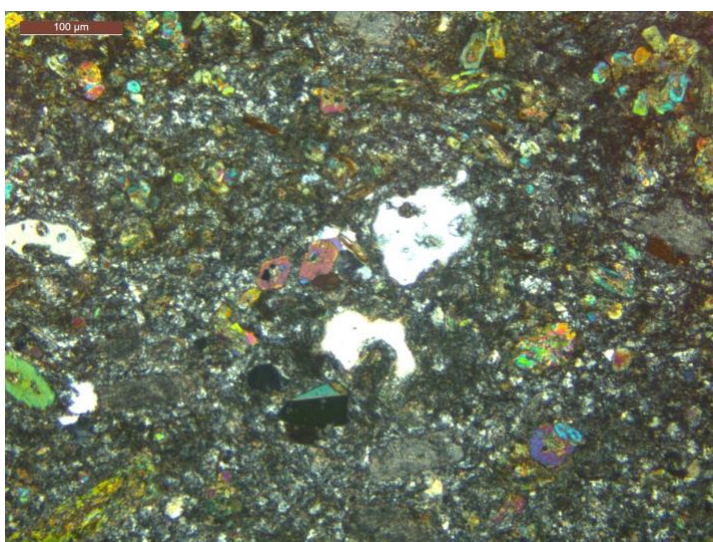
11a



11b



11c



11d

Fig. 11a-d. G401398 RAL10. Beulah: Dasher River. Hornblende andesite/plagidacite

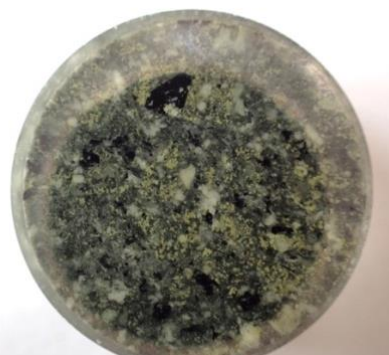
Mineral Resources Tasmania

G401085 RAL11 Bradshaws Rd Andesitic-rock

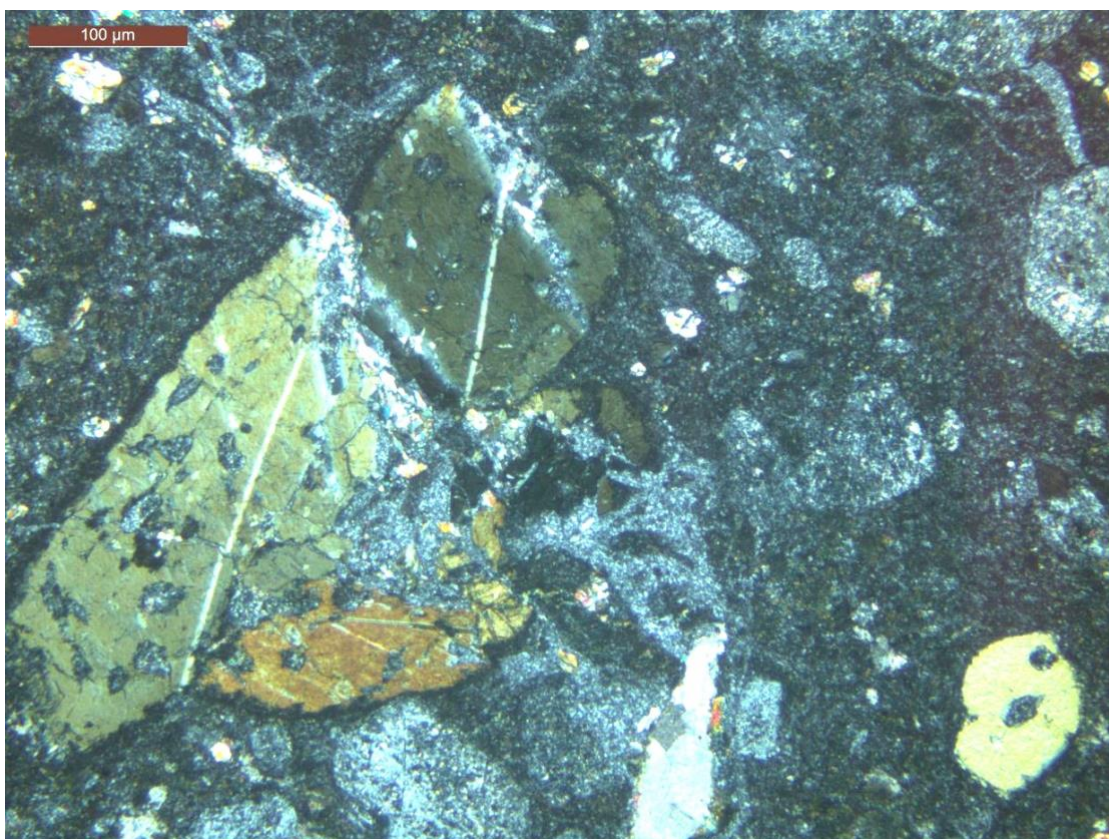
This rock is a grey-white-mottled, fine grained black volcanic rock. It is an altered (chlorite-epidote-sericite), autobrecciated, hornblende-clinopyroxene-plagioclase phyric andesite/plagidacite.



12a



12b



12c

Fig. 12a-c G401085 RAL11 Bradshaws Rd Autobrecciated, phyric andesitic-rock (andesite) Hornblende andesite/plagidacite

Mineral Resources Tasmania

G401339 RAL12 Murchison Hwy Gabbro

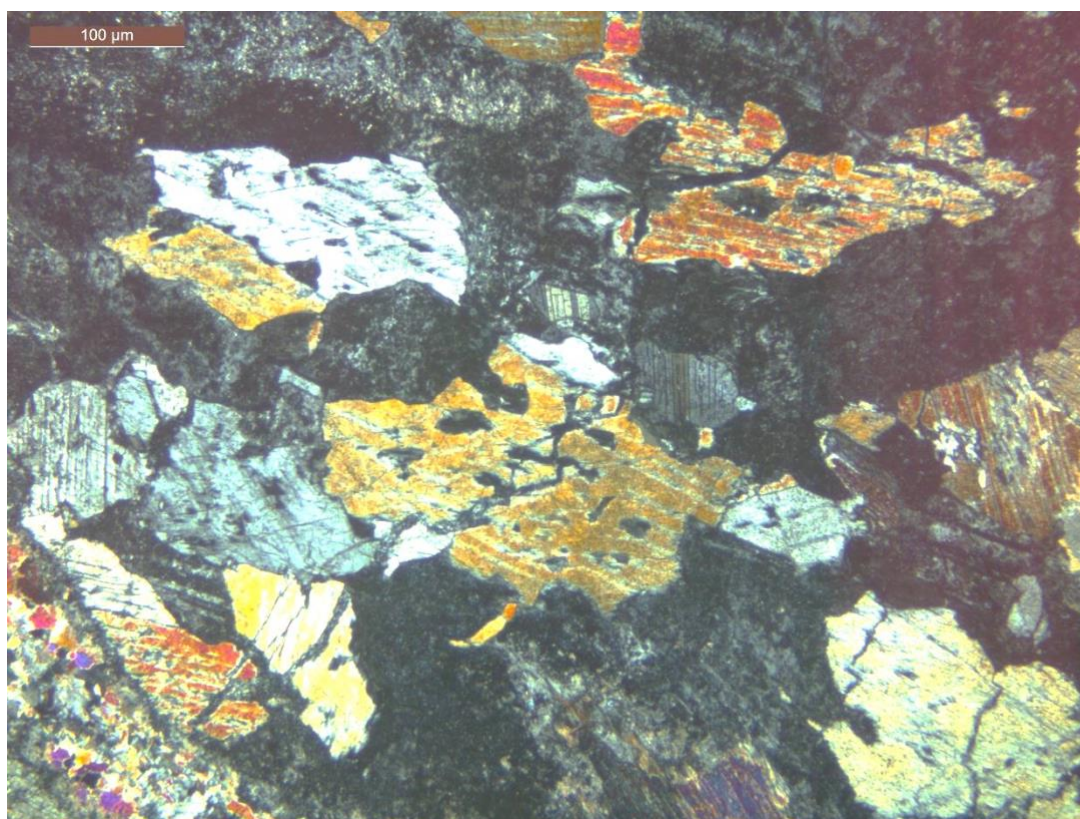
This rock is a mottled, coarse white/black gabbroic rock. It is an altered (chlorite-prehnite-hydrogrossular- sericite), equigranular hornblende-biotite Gabbro.



13a



13b



13c

Fig. 13a-c. G401339 RAL12 Murchison Hwy Altered hornblende Gabbro

Mineral Resources Tasmania

G401388 RAL13 Mt Agnew Microgranodiorite

This rock is a mottled, fine-medium white/pink/black granitic rock. It is a weakly altered (chlorite-kaolinite-smectite), granophyric Microgranodiorite

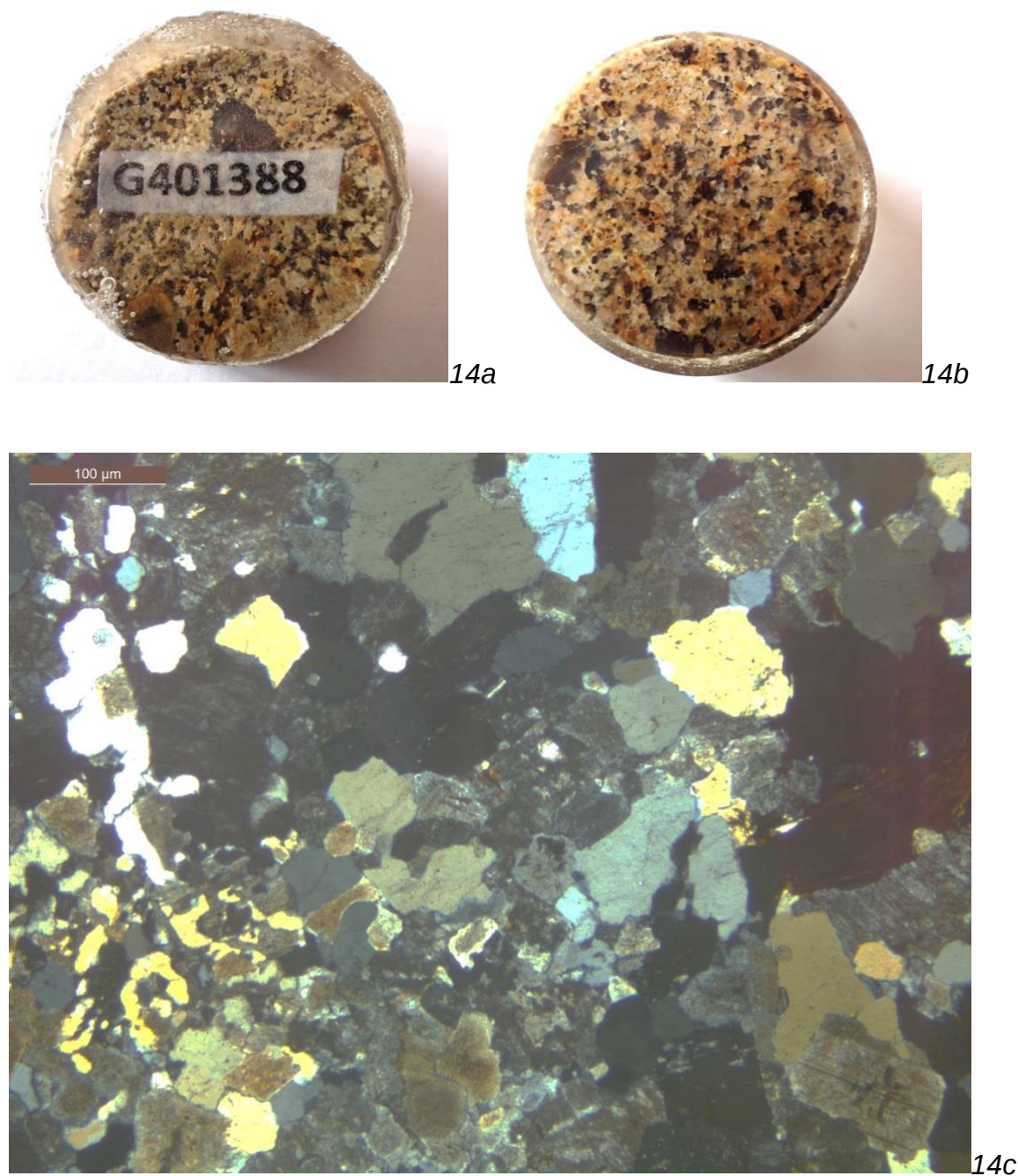


Fig 14a-c. G401388 RAL13 Mt Agnew Microgranodiorite

Mineral Resources Tasmania

G401340 RAL14 Savage River Rd Granite

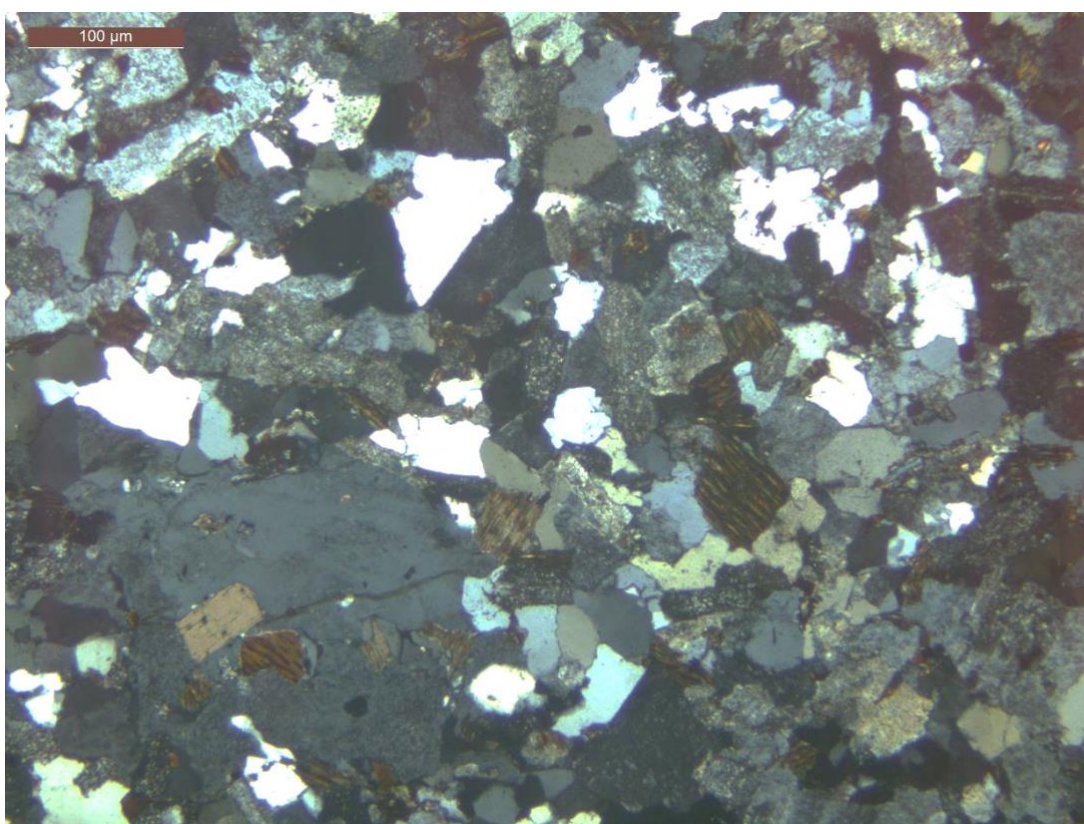
This rock is a mottled, fine-medium grained white/ black granitic rock. It is a weakly altered (chlorite-epidote-sericite), equigranular Micro-monzogranite.



15a



15b



15c

Fig. 15a-c. G401340 RAL14 Savage River Rd Micro-monzogranite

Mineral Resources Tasmania

G401069 RAL15 Bradshaws Rd Rhyodacite

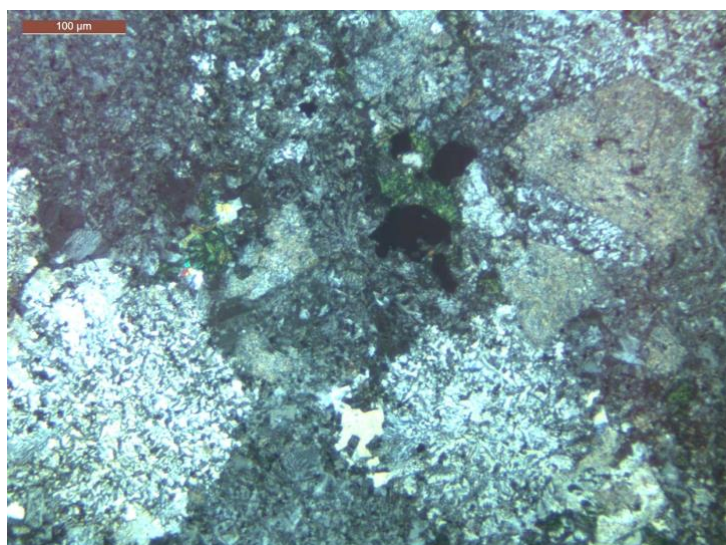
This rock is a red-black-white-mottled, fine-coarse-grained volcanic rock. It is an altered (chlorite-epidote-sericite) feldspar-phyric Rhyodacite.



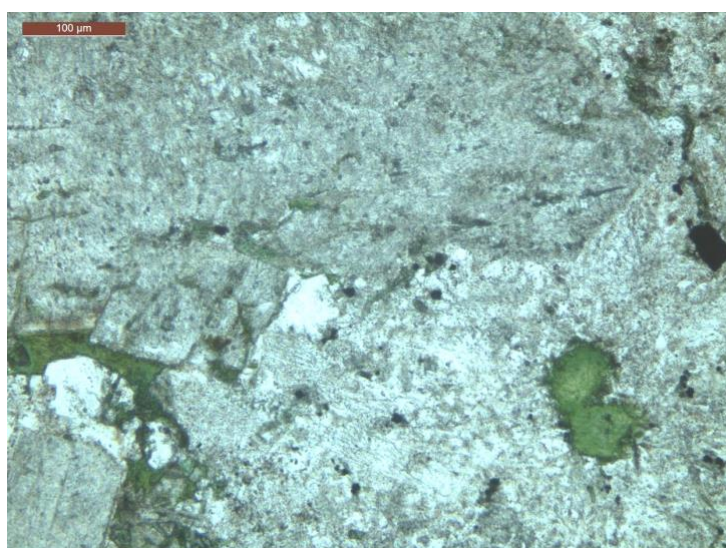
16a



16b



16c



16d

Fig. 16a-d. G401069 RAL15 Bradshaws Rd Porphyritic Rhyodacite

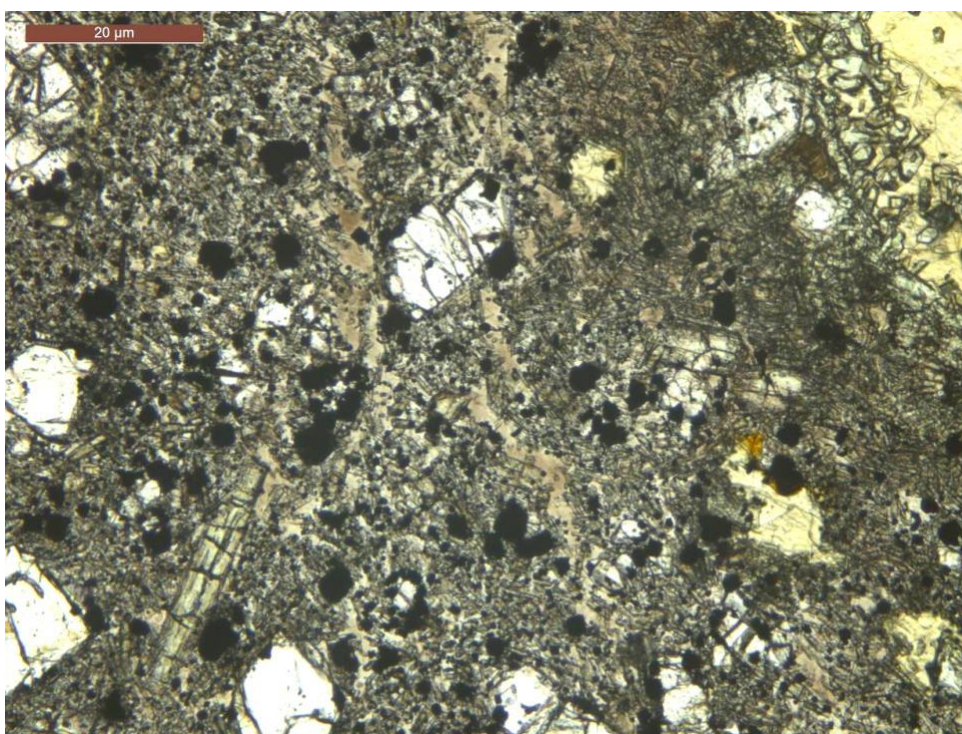
Mineral Resources Tasmania

R005508 RAL16 Llewellyn Basanite

This rock is a black, fine-grained volcanic rock. It is an unaltered olivine, clinopyroxene and orthopyroxene-phyric Basanite with fine grained patches of nepheline and sparse amygdales filled with smectite.



17a



17b

Fig. 17. R005508 RAL16 Llewellyn Glassy, olivine-pyroxene-phyric basanite with patches of nepheline.

Mineral Resources Tasmania

G401010 RAL17 Murchison Hwy Rhyolite

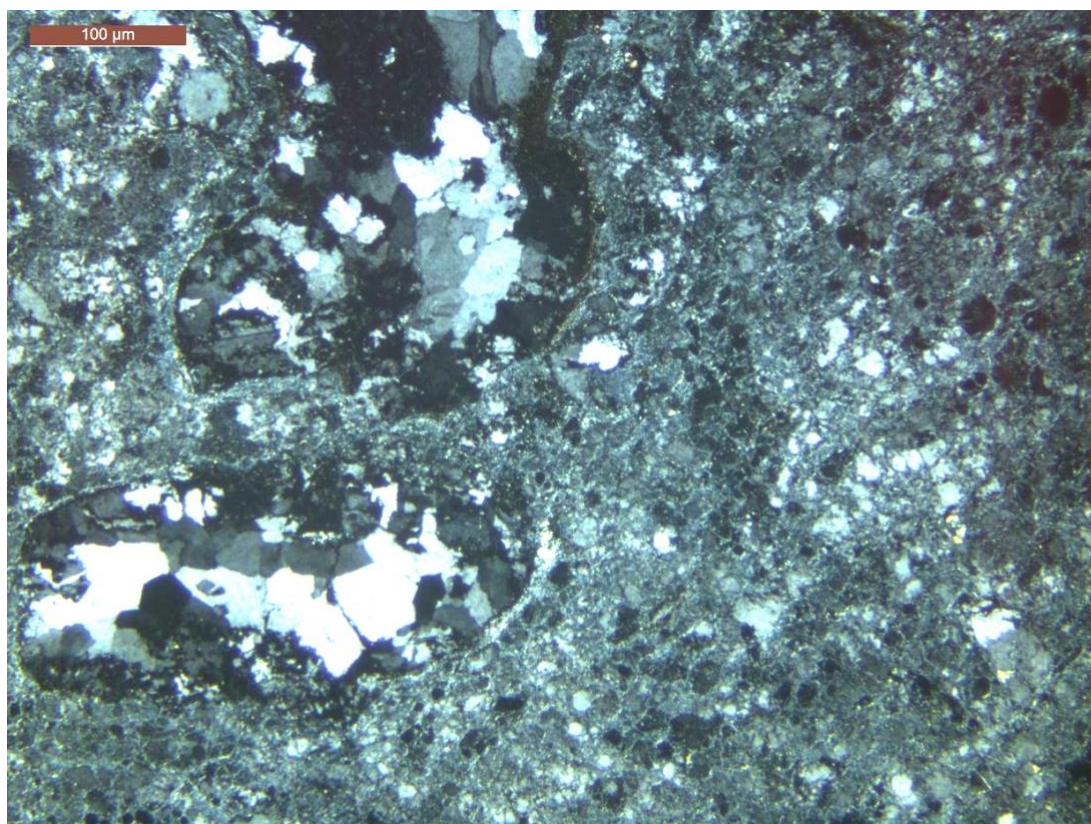
This rock is a pale greenish, iron stained and veined, fine-grained volcanic rock. It is an altered (kaolinite-sericite) aphyric Rhyolite, with quartz-filled amygdales.



18a



18b



18c

Fig. 18a-c. G401010 RAL17 Murchison Hwy Altered amygdular Rhyolite

Mineral Resources Tasmania

G401016 RAL18 Elliot Bay Rhyolite

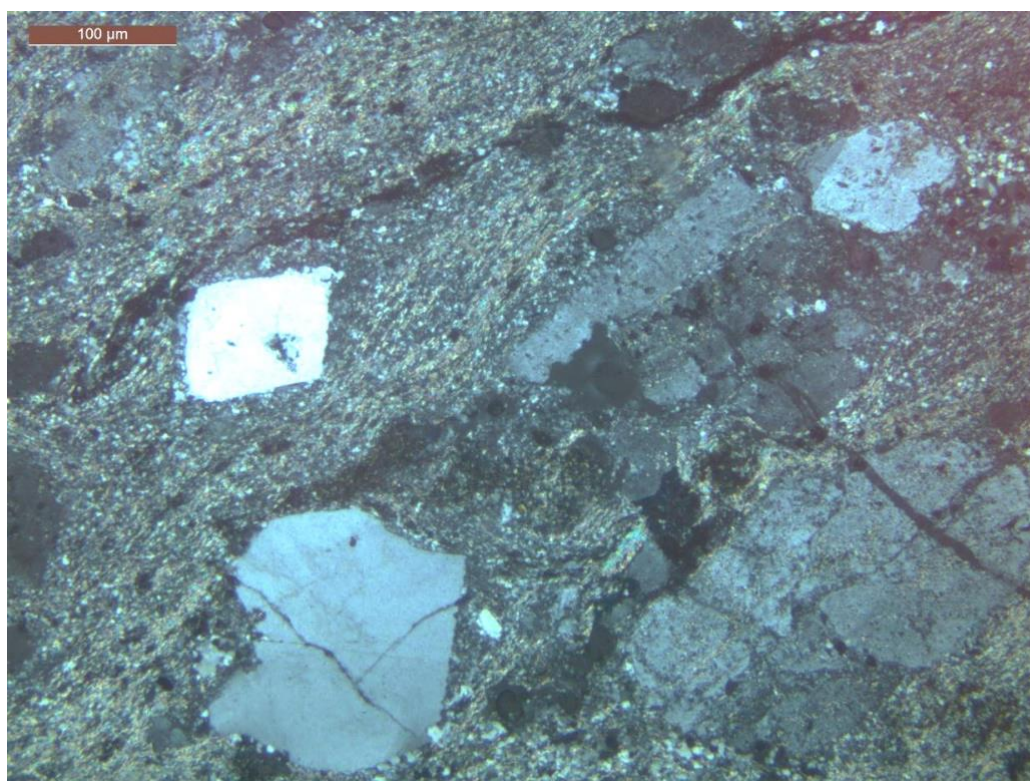
This rock is a grey-mottled, fine-grained volcanic rock. It is an altered (chlorite-epidote-sericite) quartz and feldspar-phyric Rhyolite.



19a



19b



19c

Fig. 19a-c. G401016 RAL18 Elliot Bay Phyric, schistose, altered Rhyolite

Mineral Resources Tasmania

R004131 RAL19 E of St Columba Hotel Granite

This rock is a black and white mottled, coarse-grained granitic rock. It is a weakly altered (chlorite- sericite), equigranular, hornblende Micro-monzogranite

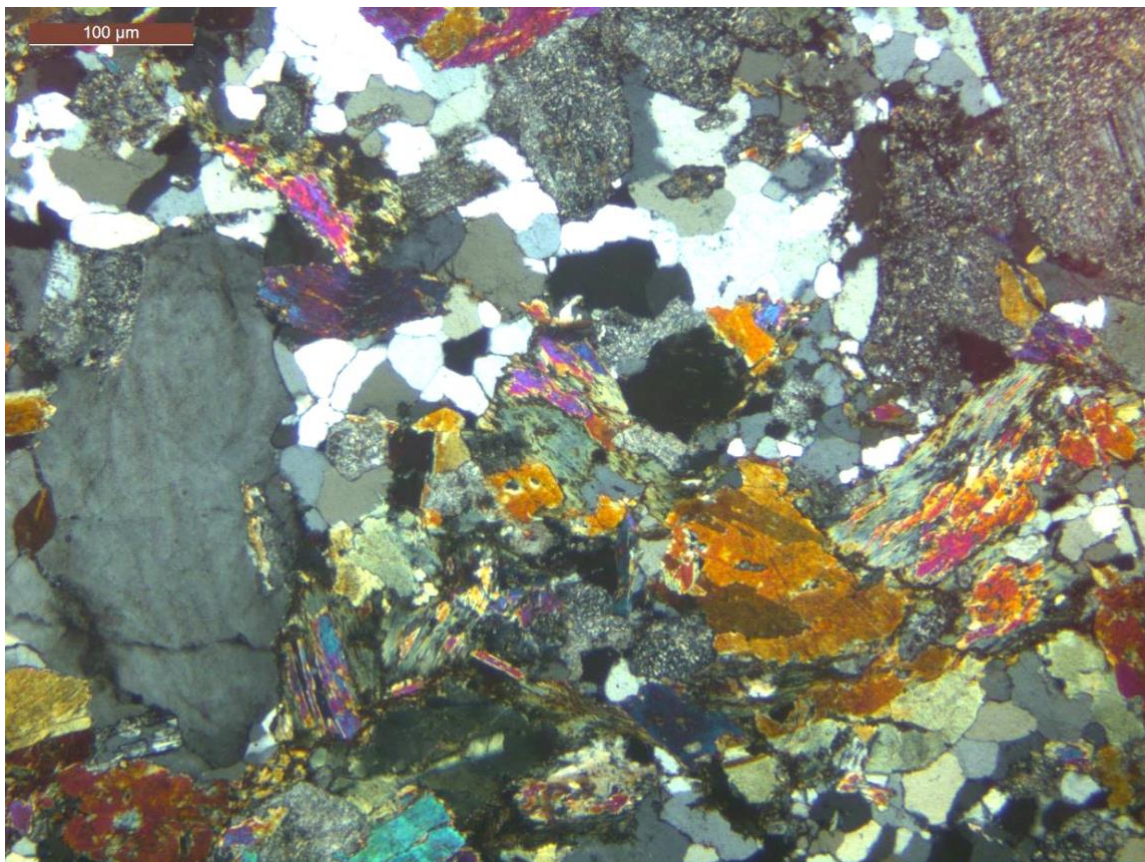


Fig. 20. R004131 RAL19. E of St Columba Hotel. Hornblende granodiorite.

Mineral Resources Tasmania

R004475 RAL20 Haleys New Country Diorite

This rock is a black and white mottled, medium-coarse-grained granitic rock. It is a weakly altered (chlorite- kaolinite), weakly feldspar-phyritic, hornblende-biotite Microdiorite, with quartz clots.

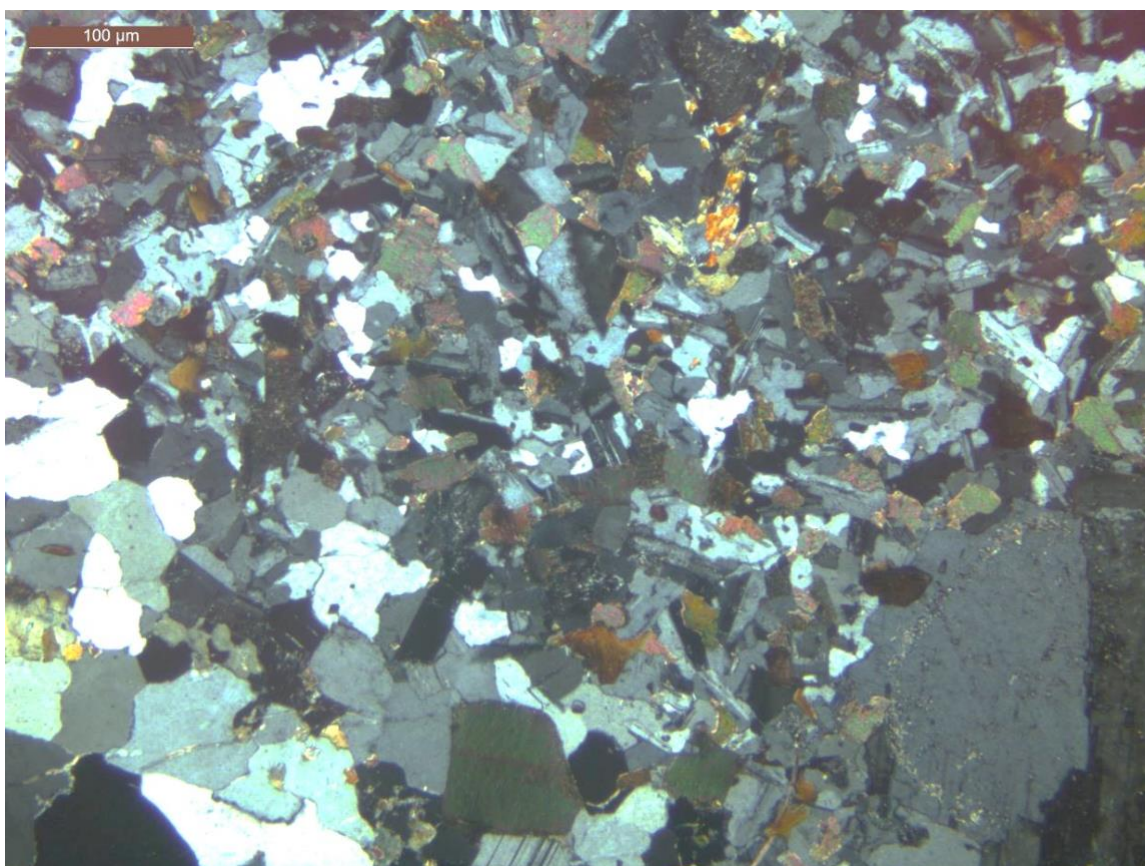


Fig. 21. R004475 RAL20 Haleys New Country Biotite Microdiorite.

SEM/EDAX ANALYSES

The samples were subsampled, with representative polished blocks or polished thin sections prepared, and these were analysed by SEM-EDS, CSL, at the University of Tasmania. This data was used to confirm the mineralogy and also to use average mineral compositions in the MINSQ program. Summaries of this data is provided in Appendix 4 & 5.

Mineral Resources Tasmania

XRF

Subsamples of all these samples were all crushed, milled and analysed for major elements on a fused disc, in a Bruker ASX58 XRF (X-ray fluorescence spectrometer), with proprietary Bruker software and a series of commercial standards. The results are shown in Appendix 2.

XRD

The samples were prepared, examined and analysed in the MRT laboratories, Rosny Park, Tasmania. They were run on a Rigaku Miniflex 600 X-Ray Diffractometer system: a 600W generator 150mm goniometer with a Cu tube; 40kV/15mA, sample spinner and a Scintillation counter (SC) with Be window, -3° to 145° 2θ scanning range and 2° - 145° 2θ measuring range, with a scanning speed of 0.01 to 100°/min, a graphite counter monochromator and a K β Ni- filter. The analysis software used is the PDXL2 using the ICCD database.

The results are shown in Appendix 1. The minerals are generally put into groups or subgroups in this report, eg. biotite, chlorites, amphiboles, clinopyroxenes, etc, rather than listing precise species, to aid comparisons between methods.

NDIR

The carbon and sulphur contents of these samples were determined by Non-dispersive infrared (NDIR) analysis using a Bruker G4 Icarus analyser, in the MRT laboratories, Rosny Park.

The results have been included in Appendix 3.

Mineral Resources Tasmania

MINSQ

SEM/EDS, XRF, XRD and Petrological data were all combined into the MINSQ program to refine the mineralogical results, using a least-squares refinement process (Herrmann and Berry, 2002). This data is shown in Table 2, with summarised XRD and petrological results, plus some Hylogger summaries for comparison.

Table 2: summarised Results

R010760 RAL1 Pyengana Hornblende Biotite granodiorite

Test Type	XRD Wt%	Pet Vol%	Hylogger dCLST	Hylogger sTSAT	SEM No#	MinSQ
Quartz	28	20		30	5	17.5
K- spar	6	5			2	4
Plagioclase	29	22		22	7	35
Biotite	15	20			8	10
Titanite					3	1
Chlorite	2	2		33	5	5.5
Calcite						0.5
Epidote						
Apatite		<1			3	0.5
Opaques						
Amphiboles	16	20		13	5	19
Clinopyroxenes	5	5				3
Pyrite		<1				
Prehnite						
White mica		5		2	3	4
Kaolinite		2				
Zeolite					2	
Total	101	101		100	43	100

Mineral Resources Tasmania

G401107 RAL2 Pieman Rd Altered dacite

Test Type	XRD Wt%	Pet Vol%	Hylogger dCLST	Hylogger sTSAT	SEM No#	MinSQ
Quartz	55	40		38	5	35
K- spar						4
Plagioclase	27	30		26	7	25
Biotite		2				2
Titanite		1				0.2
Chlorite	7	10		10	12	5
Calcite						1.5
Epidote		1				
Apatite						
Opaques		1			3	
Amphiboles						
Clinopyroxenes						
Pyrite		<1				
Prehnite						
White mica	10	15		26	10	17
Kaolinite		1			1	19
Total	99	101		100	38	109

R010856 RAL3 Medeas Cove, St Helens Microcline monzogranite

Test Type	XRD Wt%	Pet Vol%	Hylogger dCLST	Hylogger sTSAT	SEM No#	MinSQ
Quartz	61	40		55	7	38
K- spar	23	35		41	4	36.0
Plagioclase	15	15		5	6	25.0
Biotite	<1	2				0.5
Titanite						0.0
Chlorite		2			10	0.6
Calcite						
Epidote		<1				
Apatite		<1				
Opaques		<1			1	
Amphiboles						
Pyrite		1				
Prehnite						
White mica		5				
Kaolinite					1	
Total	99	100		101	29	100

Mineral Resources Tasmania

G401102 RAL4 Murchison Dam Rd Altered micro-monzogranite

Test Type	XRD Wt%	Pet Vol%	Hylogger dCLST	Hylogger sTSAT	SEM No#	MinSQ
Quartz	36	25		27	2	18
K- spar	17	28		25	3	19
Plagioclase	22	25		15	5	24
Biotite		2				
Titanite		1				
Chlorite	5	10		17	17	17
Calcite						0.8
Epidote	7				1	5
Apatite						0.5
Opaques					5	1.5
Amphiboles	8				11	2
Pyrite		1				
Prehnite						
White mica	6	10		16	3	12
Total	101	102		100	47	99.8

G401103 RAL5 Murchison Dam Rd Chloritised microgranodiorite

Test Type	XRD Wt%	Pet Vol%	Hylogger dCLST	Hylogger sTSAT	SEM No#	MinSQ
Quartz	29	10		21	3	12
K- spar	19	20			10	10
Plagioclase	41	35		52	10	50
Biotite	2	2			13	2
Titanite		1			4	0.3
Chlorite	8	10		27	11	13
Calcite						1
Epidote		2				1
Apatite		<1			3	
Opaques		<1			9	2
Amphiboles		15				2
Clinopyroxenes						
Orthopyroxene						
Pyrite		<1				
Prehnite						
White mica		<1				2
Kaolinite		2				3
Zeolite						
Smectite						
Total	99	102		100	63	98

Mineral Resources Tasmania

G401082 RAL6 Bradshaws Rd Altered dacite

Test Type	XRD Wt%	Pet Vol%	Hylogger dCLST	Hylogger sTSAT	SEM No#	MinSQ
Quartz	61	20		46	7	42
K- spar						
Plagioclase	8	25			9	8
Biotite		5				
Titanite						
Chlorite	5	10			7	6
Calcite						
Epidote						
Apatite						
Opaques					2	2
Amphiboles						
Clinopyroxenes	8					
Pyrite		<1				
Prehnite						
White mica	10	20		41	10	24
Kaolinite	8	15		13	1	17
Smectite		5				
Total	100	100		100	36	99

G401054 RAL7 Anthony road Altered rhyodacite

Test Type	XRD Wt%	Pet Vol%	Hylogger dCLST	Hylogger sTSAT	SEM No#	MinSQ
Quartz	54	20		45	2	28
K- spar		30			2	14
Plagioclase	12	20		12	4	19
Biotite	3	5			6	3
Titanite		2			7	1
Chlorite	27	10		28	10	13
Calcite						0.5
Epidote		5			5	7
Apatite		<1				0.5
Opaques		3			2	2
Amphiboles						
Clinopyroxenes	4					
Orthopyroxene						
Olivine						
Pyrite		<1				0.5
Prehnite						
White mica	1	5		14		3
Kaolinite						7
Total	101	100		99	38	99

Mineral Resources Tasmania

G401057 RAL8 Murchison Dam Rd Altered dacite

Test Type	XRD Wt%	Pet Vol%	Hylogger dCLST	Hylogger sTSAT	SEM No#	MinSQ
Quartz	62	40		51	7	45
K- spar	<1					
Plagioclase	20	30		29	8	29
Biotite	0					
Titanite						
Chlorite	8	2		6	8	5
Calcite						
Epidote						
Apatite						
Opaques						
Amphiboles						
Clinopyroxenes						
Orthopyroxene						
Pyrite						
Prehnite						
White mica	9	30		14	9	18
Kaolinite						1
Total	99	102		100	32	98

R010754 RAL9 Hogans Road Altered Tonalite

Test Type	XRD Wt%	Pet Vol%	Hylogger dCLST	Hylogger sTSAT	SEM No#	MinSQ
Quartz	7	15		17	4	9
K- spar		5			2	2
Plagioclase	10	15			8	6
Biotite		10			4	8
Titanite					1	
Chlorite	3	10		26	5	16
Calcite						0.5
Epidote					1	6
Apatite		<1			1	0.5
Opaques		<1			2	
Amphiboles	58	25		49	12	38
Clinopyroxenes						
Orthopyroxene						
Olivine						
Pyrite		<1			1	
Prehnite		10				10
White mica	21	10		8		4
Total	99	101		100	41	100

Mineral Resources Tasmania

G401398 RAL10 Beulah: Dasher River: Hornblende andesite/plagidacite

Test Type	XRD Wt%	Pet Vol%	Hylogger dCLST	Hylogger sTSAT	SEM No#	MinSQ
Quartz	36	10		41	9	20
K- spar	6	10			11	2
Plagioclase	8	30			7	18
Biotite		8			3	8
Titanite		1			4	0.5
Chlorite	4	2		14	5	9
Calcite						0.5
Epidote	15	15			9	10
Apatite					2	0.5
Opagues		<1				1
Amphiboles	20	20		38	12	18
Clinopyroxenes						
Pyrite		<1			2	0.5
Prehnite						
White mica	12	15		7		9
Kaolinite		1				0.5
Zeolite					2	
Garnet					2	
Smectite						
Total	101	102		100	68	98

G401339 RAL12 Murchison Hwy Altered Hornblende Gabbro

Test Type	XRD Wt%	Pet Vol%	Hylogger dCLST	Hylogger sTSAT	SEM No#	MinSQ
Quartz						
K- spar						
Plagioclase	18	25	22	23	21	30
Biotite						
Titanite						
Chlorite	8	10	29	28	12	8
Calcite		<1				
Epidote		20			4	
Apatite		<1				
Opagues		<1				
Amphiboles	14	15	9		15	26
Clinopyroxenes	40	25	16	48	8	18
Pyrite		<1				
Prehnite	11	2				2
White mica	10	2	23		7	10
Kaolinite		1				
Garnet		2			2	5
Total	101	102	99	99	69	99

Mineral Resources Tasmania

G401085 RAL11 Bradshaws Rd; Hornblende andesite/plagidacite

Test Type	XRD Wt%	Pet Vol%	Hylogger dCLST	Hylogger sTSAT	SEM No#	MinSQ
Quartz	37	10	35	53.4	9	19
K- spar	8	30	20		16	
Plagioclase	15	10		24.7	4	31
Biotite						
Titanite					7	1
Chlorite	11	5	23	22	27	9
Calcite		3				2
Epidote	10	10	12		6	8
Apatite		<1			10	
Opaques		<1				
Amphiboles	4	15	0			10
Clinopyroxenes	14	5			12	8
Orthopyroxene						
Olivine						
Pyrite		<1				
Prehnite		2				
White mica		10	11			10
Glass						
Serpentine						
Kaolinite						
Total	99	100	101	100	91	98

G401388 RAL13 Mt Agnew Microgranodiorite

Test Type	XRD Wt%	Pet Vol%	Hylogger dCLST	Hylogger sTSAT	SEM No#	MinSQ
Quartz	53	30	50	49	2	35
K- spar	18	30	26	19	10	34
Plagioclase	25	30	24	32	13	32
Biotite	<1	2				
Titanite						
Chlorite	<1	2			33	1
Calcite						
Epidote						
Apatite		<1				
Opaques		<1			5	
Amphiboles						
Clinopyroxenes						
Orthopyroxene						
Pyrite		<1				
Prehnite						
White mica		2				
Kaolinite	2	2			2	
Smectite		2			2	
Total	99	100	100	100	67	102

Mineral Resources Tasmania

G401340 RAL14 Savage River Rd Micro-monzogranite

Test Type	XRD Wt%	Pet Vol%	Hylogger dCLST	Hylogger sTSAT	SEM No#	MinSQ
Quartz	52	25	44	39	3	32
K- spar	23	25	27	61	8	32
Plagioclase	18	20	19		7	24
Biotite		8				
Titanite					1	1
Chlorite	4	2	10		12	4
Calcite						
Epidote		3			15	2
Apatite		<1			5	
Opaques		<1			1	0.4
Amphiboles						
Clinopyroxenes						
Pyrite		<1				
Prehnite						
White mica	3	5			2	5
Kaolinite						
Smectite						
Total	100	98	100	100	54	100

G401069 RAL15 Bradshaws Rd Rhyodacite

Test Type	XRD Wt%	Pet Vol%	Hylogger dCLST	Hylogger sTSAT	SEM No#	MinSQ
Quartz	59	30	46	51	1	30
K- spar	12	35	20	0	7	24
Plagioclase	17	15	19	28	7	31
Biotite						
Titanite					1	
Chlorite	5	5	7		7	7
Calcite						
Epidote	3	2			6	4
Apatite		<1				
Opaques		2			2	
Amphiboles					1	
Clinopyroxenes						
Pyrite		<1				
Prehnite		2				
White mica	5	10	9		9	3
Serpentine				21		
Kaolinite						
Total	101	101	101	100	41	99

Mineral Resources Tasmania

R005508 RAL16 Llewellyn Basanite

Test Type	XRD Wt%	Pet Vol%	Hylogger dCLST	Hylogger sTSAT	SEM No#	MinSQ
Quartz	2					
K- spar	2					
Plagioclase						
Biotite						
Titanite						
Chlorite						
Calcite		1				0.5
Epidote						
Apatite	4	2			17	3.5
Opaques	12	10			24	7.5
Amphiboles						
Clinopyroxenes	50	40	15		16	25
Orthopyroxene		5				8
Olivine	15	20	42	35	10	17.5
White mica		<1	43	40		
Glass		12			14	30
Kaolinite						
Smectite		1			10	1
Nepheline	14	10			13	7.5
Topaz				25		
Pyrrhotite					1	
Total	99	101	100	100	105	101

G401010 RAL17 Murchison Hwy Altered Rhyolite

Test Type	XRD Wt%	Pet Vol%	Hylogger dCLST	Hylogger sTSAT	SEM No#	MinSQ
Quartz	64	42	58	56	20	48
K- spar	1	20		20	25	10
Plagioclase	7					6
Biotite						
Titanite						
Chlorite		5			3	
Calcite						1
Epidote						
Apatite		<1				
Opaques		<1			2	
Amphiboles	<1					
Clinopyroxenes	2					
Pyrite		<1				
White mica	13	10	32	24		21
Kaolinite	8	3	10		4	13
Smectite	4	6			33	
Total	99	101	100	100	87	99

Mineral Resources Tasmania

G401016 RAL18 Elliot Bay Altered Rhyolite

Test Type	XRD Wt%	Pet Vol%	Hylogger dCLST	Hylogger sTSAT	SEM No#	MinSQ
Quartz	52	20	46	43	4	35
K- spar	13	28	36		5	31
Plagioclase	3	10		30	3	5
Biotite		2			9	
Titanite		2			10	
Chlorite	1	5		22	3	6
Calcite						
Epidote		2			5	
Apatite		<1			1	
Opaques		<1			3	
Amphiboles						
Pyrite		2				
White mica	30	28	19		6	21
Kaolinite						
Zeolite						
Smectite						
Total	99	99	101	95	49	98

R004131 RAL19 E of St Columba Hotel Altered Hornblende granodiorite

Test Type	XRD Wt%	Pet Vol%	Hylogger dCLST	Hylogger sTSAT	SEM No#	MinSQ
Quartz	25	15	37	35	3	18
K- spar	5	10			17	10
Plagioclase	18	28	23	30	21	23
Biotite	10	2				
Titanite		1			2	
Chlorite	1	10	21		9	1
Calcite						
Epidote		1				
Apatite	3	<1			2	
Opaques		<1				
Amphiboles	36	25	13	35	9	39
Pyrite		<1				
Prehnite		5			9	
White mica		5	7		12	9
Smectite	1					
Total	99	102	101	100	84	100

Mineral Resources Tasmania

R004475 RAL20 Haleys New Country Biotite Microdiorite

Test Type	XRD Wt%	Pet Vol%	Hylogger dCLST	Hylogger sTSAT	SEM No#	MinSQ
Quartz	49	30	60	53.4	4	31
K- spar	2	2			1	2.5
Plagioclase	30	30	19	24.7	14	34
Biotite	15	25			14	20
Titanite		1			3	0.8
Chlorite		2		22	6	1.5
Calcite		1			4	1.8
Epidote		1			1	0.5
Apatite		1				0.5
Opaques		<1			2	1
Amphiboles	2	8	22			3
Pyrite		<1				1
White mica		<1				
Kaolinite	2	1				5.5
Zeolite						
Smectite						
Total	100	102	101	100	49	103

Mineral Resources Tasmania

SUMMARY AND DISCUSSION

The XRD, petrography and geochemistry were combined to give the lithological names shown in Table 3.

Table 3: Summary of rocktypes (combined info from XRD, XRF and petrology)

MRT Reg. No.	RAL No.	Location	Original Description	Revised Rock name
R010760	RAL1	Pyengana	Granodiorite (dolerite)	Hornblende Biotite granodiorite
G401107	RAL2	Pieman Rd	Lava (dacite)	Altered dacite
R010856	RAL3	Medeas Cove, St Helens	Granite	Microcline monzogranite
G401102	RAL4	Murchison Dam Rd	Granodiorite	Altered micro-monzogranite
G401103	RAL5	Murchison Dam Rd	Granodiorite	Chloritised microgranodiorite
G401082	RAL6	Bradshaws Rd	Phyric volcanic (andesite)	Altered dacite
G401054	RAL7	Anthony road	Phyric volcanic (andesite)	Altered rhyodacite
G401057	RAL8	Murchison Dam Rd	Phyric volcanic (rhyolite)	Altered dacite
R010754	RAL9	Hogans Road	Gabbro	Altered Tonalite
G401398	RAL10	Beulah: Dasher River	Volcanic rock (basalt)	Hornblende andesite/plagidacite
G401085	RAL11	Bradshaws Rd	Autobrecciated, phyric andesitic-rock (andesite)	Hornblende andesite/plagidacite
G401339	RAL12	Murchison Hwy	Gabbro	Altered Hornblende Gabbro
G401388	RAL13	Mt Agnew	Adamellite	Microgranodiorite
G401340	RAL14	Savage River Rd	Granite	Micro-monzogranite
G401069	RAL15	Bradshaws Rd	Porphyritic, spherulitic volcanic (rhyolite)	Rhyodacite
R005508	RAL16	Llewellyn	Hawaiite (basalt)	Basanite
G401010	RAL17	Murchison Hwy	Amygdaloidal, phyric volcanic (dacite)	Altered Rhyolite
G401016	RAL18	Elliot Bay	Phyric, schistose volcanic (dacite)	Altered Rhyolite
R004131	RAL19	E of St Columba Hotel	Granodiorite	Altered Hornblende granodiorite
R004475	RAL20	Haleys New Country	Diorite	Biotite Microdiorite

The XRD, XRF and Petrological results generally confirm the presence of many of the minerals indicated by the Hylogger/IR methods. There are some significant misidentifications or misses in the Hylogger results. The Hylogger results shown in Table 2 are classified here as:

Mineral Resources Tasmania

Very Good: Three or more main minerals identified, no major misidentifications.

Good: Two or more main minerals identified, no major misidentifications.

Fair: Two main minerals confirmed, some misidentified; some subordinates detected correctly.

Poor: One main phase confirmed, some subordinates detected correctly; misidentifications.

Very poor: No phases detected correctly.

The results thus vary from very good to poor; most are good.

Table 4: Summary of sTSAT accuracy

MRT Reg. No.	RAL No.	sTSAT accuracy	Comment
R010760	RAL1	Good	High chlorite, missed biotite
G401107	RAL2	Good	Missed kaolinite
R010856	RAL3	Very good	
G401102	RAL4	Very good	
G401103	RAL5	Good	Missed Kspar
G401082	RAL6	Very good	Missed plagioclase
G401054	RAL7	Good	Missed Kspar, high mica
G401057	RAL8	Very good	
R010754	RAL9	Very good	Missed prehnite
G401398	RAL10	Good	Missed epidote, plagioclase
G401085	RAL11	Good	Missed amphibole, pyroxenes
G401339	RAL12	Good	Missed amphiboles, micas
G401388	RAL13	Very good	
G401340	RAL14	Good	Missed plagioclase
G401069	RAL15	Fair	Missed Kspar, mica; misidentified Antigorite
R005508	RAL16	Poor	Missed pyroxenes, nepheline, glass, misidentified mica, topaz
G401010	RAL17	Very good	Missed kaolinite
G401016	RAL18	Poor	Missed Kspar, mica; High in Plagioclase, Chlorite
R004131	RAL19	Very good	Missed Kspar, mica
R004475	RAL20	Good	Missed biotite, High chlorite

Notable results and possible issues include that:

1. In several samples abundant feldspars are often missed by Hylogger, usually when both are present in large quantity.

Mineral Resources Tasmania

2. In several samples abundant white micas are often missed by Hylogger, usually when both are present in large quantity.
3. In several samples high chlorite was reported by Hylogger, but only small amounts were found by XRD and petrology.
4. In one sample topaz and mica were incorrectly reported by Hylogger, rather than basaltic glass, nepheline and two pyroxenes.
5. The Hylogger incorrectly reported antigorite in one sample.

Each analytical method used has some advantages and drawbacks, eg.:

1. Optical petrography struggles to identify very fine grained feldspars.
2. XRD struggles to distinguish biotite from muscovite and phengite.
3. SEM studies tend to be subjective and over-influenced by unusual phases, especially with high mean atomic number.
4. MINSQ can be very subjective, eg. if several Ca-Al phases are present there can be a large range of potential mineral assemblages that may fit.
5. There may be some heterogeneity in some samples, meaning the mineralogy of some thin and polished sections may not necessarily match exactly with samples used in the other analyses.

REFERENCES

W. Herrmann & R.F. Berry (2002). *MINSQ – a Least Squares spreadsheet method for calculating mineral proportions from whole rock major element analyses*. Centre for Ore Deposit Research University of Tasmania.

Mineral Resources Tasmania

R.S. Bottrill
MINERALOGIST/PETROLOGIST

L Unwin & T Coyte
TECHNICAL OFFICERS

Disclaimers

While every care has been taken in the preparation of this report, no warranty is given as to the correctness of the information and no liability is accepted for any statement or opinion or for any error or omission. No reader should act or fail to act on the basis of any material contained herein. Readers should consult professional advisers. As a result the Crown in Right of the State of Tasmania and its employees, contractors and agents expressly disclaim all and any liability (including all liability from or attributable to any negligent or wrongful act or omission) to any persons whatsoever in respect of anything done or omitted to be done by any such person in reliance whether in whole or in part upon any of the material in this report. The MRT laboratories are not NATA registered but work to similar standards.

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.

Mineral Resources Tasmania

Appendix 1: XRD Analysis Report

Client: J Moltzen

Sample Source: Tasmania

MRT Job Number: LJN2019-105

Analysis: Approximate Mineralogy

Methods: X-Ray Diffraction

Operator: T Coyte

Sample ID	R010760	G401107	R010856	G401102	G401103	G401082	G401054
RAL No.	RAL1	RAL2	RAL3	RAL4	RAL5	RAL6	RAL7
Test Type	XRD Wt%	XRD Wt%	XRD Wt%	XRD Wt%	XRD Wt%	XRD Wt%	XRD Wt%
Quartz	28	55	61	36	29	61	54
K- spar	6		23	17	19		
Plagioclase	29	27	15	22	41	8	12
Biotite	15		<1		2		3
Chlorite	2	7		5	8	5	27
Epidote				7			
Apatite							
Amphiboles	16			8			
Clinopyroxene	5					8	4
Orthopyroxene							
Sericite/muscovite		10		6		10	1
Kaolinite						8	
total	101	99	99	101	99	100	101

Sample ID	G401057	R010754	G401398	G401085	G401339	G401388	G401340
RAL No.	RAL8	RAL9	RAL10	RAL11	RAL12	RAL13	RAL14
Test Type	XRD Wt%	XRD Wt%	XRD Wt%	XRD Wt%	XRD Wt%	XRD Wt%	XRD Wt%
Quartz	62	7	36	37		53	52
K- spar	<1		6	8		18	23
Plagioclase	20	10	8	15	18	25	18
Biotite						<1	
Titanite							
Chlorite	8	3	4	11	8	<1	4
Epidote			15	10			
Apatite							
Amphiboles		58	20	4	14		
Clinopyroxene				14	40		
Prehnite					11		
Sericite/muscovite	9	21	12		10		3
Kaolinite						2	
Smectites							
Total	99	99	101	99	101	99	100

Mineral Resources Tasmania

Sample ID	G401069	R005508	G401010	G401016	R004131	R004475
RAL No.	RAL15	RAL16	RAL17	RAL18	RAL19	RAL20
Test Type	XRD Wt%	XRD Wt%	XRD Wt%	XRD Wt%	XRD Wt%	XRD Wt%
Quartz	59	2	64	52	25	49
K- spar	12	2	1	13	5	2
Plagioclase	17		7	3	18	30
Biotite					10	15
Titanite						
Chlorite	5			1	1	
Calcite						
Epidote	3					
Apatite		4			3	
Opauques		12				
Amphiboles			<1		36	2
Clinopyroxene		50	2			
Orthopyroxene						
Olivine		15				
Prehnite						
Sericite/muscovite	5		13	30		
Kaolinite			8			2
Zeolites						
Smectites			4		1	
Nepheline		14				
Total	101	99	99	99	99	100

Mineral Resources Tasmania

Appendix 2: XRF Analysis Report

Client: J Moltzen

Sample Source: Tasmania

MRT Job Number: LJN2019-105

Analysis: Major element chemistry

Methods: X-Ray Fluorescence

Operator: L Unwin

Reg. #	R010760	G401107	R010856	G401102	G401103
RAL No.	RAL1	RAL2	RAL3	RAL4	RAL5
Rock name	Hornblende Biotite granodiorite	Altered dacite	Microcline monzogranite	Altered micro-monzogranite	Chloritised microgranodiorite
SiO ₂ %	58.39	68.42	77.3	60.61	62.54
TiO ₂ %	0.78	0.67	0.05	0.79	0.78
Al ₂ O ₃ %	15.03	15.99	12.53	15.77	15.26
Fe ₂ O ₃ %	8.17	4.68	0.6	7.22	6.66
MnO %	0.12	0.03	0.01	0.11	0.1
MgO %	4.6	0.84	0.07	2.87	2.89
CaO %	6.58	0.15	0.71	2.97	1.04
Na ₂ O %	2.48	3.62	2.66	2.94	4.89
K ₂ O %	2.38	2.9	5.77	4.11	3.56
P ₂ O ₅ %	0.19	0.13	0.02	0.19	0.19
LOI %	0.94	2.25	0.39	2.05	1.98
TOTAL %	99.67	99.69	100.12	99.63	99.9

Reg. #	G401082	G401054	G401057	R010754	G401398
RAL No.	RAL6	RAL7	RAL8	RAL9	RAL10
Rock name	Altered dacite	Altered rhyodacite	Altered dacite	Altered Tonalite	Hornblende andesite/plagidacite
SiO ₂ %	65.98	61.96	74.14	50	56.42
TiO ₂ %	0.61	0.67	0.32	0.56	0.49
Al ₂ O ₃ %	17.64	14.96	13.88	12.88	13.88
Fe ₂ O ₃ %	5.3	8.73	2.71	8.41	9.17
MnO %	0.01	0.06	0.02	0.13	0.16
MgO %	1.07	2.88	0.78	12.45	6
CaO %	0.01	2.86	0.05	9.74	6.94
Na ₂ O %	0.89	2.23	3.37	0.96	1.26
K ₂ O %	2.54	3.09	2.54	1.65	2.43
P ₂ O ₅ %	0.06	0.14	0.05	0.15	0.23
LOI %	5.68	2.03	1.78	2.38	2.4
TOTAL %	99.78	99.61	99.66	99.31	99.38

Mineral Resources Tasmania

Reg. #	G401085	G401339	G401388	G401340	G401069
RAL No.	RAL11	RAL12	RAL13	RAL14	RAL15
Rock name	Hornblende andesite/ plagidacite	Altered Hornblende Gabbro	Microgranodiorite	Micro-monzogranite	Rhyodacite
SiO2 %	59.05	49.27	76.38	72.41	69.61
TiO2 %	0.42	0.1	0.13	0.42	0.38
Al2O3 %	14.33	17.16	12.58	13.71	14.11
Fe2O3 %	7.09	5.39	1.08	2.43	3.91
MnO %	0.1	0.13	0.02	0.05	0.08
MgO %	4.07	9.22	0.03	0.56	0.6
CaO %	7.3	13.11	0.13	1.26	1.82
Na2O %	3.06	1.97	3.46	2.85	3.23
K2O %	1.81	1.06	5.15	5.51	4.5
P2O5 %	0.2	0.01	0.02	0.13	0.09
LOI %	2.4	2.66	0.87	0.95	1.36
TOTAL %	99.83	100.08	99.84	100.27	99.68

Reg. #	R005508	G401010	G401016	R004131	R004475
RAL No.	RAL16	RAL17	RAL18	RAL19	RAL20
Rock name	Basanite	Altered Rhyolite	Altered Rhyolite	Altered Hornblende granodiorite	Biotite Microdiorite
SiO2 %	43.38	73.51	69.66	61.3	64.07
TiO2 %	2.5	0.29	0.52	0.67	0.83
Al2O3 %	9.95	13.97	14.19	13.45	15.56
Fe2O3 %	13.15	3.43	3.31	6.65	6.05
MnO %	0.17	0.01	0.09	0.1	0.1
MgO %	13.58	0.86	1.33	5.15	2.53
CaO %	7.89	0.01	0.85	6.34	5.1
Na2O %	3.53	0.75	0.72	2.23	2.54
K2O %	2.08	3.16	7.38	2.82	2.2
P2O5 %	1.58	0.04	0.1	0.22	0.16
LOI %	1	3.78	1.48	0.94	0.77
TOTAL %	98.82	99.81	99.63	99.88	99.92

Mineral Resources Tasmania

Appendix 3: Caron and Sulphur

Client: J Moltzen

Sample Source: Tasmania

MRT Job Number: LJN2019-105

Analysis: Carbon and Sulphur

Methods: NDIR

Operator: L Unwin & T Coyte

Reg. #	Carbon %	Sulphur %
DL	0.05	0.03
R010760	0.05	0.05
G401107	0.12	0.05
R010856	0.07	<0.03
G401102	0.1	0.06
G401103	0.12	0.11
G401082	0.71	0.11
G401054	<0.05	0.22
G401057	0.08	0.04
R010754	0.06	0.17
G401398	0.07	0.27
G401085	0.21	0.04
G401339	<0.05	0.05
G401388	0.21	0.03
G401340	<0.05	0.04
G401069	0.08	0.04
R005508	0.05	0.06
G401010	0.17	0.07
G401016	0.07	0.04
R004131	<0.05	0.04
R004475	0.05	0.04

Mineral Resources Tasmania

Appendix 4: Laboratory Report –SEM analytical conditions

Hitachi SU-70 analytical field emission SEM

- Installed February 2011
- Schottky thermal field emission source
- ultra-high resolution (1.0 nm @ 15kV, 1.6 nm @ 1kV for SE imaging)
- high vacuum operation only (i.e. no variable pressure in chamber)
- Hitachi in-chamber and in-lens scintillation detectors, Super ExB filter, beam deceleration
- Hitachi in-chamber 5-segment solid state BSE detector, retractable
- in-column Faraday cup with picoammeter for beam current measurement
- anticontamination cold plate, liquid nitrogen cooled
- 5 axis motorised fully eucentric stage, XYZ range 110x110x40mm
- Oxford AZtec EDS/EBSD system with
 - X-Max 80 SDD EDS, MnKa 125 eV resolution, elements B-U, large area hyperspectral mapping, standardless and standards-based quantification, feature analysis
 - HKL NordlysNano EBSD camera & forescatter detector system, HKL & Channel 5 software packages, Synergy EDS/EBSD integration, HKL, ICSD & American Mineralogist phase databases
- NEW June 2017: Gatan ChromaCL2 colour cathodoluminescence imaging system with integrated BSE detector, Digital Micrograph 3 software, automated mosaic acquisition, simultaneous acquisition of SE, iBSE and colour CL images.

Label:	am 179
Element List Type:	Current Spectrum
Processing Option:	All Elements
Specimen Coating:	On
Beam Calibration Element Coating:	Off
Coating Element:	Carbon
Coating Thickness:	20 nm
Coating Density:	2.25 g/cm ³
Automatic Line Selection:	Disabled
Normalization:	Enabled
Thresholding:	Sigma level = 1
Detector Window Correction:	Enabled
Deconvolution Elements:	None
Selected Standards:	Minerals_15kV_2017-10-20 [User]
Pulse Pile Up Correction:	Succeeded
Detector file:	X-Max 3
Efficiency:	File based

Mineral Resources Tasmania

Appendix 5: SEM Summaries

Client: J Moltzen

Sample Source: Tasmania

MRT Job Number: LJN2019-105

Analysis:

Methods: SEM

Operator: R Bottrill & T Coyte

Note: Most Trace phases omitted

R010760

Phase	O (%)	F (%)	Na (%)	Mg (%)	Al (%)	Si (%)	P (%)	Cl (%)	K (%)	Ca (%)	Ti (%)	V (%)	Mn (%)	Fe (%)	Ba (%)	Total (%)
Amphibole	43.5		0.6	7.2	3.2	22.1		0.1	0.5	8.2	0.4		0.3	12.9		99.0
Chlorite	45.6			8.9	9.9	12.6		0.1	1.7	0.1	0.5	0.2	0.3	20.5		98.4
Quartz	54.7					47.1								0.3		101.9
Apatite	39.4	2.3				0.2	19.3	0.6		39.5				0.5		101.8
Biotite	42.2			6.4	7.9	16.9		0.3	7.9		2.0		0.2	16.5		100.2
Titanite	43.2			0.1	1.2	14.1	0.5			20.4	22.1	0.3		0.8		102.2
Plagioclase	49.2		4.8		14.5	26.9			0.1	6.2				0.3		102.0
Zircon	33.0					14.4								0.3		95.2
K-Spar	46.7		0.4		9.9	29.6			12.7					0.3	0.8	100.3
Thomsonite	48.6		2.5		17.1	23.6			0.3	10.2						102.1

G401107

Phase	O (%)	S (%)	Na (%)	Mg (%)	Al (%)	Si (%)	P (%)	Cl (%)	K (%)	Ca (%)	Ti (%)	Mn (%)	Fe (%)	Total (%)
Chlorite	45.3			4.3	11.1	11.9			0.7		1.1	0.2	26.4	99.6
Muscovite	48.5		0.2	0.9	16.1	22.2			8.6		0.3		3.8	100.5
Chlorite	55.2				0.6	46.6			0.3				0.4	102.7
Zircon	35.4		0.7		3.0	15.2	0.9		0.3	0.2			6.3	92.7
Rutile	43.7				0.1	0.3			0.1		59.6		0.6	104.3
Kaolinite	11.8	0.2			6.7	6.8	0.2	0.3	0.6		0.1		1.5	28.2
Ilmenite	34.0					0.2					31.2	8.6	27.9	101.9
Albite	64.1		10.4		11.8	34.6				0.2			0.4	121.1

R010856

Phase	O (%)	Na (%)	Mg (%)	Al (%)	Si (%)	Cl (%)	K (%)	Ca (%)	Ti (%)	Mn (%)	Fe (%)	Total (%)
Chlorite	53.0				47.0						0.4	100.2
K-Spar	45.8	0.5		9.9	30.2		13.0				0.3	99.5
Albite	50.0	6.6		12.7	29.5		0.2	3.2			0.2	102.3
Biotite	43.9		3.4	10.7	16.2	0.2	3.1		0.8	0.3	18.3	96.9
Chlorite	43.9		4.3	11.4	11.4					0.8	26.4	98.1

Mineral Resources Tasmania

G401102

Phase	O (%)	Na (%)	Mg (%)	Al (%)	Si (%)	P (%)	Cl (%)	K (%)	Ca (%)	Sc (%)	Ti (%)	V (%)	Cr (%)	Mn (%)	Fe (%)	Ba (%)	Total (%)
Amphibole	42.9	0.6	7.3	1.7	23.8		0.1	0.4	8.5	0.2	0.5			2.1	12.3		99.1
Chlorite	46.6	0.2	9.1	9.8	13.9			0.5	0.2		0.3			0.4	16.6		97.1
Chlorite	53.0				46.8										0.3		100.0
Epidote	44.3	0.2		13.4	17.7			0.1	16.2					0.2	8.2		100.4
Muscovite	47.2	0.4	0.8	17.1	21.9			8.7							2.1	0.4	98.0
Albite	49.3	8.0		10.8	31.6			0.1	0.6						0.2		100.3
Andradite	40.3			5.4	16.5				24.8		0.5	0.2		0.4	11.9		99.9
K-Spar	45.8	0.8		10.1	29.3		0.1	11.9							0.4	1.0	98.9
Magnetite	26.6			0.1	0.1						0.2	0.2	0.1		71.4		98.7
Ilmenite	39.3		1.0	1.0	0.8	0.2			0.1		29.1			6.0	28.8		105.5

G401103

Phase	O (%)	F %	S (%)	Na (%)	Mg (%)	Al (%)	Si (%)	P (%)	Cl (%)	K (%)	Ca (%)	Ti (%)	V (%)	Mn (%)	Fe (%)	Ba (%)	Total (%)
Chlorite	45.0			2.0	10.7	10.1	12.8		0.6	1.0	0.1	0.4		0.4	16.7		97.0
Chlorite	53.2					0.3	46.6			0.1							100.2
Apatite	38.9	3.5	0.2	0.2			0.3	18.8	0.2		38.8				0.4		101.0
Biotite	41.8				7.2	8.6	17.0		0.2	7.4		1.6	0.2	0.3	14.1		98.0
K-Spar	46.2			0.4		9.9	29.9		0.2	13.1		0.3			0.2	0.6	99.7
Albite	49.3			6.6		9.3	33.2			2.3	0.1				0.3	0.7	100.1
Titanite	41.8	1.0			0.6	1.5	14.0				18.9	20.9	0.5		2.0		100.2
Magnetite	26.6						0.1					0.4	0.2		71.9		99.2
Rutile	43.4					0.2	0.2			0.2	0.5	58.5	0.7	0.6	1.5		104.0
Pyrite			53.6												44.2		100.1
Ilmenite	34.1						0.2				0.2	31.6		10.6	25.1		101.6

G401082

Phase	O (%)	Na (%)	Mg (%)	Al (%)	Si (%)	P (%)	Cl (%)	K (%)	Ca (%)	Ti (%)	V (%)	Mn (%)	Fe (%)	Ba (%)	Total (%)
Chlorite	44.3		3.3	11.8	14.2	0.2		0.4				0.2	21.2		95.0
Quartz	53.7		0.3	1.0	44.7			0.2					1.0		100.6
Albite	50.4	8.1	0.3	11.9	30.1			0.2	0.2				0.6		101.3
Muscovite	45.4	0.2	0.9	15.5	21.1		0.1	7.1		0.4			3.2	0.5	93.5
Rutile	45.2			1.3	1.3	0.2		0.2		51.3			4.4		103.8
Kaolinite	56.2		0.4	19.8	21.5			2.0		0.3			1.6		101.6

G401057

Phase	O (%)	Na (%)	Mg (%)	Al (%)	Si (%)	K (%)	Ca (%)	Ti (%)	Mn (%)	Fe (%)	Ba (%)	Total (%)
Chlorite	43.0		5.0	10.9	11.6	0.2			0.3	26.1		96.9
Quartz	53.3	0.2		1.4	46.2	0.8				0.4		100.7
Albite	49.0	8.2		10.6	32.1	0.1	0.2			0.2		100.0
Muscovite	46.7	0.0	1.1	15.9	22.7	8.6		0.3		2.7	0.5	98.4

Mineral Resources Tasmania

G401054

Phase	O (%)	F (%)	Na (%)	Mg (%)	Al (%)	Si (%)	P (%)	Cl (%)	K (%)	Ca (%)	Sc (%)	Ti (%)	V (%)	Mn (%)	Fe (%)	Ba (%)	Total (%)
Chlorite	46.6		1.3	8.6	10.4	12.9		0.2	0.9	0.5		0.7		0.3	20.1		100.0
Quartz	54.3			0.3	0.4	46.5									0.6		101.7
Zircon	38.8			0.9	0.8	14.8			0.2	0.3	0.2				1.5		101.2
Epidote	45.1				12.4	17.5				16.8		0.2			10.3		102.0
Titanite	43.4	1.3		1.4	2.9	14.4			0.4	18.5		18.1	0.3		2.9		101.6
Albite	50.3		7.3	0.8	10.9	30.1			1.2	0.7					1.6		101.9
K-Feldspar	49.4		0.2	0.4	9.5	30.8			12.0						1.1	0.5	103.8
Biotite	42.4		1.4	6.1	8.8	16.6		0.6	6.6	0.9		1.0		0.2	17.4		100.0
Apatite	38.9	4.3					19.3			39.5		0.3			0.4		102.5
Ilmenite	39.4				0.1	1.3				2.2		32.4		1.8	28.0		105.2
Rutile	45.6				0.2	1.5				2.5		56.8			1.0		107.4

R010754

Phase	O (%)	F (%)	S (%)	Na (%)	Mg (%)	Al (%)	Si (%)	P (%)	Cl (%)	K (%)	Ca (%)	Ti (%)	V (%)	Cr (%)	Mn (%)	Fe (%)	Total (%)
Amphibole	46.0			0.7	10.5	2.7	24.3			0.2	8.6	0.3		0.2	0.2	7.5	100.6
Chlorite	48.1			0.8	13.1	10.8	13.4				0.2				0.2	12.8	98.6
Quartz	54.2			0.2			47.2									0.2	101.5
Epidote	43.9					14.0	17.6				16.0					7.0	98.5
Plagioclase	48.8			5.5	1.0	13.4	27.9			0.1	5.0					0.4	101.1
Pyrite			54.6													46.0	100.6
Apatite	40.4	2.2					0.2	19.2	0.5		39.1					0.6	102.1
Rutile	32.7						0.2					30.2	0.3	0.2	2.5	35.9	101.7
Biotite	44.2				9.4	7.7	17.1			7.3		1.4		0.3		10.4	97.7
K-Spar	48.3			0.2		10.0	31.1			13.2							102.9
Titanite	45.9	1.5		0.2	0.2	3.5	15.3				19.9	18.1				0.4	105.0

G401085

Phase	O (%)	F (%)	Na (%)	Mg (%)	Al (%)	Si (%)	P (%)	Cl (%)	K (%)	Ca (%)	Ti (%)	V (%)	Cr (%)	Mn (%)	Fe (%)	Ba (%)	Total (%)
Chlorite	44.4		0.6	9.7	9.9	13.2	0.9		0.9	0.6	0.2		0.2	0.3	17.2		95.4
Quartz	52.4			0.1	0.4	45.7			0.2	0.3					0.3		98.7
K-Spar	46.3		0.6	0.5	11.0	27.4	0.3		11.0	1.3					1.2	0.8	98.5
Titanite	42.8	1.6	0.2	0.6	3.0	14.4		0.1	0.5	18.7	17.5	0.4			1.9		100.2
Pyroxene	42.9		0.2	9.1	1.5	23.4				14.8	0.3			0.2	6.6		98.8
Epidote	43.2				11.7	17.2			0.2	15.9	0.9	0.1			10.1		99.1
Albite	47.9		6.8	0.2	11.5	29.6			0.7	1.8					0.4		98.2
Apatite	37.0	3.0	0.7	0.2	0.1	0.5	18.1	0.8	0.3	33.4					0.4		100.6

Mineral Resources Tasmania

G401398

Phase	O (%)	F (%)	S (%)	Na (%)	Mg (%)	Al (%)	Si (%)	P (%)	Cl (%)	K (%)	Ca (%)	Ti (%)	V (%)	Cr (%)	Mn (%)	Fe (%)	Ba (%)	Total (%)
Amphibole	45.8			0.6	9.0	3.0	23.6		0.3	0.5	8.7	0.7	0.2		0.3	10.2		101.8
Chlorite	45.8				10.6	8.3	16.1		0.1	0.8	1.2	0.3		0.3	0.2	14.6		97.6
Quartz	55.6			0.3		0.4	47.1			0.3	0.2					0.3		103.3
Epidote	45.6				0.4	12.8	17.8			0.8	16.2				0.3	9.2		102.0
Titanite	45.0		0.1		1.6	2.8	14.8			0.4	18.8	18.1	0.4			2.2		102.9
K-Spar	47.9			0.4		10.3	30.0			12.7	0.6					0.4	1.4	102.5
Philipsite	49.4			2.6		14.7	26.6			4.2	5.2					0.5	0.4	103.4
Apatite	41.5	3.5				0.4	1.6	18.7	0.3		38.8					0.5		104.7
Plagioclase	50.3			4.2	1.0	14.1	27.4			0.7	5.9					0.9		103.5
Biotite	45.6				8.6	8.2	17.2		0.3	6.8	1.2	1.3				13.4		101.7
Garnet	45.1				2.7	8.6	17.5			0.1	19.8		0.3		0.3	9.4		102.1
Pyrite			54.3				0.3									46.4		100.8

G401339

Phase	O (%)	Na (%)	Mg (%)	Al (%)	Si (%)	Cl (%)	K (%)	Ca (%)	Ti (%)	Mn (%)	Fe (%)	Zn (%)	Total (%)
Amphibole	45.1	0.6	9.9	2.6	23.9	0.1		9.0	0.2	0.2	7.9		99.2
Chlorite	47.3	0.6	13.3	10.8	13.9			0.6		0.2	9.9		96.1
Pyroxene	42.7	0.4	9.2	0.5	24.3	0.4	0.2	16.2	0.2	0.2	5.1		98.5
Albite	48.6	7.1	0.4	11.5	29.9	0.1	0.2	1.5			0.4	0.7	99.1
Muscovite	48.1	1.0	0.6	17.8	22.7		7.3	0.7			0.7		98.3
Garnet	44.2	0.1	0.1	12.6	18.7		0.2	24.4		0.4	1.1		101.5
Epidote	46.3	0.3		15.5	18.6		0.2	17.3			3.2		100.3
Anorthite	47.4	1.4	0.2	18.0	21.7	0.1	0.3	11.7			0.3		100.5

G401388

Phase	O (%)	F (%)	S (%)	Na (%)	Mg (%)	Al (%)	Si (%)	P (%)	Cl (%)	K (%)	Ca (%)	Ti (%)	Mn (%)	Fe (%)	Total (%)
Chlorite	43.7			0.2	2.3	10.1	13.9		0.2	0.8		0.5	0.3	22.1	93.0
Quartz	52.9					0.3	46.5								99.5
Albite	48.8			7.9		10.3	30.5			0.3	0.3			0.5	98.1
K-Spar	44.1			0.4		9.5	28.3		0.5	12.5				1.1	95.3
Berthierine	39.8		0.1	1.1	1.1	8.2	10.8	0.2	0.2	0.6		0.4	0.4	30.7	91.3
Smectite	41.1		0.2	0.6		18.3	21.1		0.2					4.5	85.9
Kaolinite	38.6		0.2			14.0	14.6		0.1					5.3	72.7
Magnetite	36.8		0.1			0.7	1.4							57.1	96.1

Mineral Resources Tasmania

G401340

Phase	O (%)	F (%)	Na (%)	Mg (%)	Al (%)	Si (%)	P (%)	Cl (%)	K (%)	Ca (%)	Ti (%)	V (%)	Mn (%)	Fe (%)	Ba (%)	Total (%)
Chlorite	44.0			5.3	9.1	13.2		0.3	1.8	1.1	1.5		0.2	23.0		98.8
Quartz	53.7					46.5								0.3		100.4
K-Spar	46.4		0.7		9.8	29.7			12.6					0.3	0.3	99.2
Epidote	48.2		0.8	1.1	13.3	17.5			1.1	15.3	0.3			4.4		100.2
Zircon	34.1				0.3	14.3				0.5				0.7		95.9
Albite	49.9		7.7	0.3	10.7	31.0			0.6	0.5				0.8		100.3
Muscovite	48.9		1.0		18.2	22.9			7.5					0.4		98.8
Apatite	39.0	4.2	0.3		0.5	0.6	18.5		0.3	38.1				0.3		101.0
Rutile	42.1				0.7	1.6			0.1	0.9	53.4	1.0		1.0		101.3

R005508

Phase	O (%)	F (%)	S (%)	Na (%)	Mg (%)	Al (%)	Si (%)	P (%)	Cl (%)	K (%)	Ca (%)	Sc (%)	Ti (%)	V (%)	Cr (%)	Mn (%)	Fe (%)	Ba (%)	Total (%)
Apatite	39.4	2.9		0.3	0.3	0.8	1.5	17.7	0.8	0.5	35.9						0.6		101.3
Magnetite	29.9				2.4	1.1	0.2	0.4		0.1	0.3		11.9	0.2	0.4	0.6	52.6		99.3
Clinopyroxene	42.6			0.5	8.0	1.9	22.4			0.5	15.5	0.2	1.3		0.3	0.2	5.6		97.9
Olivine	42.0				23.9		18.0				0.2					0.4	16.7		101.3
Pyrrhotite			38.5			0.1	0.5										58.5		97.7
Chromite	31.0				3.7	4.2	0.3						3.5	0.2	16.2		39.2		98.2
Ilmenite	35.4				4.3	0.1	0.6			0.1	0.3		30.4	0.4	0.2	0.4	30.4		102.4
Glass	46.9			5.4	0.3	11.5	24.3	0.1	0.4	4.4	0.4		0.6				1.5	0.4	95.5
Smectite	43.6			0.2	6.3	7.9	19.7		0.2	0.4	1.7		0.3			0.4	3.9		84.1
Nepheline	46.9			11.5		16.0	23.1			2.0	0.3						0.7		100.4

G401010

Phase	O (%)	S (%)	Na (%)	Mg (%)	Al (%)	Si (%)	P (%)	Cl (%)	K (%)	Ca (%)	Ti (%)	Mn (%)	Fe (%)	Ba (%)	Total (%)
Quartz	52.8		0.2	1.3	1.2	45.0			0.4		0.2	0.2	1.3		99.6
Cronstedtite	43.8	0.1			5.6	5.6	0.8		0.3				42.9		99.0
Al-natronite	45.8				13.0	13.9	0.4		0.7				19.5		93.4
K-Spar	50.2		0.3	1.3	11.9	28.1		0.5	10.9		0.3		2.3	0.8	103.7
Illite	53.0			1.8	15.2	23.0			6.8				4.8	0.3	104.9
Kaolinite	50.3			1.1	16.4	18.7			0.6				7.3		94.4
Rutile	46.2			0.1	0.6	1.1			0.6	0.2	56.9		0.5		105.5
Albite	49.5		8.3		10.5	31.7			0.1	0.2					100.3
Magnetite	27.6					0.3							70.0		97.8

Mineral Resources Tasmania

G401016

Phase	O (%)	F (%)	Na (%)	Mg (%)	Al (%)	Si (%)	P (%)	Cl	K (%)	Ca (%)	Ti (%)	V (%)	Cr (%)	Mn (%)	Fe (%)	Ba (%)	Total (%)
Apatite	37.1	4.1				0.2	18.9			39.0					0.3		99.6
ilmenite	33.4					0.1				0.3	31.2			11.2	24.8		101.0
Muscovite	47.9		0.2	1.5	15.6	22.2			9.1		0.2				3.1		99.5
Chlorite	44.4			8.3	10.3	11.9								0.9	21.0		96.8
Titanite	44.1	1.0	1.4	0.3	1.8	14.4	0.1		0.3	19.1	21.3	0.3			0.8		102.5
Albite	50.5		8.0		11.0	31.6			0.5	0.4					0.3		102.1
Biotite	39.6			5.8	8.5	16.5		0.1	7.1	0.5	0.8			0.5	15.2		94.1
Epidote	43.1				13.2	17.3			0.3	16.5		0.4	0.4	0.3	7.8		98.3
Quartz	53.3				0.4	46.5									0.4		100.1
K-Spar	46.7		0.2		9.8	29.9			13.3	0.7	1.0				0.2	0.6	100.4

R004131

Phase	O (%)	F (%)	Na (%)	Mg (%)	Al (%)	Si (%)	P (%)	Cl (%)	K (%)	Ca (%)	Ti (%)	V (%)	Cr (%)	Mn (%)	Fe (%)	Nb (%)	Ba (%)	La (%)	Ce (%)	Total (%)
Amphibole	46.1		0.4	8.0	4.1	21.4		0.1	0.3	8.2	0.9	0.2	0.2	0.3	11.7					100.7
Apatite	39.6	2.8			0.1	0.3	18.9	0.4		38.8					0.3					101.0
Chlorite	45.9			10.1	8.5	13.4			0.4	0.1	0.4		0.2	0.2	19.0					97.4
K-Spar	46.9		0.4	0.1	10.2	29.6			12.6	0.9					0.3	0.3	1.2			100.6
Muscovite	48.9		0.7	0.4	18.6	22.3			8.7	0.3					0.7					99.7
Plagioclase	49.2		6.2		12.6	28.9			0.7	3.4	0.1				0.4		0.3			100.8
Prehnite	47.3		0.4	1.0	13.2	19.5			0.6	17.1	1.1				2.3			2.5	5.6	100.7
Quartz	54.6					46.9														101.4
Titanite	43.3				0.7	14.1				20.1	22.9				0.5					101.6

R004475

Phase	O (%)	F (%)	Na (%)	Mg (%)	Al (%)	Si (%)	P (%)	Cl (%)	K (%)	Ca (%)	Ti (%)	Mn (%)	Fe (%)	Total (%)
Apatite	41.1	3.2		0.1	0.4	1.7	18.3		0.2	38.1	0.3			102.6
Chlorite	44.5			7.7	9.3	12.9		0.2	0.6	0.4	0.4	0.5	20.8	96.9
Plagioclase	48.5		3.7		15.6	25.3			0.1	8.0				101.2
Quartz	54.3					47.0								101.3
Biotite	41.6			5.9	8.2	16.5		0.2	7.3		1.6	0.3	16.6	98.2
Epidote	48.5		0.2		17.0	19.6			1.0	16.0			0.4	102.6
K-Spar	46.8		0.3		10.2	30.2			13.4					100.8
Titanite	43.4			0.2	1.1	14.1			0.2	20.0	22.1		0.5	101.4
Zircon	34.4					14.6				0.2			0.3	97.4