

Tasmanian Geological Survey
Record 2004/07

**Petrology and geochemistry
of some rock samples
collected for the WTRMP
Project, northwestern
Tasmania**

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Abstract

Forty-three samples were collected in the Smithton-Balfour-Marrawah area to assist with field-checking of geophysical anomalies for the WTRMP project. The samples were mostly from the Smithton Synclinorium and Rocky Cape Group, and included various carbonate rocks (Neoproterozoic dolostone and magnesite plus Tertiary limestone), and Neoproterozoic to Early Cambrian siltstone, dolerite, sandstone and basalt. Some ferruginous cherty rocks resemble gossans, and appear to be just highly altered and unmineralised dolostone or magnesite. Some disseminated magnetite in siltstone may be related to regional (granite-related?) metasomatism. One 'Neoproterozoic' dolostone sample is fossiliferous, and the fossils may indicate the unit is actually Early to mid-Cambrian in age.

Introduction

As part of the Western Tasmanian Regional Minerals Program (WTRMP), some geophysical anomalies in parts of northwest Tasmania were field-checked by Dr D. McP. Duncan (Duncan, 2002). This report was part of a project to investigate the geological basis of geophysical responses (magnetic and radiometric) contained in the then recently-acquired airborne data covering northwest Tasmania.

Forty-three samples were collected during this field work and were submitted to MRT for petrology, mineralogy and geochemistry. The samples are mostly from the Early Cambrian Smithton Synclinorium and Neoproterozoic Rocky Cape Group.

The samples were registered by MRT as R011101 to R011141. Sample details are summarised in Appendix 1 (AMG co-ordinates in AGD66 datum).

The samples were analysed by polarised light microscopy (some under reflected as well as transmitted light), most by XRF whole-rock analysis, some by X-ray diffraction (XRD) and one (R011141, dolerite, Smithton) by Electron Microprobe Analysis. The petrological descriptions follow below; X-ray diffraction analysis results are given in Appendix 2, the probe analyses in Appendix 3, and the XRF analyses in Appendix 4.

Petrological descriptions

R011104: Metapelite

This rock is a micaceous siltstone, thinly interbedded with medium-grained micaceous quartz arenite, in beds less than 5 mm thick, with some graded bedding in the silty layers. The beds are contorted and broken, possibly by syn-sedimentary deformation. The sandy layers contain some disseminated pyrite and the siltstone contains possible carbonaceous material. There is a very weak cleavage, but no detectable veining, alteration or mineralisation.

R011105: Orthoquartzite

The rock is a fine-grained, silicified quartz sandstone or orthoquartzite, with sutured grain boundaries, little primary texture and no matrix except quartz. The only accessory mineral observed was trace zircon. There is no obvious cleavage, alteration or mineralisation.

R011106: Metapelite

This rock is a quartz-mica siltstone with thin carbonaceous, pelitic interlayers. The siltstone contains about 10% sericitic muscovite and about 20% green-brown biotite flakes and ~5% altered bladed 'leucoxene' porphyroblasts, up to 0.1 mm in size. There is about 1% green-brown tourmaline (prismatic overgrowths on primary grains), and ~2% ragged chlorite clots (up to 2 mm diameter, possibly pseudomorphs after cordierite?) in one quartzose layer. There is a trace of quartz-chlorite veinlets, containing possible minor pyrite, but no other indications of alteration or mineralisation. There is only a faint cleavage.

R011112: Dolerite

This rock is an altered dolerite, containing ~45% highly sericitised plagioclase laths, ~0.5–2 mm in length, in a subophitic to intersertal textured matrix. Other primary minerals include clinopyroxene (colourless, ~10%; ~0.5–1 mm in size), ~5% opaques (intergrown magnetite and leucoxene, after ilmenite or ulvospinel?) and ~5% hornblende (blue-brown-green; largely altered to actinolite). Much of the groundmass consists of fine-grained epidote, chlorite and green amphibole (all replacing primary pyroxenes?) and ~15% mesostasis (fine-grained aggregates of quartz, K-feldspar and apatite). There is a trace of disseminated pyrite but no obvious mineralisation or cleavage.

R011114: Greywacke

This is a very coarse-grained greywacke, with strongly compacted and sutured lenticular, lithic grains in an argillaceous to silty matrix. The lithic grains are mostly (~50%) argillaceous siltstone and phyllite, some weakly pyritic. About 40% of the grains are siliceous (fine sandstone, chert, and quartzite), and ~10% are volcanic rocks (basaltic to andesitic) with possibly some minor tuff. There is no obvious cleavage, alteration or mineralisation.

R011117: Dolostone

This is a siliceous carbonate, with about 20% medium-grained, rounded (but partly replaced) quartz grains, plus a trace of lithic grains, in a fine-grained, sparry carbonate matrix. There are numerous coarse augen-like structures, most of which appear to be fossils, probably echinoderm ossicles

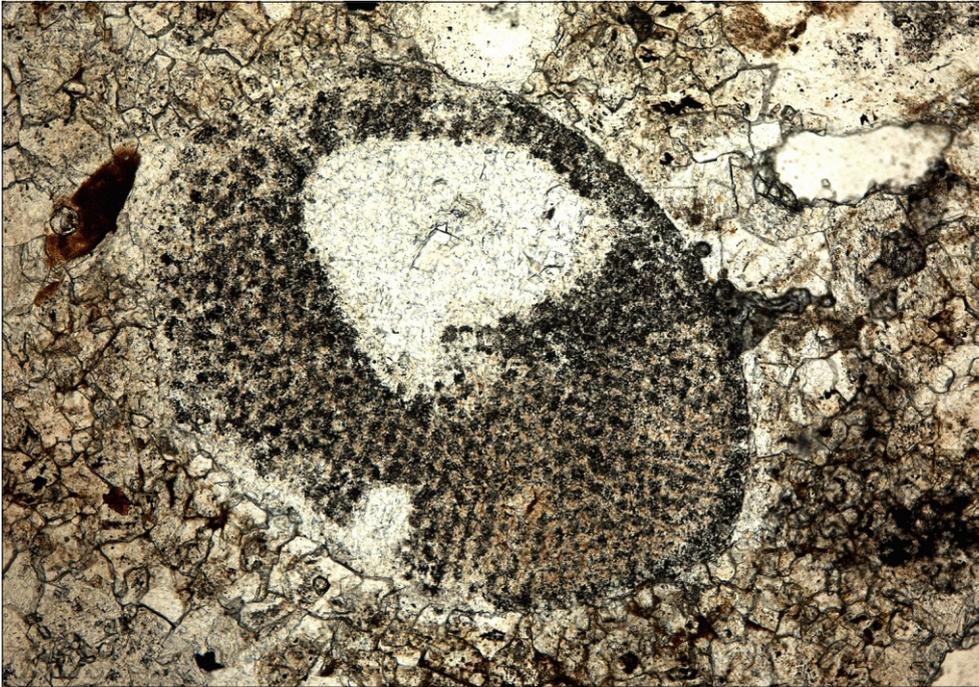


Plate 1

Photomicrograph, sample R01117, plane polarised light, showing a probable echinoderm ossicle in a sparry dolomite matrix, with quartz grains to the top right. Field of view 1.2 1.8 mm.

(C. R. Calver pers. comm.; Plate 1). There is a trace of fine disseminated brown spots, probably limonite after pyrite. XRD indicates that the carbonate has a composition near ankerite, with trace calcite (Appendix 2).

R01118: Dolostone

A medium-grained, homogeneous, pure carbonate rock. There is no obvious cleavage, alteration or mineralisation. XRD indicates that the carbonate has a composition near dolomite, with minor calcite, and trace amounts of quartz and mica.

R01119: Basalt

This rock is a basaltic breccia, composed of irregular clasts from several millimetres to ~10 mm in size. The clasts are composed mostly of fine plagioclase laths (<0.1 mm long) in a very fine-grained groundmass of chlorite, quartz and pumpellyite. There are some plagioclase microphenocrysts to 0.5 mm, commonly aggregated in glomerocrysts, and abundant chlorite-altered mafic phenocrysts (pyroxene?) of similar size. Irregular fine-grained aggregates (<1 mm diameter) of chlorite, amphibole, quartz and calcite represent both vesicles and matrix cavity fillings. There is no obvious cleavage or mineralisation.

R01120: Basalt

This rock is an altered, amygdular basaltic tuff or agglomerate, composed of irregular basaltic clasts from 1 to 3 mm in diameter. These are composed mostly of fine plagioclase laths (<0.1 mm long) in a very fine-grained groundmass of chlorite. There are some sparse mafic microphenocrysts to 0.5 mm, altered to chlorite (amphibole?), which probably represent altered olivine phenocrysts. There are abundant amygdules (to 2 mm in diameter), containing mostly opaque bituminous material, surrounded by fine-grained quartz and chlorite. These

vesicles can host native copper mineralisation elsewhere in these volcanic rocks. Calcite and quartz occur as patchy disseminated alteration of the groundmass, and also in some vesicles. There is a trace of fine-grained, disseminated pyrite and chalcopyrite but there is no obvious mineralisation or cleavage present.

R01121: Siltstone

This rock is a laminated, micaceous, chloritic quartz siltstone, with some very fine-grained chlorite-mica rich sandstone interbeds. There is some disseminated magnetite (about 1–2%), as poikiloblastic porphyroblasts, about 20–250 μm in size, dispersed throughout the various layers of the rock. They vary from ragged/amoeboid to euhedral/equant (octahedral?) in form, and are variably altered to coarse-grained hematite. This magnetite is discussed further in Bottrill and Taheri (2003), and may be of metasomatic origin. There are also rare, thin, heavy-mineral layers containing fine-grained magnetite, hematite, rutile, leucosene, zircon and minor tourmaline. There is no obvious cleavage or mineralisation.

R01122: Siltstone

This rock is a laminated, chloritic quartz siltstone, similar to the above sample. It again contains abundant disseminated magnetite and hematite as above. There is also some silicification, as shown by quartz and chert veinlets, and some cherty silicification in some parts of the rock. Some of this silicification is associated with abundant limonite, probably replacing cubic pyrite crystals to about 0.5 mm in diameter. There are also some pseudomorphs of cherty quartz and limonite after some unidentified equant porphyroblasts (garnet? – see Bottrill, 2004) and some chlorite micro-porphyroblasts. There is no obvious cleavage or mineralisation.

R011123: Dolostone

This is a very fine-grained (micritic, <0.005 mm), homogeneously-textured carbonate rock, with traces of medium-grained quartz and lithic grains and very fine grained disseminated opaque minerals (pyrite?). XRD indicates that the carbonate has a composition near dolomite.

R011124: Dolostone

This is a very fine-grained (micritic, <0.01 mm), homogeneously-textured carbonate rock, with traces of very fine-grained disseminated opaque minerals (pyrite?). There is mottled, disseminated cherty alteration over ~50% of the rock, and some irregular banded chalcedonic, agate cavity fill to a few millimetres. There are some small quartz-carbonate (calcite?) veinlets. XRD indicates that the main carbonate has a composition near dolomite, with minor magnesian calcite.

R011125: Magnesite (magnesite-stone)

This is a very fine-grained (micritic, <0.002 mm), homogeneously-textured carbonate rock, with <1% of very fine-grained disseminated opaque minerals (pyrite?) and a trace of quartz grains. There are some irregular, pyritic, carbonate veinlets, vermicular structures, porphyroblasts and clots, perhaps all representing incipient recrystallisation to sparry dolomite. XRD indicates that the carbonate is mostly magnesite, with subordinate dolomite and trace calcite.

R011126: Dolostone

This is a medium-grained (<0.5 mm), homogeneously textured, sparry carbonate rock, with traces of very fine-grained disseminated opaque minerals (pyrite?). XRD indicates that the carbonate has a composition near ferroan dolomite, with subordinate calcite.

R011127: Dolostone

This is a fine-grained (<0.2 mm), homogeneously textured, sparry carbonate rock which appears to be quite pure and unaltered. XRD indicates that the carbonate has a composition near dolomite, with subordinate calcite.

R011128: Dolostone

This is a fine-grained (<0.2 mm), homogeneously textured, sparry carbonate rock which appears to be quite pure and unaltered. XRD indicates that the carbonate has a composition near dolomite, with subordinate calcite.

R011129: Gossan

This is a cherty, laminated, ferruginous chert with abundant fine-grained talc (fine-grained micaceous aggregates, confirmed by XRD), magnetite (fine to medium grained), hematite (some pseudomorphous after magnetite) and limonite (partly pseudomorphous after pyrite?). The talc could suggest an ultramafic origin, but the lack of chromite, or Cr or Ni in the analyses, suggests it is more likely a highly

altered dolostone or magnesite. This is supported by the presence of some very fine-grained carbonate minerals in some quartz grains. The rock is highly altered but does not appear to be significantly mineralised, with the XRF analyses (Appendix 4) indicating no anomalous base metals or gold. There is no obvious cleavage.

R011130: Gossan

This is similar to the above sample, a limonitic chert breccia, with abundant limonite (possibly pseudomorphous after pyrite or siderite?) and fine-grained hematite and some minor talc. It is highly porous, perhaps due to loss of talc during weathering? The sample was probably an altered dolostone. It does not appear to be significantly mineralised, with the XRF analyses (Appendix 4) indicating no anomalous base metals or gold. There is no obvious cleavage.

R011131: Basalt

This rock is a porphyritic basalt, composed mostly of fine plagioclase laths (<0.1 mm long) in a very fine-grained groundmass of chlorite and mica. There are about 10% augite microphenocrysts to 0.5 mm, and about 5% plagioclase phenocrysts to about 4 mm long. XRD also indicates minor apatite (in the fine-grained groundmass?). There is no obvious cleavage, alteration or mineralisation.

R011132: Basalt

The rock is a medium-grained epidosite, containing about 70% epidote, 20% quartz and about 5% opaque minerals (magnetite and limonite). There are coarse grained quartz-epidote veins. The magnetite is mostly subhedral, intergrown with leucoxene, and less than 0.2 mm in size, but some coarser magnetite aggregates (to 1.5 mm) occur in vein selvages. The limonite probably represents weathered pyrite. The rock was probably originally a basalt or fine-grained dolerite, and contains some altered phenocrysts (now replaced by quartz and epidote). There is no obvious cleavage or mineralisation.

R011134: Sandstone

This is a fine-grained greywacke, very altered, weathered and limonite rich. Clasts comprise about 20% quartz, 20% feldspars and 60% lithic fragments (mostly siltstone, but including a trace of mafic volcanic rocks). The matrix appears to be composed of degraded lithic fragments and/or argillaceous material. There is no obvious cleavage or mineralisation.

The geochemistry shows high Ti, Zr, Cr and REE, suggesting a high heavy mineral content. There is a particularly high Cr content, suggesting a possible ultramafic precursor.

R011135: Basalt

This rock is a relatively non-porphyritic basalt, composed mostly of a subophitic aggregate of plagioclase laths (<0.05 mm long) and clinopyroxene

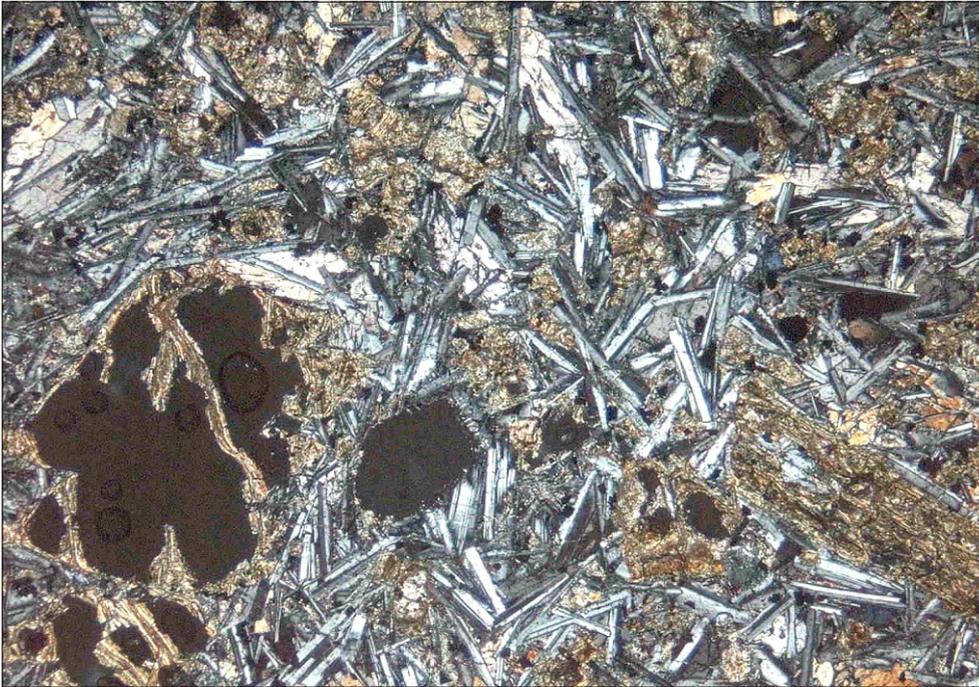


Plate 2

Photomicrograph, sample R011141, cross polarised light, showing plagioclase laths in a siderite-saponite matrix, and cavities after olivine(?) phenocrysts. Field of view 1.2 1.8 mm.

(<0.05 mm). There is about 10% of very fine-grained chlorite in patches and interstitial to plagioclase and pyroxene. There is a trace of augite microphenocrysts to ~1 mm. There is no obvious cleavage or mineralisation.

R011137: Limestone

This is a highly fossiliferous carbonate rock with ~75% fossil foraminifera in a medium-grained sparry carbonate groundmass, and traces of fine, rounded quartz grains. It is probably a Tertiary limestone.

R011138: Dolostone

This is a mottled, sparry carbonate rock, with a variable grain size from aphanitic to medium grained (up to 0.5 mm). Some minor, irregular fine carbonate veinlets are present. XRD indicates that the rock contains dolomite > calcite, suggesting it is metasomatically recrystallising from limestone to dolostone.

R011140: Dolostone

This is an arenaceous carbonate rock, or calcarenite, mostly very fine grained or micritic (<0.002 mm), with rounded to lenticular micritic casts from 0.1 to 0.5 mm in diameter. There are some medium-grained sparry patches or fenestral structures of similar size, interstitial to the clasts. There are also some small carbonate veinlets. XRD indicates that the carbonate has a composition near dolomite, with trace calcite (in the veins?) and pyrite.

R011141: Dolerite

This rock is a moderately altered, fine-grained porphyritic dolerite, composed mostly of a subophitic aggregate of plagioclase laths (<0.1 mm long) and clinopyroxene (<0.1 mm) in a clay-carbonate altered groundmass (probably altered glass; Plate 2). There is also about 10% of altered euhedral phenocrysts, most

probably originally olivine, to about 1 mm, now totally pseudomorphed by fine-grained saponite and siderite. Some probe analyses of the various minerals in this rock are given in Appendix 3. The pyroxene is a titanian augite, typical of many Cainozoic basalts, as is the ulvospinel. The plagioclase is unaltered (An₆₆), in contrast to most altered Proterozoic and Cambrian basalts in the district. The alteration appears to be unrelated to regional metamorphic effects. There is no obvious cleavage or mineralisation.

R011142: Dolostone

This is an undeformed, pelletal carbonate rock, mostly medium grained (~0.2 mm) and sparry, with rounded fine-grained/micritic pellets from about 0.4 to 0.5 mm in diameter. XRD indicates that the carbonate has a composition near dolomite, with subordinate calcite.

Microprobe analyses

The minerals were analysed with a Cameca SX-50 electron microprobe, using WDS spectrometers at 15 kV, at the University of Tasmania. The results are shown in Appendix 3. The analyses of the primary minerals (plagioclase, augite and ulvospinel) are typical of minerals in Tertiary basalt.

XRD analyses

The samples were prepared by drying, grinding to about 10–75 μm (~300#) and pressing into a 25 mm diameter aluminium sample holder. The samples were run on an automated Philips X-ray diffractometer system: PW1729 generator, PW1050 goniometer, PW1710 microprocessor, with nickel-filtered copper radiation at 40 kV/30 mA, a graphite monochromator (PW1752), sample spinner and a proportional detector (sealed gas filled, PW1711).

The PW1710 system is currently driven by the Diffraction Technology software *Visual XRD v2.6* and CSIRO software *PW1710 for Windows*, with plotting software *XPLOT for Windows* (CSIRO) and *Traces v.5.1* (Diffraction Technology). Interpretation was mostly by manual methods. The samples were calibrated with an internal standard, usually of natural quartz. The semi-quantitative mineralogy was determined by manual search-match methods, using a series of prepared standards.

Geochemistry

Selected samples were analysed for major and trace elements; the results are shown in Appendix 4.

The compositions of the dolerite and basalt are discussed by Everard (Appendix 5). In summary most of the dolerites are similar to the Neoproterozoic Rocky Cape dyke swarm, and the basalts are similar to the Neoproterozoic Spinks Creek Volcanics, but are compositionally variable and most are significantly altered or weathered. Sample R0011141 is unlike the other mafic rocks and may be related to Tertiary basalt. Some of the basalts are slightly enriched in rare earths (Ce, La and Nd), Ba and Sr.

None of the samples are significantly mineralised, including the 'gossanous' samples, but some of the Proterozoic dolerites are slightly anomalous in copper.

Conclusions

The samples examined fall mostly into two groups: weakly metamorphosed Neoproterozoic sedimentary rocks (dolostone, magnesite-stone, siltstone and arenite) and Early Cambrian mafic rocks (altered basalt and dolerite), plus two ferruginous cherts, one Tertiary basalt/dolerite and one Tertiary limestone.

The metamorphism of the sedimentary rocks is mostly weak (lower greenschist?), as shown by the lack of prominent metamorphic foliations and metamorphic minerals, but altered porphyroblasts of cordierite(?) and garnet(?) may occur in some samples.

There is no indication of any metamorphic assemblages in the carbonate rocks.

The metamorphism of the igneous rocks is mostly weak (prehnite-pumpellyite to lower greenschist), as shown by the lack of prominent metamorphic

foliations and metamorphic minerals, other than chlorite, actinolite, pumpellyite and epidote.

Fine-grained dolerite dykes occurring in the Smithton dolomite quarry (R011141) have a different alteration style, and appear similar to the local Tertiary basalt. M. Zwingmann (pers. comm.) has dated one sample ($^{40}\text{Ar}/^{39}\text{Ar}$) at 96 Ma, suggesting it is of Cretaceous age.

One dolostone (R011117) is fossiliferous (containing probable echinoderm ossicles), and although nominally classified as Neoproterozoic, the fossils may indicate either that the Smithton Dolomite is partly Cambrian or that the sampled outcrop is dolomitised Tertiary limestone (C. Calver, pers. comm.).

Two ferruginous samples are gossan like (R001129, R001130), but are unmineralised and probably represent highly altered dolostone or magnesite-stone, as shown by the presence of minor talc and carbonate. Two other samples contain disseminated magnetite and hematite (R011121, R011122) which also may be metasomatic in origin (Bottrill and Taheri, 2003). This alteration may be similar to some magnetite-siderite alteration in the Brooks Creek drill hole near Mathinna in northeastern Tasmania, which is thought to be related to alteration by underlying Devonian granite (Roach, 1994).

There is no indication of significant mineralisation or hydrothermal alteration in any other samples examined.

References

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[31 October 2007]

APPENDIX 1

Sample details

Tasrock No.	Locality	AMG (mE)	AMG (mN)	Lithology	Date	Age
R011101	Hays Tier	314712	5466003	laterite/maghemite?	07/02/2002	
R011102	West Point	300347	5466007	shear zone in orthoquartzite	07/02/2002	Proterozoic
R011103	West Point	301431	5465511	basalt	08/02/2002	Proterozoic
R011104	Marrawah	303692	5462943	pelite	09/02/2002	Proterozoic
R011105	Marrawah	303749	5462319	quartz-arenite	09/02/2002	Proterozoic
R011106	Temma	306622	5434431	pelite	01/01/2002	Proterozoic
R011107	Milkshake Road	344781	5450018	pelite	01/01/2002	Proterozoic
R011108	Milkshake Road	344400	5449750	pelite	01/01/2002	Proterozoic
R011109	Milkshake Road	344461	5449842	dolerite	01/01/2002	Proterozoic
R011110	Wedge Plains Road gravel pit	347125	5456277	sedimentary concretion or nodule	01/01/2002	Proterozoic
R011111	Tipunah Road	351680	5467181	dolerite	01/01/2002	Proterozoic
R011112	Apiary Road	352512	5458459	dolerite	01/01/2002	Proterozoic
R011113	Gibsons Plains Track	348943	5460419	dolerite	01/01/2002	Proterozoic
R011114	Welcome River	313000	5481100	lithicwacke	01/01/2002	Proterozoic
R011115	Woolnorth Road	315350	5483150	basalt	01/01/2002	Proterozoic
R011116	Woolnorth Road	309461	5487658	basalt	01/01/2002	Proterozoic
R011117	Welcome River	311219	5481300	dolostone	01/01/2002	Proterozoic
R011118	Welcome River	311219	5481300	dolostone	01/01/2002	Proterozoic
R011119	Kanunnah Bridge	330632	5446300	basalt	01/01/2002	Proterozoic
R011120	Kanunnah Bridge	330632	5446300	basalt	01/01/2002	Proterozoic
R011121	Frankland River 50 m upstream of Blackwater Road bridge	321820	5438350	siltstone with disseminated magnetite	01/01/2002	Proterozoic
R011122	Frankland River 50 m upstream of Blackwater Road bridge	321820	5438350	siltstone	01/01/2002	Proterozoic
R011123	Duck River bridge, Bass Highway	339700	5475500	dolostone	01/01/2002	Proterozoic
R011124	Duck River bridge, Bass Highway	339700	5475500	nodule in dolostone	06/04/2002	Proterozoic
R011125	Keith River	368970	5439000	magnesite	07/04/2002	Proterozoic
R011126	Redpa	312967	5462760	dolostone	07/04/2002	Proterozoic
R011127	Togari	323784	5460735	dolostone	07/04/2002	Proterozoic
R011128	Redpa	312967	5462760	dolostone	07/04/2002	Proterozoic
R011129	Keith River	368104	5437957	gossan	07/04/2002	
R011130	Keith River	368104	5437957	gossan	07/04/2002	
R011131	Buckbys Road, Spur 15	323292	5477775	basalt	01/01/2002	Proterozoic
R011132	Buckbys Road, Spur 15	323292	5477775	basalt	01/01/2002	Proterozoic
R011133	Jims Plain Road	313148	5469973	basalt	01/01/2002	Proterozoic
R011134	Off Jims Plain Road	312577	5470208	sandstone	01/01/2002	Proterozoic
R011135	Jims Plain Road	314462	5472967	basalt	01/01/2002	Proterozoic
R011136	Jims Plain Road	319533	5474978	?bituminous fault rock	01/01/2002	Proterozoic
R011137	King property, Redpa	312801	5463637	limestone	01/01/2002	Tertiary
R011138	Redpa – Gunns plantation south of Kings Road	312967	5462760	dolostone	01/01/2002	Proterozoic
R011139	Richardsons Flat on Westmore property	307050	5459150	sandstone	01/01/2002	Proterozoic
R011140	Circular Head Dolomite quarry	339644	5476473	dolostone	10/04/2002	Proterozoic
R011141	Circular Head Dolomite quarry	339644	5476473	dolerite	10/04/2002	Tertiary
R011142	Lees property, Togari	323784	5460735	dolostone	01/01/2002	Proterozoic
R011143	Blackwater 1 spur	327531	5446969	sand	01/01/2002	Tertiary?

NB: co-ordinates in AGD66 datum.

APPENDIX 2 XRD analyses

Tasrock No.	Plagioclase	Clinopyroxene	Quartz	Chlorite	Amphibole	Mica	Calcite	Talc	Goethite	Hematite	Magnetite	Apatite
R011112	25	15	10	25	15	10						
R011119	40	25	5	25			2					
R011120	50	20	5	20			2					
R011129			50					20	5	10	15	
R011130			50					5	30	10		
R011131	25	30	25	10		2						5
Tasrock No.	Dolomite	Fe-Dolomite	Ankerite	Calcite	Mg-Calcite	Magnesite	Quartz	Mica	Goethite	Smectite	Pyrite	
R011117			90	*			5	2	2			
R011118	85			10			2	2				
R011123	80						10	10		*		
R011124	15				2		80	*				
R011125	20			*		75	*					
R011126		80		15			5	2		*		
R011127	85			15								
R011128	85			15								
R011138	60			35						2		
R011140	90			2			2	*		2	2	
R011142	85			15								

All values approximate wt%
* = trace (<2%)

Appendix 3

Probe analyses, sample R011141

Pyroxenes

Label	011141-4	011141-5
SiO ₂	44.34	44.67
TiO ₂	3.23	3.47
Al ₂ O ₃	7.07	7.25
Cr ₂ O ₃	0.21	0.21
Fe ₂ O ₃ (c)	3.50	4.27
FeO(c)	5.35	5.45
MnO	0.17	0.16
MgO	11.21	11.25
ZnO	0.00	0.04
CaO	22.13	22.27
Na ₂ O	0.45	0.50
K ₂ O	0.00	0.01
Sum Ox (%)	97.65	99.54

Formulae: 6 oxygen

Si	1.709	1.693
Ti	0.094	0.099
Al/Al ^{IV}	0.291	0.307
Sum T	2.094	2.099
Al ^{VI}	0.030	0.017
Cr	0.006	0.006
Fe ³⁺	0.101	0.122
Fe ²⁺	0.172	0.173
Mn ²⁺	0.006	0.005
Mg	0.644	0.636
Zn	0.000	0.001
Ca	0.914	0.904
Na	0.033	0.037
K	0.000	0.000
Sum Oct	1.906	1.901
Sum Cations	4.000	4.000

End members (mol. %)

Wo(Ca)	52.8	52.8
En(Mg)	37.2	37.1
Fs(Fe ²⁺)	10.0	10.1
XMg	0.8	0.8

Feldspars

Label	011141-1	011141-2
SiO ₂	50.59	50.51
TiO ₂	0.11	0.13
Al ₂ O ₃	29.00	29.22
Fe ₂ O ₃	0.64	0.66
MgO	0.16	0.14
CaO	13.62	13.83
SrO	0.16	0.11
BaO	0.00	0.05
Na ₂ O	3.61	3.49
K ₂ O	0.26	0.25
Rb ₂ O	-	-
Sum Ox (%)	98.16	98.39

Formulae: 8 oxygen

Si	2.354	2.346
Ti	0.004	0.005
Al/Al ^{IV}	1.590	1.599
Sum T	3.948	3.950
Al ^{VI}	0.000	0.000
Fe ³⁺	0.023	0.023
Mg	0.011	0.010
Ca	0.679	0.688
Sr	0.004	0.003
Ba	0.000	0.001
Na	0.326	0.314
K	0.015	0.015
Rb	-	-
Sum alk	1.058	1.054
Sum Cat#	5.006	5.003

End members (mol. %)

Ab	31.8	30.8
An	66.3	67.4
Or	1.5	1.4
Celsian	0.0	0.1
Rb-Feld	0.0	0.0
Sr-Feld	0.4	0.3

Ulvospinel

<i>Label</i>	011141-9	011141-10
SiO ₂	0.08	0.08
TiO ₂	19.59	20.98
Al ₂ O ₃	3.32	2.79
Cr ₂ O ₃	0.00	0.00
Fe ₂ O ₃ (c)	59.76	58.19
FeO(c)	14.17	15.60
V ₂ O ₃	0.00	0.00
MnO	0.59	0.81
MgO	1.56	1.31
CaO	0.05	0.04
ZnO	0.10	0.23
NiO	0.05	0.00
CoO	-	-
ZrO ₂	0.07	0.09
Nb ₂ O ₅	-	-
Sum Ox (%)	99.33	100.13

Formulae: 4 oxygen

Si	0.003	0.003
Ti	0.563	0.600
Al ^{VI}	0.149	0.126
Cr	0.000	0.000
Fe ³⁺	0.718	0.665
Fe ²⁺	1.453	1.497
V	0.000	0.000
Mn ²⁺	0.020	0.026
Mg	0.089	0.075
Ca	0.002	0.002
Zn	0.003	0.006
Ni	0.002	0.000
Co	0.000	0.000
Zr	0.002	0.002
Nb	0.000	0.000
Sum Cations	3.000	3.000

End members (mol. %)

ulvospinel	56.3	60.0
chromite	0.0	0.0
gahnite	0.3	0.6
spinel	0.6	1.2
hercynite	6.5	4.5
jacobsite	2.0	2.6
magnesioferrite	8.3	6.3
magnetite	25.7	24.4

Saponite

<i>Label</i>	011141-9
SiO ₂	51.14
TiO ₂	0
Al ₂ O ₃	3.51
Cr ₂ O ₃	0
Fe ₂ O ₃	9.76
MgO	22.63
CaO	0.58
NiO	0
Na ₂ O	0.05
MnO	0.05
K ₂ O	0.18
H ₂ O(c)	13.2
Sum Ox (%)	101.08

Formulae: 12 oxygen

Si	3.713
Al/Al ^{IV}	0.287
Sum T	4.000
Al ^{VI}	0.014
Ti	0.000
Cr	0.000
Fe	0.534
Mg	2.449
Ni	0.000
Mn	0.003
Sum M	3.000
Ca	0.045
Na	0.006
K	0.016
Sum A	0.067
Sum Cations	7.067

Formulae: 12 oxygen

Si	3.98
Ti	0.00
Al/Al ^{IV}	0.00
Al ^{VI}	0.32
Cr	0.00
Fe ³⁺	0.57
Mg	2.63
Ca	0.05
Ni	0.00
Na	0.01
Mn ²⁺	0.00
K	0.02
	7.58
XMg	0.821

Carbonates

<i>Carbonate Label</i>	<i>siderite 011141-3</i>	<i>siderite 011141-6</i>	<i>siderite 011141-7</i>
SiO ₂	0.00	0.02	0.04
FeCO ₃	85.65	86.43	79.00
MnCO ₃	1.01	1.36	1.35
MgCO ₃	4.20	2.96	4.80
CaCO ₃	5.60	6.49	10.07
BaCO ₃	0.00	0.00	0.00
SrCO ₃	0.00	0.00	0.00
NiCO ₃	0.00	0.06	0.02
Sum Ox (%)	96.46	97.32	95.29

Formulae: 3 oxygen

Si	0.000	0.000	0.001
Fe ²⁺	0.866	0.869	0.800
Mn ²⁺	0.010	0.014	0.014
Mg	0.058	0.041	0.067
Ca	0.066	0.076	0.118
Ba	0.000	0.000	0.000
Sr	0.000	0.000	0.000
Ni	0.000	0.001	0.000
Sum Cat#	1.000	1.000	1.000

End members (mol. %)

gaspeite	0.0	0.1	0.0
rhodochrosite	1.0	1.4	1.4
magnesite	5.8	4.1	6.7
siderite	86.6	86.9	80.0
calcite	6.6	7.6	11.8

Appendix 4 Geochemistry

Reg. No.	Tasrock No.	SiO ₂ (wt %)	TiO ₂ (wt %)	Al ₂ O ₃ (wt %)	Fe ₂ O ₃ (wt %)	FeO (wt %)	MnO (wt %)	MgO (wt %)	CaO (wt %)	Na ₂ O (wt %)	K ₂ O (wt %)	P ₂ O ₅ (wt %)	SO ₃ (wt %)	CO ₂ (wt %)	H ₂ O ⁺ (wt %)	Total (wt %)	LOI (wt %)
20020365	R011102	96.56	0.06	1.68	0.03	0.39	0.00	0.14	0.03	0.01	0.20	0.00	0.00	0.14	0.63	99.87	0.73
20020366	R011104	84.81	0.40	9.59	0.02	0.39	0.00	0.23	0.01	0.01	2.60	0.00	0.00	0.26	1.42	99.74	1.64
20020367	R011105	98.77	0.14	0.28	0.03	0.39	0.01	0.03	0.00	0.00	0.03	0.00	0.00	0.05	0.12	99.84	0.13
20020368	R011106	49.36	0.36	16.92	5.74	14.23	0.29	3.77	0.03	0.21	2.18	0.09	0.00	0.67	5.96	99.81	5.05
20020369	R011109	51.09	1.81	20.73	10.58	2.00	0.07	2.61	0.02	0.13	1.30	0.06	0.00	0.79	8.61	99.80	9.18
20020370	R011111	50.73	1.99	16.28	9.88	5.09	0.11	5.28	0.05	1.49	0.66	0.14	0.00	0.92	7.19	99.80	7.55
20020371	R011112	50.17	1.57	14.35	4.72	6.89	0.18	6.21	7.82	2.24	2.10	0.17	0.00	0.28	3.10	99.81	2.61
20020372	R011113	48.50	1.79	19.44	17.46	0.97	0.06	0.30	0.04	0.13	0.04	0.26	0.00	1.53	9.26	99.76	10.68
20020373	R011114	79.30	0.73	6.55	2.94	3.28	0.29	2.08	0.30	0.60	0.87	0.12	0.00	0.40	2.51	99.97	2.55
20020374	R011117	5.58	0.04	0.80	0.84	0.06	0.09	17.40	30.68	0.09	0.07	0.08	0.05	43.90	0.33	100.02	44.22
20020375	R011118	0.85	0.02	0.33	0.04	0.06	0.02	18.69	32.28	0.02	0.01	0.05	0.00	46.30	0.62	99.28	46.91
20020376	R011119	48.63	1.66	12.86	4.32	8.57	0.18	6.11	7.97	4.26	0.06	0.15	0.00	1.52	3.67	99.95	4.24
20020377	R011120	49.32	1.72	14.60	2.00	8.69	0.12	5.97	4.86	5.47	0.07	0.20	0.01	2.28	4.46	99.76	5.77
20020378	R011121	66.47	0.67	16.03	3.15	3.16	0.06	1.81	0.06	1.70	3.41	0.07	0.00	0.24	2.91	99.73	2.80
20020379	R011122	67.33	0.66	16.84	2.64	2.00	0.05	1.43	0.04	1.10	4.19	0.03	0.00	0.19	2.96	99.46	2.92
20020380	R011123	7.75	0.07	1.02	0.64	0.19	0.01	20.96	26.93	0.08	0.06	0.06	0.14	41.10	1.01	100.03	42.09
20020381	R011124	67.15	0.02	0.30	0.06	0.26	0.01	6.28	10.56	0.01	0.02	0.02	0.01	14.60	0.62	99.89	15.19
20020382	R011125	0.69	0.00	0.09	0.39	0.06	0.03	43.05	5.02	0.00	0.00	0.00	0.02	49.70	1.05	100.12	50.75
20020383	R011126	5.90	0.07	1.54	0.33	0.19	0.01	17.73	30.72	0.05	0.35	0.14	0.18	41.80	1.02	100.03	42.79
20020384	R011127	0.35	0.01	0.25	0.01	0.06	0.01	19.28	33.22	0.10	0.00	0.06	0.02	44.80	1.36	99.53	46.15
20020385	R011128	0.49	0.01	0.20	0.03	0.06	0.01	18.98	33.70	0.03	0.00	0.06	0.02	44.40	1.69	99.67	46.08
20020386	R011129	54.09	0.04	0.71	34.26	4.32	0.02	2.84	0.06	0.49	0.02	0.19	0.01	0.36	2.48	99.88	2.36
20020387	R011130	11.23	0.02	0.33	78.07	4.44	0.03	0.74	0.05	1.17	0.01	0.40	0.01	0.14	3.27	99.91	2.92
20020388	R011131	49.61	2.23	13.08	10.74	7.79	0.24	2.40	5.23	2.31	2.62	0.67	0.00	0.16	2.74	99.82	2.03
20020389	R011132	54.86	1.19	12.84	14.63	0.84	0.20	0.25	11.77	0.04	0.04	0.30	0.00	0.00	2.85	99.80	2.76
20020390	R011134	51.37	2.80	14.56	15.63	0.84	0.09	3.38	0.10	0.70	1.84	0.30	0.00	0.98	7.09	99.68	7.97
20020391	R011135	47.28	2.06	15.15	6.56	7.54	0.18	5.04	7.88	2.41	2.02	0.22	0.00	0.05	3.45	99.86	2.67
20020392	R011137	2.07	0.03	0.53	0.74	0.06	0.02	0.82	52.91	0.07	0.03	0.15	0.06	40.40	2.16	100.05	42.55
20020393	R011138	0.91	0.01	0.25	0.02	0.06	0.01	14.46	38.85	0.02	0.00	0.07	0.01	44.10	0.72	99.48	44.81
20020394	R011140	1.97	0.03	0.50	0.52	0.19	0.01	20.91	29.66	0.07	0.02	0.07	0.83	44.20	1.09	100.08	45.27
20020395	R011141	45.66	1.73	14.80	3.62	8.31	0.15	7.74	9.13	2.62	1.13	0.38	0.02	1.20	3.26	99.74	3.54
20020396	R011142	0.52	0.02	0.25	0.06	0.06	0.01	18.70	33.85	0.01	0.00	0.04	0.00	44.40	0.92	98.84	45.31
20020397	R011143	98.23	0.09	0.11	0.00	0.26	0.00	0.05	0.17	0.00	0.00	0.00	0.00	0.17	0.32	99.40	0.46

Reg. No.	Tasrock No.	Ag (ppm)	Au (ppm)	Th (ppm)	Sr (ppm)	U (ppm)	Rb (ppm)	Y (ppm)	Zr (ppm)	Nb (ppm)	Mo (ppm)	Cr (ppm)	V (ppm)	Sc (ppm)	Co (ppm)	As (ppm)	Bi (ppm)	Ga (ppm)	Zn (ppm)	W (ppm)	Cu (ppm)	Ni (ppm)	Sn (ppm)	Pb (ppm)	S (%)	Nd (ppm)	Ce (ppm)	La (ppm)	Ba (ppm)
20020365	R011102			<10	<5	<10	<5	<5	83	<3	<5	11	7	<9	<8	<20	<5	5	<5	<10	13	12	<9	<10	0.0	<20	<28	<20	<23
20020366	R011104			<10	13	<10	69	22	260	5	<5	38	47	<9	8	<20	<5	12	<5	<10	48	9	<9	<10	0.0	24	76	29	105
20020367	R011105			<10	<5	<10	<5	<5	69	<3	<5	6	<5	<9	<8	<20	<5	<5	<5	<10	13	6	<9	<10	0.0	<20	<28	<20	<23
20020368	R011106			23	8	<10	110	67	210	11	<5	35	51	10	<8	<20	<5	22	120	<10	9	25	<9	14	0.0	22	56	21	160
20020369	R011109			20	9	<10	66	27	260	28	<5	70	430	44	35	<20	<5	27	120	<10	280	43	<9	27	0.0	32	58	<20	240
20020370	R011111			15	19	<10	29	39	240	29	<5	32	510	46	48	<20	<5	23	170	<10	220	42	<9	17	0.0	21	54	<20	125
20020371	R011112			<10	160	<10	95	26	135	13	<5	120	320	33	47	<20	<5	21	130	<10	74	86	<9	12	0.0	23	36	<20	360
20020372	R011113			21	<5	<10	6	6	220	25	<5	70	910	71	23	<20	<5	36	37	<10	145	34	<9	28	0.1	<20	<28	<20	24
20020373	R011114			<10	31	<10	33	18	125	7	<5	180	125	15	39	<20	<5	11	64	<10	36	56	<9	<10	0.0	<20	<28	<20	610
20020374	R011117			14	240	<10	11	<5	36	7	<5	25	44	<9	24	<20	<5	5	30	<10	<5	57	<9	15	0.1	<20	38	<20	<23
20020375	R011118			10	175	<10	9	<5	16	8	<5	7	6	<9	9	<20	<5	5	14	<10	<5	6	<9	11	0.0	<20	<28	<20	<23
20020376	R011119			<10	78	<10	<5	26	110	8	<5	125	310	44	52	<20	<5	16	100	<10	125	74	<9	<10	0.0	<20	<28	<20	34
20020377	R011120			<10	48	<10	<5	37	115	10	<5	140	350	47	48	<20	<5	17	90	<10	84	59	<9	<10	0.0	<20	<28	<20	39
20020378	R011121	2	<0.01	22	34	<10	175	54	380	19	<5	43	52	13	15	<20	<5	20	67	<10	7	20	<9	<10	0.0	39	96	50	520
20020379	R011122	1	<0.01	16	28	<10	220	34	220	16	<5	51	67	16	13	<20	<5	22	58	<10	10	17	<9	10	0.0	27	74	35	630
20020380	R011123			<10	125	<10	21	<5	21	7	<5	32	45	<9	13	<20	<5	6	18	<10	<5	21	<9	11	0.1	<20	<28	<20	<23
20020381	R011124			<10	27	<10	<5	<5	8	<3	<5	13	8	<9	10	<20	<5	5	5	<10	<5	7	15	<10	0.0	<20	<28	<20	<23
20020382	R011125			<10	83	<10	<5	<5	11	6	<5	7	6	<9	8	<20	<5	<5	30	<10	<5	6	<9	10	0.0	<20	<28	<20	<23
20020383	R011126			10	175	13	29	<5	32	8	<5	36	44	<9	<8	<20	<5	6	32	<10	<5	11	<9	11	0.0	<20	37	<20	25
20020384	R011127			<10	200	<10	8	<5	17	7	<5	8	21	<9	<8	<20	<5	<5	14	<10	<5	6	<9	<10	0.0	<20	<28	<20	<23
20020385	R011128			<10	210	<10	7	<5	17	7	<5	7	13	<9	<8	<20	<5	<5	12	<10	<5	7	<9	<10	0.0	<20	<28	<20	<23
20020386	R011129			<10	<5	<10	<5	<5	7	<3	6	26	91	<9	26	<20	<5	6	18	10	11	5	<9	<10	0.0	<20	<28	<20	<23
20020387	R011130			<10	<5	<10	<5	<5	<5	<3	<5	29	30	<9	51	<20	<5	6	17	20	26	<5	<9	<10	0.1	<20	<28	<20	<23
20020388	R011131			18	165	<10	68	56	220	69	<5	21	155	48	38	<20	<5	20	175	<10	10	13	<9	<10	0.0	39	87	51	980
20020389	R011132			<10	1150	<10	<5	38	170	38	<5	27	110	31	16	<20	<5	26	64	<10	<5	7	<9	11	0.0	26	64	30	49
20020390	R011134			20	58	<10	100	40	320	63	<5	1500	220	32	56	<20	<5	21	220	<10	105	300	<9	22	0.0	49	370	70	320
20020391	R011135			10	280	<10	55	32	160	17	<5	180	410	40	52	<20	<5	22	130	<10	63	93	<9	<10	0.0	25	<28	<20	450
20020392	R011137			22	310	11	14	<5	35	10	<5	14	37	<9	13	<20	<5	<5	30	<10	<5	29	<9	17	0.0	<20	<28	<20	<23
20020393	R011138			12	210	<10	7	<5	18	8	<5	11	30	<9	<8	<20	<5	5	20	<10	<5	9	<9	<10	0.0	<20	<28	<20	<23
20020394	R011140			<10	155	10	7	<5	18	7	<5	22	29	<9	<8	<20	<5	5	15	<10	<5	12	<9	10	0.3	<20	<28	<20	<23
20020395	R011141			<10	460	<10	27	23	155	43	<5	380	170	25	53	<20	<5	20	100	<10	71	240	<9	<10	0.1	<20	49	<20	320
20020396	R011142			12	220	11	6	<5	19	8	<5	10	11	<9	<8	<20	<5	<5	14	<10	<5	8	<9	10	0.0	<20	<28	<20	<23
20020397	R011143			<10	<5	<10	<5	<5	12	<3	7	32	<5	<9	<8	<20	<5	5	<5	<10	9	8	<9	<10	0.0	<20	<28	<20	<23

Appendix 5

Notes on geochemistry of mafic rocks

J. L. Everard

Rocky Cape Dyke Swarm dolerites

Sample R011112 is from Apiary Road, east of Nabageena, where a Proterozoic dolerite dyke is depicted on the Trowutta 1:50 000 scale map sheet (Everard *et al.*, 1996). The analysis (Table 1) closely resembles a previous analysis of a sample (R000208) from the same locality (D. B. Seymour, unpublished data). Both have major and trace element chemistry fairly typical of the mostly NNE-trending Rocky Cape Dyke Swarm. A feature of these samples, and some other members of the swarm, is high K₂O, despite an otherwise tholeiitic chemistry. TiO₂ is rather high and MgO rather low, but well within the known range of the Rocky Cape Dyke Swarm dolerites (e.g. unpublished data of J. L. Everard and A. V. Brown, about 100 analyses).

The other analysed dolerites (R011109, R01111, R011113, Table 1) are obviously very altered (weathered?) and no thin sections are available. Sample R011109, from Milkshake Road, is from a previously mapped dyke (Everard *et al.*, 1996), whereas R011111 (Tipunah Road near Mengha) and R011113 (Gibsons Plains southeast of Lileah) are occurrences not documented on the Smithton map (Lennox *et al.*, 1982). They have high H₂O⁺ (7.19–9.26%) and Fe₂O₃/FeO and extremely low CaO (0.50%) and, particularly in the case of 109 and 113, low Na₂O and MgO. Immobile element ratios (e.g. Ti/Zr) are broadly similar to the Rocky Cape Dyke Swarm dolerites, although absolute values of these elements are about twice those in fresh samples, suggesting around 50% mass loss during alteration. Conclusions are difficult to draw for the extremely altered sample R011113, which has lost much of its Y, Sr and Ba. A Cainozoic age cannot be ruled out as it lies within 500 m of mapped basalt.

Cainozoic(?) dolerite, Smithton quarry

Sample R011141, from a dyke within a dolomite quarry near Smithton, lies over one of a series of linear WNW/SSE-trending magnetic anomalies which extend from the Forest area towards Cape Grim, and may be representative of their source. The anomalies crosscut a range of rock types, indicating that they are post-Middle Cambrian. A relatively young age for the sample is also suggested by the presence of fresh olivine in some thin sections.

The analysis contains 1.20% CO₂ and 3.26% H₂O⁺, but otherwise may be a near-magmatic composition. It is near-saturated (hy 2.68% in CIPW norms) and is a transitional olivine basalt in the Johnson and Duggan (1989) classification. Low MgO and Mg# (57.5 at Fe₂O₃/FeO = 0.20) indicate that it is moderately

fractionated. However trace elements (e.g. Nb > Y) clearly show alkalic affinities, which is supported by the presence of titaniferous augite. The rock plots within the field of Tasmanian Cainozoic basalts for virtually all major and trace elements. It may be related to Miocene alkali basalt and hawaiite at Mt Cameron West and Marrawah, but the apparent nature of the occurrence (a regionally extensive dyke swarm) is unusual for the Tasmanian Cainozoic.

A correlation with the mainly tholeiitic Rocky Cape Dyke Swarm is discounted on the basis of field relationships (trend and apparent age), petrography and geochemistry. Further east, near Burnie, the Cooee dolerite (K/Ar age 725 ± 35 Ma) and probable equivalent dykes inland are alkalic, as are small altered dykes on Hunter Island (Everard *et al.*, 1996), near Balfour (A. Reed *in* Everard *et al.*, 2007) and at Temma (A. Reed, unpublished). A relationship with this rock is also considered unlikely on the basis of petrographic differences and likely age.

Spinks Creek Volcanics

Kanunnah Bridge

The analyses of basalts R011119 and R011120, from the Arthur River near Kanunnah Bridge, are fairly typical of the 'Chemical Group C' member of the Neoproterozoic Spinks Creek Volcanics, including a previous analysis (AR113) from about 50 m upstream (Everard *et al.*, 2007). Group C basalts are moderately fractionated rift tholeiites, characterised by 1.44–1.78% (typically 1.6–1.7%) TiO₂. They are the most voluminous basalt type in the area, and form the bulk of the thick volcanic pile east of the Roger River Fault, probably as a single flow. They also occur immediately west of the fault, but are unknown further west on the Woolnorth map sheet.

Both petrography and high CO₂ clearly indicate that these two samples are more altered than most other previously analysed representatives. Most major and trace elements fall within the range displayed by previous data (n = 166), as do key immobile element ratios (e.g. Ti/Zr, Nb/Zr).

Sample R011120 is slightly lower in total FeO and higher in Na₂O, whilst R011118 is slightly lower in Al₂O₃ than usual in Group C basalts. This may simply be due to alteration.

Buckbys Road

These samples occur south of Montagu within areas mapped as Kanunnah Subgroup (Seymour and Baillie, 1992), close to intercalated basalt. Sample R011131 is an unusual strongly fractionated (e.g. low MgO) potassic (K₂O > Na₂O) ferrobasalt. The high Nb, REE

and P_2O_5 suggest weakly alkalic affinities. For most elements it is similar to the 'Chemical Group E' ferrobasalts, a relatively rare type of the Spinks Creek Volcanics (five out of about 160 analysed samples). However K_2O and Rb are higher than previous Group E analyses.

Sample R011132 is an altered epidote-rich rock, probably derived from similar basalt, with very low Na_2O , K_2O and MgO. Fairly high Nb, REE and P_2O_5 again suggest possible alkalic affinities.

Jims Plain Road

Sample R011135 was collected from Jims Plain Road northwest of Marrawah. Although no basalt is mapped in the immediate area (Seymour and Baillie, 1992), Kanunnah Subgroup sedimentary rocks, which are intercalated with basalt elsewhere, crop out nearby. The analysis is similar for many elements to 'Chemical Group D' of the Spinks Creek Volcanics, which are widespread in the west of the Smithton Synclinorium. These are evolved tholeiites with 2.1–2.4% TiO_2 , and include a previously analysed sample (R000111) from two kilometres to the south (D. B. Seymour, unpublished data). Sample R011135 differs from other analysed Group D basalts in containing much higher K_2O (2.02% *cf.* 0.08–0.99%) and Rb (55 ppm *cf.* 5–24 ppm), and slightly higher Al_2O_3 (15.15% *cf.* 13.44–14.20%), and may be a minor

potassic variant, but low levels of some other elements (e.g. P_2O_5 and Nb) are not consistent with alkalic affinities. Contamination of the sample with pelitic sedimentary material is another possible explanation, although there does not seem to be any petrographic evidence for this.

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Table 1
Analyses of the igneous rocks discussed in Appendix 5

Reg. No.	R011109	R011111	R011112	R011113	R011141	R011119	R011120	R011131	R011132	R011135
Anal. No.	20020369	20020370	20020371	20020372	20020395	20020376	20020377	20020388	20020389	20020391
Rock type	Dolerite	Dolerite	Dolerite	Dolerite	Dolerite	Basalt	Basalt	Basalt	Basalt	Basalt
SiO ₂	51.09	50.73	50.17	48.50	45.66	48.63	49.32	49.61	54.86	47.28
TiO ₂	1.81	1.99	1.57	1.79	1.73	1.66	1.72	2.23	1.19	2.06
Al ₂ O ₃	20.73	16.28	14.35	19.44	14.80	12.86	14.60	13.08	12.84	15.15
Fe ₂ O ₃	10.58	9.88	4.72	17.47	3.62	4.32	2.00	10.74	14.63	6.56
FeO	2.00	5.09	6.89	0.07	8.31	8.57	8.69	7.79	0.84	7.54
MnO	0.07	0.11	0.18	0.06	0.15	0.18	0.12	0.24	0.20	0.18
MgO	2.61	5.28	6.21	0.30	7.74	6.11	5.97	2.40	0.25	5.04
CaO	0.02	0.05	7.82	0.04	9.13	7.97	4.86	5.23	11.77	7.88
Na ₂ O	0.13	1.49	2.24	0.13	2.62	4.26	5.47	2.31	0.04	2.41
K ₂ O	1.30	0.66	2.10	0.04	1.13	0.06	0.07	2.62	0.04	2.02
P ₂ O ₅	0.06	0.14	0.17	0.26	0.38	0.15	0.20	0.67	0.30	0.22
SO ₃	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CO ₂	0.79	0.92	0.28	1.53	1.20	1.52	2.28	0.16	0.00	0.05
H ₂ O ⁺	8.61	7.19	3.10	9.29	3.26	3.67	4.46	2.74	2.85	3.45
TOTAL	99.80	99.80	99.81	99.76	99.74	99.95	99.76	99.82	99.80	99.86
LOI	9.18	7.55	2.61	10.68	3.54	4.24	5.77	2.03	2.76	2.67
Sc	44	46	33	71	25	44	47	48	31	40
V	430	510	320	910	170	310	350	155	110	410
Cr	70	32	120	70	380	125	140	21	27	180
Co	35	48	47	23	53	52	48	38	16	52
Ni	43	42	86	34	240	74	59	13	7	93
Cu	280	220	74	145	71	125	84	10	<5	63
Zn	120	170	130	37	100	100	90	175	64	130
Ga	27	23	21	36	20	16	17	20	26	22
As	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Rb	66	29	95	6	27	<5	<5	68	<5	55
Sr	9	19	160	<5	460	78	48	165	1150	280
Y	27	39	26	6	23	26	37	56	38	32
Zr	260	240	135	220	155	110	115	220	170	160
Nb	28	29	13	25	43	8	10	69	38	17
Mo	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Sn	<9	<9	<9	<9	<9	<9	<9	<9	<9	<9
Ba	240	125	360	24	320	34	39	980	49	450
La	<20	<20	<20	<20	<20	<20	<20	51	30	<20
Ce	58	54	36	<28	49	<28	<28	87	64	<28
Nd	32	21	23	<20	<20	<20	<20	39	26	25
W	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Pb	27	17	12	28	<10	<10	<10	<10	11	<10
Bi	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Th	20	15	<10	21	<10	<10	<10	18	<10	10
U	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Mg# (0.20)	32.24	44.27	53.99	3.69	58.46	50.79	54.51	22.44	3.66	44.10
Ti/Zr	41.67	49.65	69.63	48.68	66.78	90.29	89.89	60.87	41.84	77.32
Nb/Zr	0.108	0.121	0.096	0.114	0.277	0.073	0.087	0.314	0.224	0.106