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3-D Geological Modelling and Mineral Systems in Tasmania

Explanatory notes for the map of volcanic facies associations and volcanic centres in the Mount Read Volcanics, Tasmania

Introduction

These explanatory notes outline the project background, data sources, method of data compilation and interpretation, and the format of the GIS map of volcanic facies associations and volcanic centres in the Mount Read Volcanics.

The map of volcanic facies associations and volcanic centres covers the Mount Read Volcanics from Mount Darwin to Hellyer. It has been compiled from publicly available data, specifically research theses available from the School of Earth Sciences at the University of Tasmania, published papers, published maps, unpublished MRT, company and research reports on file at MRT. The degree of confidence in the map varies depending on amount and quality of the available data.

The map is delivered as GIS digital data, spatially registered to the standard 1:25,000 digital topographic base (AGD66) generated in ArcInfo v. 8.2 and Arcview v.3.2a software. Paper copies are also provided at 1:100,000 scale.

The map of volcanic facies associations and volcanic centres has four main components:

- Polygons that delineate the volcanic facies associations,
- Points that locate interpreted volcanic centres,
- A table of attributes that describe each of the volcanic facies association polygons in terms of location, facies, shape, size, composition, mineralogy and their interpretation, and
- A table of attributes that describes each of the volcanic centres.

A list of the computer files related to the map and their locations are given in Appendix 2. Accompanying the map are Microsoft Excel™ tables of the volcanic facies association attributes (*T1 vfa.xls*), volcanic facies association attribute codes (*T2 attributes.xls*), the volcanic centre attributes (*T3 vc.xls*), volcanic centre attributes codes (*T4 attributes.xls*), lithostratigraphic name codes (*T5 Strat codes.xls*), mineral codes (*T6 Min codes.xls*) and references (*T7 Ref_no.xls*). Each polygon on the map delineates a volcanic facies association and its attributes are recorded as a row in the volcanic facies association attributes table (*T1 vfa.xls*). Numbers on the map refer to separate volcanic centres that are described in the file *T3 vc.xls*.

Objectives

This map aims to contribute to the 3-D mineralisation and structural model of western Tasmania being prepared by the pmd*CRC by providing information on the nature of the volcanic succession that hosts mineral deposits in western Tasmania. It provides a digital compilation of facies descriptions and volcanic facies mapping in the Mount Read Volcanics and interpretations of the proximity to source, the eruption styles, volcano types and their possible locations.

During the compilation processes a number of unresolved geological problems and under-explored or under-studied areas in the Mount Read Volcanics were recognised. These are outlined in Appendix 5.

The identification of ancient volcanic centres is a new approach to the geology of the Mount Read Volcanics. The location of volcanic centres is important because they are the major heat sources in submarine volcanic successions and contribute heat and in some cases magmatic fluid and metals to hydrothermal systems. They are commonly associated with altered zones, mineralised zones and major structures. The identification and location of different volcanic centres within the central Mount Read Volcanics is a valuable addition to the model of geology in the Mount Read Volcanics.

Data sources and methods of compilation

Data for the volcanic facies associations were collected from open file volcanology and regional geology studies, including published papers, published maps, research theses, research reports (e.g. AMIRA reports), and unpublished MRT and company reports. In addition, the local knowledge of the authors and research staff at the University of Tasmania was invaluable.

From the data we have delineated 215 polygons. Each polygon represents a collection of related volcanic facies and may include other facies (e.g. mudstone, limestone or quartz porphyry) that are intercalated with or intruded into the related volcanic facies. These polygons capture the main volcanic facies associations and their distribution in the central part of the Mount Read Volcanics between Mount Darwin and Hellyer.

Some known outcrops or volcanic facies in Mount Read Volcanics were omitted from the final compilation because:

- They were insufficiently described or delineated,
- No information additional to their distribution on the 1:25,000 geological map series could be ascertained,
- The data remains in confidential exploration reports and in-house maps, or
- They were described only in drill holes or cross sections and had not been projected to surface.

A list of a possible 45 attributes (described in Appendix 1) was developed to facilitate the collection of descriptive data. Attributes were recorded in a Microsoft Excel™ spreadsheet with a single row for each polygon. We recorded descriptions of the facies, texture, composition, primary or relic mineralogy, and whole-rock geochemistry. Wherever possible, the original observations and interpretations were recorded directly from the references, however many of the polygons were delineated and described from more than one reference or used old terminology. In order to make the descriptions and terminology in the database consistent some interpretations were made and some facies renamed during data entry. In addition to recording descriptions of facies and volcanic facies associations, we made interpretations about the type of volcanic facies, type of volcanic facies association, eruption style, volcano type and volcanic centre (source).

The data source/s for each polygon are cited as a number in the *Ref_no* column of the attributes tables (*T1 vfa.xls* and *T3 vc.xls*). This number corresponds to a reference in file *T7 Ref_no.xls*.

Volcanic facies association attributes

Identification and nomenclature (attributes 6 and 7)

A *facies association* is a collection of facies that are spatially, mineralogically, compositionally or texturally related and may also be genetically related. For example, quartz-phyric rhyolite facies association may include massive coherent quartz-phyric rhyolite, jigsaw fit quartz-phyric rhyolite breccia, blocky clast-rotated quartz-phyric rhyolite breccia and mudstone-rhyolite breccia. All of these facies may be genetically related to the emplacement of a quartz-phyric rhyolite lava that developed a carapace of hyaloclastite and a peperitic base where it flowed over wet unconsolidated mud.

Volcanic facies associations were identified based on composition (i.e. mafic versus felsic) and on the dominant volcanic or sedimentary facies. There are four dominant volcanic facies types described in the Mount Read Volcanics:

- *coherent volcanic facies*
- *volcaniclastic facies*, these are primary or resedimented syn-eruptive volcaniclastic facies
- *volcanogenic facies*, these are post-eruptive resedimented volcaniclastic facies, which contain volcanic particles derived from the erosion and reworking of pre-existing volcanic deposits and may include a significant proportion of non-volcanic particles.

- *volcanosedimentary facies*, are intercalated sedimentary and volcanic facies, where there is a high proportion of non-volcanic sedimentary facies.

In a few cases, the descriptive data was insufficient to determine the dominant volcanic facies type for the volcanic facies association.

The nomenclature used for the volcanic facies associations reflects the composition and/or interpreted dominant volcanic facies type. Some examples of common volcanic facies associations in the Mount Read Volcanics are mafic volcanoclastic facies association, volcanogenic facies association, pumice-rich volcanoclastic facies association and quartz rhyolite facies association.

Each volcanic facies association polygon was given a unique identification number (*Poly_id*) and a volcanic facies association name (*Assoc*). The volcanic facies association name is constructed from the geographic area and the volcanic facies association (i.e. geographic location + composition + volcanic or sedimentary facies; e.g. the White Spur felsic volcanoclastic facies association). Where correlation between two or more polygons was well established the polygons share the same name, but have different identification numbers.

Location (attributes 8, 9, 10 and 11)

The location of the volcanic facies association is described in four attributes (*Geog_area*, *Map_sheet*, *Amg_e* and *Amg_n*). The geographic area (*Geog_area*) refers to a geographic feature near the centre of the volcanic facies association polygon. Typically these features include: rivers, creeks, towns, mountains, mines and mineral prospects. The *Map_sheet* refers to the name of the 1:25,000 topographic base map on which the polygon occurs. The map sheets used in this project were: Charter, Parsons, Block, Rosebery, Tullah, Dundas, Selina, Oceana, Tyndall, Professor, Gormanston, Strahan, Owen, Darwin and Engineer.

Lithostratigraphic unit (attributes 12, 13, 14, 15 and 16)

Wherever possible, the volcanic facies association polygons have been assigned to a lithostratigraphic unit (*Strat_unit*), *Group*, *Formation* and *Member* as described in Corbett (1992), White and McPhie (1996) and Gifkins (2001). The abbreviations for the lithostratigraphic names are provided in Appendix 3 and *T5 Strat codes*. An additional attribute, the *Fm_id* is also included. The *Fm_id* is a two-letter code based on the Formation, however where no Formation is assigned the Group or undifferentiated lithostratigraphic unit is used. The *Fm_id* allows us to produce a map of the stratigraphic elements of the Mount Read Volcanics as we currently understand them (Map 1). It highlights some of the areas where further work is required (see Appendix 5).

Volcanic facies (attribute 17)

The spatially related facies that comprise the volcanic facies association polygons are listed in the *facies* attribute. The facies were either recorded directly from the data source or were interpreted from descriptions of the field relationships, relic textures and mineral assemblages. Relic volcanic textures were particularly helpful in deciphering the primary volcanic facies. Porphyritic texture, spherulites, lithophysae, micropoikilitic texture, perlite, flowbanding, columnar joints and pillows were all used to characterise coherent volcanic units. Volcanic components such as pumice and scoria clasts, glass shards, accretionary lapilli and non-vesicular volcanic bombs or blocks, as well as bedding and cross stratification helped to identify volcanoclastic deposits. This enabled us to interpret coherent versus clastic volcanic facies in all but the most intensely altered rocks, such as those at Philosophers Ridge near Queenstown. The facies terminology used is based on McPhie et al. (1993). For more information of volcanic facies, their identification and interpretation the reader is referred to Cas and Wright (1987) and McPhie et al. (1993).

Volcanic facies association interpretation (attributes 18 and 19)

The attribute *Interpret* refers to the volcanic facies and volcanic facies association interpretation. Three main volcanic facies associations occur in the Mount Read Volcanics:

- lavas (lavas, lava domes and cryptodomes)
- syn-volcanic intrusions (sills and dykes), and
- resedimented syn-eruptive volcanoclastic facies associations.

The lava and syn-volcanic intrusion facies associations are dominated by coherent and autoclastic facies. Lavas may include coherent, massive, flowbanded or pillow facies, autobreccia, hyaloclastite, insitu and clast-rotated breccia, jigsaw

fit breccia, blocky monomictic breccia and peperite. Syn-volcanic intrusions may include coherent, massive, flowbanded or pillow facies, hyaloclastite, jigsaw fit breccia and peperite.

The lava and syn-volcanic intrusion facies associations are:

- lavas,
- lava domes,
- cryptodomes,
- sills,
- dykes, and
- intrusions (undifferentiated).

The resedimented syn-eruptive volcanoclastic facies can be divided into two principal categories, those dominated by non- to poorly-vesicular blocky lava clasts and related to the submarine emplacement of lavas and lava domes, and others that contain abundant vesicular pumice or scoria clasts produced by explosive eruptions.

Syn-eruptive pyroclastic facies are composed dominantly of unmodified juvenile pyroclasts and are associated with the products of both effusive and explosive volcanism. They can occur directly from eruption where clasts bypass initial deposition as primary pyroclastic deposits and are delivered directly to sedimentary transport and deposition systems or they may undergo rapid remobilisation and redeposition during or shortly after the volcanic event.

Syn-eruptive autoclastic facies comprise volcanic particles generated by insitu non-explosive fragmentation of lava or magma (autobrecciation and quench fragmentation) and include autobreccia, hyaloclastite and peperite, which are common in submarine volcanic centres.

The resedimented syn-eruptive volcanoclastic facies associations are:

- resedimented autoclastic facies,
- lava fountain breccias,
- mass-flow emplaced volcanic breccias (undifferentiated eruption style),
- mass-flow emplaced pumice breccias,
- mass-flow emplaced eruption-fed pumice breccias,
- mass-flow emplaced eruption-fed pyroclastic facies,
- water-settled pumice and shard-rich facies,
- resedimented pyroclastic facies, and
- resedimented volcanoclastic facies (undifferentiated eruption style).

In addition to the three main volcanic facies associations, there are volcanogenic and volcanosedimentary facies associations. Volcanogenic facies contain volcanic particles derived from the erosion and reworking of pre-existing volcanic deposits and may include a significant proportion of non-volcanic particles. The particles were transported and emplaced by sedimentary processes, such as mass flows and turbidity currents. In this project, volcanosedimentary facies associations refer to intercalated sedimentary and post-eruptive volcanoclastic facies, where there is a high proportion of non-volcanic sedimentary facies.

The volcanogenic and volcanosedimentary facies associations are:

- volcanoclastic turbidites,
- volcanosedimentary facies,
- mixed provenance volcanic turbidites, and
- mixed provenance turbidites.

The *Interp_id* refers to a two-letter code for the dominant volcanic facies or volcanic facies association interpretation, such that cl = lava, ci = intrusion, vc = undifferentiated volcanoclastic facies, vg = volcanogenic or volcanosedimentary facies, vp = pumice-rich volcanoclastic facies, and va = autoclastic facies (see Maps 1 and 2).

Size and shape (attributes 20, 21 and 22)

The dimensions of the volcanic facies association polygon are recorded in the *Morphology*, *Distrib* and *Thickness* attributes. The morphology is described using the parameters: sheet, dome or lens. The *Distrib* refers to the strike extent. The *Distrib* and *Thickness* are recorded in metres.

Dominant texture (attribute 23)

The *Texture* attribute refers to the dominant texture in the volcanic facies association; coherent or clastic. In the Mount Read Volcanics, clastic facies are dominated by insitu autoclastic facies (autobreccia, hyaloclastite and peperite) and resedimented syn-eruptive volcanoclastic facies (pumice breccia, polymictic volcanic breccia, monomictic volcanic breccia etcetera). Coherent facies are typically the volumetrically dominant facies of lavas and intrusions.

Dominant composition (attributes 24, 25, 26, 27, 28, 29, 30 and 31)

The composition of the volcanic facies association was determined using a combination of original composition descriptions, relic primary mineralogy and where available whole-rock geochemical data.

Typically major element data (i.e. SiO_2 , Na_2O and K_2O) is used to classify fresh, modern volcanic rocks. However, these major elements are commonly mobile during alteration (MacLean and Krandidiotis, 1987; Rollinson, 1993). Thus compositional classification of ancient volcanic rocks relies on the comparison of their immobile element concentrations with those of modern examples from known tectonic settings (e.g. Pearce and Cann, 1973; Winchester and Floyd, 1977; Rollinson, 1993; Barrett and MacLean, 1997). Elements that are generally considered to be immobile during greenschist facies metamorphism and hydrothermal alteration associated with VHMS mineralisation are the high field strength (i.e. Ti, Zr, Hf, Y, Nb, Ta, Th, U) and rare-earth elements (Winchester and Floyd, 1977; Barrett and MacLean, 1994).

In the Mount Read Volcanics, TiO_2 , Al_2O_3 , P_2O_5 , Zr, Nb, V, Sc and Y have been proven to have been immobile, showing no evidence of fractionation relative to each other during emplacement or alteration (McNeill and Corbett, 1989; Gifkins, 2001). Thus the fractionation-dependent compatible-incompatible immobile ratio, Ti/Zr, is commonly used to estimate the primary magmatic composition. This ratio is dependent on the initial Ti/Zr ratio in the source (i.e. protolith) and the degree of fractionation. Gifkins (2001) calculated ranges in Ti/Zr for rhyolitic, dacitic, andesitic and basaltic compositions in the Mount Read Volcanics by comparing the SiO_2 and Ti/Zr values of least-altered samples from the northern Central Volcanic Complex with values from unaltered modern volcanic rocks. In this project, rock compositions were classified on the basis of their relic primary mineralogy and Ti/Zr values as in Table 1.

Table 1: Summary of the common volcanic rock compositions, their chemical classification (SiO_2 content and Ti/Zr) and likely phenocryst mineralogy (modified after Gifkins et al., in prep).

Rock composition	SiO_2 (wt%)	Ti/Zr	Main phenocryst minerals	Other common phenocryst minerals
Rhyolite	>69	4-10	K-feldspar (orthoclase)	± quartz ± plagioclase ± biotite ± muscovite ± amphibole ± pyroxene ± fayalite
Dacite	63-69	10-20	Na-plagioclase	± quartz ± biotite ± amphibole ± pyroxene
Andesite	52-63	20-60	Na- or Ca-plagioclase + biotite or amphibole or pyroxene	± quartz ± k-feldspar ± olivine
Basalt	<52	60-157	Ca-plagioclase + pyroxene	± olivine ± hornblende

Ti/Zr are for different compositions in the Mount Read Volcanics (from Large et al., 1986; Gifkins, 2001), including altered and least-altered samples. SiO_2 contents for unaltered modern subduction-related volcanic rocks are from Ewart (1979 and 1982) and are comparable to SiO_2 contents of least-altered volcanic rocks in the northern Central Volcanic Complex.

The compositional data was recorded in 11 attributes:

- *Main_comp* is the dominant composition (rhyolite, dacite, andesite, basaltic andesite or basalt)
- *Other_comp* other minor compositions
- *Comp_id* is a three-letter code for the dominant composition (rhy, dac, and, ban or bas)
- *Mineralogy* is a two-letter code for the relic primary phenocrysts or crystals, listed in order of decreasing abundance (FS, QZ, PX, HB etc.). The mineral codes are listed in Appendix 4.
- *Min_id* is a two-letter mineral code for the defining mineral. Facies that contain ONLY feldspar (FS) are differentiated from those that contain quartz ± feldspar ± pyroxene ± biotite ± hornblende (QZ) and those that contain significant pyroxene (PX) or hornblende (HB).

- *Ti/zr* is the Ti/Zr range for facies in the volcanic facies association
- *Chem_id* is based on the Ti/Zr ratio (fr, fd, in or ma, see Appendix 1)
- *Total_comp* is a combination of the *Min_id* and *Comp_id* (e.g. feldspar-phyric rhyolite = FS + R = FSR)
- *Mag_suite* refers to the magmatic affinity: calc alkaline, transitional, shoshonitic or tholeiitic
- *Mrv_suite* is the magmatic suite (1 to 5) as defined by Crawford et al. (1992)
- *Comp+suite* is a combination of the *Total_comp* and *Mrv_suite* (e.g. suit IV pyroxene-phyric basalt = 4 + PX + B = 4PXB).

The relative percentages of the different compositions of volcanic facies association polygons in the Mount Read Volcanics are: rhyolite 49.3%, dacite 36.3%, andesite 9.5%, basaltic andesite 0.5%, and basalt 4.4%.

Magmatic affinity (attribute 32)

The magmatic affinity of a facies or volcanic facies association was either recorded directly from the references or was determined from the whole-rock geochemical data. Calc-alkaline affinities are defined by a progressive decrease in $\text{FeO}_{\text{total}}$ and TiO_2 with increasing fractionation (increasing SiO_2 and decreasing MgO), whereas tholeiitic suites show increases in $\text{FeO}_{\text{total}}$ and TiO_2 at the mafic end of the spectrum (e.g. Irvine and Baragar, 1971). Tholeiitic and calc-alkaline associations can also be distinguished using the incompatible element pair Zr-Y (Leshner et al., 1986; MacLean and Barrett, 1993). On a Zr-Y scatter plot, samples from different parental magmas plot as separate linear fractionation trends that regress to the origin. MacLean and Barrett (1993) assigned samples with $\text{Zr/Y} < 5$ as tholeiitic, $\text{Zr/Y} = 7\text{-}30$ as calc-alkaline, and values between 5-7 as transitional. The higher Zr/Y of calc-alkaline magmas is interpreted to reflect the compatible behaviour of Y in calc-alkaline magmas and decreasing Y concentration in the magma during fractionation of hornblende (Pearce, 1982).

Mount Read Volcanics suite (attributes 33 and 34)

The tectono-magmatic evolution of the Mount Read Volcanics was examined on a regional scale by Crawford et al. (1992) using whole-rock geochemical data, and REE. Crawford et al. (1992) defined three calc-alkaline and two tholeiitic compositional suites.

Suite I is a transitional and medium to high-K calc-alkaline suite which includes rhyolites and dacites of the Eastern quartz-phyric sequence, Central Volcanic Complex, Tyndall Group, quartz-phyric intrusions, Cambrian granites, and andesites of the Que-Hellyer footwall (Mount Charter Group).

Suite II comprises dacites and andesites of high-K calc-alkaline affinity.

Suite III includes calc-alkaline to shoshonitic andesites and basalts from the Que-Hellyer hangingwall, Lynch Creek and Howard's Plain (Yolande River sequence).

Suite IV comprises tholeiitic andesites and basalts from the Henty Fault Wedge and basaltic dykes of the Henty Dyke Swarm.

Suite V comprises the tholeiitic Miners Creek Basalt.

Eruption style (attribute 35)

The style of volcanic eruption of the volcanic facies was determined from the relic volcanic textures and volcanic facies interpretations. Eruptions were explosive, effusive or intrusive. Many of the volcanic facies associations in the Mount Read Volcanics contain evidence of more than one eruption style. For example, the Red Hills felsic volcanoclastic facies association contains pumice breccia, pumiceous sandstone, crystal-rich sandstone, coherent QZ rhyolite and rhyolite-sediment breccia (peperite). These are interpreted as mass-flow emplaced pyroclastic and autoclastic facies, and sills. Thus the Red Hills felsic volcanoclastic facies association contains facies that resulted from explosive and effusive eruptions, and intrusions.

Explosive eruptions produce abundant finely fragmented particles, including vesicular pumice or scoria clasts, crystals and crystal fragments, and dense lithic clasts. It is important to note that deposits of pumice clasts can be generated by large volume explosive eruptions, explosive eruptions associated with pumiceous lava domes, and also by effusive eruptions and intrusions of highly vesicular magma (Gifkins et al., 2002). There are examples of pumice-rich facies produced by quench fragmentation of highly vesicular lava domes and intrusions in the Central Volcanic Complex.

Effusive eruptions typically produce coherent massive or flowbanded facies, insitu jigsaw fit monomictic breccias (hyaloclastite), clast-rotated monomictic breccias (hyaloclastite and autobreccia), and coherent-sediment breccia (peperite).

Intrusions are dominated by massive coherent facies, however intrusions into wet unconsolidated sediment may produce insitu jigsaw fit breccia (hyaloclastite) and peperite.

Volcano type (attribute 36)

The type of volcano, volcanic centre or volcanic complex that is interpreted to have produced each volcanic facies associations is recorded by the *Volc_type* attribute. Submarine volcanic centre types in the Mount Read Volcanics include: intrusive complex, caldera, cone, cryptodome complex, lava and dome complex, lava and intrusion complex, pumiceous dome complex, sill complex, sill-sediment complex, and spatter-like cone. In addition, shallow submarine or subareial basin margin and extrabasinal volcanic centres contributed to some volcanic facies associations (e.g. the Upper Tyndall extrabasinal volcanic centre, Lower Tyndall volcanic centre and the White Spur extrabasinal volcanic centre).

Volcanic centres (attributes 37 and 38)

Volcanic centres were located based on the presence of distinctive, genetically-related, vent-proximal volcanic facies associations. The proximal facies association of different volcanic centres vary considerably in volume, composition, porosity and permeability.

Vent-proximal facies associations are typically lavas, sills and thick syn-eruptive volcanoclastic facies, such as eruption-fed pumice breccia and resedimented hyaloclastite. However, it is important to note that although felsic lavas and sills generally do not extend far from the vent (<5 km), basaltic lavas and sills may be more laterally extensive (>10 km).

The volcanic centres are recorded as two attributes (*Centrename* and *Centre_id*) in the volcanic facies association attributes table (*T1 vfa.xls*) and are described in the volcanic centres attributes table (*T3 vc.xls*). Rows in *T3 vc attributes* refer to each volcanic centre by their identification number (*Centre_id*), centre name (*Centrename*), location (*Geog_area*, *Map_sheet*, *Amg_e* and *Amg_n*) and lithostratigraphic unit (*Strat_unit*, *Group*, *Formation* and *Member*). For each centre associated polygons (*Inclد_poly*), the volcanic facies associations (*Assoc*), volcanic and sedimentary facies (*Facies*) and their interpretations (*Interpret*) are recorded. The dominant texture (*Texture*) and compositions (*Main_comp*, *Other_comp*, *Mineralogy*, *Ti/zr*, *Total_comp*, *Mag_suite*, *Mrv_suite*, *Comp+suite*) are listed. Finally the eruption styles (*Eruption*), volcanic centre type (*Volc_type*), proximity of related volcanic facies associations (*Proximity*), their timing (*Timing*), relationship to ore deposits (*Relmindep*) and references (*Ref_no*) are recorded.

Table 2: Volcanic centres in the Mount Read Volcanics.

Volcanic centre name	Centre_id
Anthony Road andesite lava and sill complex	1
Basin Lake felsic dome complex	2
Comstock andesite lava complex	3
Crown Hill andesite lava complex	4
Darwin felsic lava and sill complex	5
Darwin mafic lava and sill complex	6
East Queen River andesite lava complex	7
Garfield andesite intrusion	8
Garfield felsic volcanic complex	9
Hellyer andesite lava and dome complex	10
Hellyer basalt sill complex	11
Henty basalt volcanic centre	12
west Henty mafic lava and sill complex	13
Hollway andesite lava complex	14
Howard's basalt volcanic centre	15
Howard's Plain mafic lava complex	16
Jukes felsic lava and dome complex	17
Lynch Creek lava complex	18
Mount Black felsic lava and dome complex	19
Mount Block felsic lava and dome complex	20
Mount Julia rhyolite lava complex	21

Murchison rhyolite sill complex	22
Newton Creek dacite dome complex	23
Newton Spillway basalt volcanic centre	24
Philosophers Ridge rhyolite lava and dome complex	25
Pinnacles rhyolite lava complex	26
Red Hills felsic lava and sill complex	27
Reservoir mafic lava and sill complex	28
Rosebery felsic volcanic centre	29
Sedgwick dacite volcanic centre	30
Sock Creek rhyolite lava and dome complex	31
Sterling Valley mafic volcanic centre	32
Upper Tyndall extrabasinal volcanic centre	33
Lower Tyndall volcanic centre	34
White Spur extrabasinal volcanic centre	35
unknown	0

Proximity to vent (attributes 39 and 40)

The proximity to the source or vent (*Proximity*) is a subjective assessment of the relative distance that a facies or volcanic facies association is from the point of eruption. Volcanic environments are typically divided into vent-proximal, vent-medial and distal environments. Note that although syn-eruptive pyroclastic facies are common in proximal submarine environments they can be extensive and are also common in medial environments.

In submarine settings, vent-proximal environments:

- are dominated by primary volcanic facies associations (e.g. lavas and syn-volcanic intrusions, which contain coherent and volcanoclastic facies) and syn-eruptive or eruption-fed volcanoclastic facies;
- contain volcanoclastic facies that lack evidence of reworking;
- are spatially associated with compositionally-related volcanic facies associations; and
- contain little or no intercalated non-volcanic sedimentary facies, as the rapid accumulation of volcanic deposits in the vent-proximal environment swamps any background sedimentation.

In comparison, vent-medial environments:

- are typically dominated by resedimented volcanoclastic facies (syn- or post-eruptive but mainly pyroclastic);
- can contain moderate volumes of intercalated sedimentary facies that are either non-volcanic in origin or are derived from other volcanic centres; and
- are unlikely to include coherent facies that are compositionally related to the resedimented volcanoclastic facies.

Distal environments:

- are dominated by syn-eruptive pyroclastic facies associations;
- include substantial thickness of sedimentary facies. These may include volcanogenic sedimentary facies, which contain volcanic particles derived from the erosion and reworking of pre-existing volcanic deposits.

Proximity is recorded as two attributes *Proximity* and the abbreviated *Prox_id*, where P = proximal, PM = proximal to medial or vice versa, M = medial, MD = medial to distal or vice versa, and D = distal.

Relative timing (attribute 41)

The *Timing* attribute refers to the timing of emplacement of the facies relative to other volcanic facies associations, volcanic centres and lithostratigraphic units, Groups, Formations or Members in the Mount Read Volcanics.

Relationship to ore deposit (attribute 42)

The relationship between the volcanic facies association and nearby ore deposits is considered in the *Relmindep* attribute. Does the volcanic facies association host an ore deposit? Is it stratigraphically equivalent to the host position? Is it part of the footwall or the hangingwall?

Degree of confidence (attribute 43)

The degree of confidence in the map varies depending on amount and quality of the available data. In areas where detailed volcanology studies have been undertaken, usually where there is abundant outcrop and/or drill core (e.g. the

Rosebery-Hercules, Que-Hellyer and Anthony Rd areas), the degree of confidence is relatively high. The degree of confidence is low in areas that have not been the focus of intensive research theses, mapping projects or exploration (e.g. the Darwin, Yolande River, north Mount Murchison areas). The degree of confidence is also low in areas where intense alteration and/or deformation obscure primary volcanic textures and mineralogies (e.g. the Mount Lyell area). The *Rel* attribute is a subjective assessment of the accuracy of the delineation and description of the volcanic facies association polygon. It is expressed as an alphabetical code:

- L = low reliability
- M = moderate reliability
- H = high reliability.

The degree of confidence is depicted in Figure 1.

ArcView representation of the map and map themes

The ArcView project map (*mr_vfa.apr*) presents the volcanic facies association polygons and volcanic centre locations. The volcanic centre facies associations are presented as 8 themes or attributes, which are coloured or patterned. These attributes include the stratigraphic unit or Formation (*Fm_id*), volcanic facies association interpretation (*Interp_id*), the volcanic centre from which they are sourced (*Centre_id*), the defining mineral (*Min_id*), dominant composition (*Comp_id*), mineralogy and composition (*Total_comp*), the proximity to the vent (*Prox_id*) and the degree of confidence (*Rel*). In addition, the alteration facies polygons from Herrmann and Kimber (2003) and the volcanic centre locations are displayed. The themes allow the user to view the map of the Mount Read Volcanics from a number of unusual and new aspects.

A combination of the *Fm_id* and *Interp_id* (Map 1) provides a good impression of the proportions of clastic to coherent facies in each of the lithostratigraphic units and throughout the Mount Read Volcanics. The Mount Read Volcanics is dominated by lavas (47%) and intrusions (7%) and includes approximately 19% volcanogenic facies, 13% undifferentiated volcanoclastic facies, 12% pumice-rich volcanoclastic facies and 2% autoclastic facies. The *Fm_id* also suggests some possible correlations, which require further work (see Appendix 5).

The *Total_comp* and *Interp_id* (Map 2) presents the distribution of the different compositions of volcanic facies associations throughout the Mount Read Volcanics and also indicates the proportions of lava- to intrusion- and volcanoclastic- dominated volcanic facies associations.

A combination of the *Centre_id* and *Prox_id* (Map 3) gives an indication for each volcanic centre of the extent of facies derived from that centre and changes in proximity. For example, the volcanic facies associations related to the Rosebery felsic volcanic centre are most proximal in the northern Central Volcanic Complex near Rosebery and Hercules. This area has been interpreted to be a caldera-style vent for the pumice-rich volcanoclastic facies of the Hercules Formation (Gifkins, 2001). North of Mount Block, at Henty and south of Queenstown the volcanic facies associations related to the Rosebery felsic volcanic centre are more medial. Lateral variations can also be seen in the Lower and Upper Tyndall volcanic centres.

Maps of *Min_id* (Map 4) and *Total_comp* are also interesting because they show that there are very few rocks (except the Central Volcanic Complex and the CV-type dacites, such as the Newton Creek dacite) that do not contain quartz. It appears that all rocks younger than the Central Volcanic Complex (except the CV-type dacite lavas and intrusions) have at least trace amounts of quartz. This includes the Anthony Road andesite and the Hellyer footwall andesites and basalts.

Acknowledgements

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FIGURE 1:
DEGREE OF CONFIDENCE
IN THE
VOLCANIC FACIES ASSOCIATIONS

MOUNT READ VOLCANICS
HELLYER-DARWIN
WESTERN TASMANIA

C. GIFKINS & B. KIMBER

CENTRE FOR ORE DEPOSIT RESEARCH
UNIVERSITY OF TASMANIA

JULY 2003

LEGEND

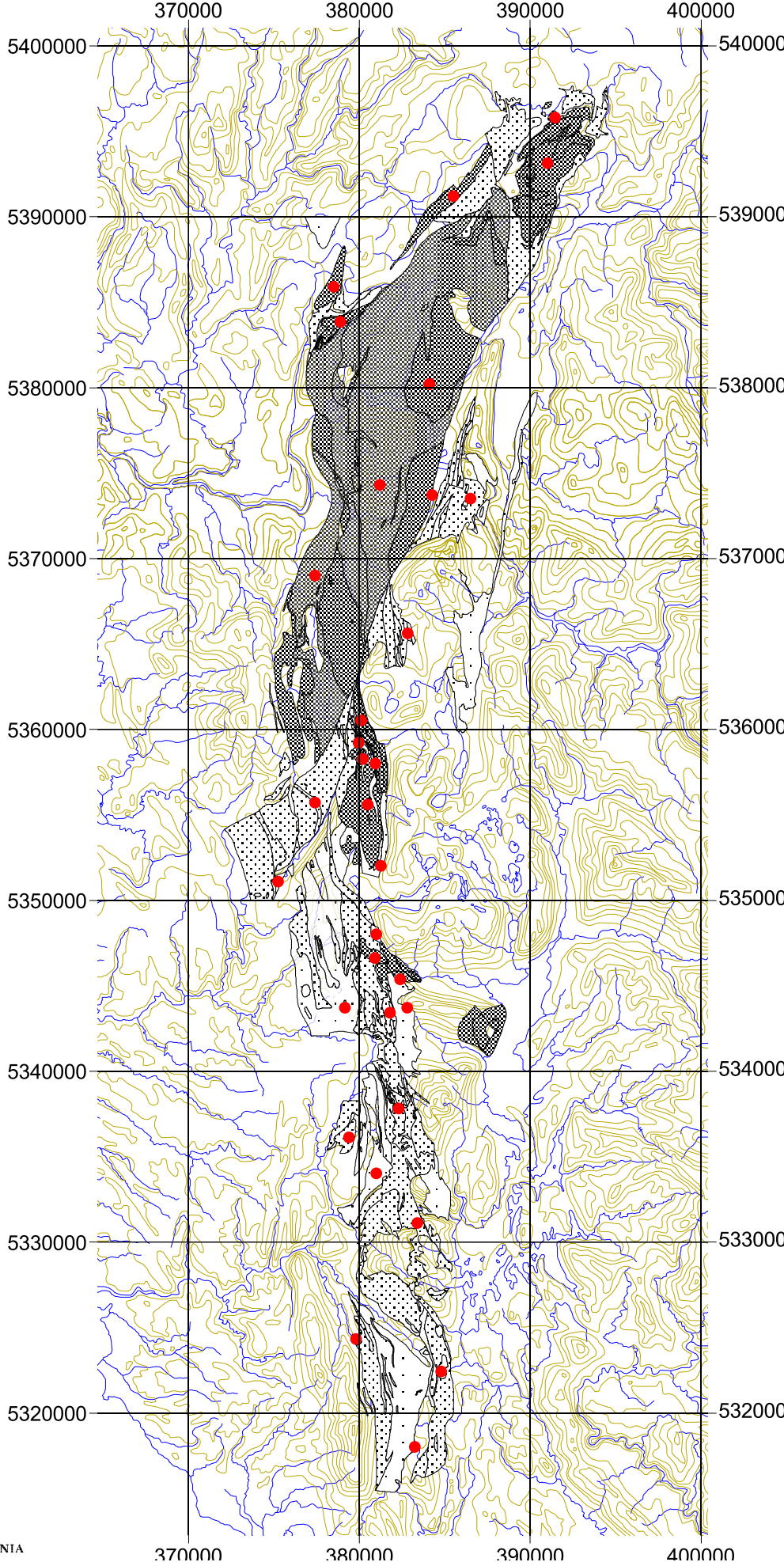
● Approximate volcanic centre location

Degree of confidence

□ Low
▤ Moderate
▨ High

— Streams (250,000 base)

— Topographic contours (250,000 base)



UNIVERSITY OF TASMANIA

370000

380000

390000

400000

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Appendix 1: Explanatory table of the volcanic facies associations attributes

No.	Attribute name	Attribute explanation
1	Shape	ArcInfo-derived attribute, i.e. polygon
2	Area	Area in square metres as calculated by ArcInfo
3	Perimeter	Perimeter in metres as calculated by ArcInfo
4	Arcinfo_a	Extraneous ArcInfo-assigned number
5	Arcinfo_b	Extraneous ArcInfo-assigned number
6	Poly_id	Number that identifies each volcanic facies association polygon on the map
7	Assoc	Interpretative name for the volcanic facies association, based on geographic area, dominant composition and facies interpretation
8	Geog_area	Name of the geographic area, based on nearby river, spur, mountain, mine, prospect etc.
9	Map_sheet	Name of the 1:25,000 scale map sheet on which the volcanic facies association is located
10	Amg_e	AMG easting of approximate centre of the volcanic facies association
11	Amg_n	AMG northing of approximate centre of the volcanic facies association
12	Strat_unit	A two-letter code for the lithostratigraphic unit as described in Corbett (1992) WO = Western volcanosedimentary sequence CV = Central VolcanicComplex ES = Eastern quartz-phyric sequence TY = Tyndall Group AA = andesites and basalts
13	Group	A two-letter code for the Group. Codes are listed in Appendix 3 and file <i>T5 Strat codes</i>
14	Formation	A two-letter code for the Formation. Codes are listed in Appendix 3 and file <i>T5 Strat codes</i>
15	Member	A two-letter code for the Member. Codes are listed in Appendix 3 and file <i>T5 Strat codes</i>
16	Fm_id	A two-letter code for the Formation, correlated Formation, or where Formation is not assigned the Group or unit. Codes are listed in Appendix 3 and file <i>T5 Strat codes</i>
17	Facies	A list of the spatially, mineralogically, compositionally or texturally related volcanic and sedimentary facies that are included in the volcanic facies association
18	Interpret	Interpretation of the volcanic facies association (e.g. lava dome, intrusion, volcanoclastic turbidites, mass-flow emplaced eruption-fed pumice breccia etc.)
19	Interp_id	A two-letter code for the volcanic facies association interpretation ci = intrusion dominated cl = lava dominated va = autoclastic facies vc = undifferentiated volcanoclastic facies vg = volcanogenic facies vp = pumice-rich volcanoclastic facies
20	Morphology	An indication of the three dimensional shape of the volcanic facies association lens dome sheet
21	Distrib	The strike extent of the volcanic facies association in metres
22	Thickness	The thickness of the volcanic facies association in metres
23	Texture	The dominant texture in the volcanic facies association. coherent clastic
24	Main_comp	The dominant composition of facies within the volcanic facies association rhyolite dacite andesite basaltic andesite basalt
25	Other_comp	Minor compositions within the volcanic facies association rhyolite dacite andesite basaltic andesite basalt
26	Comp_id	A three-letter code for the dominant composition rhy = rhyolite dac = dacite and = andesite

		ban = basaltic andesite bas = basalt
27	Mineralogy	Mineralogy of relic phenocrysts, microphenocrysts, crystals or crystal fragments. See file T6 Min codes for the two-letter mineral codes used. Minerals are generally listed in order of decreasing abundance. Minerals after the '±' sign either occur in trace amounts or references to their occurrence are inconsistent.
28	Min_id	The two-letter mineral identification code FS = feldspar only-bearing facies HB = hornblende ± pyroxene-bearing facies PX = pyroxene ± hornblende-bearing facies QZ = quartz-bearing facies (independent of FS, HB or PX contents)
29	Ti/zr	Range of the Ti/Zr ratio.
30	Chem_id	A two-letter code for the composition as interpreted from the Ti/Zr ratios fr = rhyolite, Ti/Zr = 4 to 10 fd = dacite, Ti/Zr = 10 to 20 in = andesite, Ti/Zr = 20 to 60 ma = basalt, Ti/Zr > 60
31	Total_comp	A three-letter code for the mineralogy and composition (Min_id + Comp_id) FSR = feldspar-bearing rhyolite FSD = feldspar-bearing dacite FSA = feldspar-bearing andesite FSB = feldspar-bearing basalt HBR = hornblende-bearing rhyolite HBD = hornblende-bearing dacite HBA = hornblende-bearing andesite PXD = pyroxene-bearing dacite PXA = pyroxene-bearing andesite PXB = pyroxene-bearing basalt QZR = quartz-bearing rhyolite QZD = quartz-bearing dacite QZA = quartz-bearing andesite
32	Mag_suite	Magmatic affinity as determined from the whole-rock geochemical data calc alkaline peralkaline transitional tholeiitic shoshonitic
33	Mrv_suite	The compositional suite as defined by Crawford et al. (1992) and interpreted from the whole-rock geochemical data 1 = transitional and medium to high-K calc-alkaline rhyolite to andesites 2 = high-K calc-alkalinedacites and andesites 3 = calc-alkaline to shoshonitic andesites and basalts 4 = tholeiitic andesites and basalts
34	Comp+suite	This four-digit code is a compilation of all the geochemical attributes (Mrv_suite + Total_comp) 1FSA = suite 1 feldspar-bearing andesite 1FSB = suite 1 feldspar-bearing basalt 1FSD = suite 1 feldspar-bearing dacite 1FSR = suite 1 feldspar-bearing rhyolite 1HBD = suite 1 hornblende-bearing dacite 1HBR = suite 1 hornblende-bearing rhyolite 1PXA = suite 1 pyroxene-bearing andesite 1PXB = suite 1 pyroxene-bearing basalt 1PXD = suite 1 pyroxene-bearing dacite 1QZA = suite 1 quartz-bearing andesite 1QZD = suite 1 quartz-bearing dacite 1QZR = suite 1 quartz-bearing rhyolite 2HBA = suite 2 hornblende-bearing andesite 2PXA = suite 2 pyroxene-bearing andesite 2PXB = suite 2 pyroxene-bearing basalt 3FSA = suite 3 feldspar-bearing andesite 3FSB = suite 3 feldspar-bearing basalt 3PXA = suite 3 pyroxene-bearing andesite

		3PXB = suite 3 pyroxene-bearing basalt 4FSB = suite 4 feldspar-bearing basalt 4PXB = suite 4 pyroxene-bearing basalt
35	Eruption	The dominant eruption style represented by the facies in the volcanic facies association explosive effusive intrusive weakly explosive intrusive into wet unconsolidated sediment explosive or effusive pumiceous lava domes explosive and effusive effusive and intrusive
36	Volc_type	Interpretation of the type of source volcano or volcanic complex intrusion intrusive complex submarine caldera submarine cone submarine cryptodome complex submarine dome complex submarine lava submarine lava and dome complex submarine lava and intrusion complex submarine lava complex submarine lava or intrusion submarine pumiceous dome complex submarine sill complex submarine sill-sediment complex submarine spatter-like cone shallow submarine or subaerial caldera shallow submarine or subaerial volcano
37	Centrename	Volcanic centre name, based on geographic area or genetically related volcanic facies associations and the volcano or volcanic complex type
38	Centre_id	A unique number assigned to a volcanic centre on the map 1 Anthony Road andesite lava and sill complex 2 Basin Lake felsic dome complex 3 Comstock andesite lava complex 4 Crown Hill andesite lava complex 5 Darwin felsic lava and sill complex 6 Darwin mafic lava and sill complex 7 East Queen River andesite lava complex 8 Garfield andesite intrusion 9 Garfield felsic volcanic complex 10 Hellyer andesite lava and dome complex 11 Hellyer basalt sill complex 12 Henty basalt volcanic centre 13 west Henty mafic lava and sill complex 14 Hollway andesite lava complex 15 Howard's basalt volcanic centre 16 Howard's Plain mafic lava complex 17 Jukes felsic lava and dome complex 18 Lynch Creek lava complex 19 Mount Black felsic lava and dome complex 20 Mount Block felsic lava and dome complex 21 Mount Julia rhyolite lava complex 22 Murchison rhyolite sill complex 23 Newton Creek dacite dome complex 24 Newton Spillway basalt volcanic centre 25 Philosophers Ridge rhyolite lava and dome complex 26 Pinnacles rhyolite lava complex 27 Red Hills felsic lava and sill complex 28 Reservoir mafic lava and sill complex 29 Rosebery felsic volcanic centre

		30 Sedgwick dacite volcanic centre
		31 Sock Creek rhyolite lava and dome complex
		32 Sterling Valley mafic volcanic centre
		33 Upper Tyndall extrabasinal volcanic centre
		34 Lower Tyndall volcanic centre
		35 White Spur extrabasinal volcanic centre
		0 unknown or mixed provenance
39	Proximity	The proximity of the volcanic facies association to the vent or source distal distal to medial medial medial to distal medial to proximal proximal proximal to medial
40	Prox_id	One or two-letter code for the proximity to vent. P = proximal PM = proximal to medial or medial to proximal M = medial MD = medial to distal or distal to medial D = distal
41	Timing	The timing of emplacement of the facies in the volcanic facies association relative to the lithostratigraphy, other volcanic facies associations and volcanic centres (i.e. caldera forming, equivalent to, intruded by, early, late, post-, pre- or syn-).
42	Relmindep	The spatial relationship between the volcanic facies association and ore deposits or prospects FW to HOST to equivalent stratigraphic position of HOST to HW to thrust into HW unknown relationship to none
43	Rel	A subjective estimate of the reliability of the delineation and description of the volcanic facies association polygon, expressed as an alphabetical code L = low reliability M = moderate reliability H = high reliability
44	Ref_no	Number or numbers that indicate the source of data for the volcanic facies association and its delineation. Each number refers to a single reference in the reference list (file <i>T7 Ref_no</i>).
45	Comments	Additional descriptive data, references etc.

Appendix 2: Description of computer files related to GIS map of volcanic facies associations and volcanic centres

File name	Folder	Description
mrsv_vfa.apr	vfa_map	ArcView project file that displays a view of the volcanic facies associations and volcanic centres. The polygons are classified according to the attributes: stratigraphic Formation (<i>Fm_id</i>), volcanic facies association interpretation (<i>Interp_id</i>), dominant composition (<i>Comp_id</i>), mineralogy (<i>Min_id</i>), mineralogy and composition (<i>Total_comp</i>), the volcanic centre to which they are related (<i>Centre_id</i>), proximity to vent (<i>Prox_id</i>) and the degree of confidence in the data (<i>Rel</i>). In addition, the topographic contours and streams are shown (1:250,000 base).
.avl	legends	ArcView legends used to classify and display volcanic facies association attributes.
mrsv_vfa.shp	vfa_map	ArcView shape files that delineate and describe volcanic facies associations in the Mount Read Volcanics.
mrsv_vfa.dbf		
mrsv_vfa.sbn		
mrsv_vfa.sbx		
mrsv_vfa.shx		
mrsv_vfa.e00	Info_file	File that can be imported directly into ArcInfo to obtain access to the ArcInfo files used in construction of the volcanic facies associations polygons. This facilitates export of GIS data into other spatial information software, such as MapInfo.
vc attributes.csv	vfa_map	Microsoft Excel™ version of the volcanic centre attributes table.
vfa attributes.csv	vfa_map	Microsoft Excel™ version of the volcanic facies association polygon attributes table.
T1 vfa.xls	vfa_attributes	Microsoft Excel™ version of the volcanic facies association polygon attributes table.
T2 attributes.xls	vfa_attributes	Microsoft Excel™ file of the possible attributes for each column in the volcanic facies association attributes table (T1 vfa attributes).
T3 vc.xls	vfa_attributes	Microsoft Excel™ version of the volcanic centre attributes table.
T4 attributes.xls	vfa_attributes	Microsoft Excel™ file of the possible attributes for each column in the volcanic centres attributes table (T3 vc attributes).
T5 Strat codes.xls	vfa_attributes	Microsoft Excel™ file of the two-letter codes for the stratigraphic names used in the Mount Read Volcanics.
T6 Min codes.xls	vfa_attributes	Microsoft Excel™ file for the two-letter mineral codes.
T7 Ref_no.xls	vfa_attributes	Microsoft Excel™ file of the references and their Ref_no.
Read me vfa		Pdf file of the explanatory notes. This describes the project background, data sources, method of data compilation and interpretation, and the format of the GIS map.

NB: The GIS related files were created in ArcInfo v. 8.2 and Arcview v.3.2a software.

Appendix 3: Lithostratigraphic unit codes

Units	Groups	Formations	Members	Abbrev.
Central Volcanic Complex				CV
		Sterling Valley Formation		SY
		Mount Black Formation		BK
		Hercules Pumice Formation		HP
			<i>Host-rock member</i>	<i>RK</i>
			<i>Footwall member</i>	<i>FW</i>
Western Volcanosedimentary Sequence				WO
	Dundas Group			DG
		White Spur Formation		WT
	Mount Charter Group			MH
			<i>Black Harry Beds</i>	<i>BY</i>
			<i>Animal Creek Greywacke</i>	<i>AG</i>
		Que-Hellyer Volcanics		QH
			<i>Lower basalt</i>	<i>LT</i>
			<i>Lower andesites and basalts</i>	<i>LN</i>
			<i>Mixed sequence</i>	<i>MX</i>
			<i>Hellyer basalt</i>	<i>HB</i>
			<i>Que River Shale</i>	<i>QR</i>
		Southwell Subgroup		SO
		Mount Cripps Subgroup		CR
	Henty Fault Wedge sequence			HE
			<i>Ewart Creek Track sequence</i>	<i>EC</i>
			<i>Henty Valley sequence</i>	<i>HV</i>
	Yolande River sequence			YR
Eastern Quartz-Phyric Sequence				ES
	Murchison Volcanics			MJ
	Farrell slates			FA
Tyndall Group				TY
		Comstock Formation		CZ
			<i>Mount Julia member</i>	<i>JL</i>
			<i>Lynchford Member</i>	<i>LY</i>
		Zig Zag Hill Formation		ZZ
	Mount Cripps Subgroup			MC
Andesites and basalts				AA
	Anthony Road Andesite			AR
	Crown Hill Andesite			CH
	Curtin Davis volcanics			CD
	Henty Dyke Suite			HY
	Hollway Andesite			HN
	Howard's Plain basalt			HI
	Lynch Creek basalt			LC
	Lynchford basalt			LS
	Miners Ridge basalt			MI
	Sock Creek basalt			SX
	Spillway basalt			SQ
Cambrian granite				CG
	Darwin granite			DW
	Murchison granite			MU

Appendix 4: Mineral abbreviation codes

Mineral	Code	Mineral	Code
actinolite	AC	kaolinite	KA
albite	AB	K-feldspar	KS
alunite	AL	limonite	LM
amphibole	AM	magnetite	MT
ankerite	AK	mica	MI
arsenopyrite	AS	montmorillonite	MM
augite	AT	muscovite	MS
barite	BA	olivine	OL
biotite	BI	paragonite	PG
bornite	BN	plagioclase	PL
calcite	CA	pyrite	PY
carbonate	CB	pyrophyllite	PR
cassiterite	CS	pyroxene	PX
chalcopyrite	CP	pyrrhotite	PO
chlorite	CH	quartz	QZ
clay	CL	rhodochrosite	RD
clinopyroxene	CX	sericite	SE
corundum	CO	siderite	SD
dickite	DK	smectite	SM
dolomite	DO	sphalerite	SP
epidote	EP	sulfide	SF
feldspar	FS	talc	TC
flourite	FL	tetrahedrite	TE
fuchsite	FU	topaz	TO
galena	GN	tourmaline	TM
garnet	GR	tremolite	TR
geothite	GT	unknown	U
hematite	HM	white mica	WM
hornblende	HB	wolframite	WF
illite	IL	wollastinite	WO
ilmenite	IM	zeolite	ZE
jasper	JA		

Appendix 5: Geological problems in the Mount Read Volcanics

During the course of this project I have identified a number of areas where our understanding of the geology of the Mount Read Volcanics could be improved. In particular, areas that may hold the key to important stratigraphic problems, areas where the volcanic facies are insufficiently described or delineated, and areas where the current geological interpretation either does not hold up or is inconsistent with other parts of the Mount Read Volcanics geology. Greg Ebsworth and I have constructed a brief list (in no particular order) of some of the areas and topics that we believe need further research. Where possible these areas have been shown on Figure 2.

- (1) The relationship between the Darwin Granite, the Eastern quartz-phyric sequence and the Tyndall Group at the northern end of the Darwin Granite. The relationship between these units has been critical to the interpretation of the timing of emplacement of the granite and in defining the Tyndall Group from the Eastern quartz-phyric sequence (Corbett, 1992 and Corbett, 2002). However, there are a number of unresolved issues:
 - What is the basal conglomerate directly overlying the granite?
 - Which Formation or Member of the Tyndall Group does the granite clasts-bearing unit, which overlies the granite and the basal conglomerate, belong to?
 - How is this unit different from the Eastern quartz-phyric unit that is intruded by the granite?
- (2) The nature of the contact and timing between the Murchison Granite and the Owen, and the relationship between the Murchison Granite and the quartz-phyric rhyolites of the Murchison Volcanics (Eastern quartz-phyric sequence).
 - The granite is interpreted to be younger than the Owen and to intrude the Murchison Volcanics, however the interpretation of two of the granite-Owen contacts is questioned. Does the granite actually intrude the Owen?
 - The granite and rhyolite intrusions of the Murchison Volcanics are spatially associated and have mineralogical similarities, which suggest that they may be genetically related (Giffkins et al., 1996; Stolz et al., 1996).
 - There is little evidence for extrusive facies of the Murchison Volcanics. Is the Murchison Volcanics an intrusive complex?
- (3) Detailed facies analysis and stratigraphy of the Tyndall Group correlates in the western part of the White Spur Formation in the Howard's Road area is needed. The relationship between the Tyndall Group and the White Spur Formation is critical because the White Spur Formation helps to constrain the timing of mineralisation in the northern Mount Read Volcanics (i.e. the Rosebery and Hercules ore deposits). If the relationship between these two lithostratigraphic units can be established it may help to constrain timing of mineralisation in the south.
- (4) What is the relationship between the Yolande River sequence and the Central Volcanic Complex in the southern Mount Read Volcanics? Between south Henty and Darwin the Yolande River sequence is mapped in the core of an anticline. To the west it is overlain by Tyndall Group (well constrained by the work of Selley and Meffre, 1997) and to the east by the Central Volcanic Complex. Either the structure or stratigraphy of this area is more complicated or both. Is this really a conformable sequence? Does the Yolande River sequence contain correlates of the Central Volcanic Complex, Eastern quartz-phyric sequence or the White Spur Formation? Descriptions of the Yolande River sequence on Anthony Road (McPhie and Gemmell, 1994; Jones, 1999) and elsewhere (Corbett, 1979; Corbett, 1992) suggest that it comprises Central Volcanic Complex-like volcanoclastic facies intercalated with mudstone and overlain by quartz-phyric volcanoclastic facies and quartz-porphyrific rhyolites.
- (5) Do correlates of the White Spur Formation exist south of the Henty Fault Zone? The volcanic facies south of the Henty Fault Zone are poorly understood, yet similarities between rocks in the south and facies in the north suggest possible correlations. A number of descriptions of quartz-phyric sandstones and mud-matrix volcanoclastic breccias in the Yolande River sequence west of Anthony Road and near Lynchford sound remarkably similar to facies in the White Spur Formation and Southwell Subgroup.
- (6) The eastern margin of the Mount Read Volcanics from Lake MacKintosh to Lake Beatrice is poorly described and mapped. There is potential for a number of detailed volcanic facies studies in this area.
- (7) The relationship between the Central Volcanic Complex, Hollway andesite, the Browns Tunnel sequence, Pinnacles rhyolite and the Southwell Subgroup in the Pinnacles area is critical. Previous work has suggested that the Hollway andesite, the Browns Tunnel sequence and the Que Hellyer Volcanics overlie the Central Volcanic Complex. And that the Hollway andesite and Browns Tunnel sequence are correlates of the Que-Hellyer Volcanics (McKibben, 1993; Coutts, 1990). However, the detail of mapping and facies analysis along the northern contact of the Central Volcanic Complex is insufficient to make conclusive correlations and determine the stratigraphy. There is a potential similarity between the stratigraphy at Rosebery and Pinnacles, and possible correlates for the Que River shale, the Southwell Subgroup or White Spur Formation and the Tyndall Group in this area.

- (8) The stratigraphy of the upper Central Volcanic Complex and the contact with the Animal Creek Greywacke or Que Hellyer Volcanics north of Mount Block is poorly documented. This is another key area to examine the upper contact of the Central Volcanic Complex and consider the relationship and timing between the Central Volcanic Complex and the Que-Hellyer Volcanics.
- (9) There is scope for a stratigraphic study and detailed facies analysis on the host and hangingwall succession to the Red Hills prospect. This would follow on from the speculation of Herrmann (1996).
- (10) The Henty Fault Wedge is both poorly understood and under explored.
- (11) In the southern part of the Mount Read volcanics, the volcanic facies of the Central Volcanic Complex are poorly described and mapped.
- To the southwest of Queenstown, west of the Reservoir andesite, coherent felsic rocks dominate the Central Volcanic Complex. These appear to overlie and hence be younger than the andesite. However most of the andesites in the Mount Read Volcanics are younger than the Central Volcanic Complex. Do the felsic rocks overlie the Reservoir andesite? Are they extrusive lavas or CV-type dacite intrusions?
 - Pumice-rich facies in the southern Central Volcanic Complex are poorly studied. As a result it is often difficult to determine the style of eruption, emplacement mechanisms, the proximity to source and also whether these pumice breccias are related to the Hercules Pumice Formation at Rosebery and Hercules. Determining whether or not there is a relationship between pumice breccias north and south of the Henty Fault Zone could be critical to the exploration potential of the southern Central Volcanic Complex. Are the pumice-rich facies that occur at Wart Hill near Elliott Bay also related?
- (12) Feldspar-phyric dacite lavas and intrusions typical of the Central Volcanic Complex (e.g. the Newton Creek dacite) exist at all stratigraphic levels in the Mount Read Volcanics. Are these all compositionally identical? If so what does this mean for the tectono-magmatic history of the Mount Read Volcanics?

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FIGURE 2: AREAS FOR FUTURE WORK

MOUNT READ VOLCANICS HELLYER-DARWIN WESTERN TASMANIA

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LEGEND

Formation ID

- AA (andesites and basalts)
- CV (Central Volcanic Complex)
- ES (Eastern qz-phyric sequence)
- FA (Farrell slates)
- HP (Hercules pumice formation)
- JL (Mount Julia Member)
- LY (Lynchford Member)
- QH (Que-Hellyer volcanics)
- TY (Tyndall Group)
- WO (Western volcanosedimentary sequence)
- WT (White Spur formation)
- YR (Yolande River sequence)
- ZZ (Zig Zag Hill Formation)

- Topographic contours (250,000 base)
- Streams (250,000 base)

