Tasmanian Geological Survey
Record 2008/01

Revisions to geological maps in the southern part of the Dial Range/Fossey Mountain Trough, northern Tasmania, with emphasis on Cambrian geology

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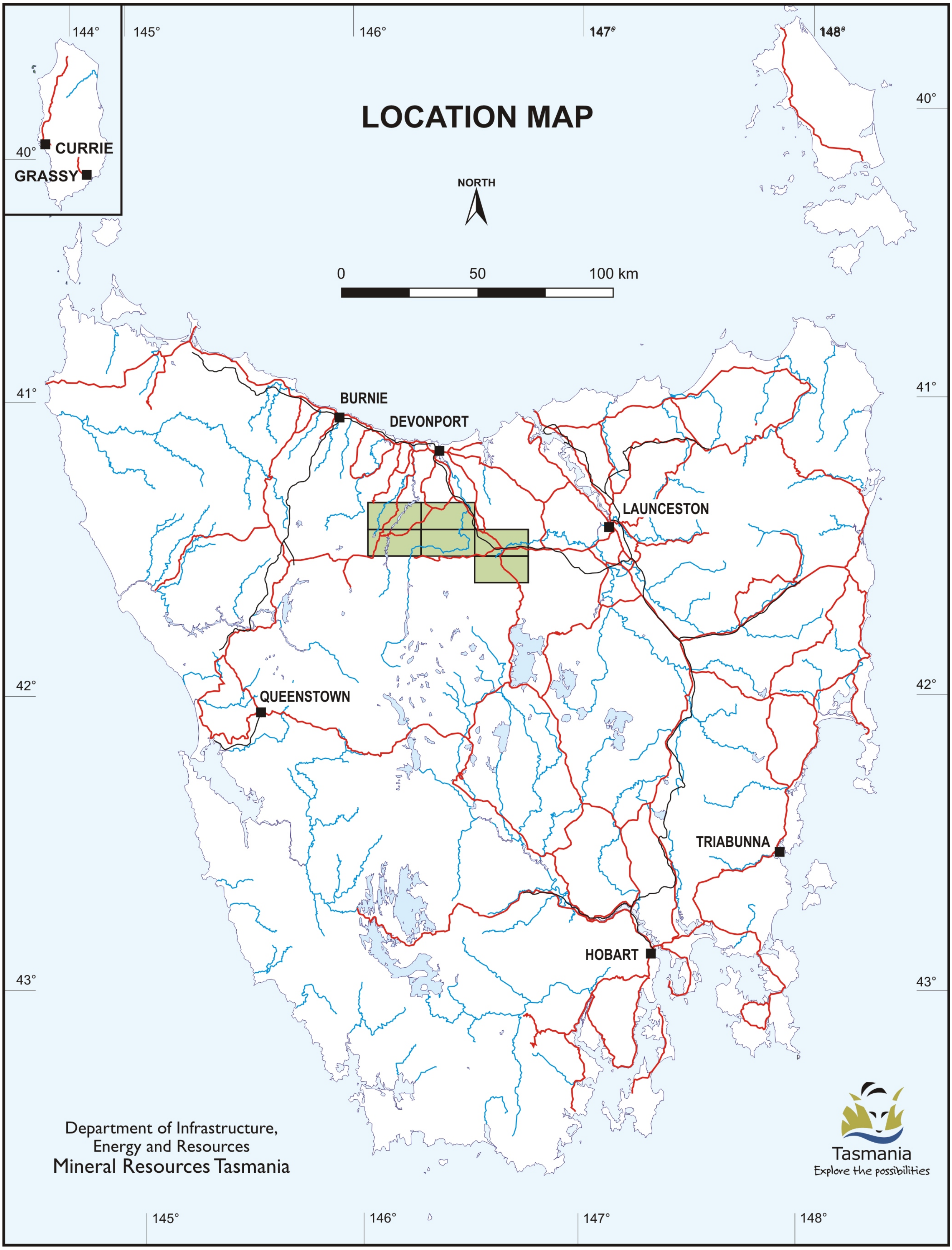

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Contents

Figures

Introduction

This report documents revisions to six 1:25 000 scale digital geological maps in the Deloraine to Cethana area. The project forms part of the four-year Tasmanian Government funded *TasExplore* Project, which aims at advancing mineral exploration in northern Tasmania by producing a refined 3D model for the region based on the integration of new geological mapping and additional geophysical studies. The review of existing data in the Deloraine to Cethana area was made as part of a regional mapping program aimed at the re-examination of the Lower Palaeozoic stratigraphy and structure in the Dial Range–Fossey Mountains region in late 2006 to June 2007 (fig. 1) and includes new work by C. Calver, J. Everard, D. Green, M. McClenaghan, D. Seymour and this author. The results of the regional mapping program and this review will be integrated in a planned project aimed at the revision of the 3D geological model of Tasmania in 2009–2010. Revised digital geological maps will be available in late 2008.

Many of the geological observations presented in this report have not been confirmed by the author and information from a wide variety of sources (unpublished field mapping, thin sections, published mapping, company reports, University theses, and published and unpublished papers) was used to constrain the interpretation. The extensive thin section collection at Mineral Resources Tasmania proved invaluable when detailed descriptions were not documented in the original source.

Several new provisional stratigraphic units have been introduced. These units are informally defined and have been indicated by the use of lower case in the lithostratigraphic descriptor (e.g. Groove Creek formation, Riana subgroup). Existing stratigraphic nomenclature as defined in the Geoscience Australia Stratigraphic Units Database (e.g. Gog Range Greywacke, Tyndall Group) is capitalised. Although the term Western Volcano-Sedimentary Sequence has not been formally defined in the Geoscience Australia Stratigraphic Units Database, it is used in this report as it is a current and commonly used stratigraphic term in western Tasmania (Corbett, 2002). The term Sprent conglomerate is used to describe parts of the Gog Range Greywacke that are mainly derived from Late Neoproterozoic–Early Cambrian protoliths. The 1:25 000 rock code mnemonics documented throughout the text, are those used in the legends on the revised maps.

The conclusions of this report remain at best preliminary, pending additional mapping and geochemical evaluation.

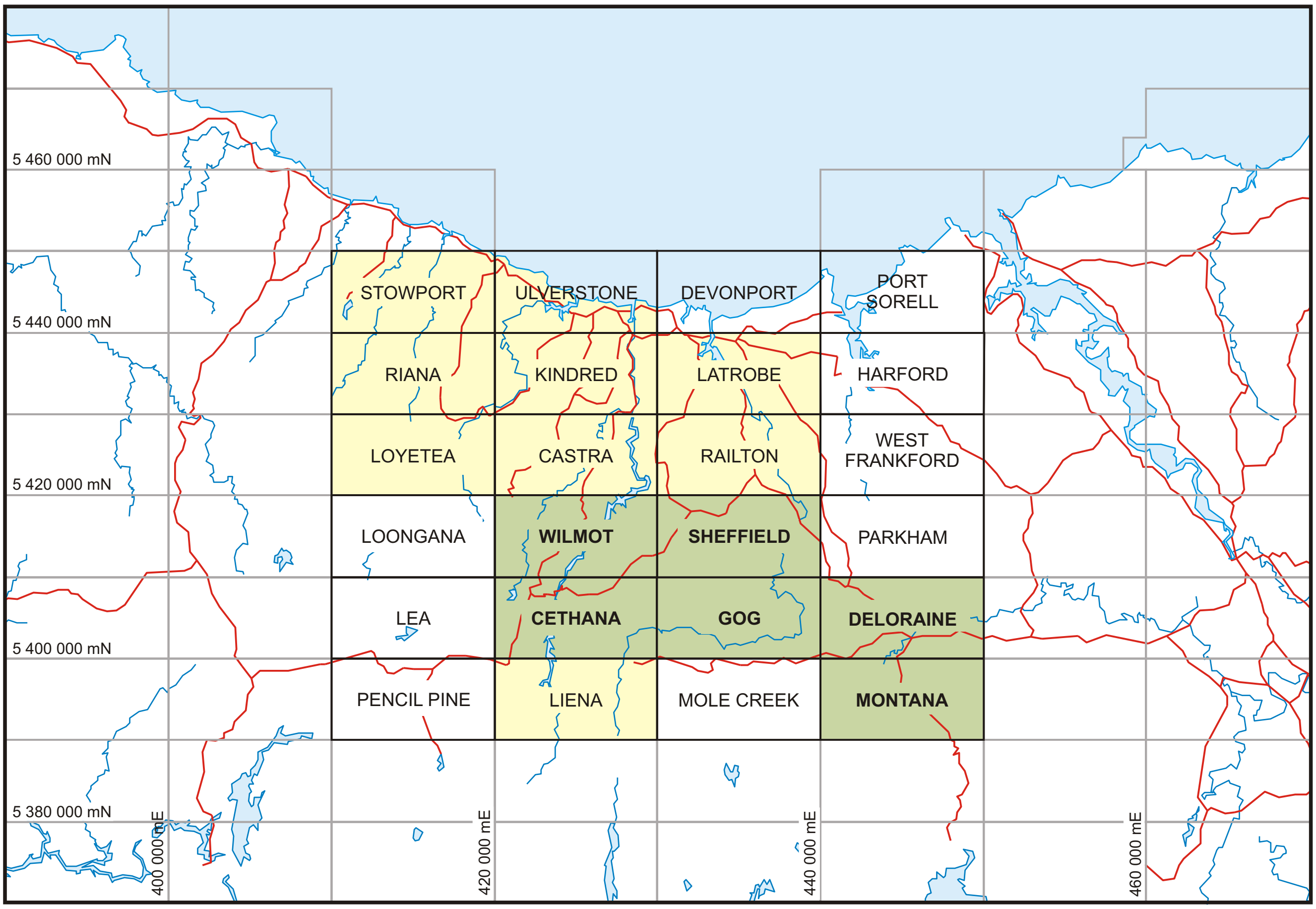

Figure 1

Index map of 1:25 000 scale map sheets in northern Tasmania showing maps revised in this study in green. Other maps updated during TasExplore Project are shown in yellow.

Montana/Deloraine map sheets

(Vicary, 2008*a*; Vicary 2008*b*)

Descriptions of the Cambrian sequence in the Deloraine–Montana area are given in Pike (1973), Barton *et al*. (1969), Wells (1957), Herrmann (1991) and Woodward *et al*. (1993), and these references form the basis for the following discussion.

The Cambrian sequence consists of interbedded micaceous greywacke, siltstone, shale, siliceous conglomerate and volcaniclastic sedimentary rocks with minor felsic–intermediate lava/intrusive units.

The bulk of the Cambrian sequence represents the along-strike continuation of similar units that outcrop in the Gog–Sheffield area and is correlated with the Gog Range Greywacke of the Western Volcano-Sedimentary Sequence. Internal subdivision within the Gog Range Greywacke is based on the relative abundance of coarse siliceous (Proterozoic derived) conglomerate facies and on the relative abundance of the felsic volcanic component (quartz-feldspar crystals and glass shards/pumice fragments).

Geological maps of the Gog Range Greywacke in the Deloraine–Montana area by Barton *et al*. (1969) and Herrmann (1991) show marked differences in the internal subdivision, and many of the mapped units are probably gradational. Original field maps for the Quamby one inch to one mile (1:63,360 scale) map show that much of the mapped distribution of conglomerate facies (Ꞓdsvgc) consists of interbedded greywacke, lithic greywacke and siltstone with discontinuous lenses of siliceous conglomerate. This sequence is gradational to the siltstone-dominated facies (Ꞓdsvg) and has an exaggerated distribution on the current map sheets. Units within Ꞓdsvg that are rich in felsic volcanic detritus have been designated Ꞓdsvgv.

A distinctive crystal-rich volcaniclastic sandstone (the 'marker horizon' of Pike, 1973) crops out to the south of Pumicestone Ridge. Two samples collected by Marshall (66/40 and 68/169) are feldspar-quartz-pyroxene phyric volcaniclastic sandstones which are petrologically similar to pyroxene phyric volcaniclastic units which define the base of the Tyndall Group in the Gog–Sheffield–Cethana area. The volcaniclastic sandstone is overlain by a mixed-provenance volcaniclastic conglomerate sequence with interbedded extrusive/intrusive rhyolite/dacite bodies. A chemical analysis (Herrmann, 1991) suggests that these bodies can be correlated with the high Zr Minnow Keratophyre in the Gog–Sheffield area. Both the crystal-rich sandstone and the overlying conglomerate sequence have been tentatively correlated with the Tyndall Group on the maps.

Pike (1973) reported that the 'marker horizon' can be traced westward to about one kilometre south of Beefeater Hill. Sample 69/102, from this location, is a quartz-feldspar phyric volcaniclastic sandstone with no obvious pyroxene crystals. It is similar to other felsic crystal-rich volcaniclastic sandstone units interbedded within the Gog Range Greywacke (Ꞓdsvgv), and may not be the lateral continuation of the basal Tyndall marker horizon as suggested by Pike.

Andesitic lavas/intrusive rocks occur within the Gog Range Greywacke at Kentish Hill. These are lithogeochemical equivalents of the Beulah andesite (Herrmann, 1991), although on the map they are designated Ꞓda rather than Ꞓdta as their stratigraphic correlation is uncertain. Mapping by Herrmann (1991) suggests that the andesitic unit at Kentish Hill occurs in the core of a syncline. It is tentatively suggested that the andesite may be at the same stratigraphic level as the Tyndall correlates near Pumicestone Ridge, although additional detailed mapping and geochemistry is needed to confirm this.

An epidote-altered tholeiitic basalt occurs at the faulted contact between the andesite sequence and the Gog Range Greywacke. This is considered to represent a structurally emplaced slice of Neoproterozoic–Early Cambrian basement, and is tentatively correlated with the Motton metabasalt (Crawford, *in* Herrmann, 1991). Tholeiitic basalts also occur in a similar structural position in the Gog Range area (Herrmann, 1991; McClenaghan *et al*., 2001).

The Wurawina Supergroup unconformably overlies Proterozoic basement and the Cambrian sequence in the Flinty Rock–Native Hop Hill area, although the contact relationships are highly modified by later faulting. The structural interpretation of Woodward *et al*. (1993) has been added to the map. This includes thrust faulting at the contact between the Wurawina Supergroup and the Proterozoic units on Native Hop Hill and between the Wurawina Supergroup and Cambrian rocks near Flinty Rock. The thrust on Native Hop Hill may continue west and cut Long Ridge at a low angle to the apparent strike. This accounts for the apparent thickening of the Wurawina Supergroup correlates on the eastern end of Long Ridge.

The Wurawina Supergroup correlates in the Flinty Rock–Native Hop Hill area were described by Wells (1957) who established the following sequence:

Gordon Limestone	~ 300 m
Caroline Creek Sandstone	~ 300 m
Owen Conglomerate	~ 90 m

The interpretation of Wells (1957) has been added to the map although his stratigraphic correlations have been modified. The unit correlated by Wells with the Caroline Creek Sandstone contains *Tritoechia careyi*, a fossil that is currently placed in the upper part of the Owen Group in the Florentine Valley Mudstone (Laurie, 1996). This unit has been correlated with the Owen Group (ꞒOsu on the map) following the stratigraphy determined by recent mapping in the Railton–Sheffield area by C. Calver (Calver *et al*., 2008). In the Native Hop Hill area, ꞒOsu overlies a basal conglomerate that is correlated with the Roland

Conglomerate (€Ocr). No definitive Moina Sandstone lithologies have been recorded in the Deloraine–Montana area although because of the limited mapping, it is possible that the upper parts of €Osu unit may include some Moina Sandstone correlates. Subdivision of Owen Group and Gordon Group correlates in the Needles Ridge–Long Ridge area remains unresolved.

The presence of a basal conglomerate horizon (€Ocr) in the Native Hop Hill area implies that although the contact with the underlying Proterozoic rocks has been modified by later thrusting (Woodward *et al.*, 1993), the amount of movement associated with this fault need not be great. Similarly the greywacke and conglomerate-rich facies of the Gog Range Greywacke contain a high proportion of quartz-muscovite schist and micaceous quartzite clasts, also implying local derivation from Proterozoic rocks.

Three discontinuous outcrops of possible Caroline Creek (Moina Sandstone) correlates have been mapped in the Stockers Plain area near 470 000 mE, 5 393 700 mN (Wells, 1957; Barton *et al.*, 1969). These have been shown on the current maps as Undifferentiated Cambrian–Ordovician (€O), although a potential correlation with either the Eldon Group or a sandstone facies of the Gordon Limestone (e.g. Mole Creek Formation) is also likely. An alternative explanation for these occurrences is that they may be Tertiary silcrete deposits (S. Forsyth, pers. comm., 2007).

The Permian geology at Quamby Brook (near 476 000 mE, 5 397 000 mN) has been updated following Moore (1971).

Gog map sheet

(McClenaghan *et al.*, 2008)

Descriptions of the Cambrian sequence in the Gog area are given in Herrmann (1991) and McClenaghan *et al.* (2001). Although no explanatory report on the latter work has been published, an extensive collection of thin sections and original field maps and notes is available at Mineral Resources Tasmania. The Cambrian sequence in the Gog area is also discussed in Corbett and McClenaghan (2003) and Callaghan (2002).

A review of thin sections collected during field mapping in the Gog area (McClenaghan *et al.*, 2001) has shown that several discontinuous outcrops of feldspar-pyroxene phyric andesitic volcaniclastic sandstone are interbedded with a regionally extensive unit of quartz-feldspar phyric pumiceous volcaniclastic sandstone that outcrops in the core of the Gog syncline. The andesitic units are petrologically similar to other andesitic volcaniclastic sandstones at the base of the Tyndall Group in the Sheffield–Roland area, and suggest that this sequence can be correlated with the Tyndall Group in contrast to a previous interpretation which placed these units in the Western Volcano-Sedimentary Sequence. This package of rocks can be traced from the hinge of the Gog syncline to the Firetower prospect and Upper Minnow River areas (Callaghan, 2002). An important result of this study is that the mineralisation at the Firetower prospect is hosted in the upper parts of the Gog Range Greywacke close to the contact with the overlying Tyndall Group. Quartz-feldspar phyric pumiceous volcaniclastic units also occur in the Western Volcano-Sedimentary Sequence, although these contain no detrital pyroxene crystals or andesitic detritus.

Both the Tyndall Group and the underlying Western Volcano-Sedimentary Sequence are intruded by the Minnow Keratophyre and in places, such as on the eastern side of Kenzies Hill, the Tyndall Group correlates are stoped out by the intrusion. The Minnow Keratophyre has been recoded as €qfpz to distinguish it from other quartz-feldspar porphyry bodies in the Mount Read Volcanics. It has a highly variable phenocryst assemblage of quartz-feldspar ± pyroxene ± hornblende ± biotite and is characterised by high zirconium contents (typically 300–600 ppm). Similar high Zr rhyolite/dacite units occur in the Sock Creek area (Barwick, 1991) and at Jukes Proprietary (Doyle, 1990).

Several felsic porphyry bodies that intrude the Western Volcano-Sedimentary Sequence to the south of the Firetower prospect and near Minnow Falls have been recoded €qfbp on the basis of their high biotite content (Callaghan, 2002). Three quartz-feldspar bodies in the Lower Beulah area have been removed from the map.

A major revision to the map is the reinterpretation of the contact between the Beulah andesite and the Gog Range Greywacke to the south of the Lower Beulah Barite prospect. South of the Lower Beulah Barite prospect, correlates of the Gog Range Greywacke dip and face south and seem to overlie the Beulah andesite. Mapping and core logging by previous workers has suggested that this contact is conformable and possibly interfingering (Rand and Noonan, 1989; Corbett and McClenaghan, 2003), although Porter (1973) favoured a faulted contact. A review of data from the adjacent Sheffield map suggests that the western contact between the Gog Range Greywacke and the Beulah andesite is conformable, with the Beulah andesite overlying the Gog Range Greywacke. A thin unit of rhyolitic–andesitic volcaniclastic sandstone (with minor pyroxene phyric andesitic volcaniclastic sandstone) occurs at the contact and is petrologically equivalent to similar units developed in the basal Tyndall Group in the Cethana, Roland and Gog areas. This suggests that the Beulah andesite is the stratigraphic equivalent of the Dasher andesite and is age-equivalent to the Tyndall Group.

Diamond-drill hole DD84BB4 (Dickson, 1992), drilled through the contact between the Gog Range Greywacke and the Beulah andesite near the Lower Beulah Barite prospect, was reviewed as part of an additional study (Vicary and Seymour, in prep.), and is summarised below. In general the hole was collared in a south-dipping and facing sequence of fine greywacke and siltstone correlated with the Gog Range Greywacke. Between 51 and 64 m, the core was strongly broken and a fault zone was interpreted at approximately 57.3 m. Below the fault, there is a pronounced change in lithology with abundant andesitic to dacitic? lavas and re-sedimented hyaloclastite breccias with interbedded thinly bedded black siltstone. Rand (1990) reported that quartz phyric rhyolitic volcaniclastic sandstone may also occur within this sequence. The black siltstones have been previously correlated with the Gog Range Greywacke sequence, however they are now considered to be part of a package of volcaniclastic sedimentary rocks and lavas which occurs at a high stratigraphic level within the Beulah andesite. A re-interpretation of the drill hole and local surficial mapping (Rand, 1990) suggests that the faulted contact between the Beulah andesite and the Gog Range Greywacke dips at a steep angle to the south-south west. The stratigraphic correlation of the Beulah andesite (see *Sheffield* section) with the Tyndall Group suggests that there is significant reverse movement on the fault.

Andesitic to dioritic rocks are common within the Gog Range Greywacke south of the fault contact and field evidence suggests they are largely intrusive. A large dioritic intrusion has been mapped in Garden of Eden Creek at 452 100 mE, 5 407 750 mN. Andesitic intrusive rocks have also been identified in the Lower Beulah Barite adit (Rand, 1990).

The Western Volcano-Sedimentary Sequence in the Gog Range area is a highly variable sequence of interbedded greywacke, siltstone, siliceous conglomerate and quartz-feldspar phyric pumiceous volcaniclastic sandstone and siltstone, with minor mixed provenance volcaniclastic sandstones and dacitic to rhyolitic lavas.

Five point occurrences of chert and basalt-rich lithicwackes (Ꞓdsvgs) have been added to the map in the Mersey River area. These are compositionally and texturally similar to lithologies from the Sprent conglomerate that outcrops extensively towards the upper parts of the Western Volcano-Sedimentary Sequence in the Dial Range area. In contrast to the greywacke and interbedded pebbly sandstone facies, which are derived from Proterozoic Tyennan protoliths, these occurrences are sourced from dominantly Neoproterozoic–Early Cambrian lithologies.

Other changes include minor revision to the Cambrian geology in the Beaumonts Road area and to the Wurawina Supergroup correlates in the Punchs Terror area based on a review of original mapping and thin sections collected by D. C. Green.

The Wurawina Supergroup correlates near Dynans Bridge have been recoded following mapping on the adjacent Sheffield map by C. R. Calver in 2007.

Sheffield map sheet

(Calver *et al*., 2008)

The lowest stratigraphic unit exposed in the Sheffield area is the Gog Range Greywacke (McClenaghan, 2004). There has been little internal subdivision of this unit to date and no Sprent conglomerate has been identified. A conglomerate horizon (Ꞓdsvgc) in the Beulah Heights area is predominantly derived from Proterozoic rocks (mainly quartzite and micaceous schist) and contains a component of chert.

The Gog Range Greywacke is overlain by the Tyndall Group in the Paradise area. The lowest units of the Tyndall Group are internally complex and have been designated Ꞓdtsc, Ꞓdtvs, Ꞓdtca and Ꞓdtsa. This subdivision reflects either a change in provenance or grain size, although the units are commonly gradational and interbedded. Ꞓdtsc is a siliceous conglomerate-rich facies mainly derived from a Proterozoic source. Ꞓdtvs is principally a volcaniclastic sandstone facies derived from andesitic and rhyolitic sources, and is possibly a lateral equivalent of Ꞓdtp on the Gog sheet. Volcaniclastic facies principally derived from andesitic sources have been designated Ꞓdtca or Ꞓdtsa depending on the dominant grain size of the unit (i.e. conglomerate or sandstone respectively).

Late Middle Cambrian fossils have been reported from the Paradise area (Jago, 1989; Laurie *et al*., 1995) and have been correlated with the Tyndall Group (Corbett, 2002; Corbett and McClenaghan, 2003). A review of data from the Paradise area (Rand, 1989; McClenaghan, unpublished data) suggests that the fossils occur in a discontinuous micaceous siltstone horizon that is underlain by a poorly defined unit of quartz-feldspar phyric pumiceous volcaniclastic sandstone. A poorly-defined sequence of interbedded feldspar-quartz ± hornblende ± pyroxene phyric crystal-rich volcaniclastic sandstone and feldspar ± biotite phyric lava overlies the fossiliferous siltstone horizon. In contrast to the above stratigraphic correlation, which places the entire sequence into the Tyndall Group, it is tentatively suggested that the fossiliferous siltstone and underlying rhyolitic pumiceous volcaniclastic sandstone occur in the upper parts of the Gog Range Greywacke. The overlying andesitic volcaniclastic sandstone and lavas are correlates of the Tyndall Group.

Fossils from the Radfords Creek Group in the Sugarloaf Gorge area (Kindred map) are similar in age to the Paradise fossils (Jago, 1989; Laurie *et al*., 1995). Previous workers (Corbett, 2002; Corbett and McClenaghan, 2003) have correlated the Radfords Creek Group with the Tyndall Group, however on the basis of the above observation and field relationships it is suggested that the Radfords Creek Group is likely to represent the upper stratigraphic part of the Gog Range Greywacke (fig. 2, 3). It is apparent from the fossil evidence that deposition of the Gog Range

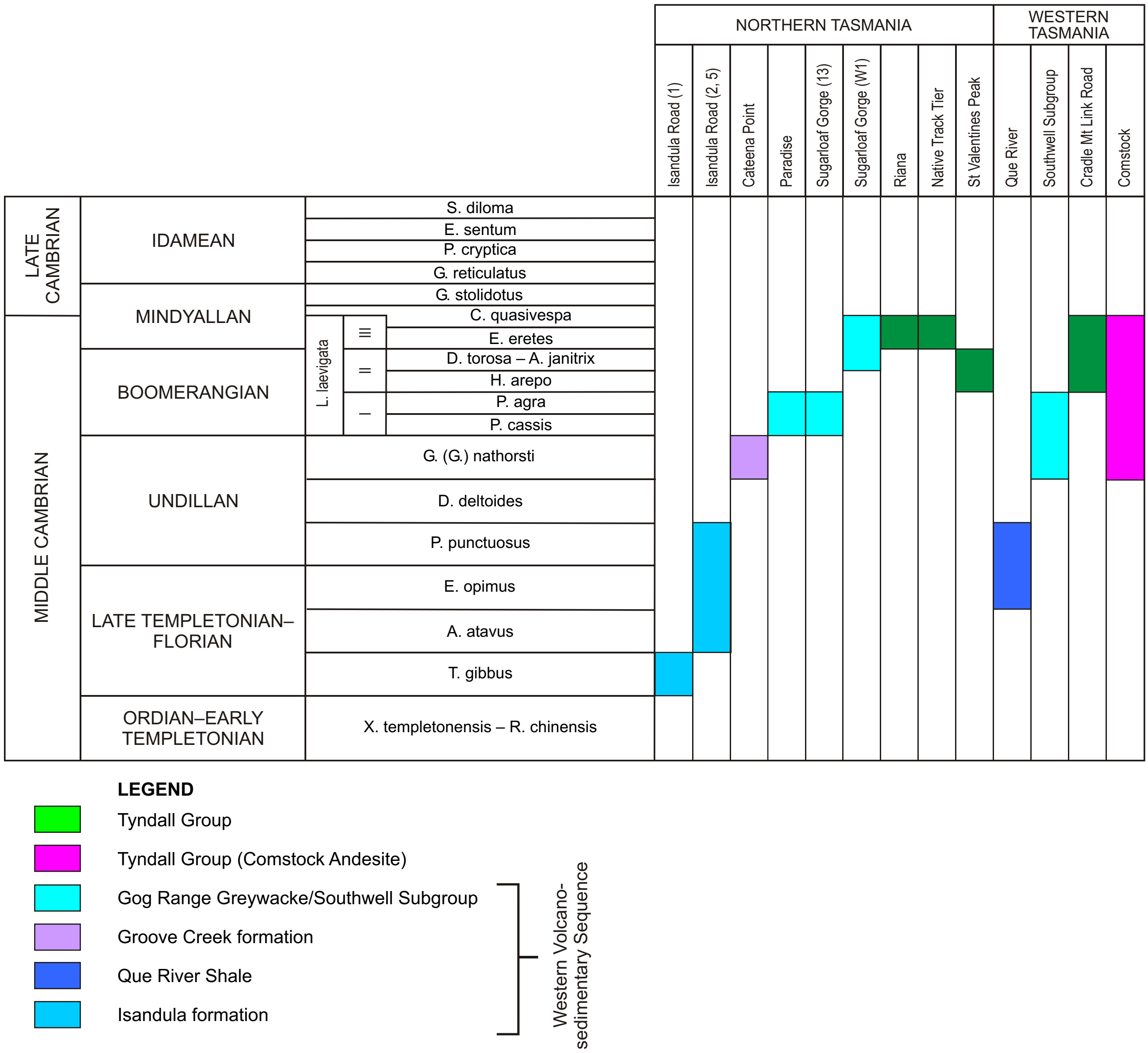

Figure 2

Middle and Late Cambrian biostratigraphic correlation chart for northern and western Tasmania (modified from Laurie et al., 1995).

Greywacke in the Dial Range area continued during the andesitic volcanism that defines the Tyndall Group in the Sheffield–Gog area.

Geological mapping in the Paradise area (Rand, 1989) shows marked divergence from the interpretation presented on the Sheffield map (McClenaghan, 2004). Given the stratigraphic importance of the Paradise fossils, additional mapping in the area is strongly recommended.

Thin sections of two samples (MR38 and MR40), collected from the Gog Range Greywacke near the western margin of the Beulah andesite in the Beulah–Golden Gate area, show that the rocks are pyroxene phyric andesitic volcaniclastic sandstones which are petrologically identical to units associated with the basal Tyndall Group in the Roland–Gog area. They have been indicated on the map as two minimum polygons of Ꞓdtsa. Rand (1989) also reports pyroxene phyric andesitic volcaniclastic sedimentary rocks at the contact between the Gog Range Greywacke and the Beulah andesite in the same area. The contact between the Gog Range Greywacke and Beulah andesite in the Beulah area requires additional mapping, as parts of the Gog Range Greywacke may in fact be Tyndall Group.

The geology in the Beulah area has been updated with additional information from Vicary and Jackson (1993). This includes some modification to the western margin of the Beulah andesite. A more detailed review of the geology and stratigraphic relationships in the Beulah area will be given in an additional report (Vicary and Seymour, in prep.).

The Lizard Hill porphyry is part of the Minnow Keratophyre and has been recoded Ꞓqfpz.

Polymict volcaniclastic conglomerate (Ꞓdtc), mainly derived from Tyndall Group and older Cambrian

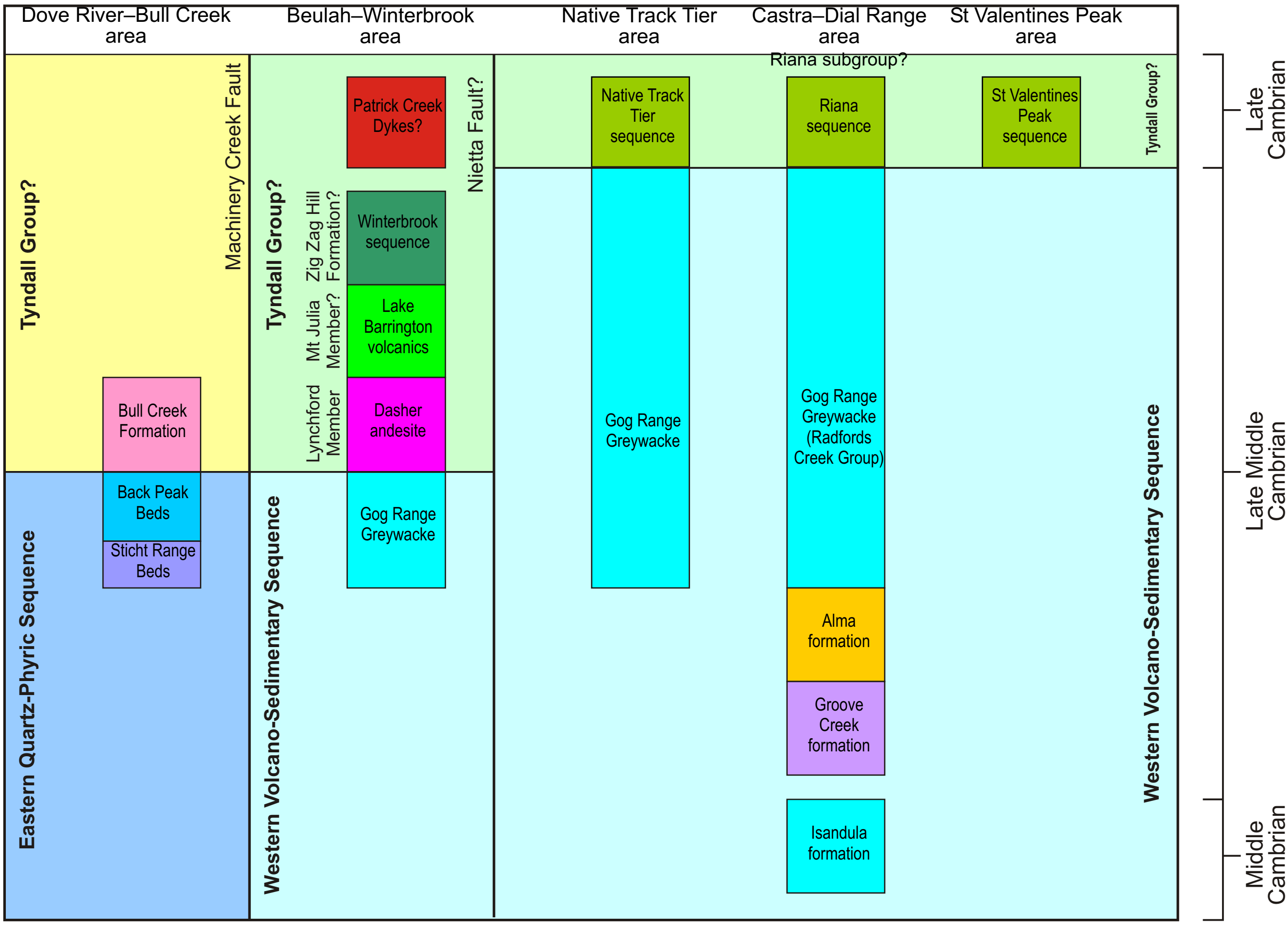

Figure 3

Provisional stratigraphic correlation chart for correlates of Mt Read Volcanics in northern Tasmania.

sequences, unconformably overlies the Western Volcano-Sedimentary Sequence in the Vinegar Hill–Blackberry Hill area. It is tentatively correlated with the Zig Zag Hill Formation. Poorly exposed quartz phyric volcaniclastic conglomerate with well rounded clasts up to 30 cm has been reported near 450 000 mE, 5 411 500 mN (Vicary and Jackson, 1993) and may be part of the same sequence.

Wilmot map sheet

(McClenaghan, Green and Vicary, 2008*a*)

Correlates of the Gog Range Greywacke crop out extensively in the Nowhere Else–Roland area (McClenaghan and Green, 1997). The sequence is largely undifferentiated and although no Sprent conglomerate lithicwacke has been mapped, chert and basalt-rich lithicwacke occurs immediately to the north on the adjacent Castra map (Vicary and McClenaghan, 2007). Siliceous conglomerate horizons, derived mainly from Proterozoic sources, occur at several stratigraphic levels within the Gog Range Greywacke (Ꞓdsvgc) and are also interbedded within the overlying Tyndall Group sequence (Ꞓdtsc). Although a siliceous conglomerate horizon is present in places at the base of the Tyndall Group, its utility as a stratigraphic marker horizon is poor and definition of the Tyndall Group is based on the occurrence of andesitic detritus (pyroxene crystals and andesite clasts).

A relatively thick sequence of predominantly rhyolitic volcaniclastic sedimentary rocks underlies a sequence of andesitic volcaniclastic sedimentary rocks to the north of the Billet Creek Fault (near 432 000 mE, 5 415 000 mN). Previous work has correlated this sequence as part of the Tyndall Group, based on the correlation of a siliceous conglomerate at the base of the sequence with a similar siliceous conglomerate at the Tyndall Group contact in the Smiths Road area. As siliceous conglomerate horizons can occur at several stratigraphic levels within the Western Volcano-Sedimentary Sequence and in the overlying Tyndall Group, they have little use as regional stratigraphic markers.

In contrast to the previous interpretation, the rhyolitic volcaniclastic sequence underlying the basal Tyndall Group andesitic volcaniclastic sequence has been correlated with the felsic volcaniclastic facies of the Gog Range Greywacke (Ꞓdsvgv). This sequence hosts chalcopyrite-galena-sphalerite veining at the Lake Barrington prospect. Detailed mapping at the Lake Barrington prospect (MacDonald, 1993) has shown that the sequence is considerably more variable than indicated on the current map and consists of interbedded quartz-feldspar phyric lavas and hyaloclastic breccias, quartz-feldspar phyric fine-grained to coarse-grained volcaniclastic sediments with minor black siltstone, feldspar phyric intrusive rocks and feldspar-quartz ± hornblende phyric lavas. It is a possible correlate of the sequence which hosts the Cethana alteration zone and possibly the Bell Mount sequence. The significance of this correlation is that it places the Cethana alteration zone and the Lake Barrington prospect at the same stratigraphic level, although the mineralisation at the Lake Barrington prospect is probably Devonian.

The apparent asymmetric stratigraphic succession within the Gog Range Greywacke across a north–south fault in the Promised Land area is suggestive that this fault may have been an active structure during Cambrian volcanism and sedimentation.

Southwest of the Billet Creek Fault there is a thick sequence of Tyndall Group correlates which comprise a basal sequence of andesitic lavas and volcaniclastic sediments (Dasher andesite) with an overlying variable sequence of rhyolitic volcaniclastic sedimentary rocks and rhyolitic to dacitic lavas (Lake Barrington volcanics). The rhyolitic volcaniclastic sequence is probably a lateral equivalent of the unit Ꞓdtss which possibly overlies the Dasher andesite on the northern slopes of Mt Roland. A review of thin sections from the Roland area suggests that much of the sequence designated Ꞓdtsa is mostly coherent andesite with subordinate volcaniclastic units.

A chemically distinct dacite lava (Ꞓdtld) outcropping in the Lake Barrington area has high zirconium contents and is probably an extrusive phase of the Minnow Keratophyre (Ꞓqfpz) which crops out extensively in the Gog–Sheffield area.

The Cambrian sequence in the Nietta–Wilmot area is poorly known (McClenaghan and Green, 1997). A review of original data collected by D. C. Green in 1996 has been undertaken and some generalised observations can be made.

Recent mapping on the adjacent Castra map sheet has shown that the bulk of the sequence in this area can be correlated with the Gog Range Greywacke. A structurally complex zone of rocks in the Andersons Road area (425 800 mE, 5 419 000 mN) contains lithicwacke with interbedded greywacke, siltstone and rhyolitic volcaniclastic sedimentary rocks. The lithicwacke (Ꞓdsvgs) contains abundant chert, basalt and dolomite clasts and suggests that parts of this sequence can be correlated with the Sprent conglomerate. The bulk of this sequence has been designated as undifferentiated Gog Range Greywacke (Ꞓdsvg) on the map with minor intercalations of felsic volcaniclastic sediments (Ꞓdsvgv). Unpublished field mapping by D. C. Green suggests that the Andersons Spur sequence overlies a predominantly greywacke sequence (Ꞓdsvgg) in a syncline. Potential correlates of the Andersons Road sequence also occur along Narrawa Road in the Wilmot area.

Several bodies of rhyolite lava and breccia within the sequence at Andersons Road have been recoded as diorite/andesite (Ꞓdaid) following a review of thin sections. The relationship between Ꞓdaid and the tholeiitic Lake Barrington diorite (Ꞓdid) (Poltock, 2002; Corbett and McClenaghan, 2003), which occurs within the Andersons Spur sequence near Wilmot, remains unresolved. The Late Cambrian sequence in the Native Track Tier area (Riana subgroup) has a distinctly tholeiitic character (Berry *et al.*, 1997). It is tentatively suggested that the Lake Barrington diorite may represent part of the Late Cambrian Riana subgroup.

A small body of quartz melasyenite (Ksm) outcropping in the Shackley Hill area is petrographically similar to the diorite/andesite rocks (Ꞓdaid) from the Wilmot area and is probably Cambrian in age.

The Cambrian sequence in the Bell Mount area has been correlated with the felsic volcanic-rich portion of the Gog Range Greywacke (Ꞓdsvgv). This is discussed in more detail in the following section. A predominantly greywacke sequence to the north of a quartz-feldspar porphyry body in the Wilmot River (near 424 000 mE, 5 411 000 mN) is probably part of the Bell Mount sequence, and has been included within the Bell Mount sequence rather than Tyndall Group as shown on previous maps (Pemberton and Vicary, 1989).

Cethana map sheet

(McClenaghan, Green and Vicary, 2008*b*)

The Cambrian sequence on the Cethana map can be subdivided into two main associations that are spatially separated by a zone of strong faulting (Machinery Creek Fault) in the Mt Claude area.

The sequence immediately north of the Machinery Creek Fault consists of quartz-feldspar phyric volcaniclastic sedimentary rocks and rhyolitic lava with interbedded siliceous sandstone, greywacke and sandstone and conglomerate with a mixed volcanic and Proterozoic provenance (Hicks, 1989; McClenaghan and Green, 1999). Rare granitic rocks and possible quartz-feldspar-biotite lavas are also recorded. This sequence has a strong NW-trending cleavage and hosts a zone of variable sericite-pyrite alteration (Cethana alteration zone). Limited dip readings suggest that the sequence dips to the N-NE. No reliable facing is known although Murphy *et al.* (1999) suggested that the sequence faces north and underlies a sequence of andesitic lavas (Dasher andesite) and volcaniclastic sedimentary rocks in the Gowrie Park–Days Road area. The latter sequence is correlated with the Tyndall Group.

Corbett and McClenaghan (2003) favoured correlation of the sequence which hosts the Cethana alteration zone with the Eastern Quartz-Phyric Sequence. The Eastern Quartz-Phyric Sequence occurs to the south of the Machinery Creek Fault and although generally poorly defined, the following stratigraphic succession has been established:

Youngest *Bull Creek Formation*: A sequence of quartz-feldspar-biotite phyric lava and volcaniclastic sedimentary rocks which is generally considered to represent an eruptive and locally reworked facies of the intrusive Bonds Range Porphyry.

Back Peak Beds: A sequence of rhyolitic volcaniclastic sedimentary rocks.

Oldest *Sticht Range Beds*: A basal siliceous conglomerate and sandstone sequence which is unconformable on Proterozoic basement.

Thin sections of the sequence which hosts the Cethana alteration zone and the Eastern Quartz-Phyric Sequence to the south of the Machinery Creek Fault were examined to find evidence to support the correlation of Corbett and McClenaghan (2003). Only rare detrital biotite and minor biotite phyric lava was observed in the rocks from the Cethana alteration zone, suggesting that direct correlation with the Bull Creek Formation is unlikely. The andesitic volcaniclastic sequence at the base of the Tyndall Group in the Cethana–Paradise area contains clasts of quartz-feldspar-biotite phyric porphyry and biotite and hornblende detritus (G. Ebsworth, M. McClenaghan, unpublished data). This suggests that a correlation between the Bull Creek Formation and the Tyndall Group is quite likely. The Back Peak Beds are derived from rhyolitic sources and are rich in quartz and feldspar crystals, pumice fragments and glass shards. The rhyolitic provenance is similar to that of the felsic volcanic-rich parts of the Gog Range Greywacke. The Sticht Range Beds are similar in provenance and facies to the siliceous conglomerate and sandstone (Ꞓdsvgc and Ꞓdsvgq) units of the Gog Range Greywacke in the Cethana and Gog areas. However as these units can occur at several stratigraphic levels within the Gog Range Greywacke and also in the overlying Tyndall Group (Ꞓdtsc), direct correlation with the Sticht Range Beds may be unreliable.

There is some evidence to support the idea of Corbett and McClenaghan (2003) that the Western Volcano-Sedimentary Sequence and the Eastern Quartz-Phyric Sequence are lateral equivalents, however this statement is very broad and poorly constrained. The results of this review suggest that the felsic volcanic-rich parts of the Gog Range Greywacke have a similar provenance to the Back Peak Beds of the Eastern Quartz-Phyric Sequence and may be lateral equivalents, although this is hard to demonstrate due to the discontinuous nature of the outcrop to the south of the Machinery Creek Fault because of Late Cambrian to Tertiary cover and Tabberabberan deformation.

In general terms, the sequence which hosts the Cethana Pyrite Zone is identical to the sequence underlying the Tyndall Group in the Lake Barrington, Sheffield and Gog areas and the favoured correlation is with the felsic volcanic-rich parts of the Gog Range Greywacke of the Western Volcano-Sedimentary Sequence. The relatively thick sequence of felsic lavas and volcaniclastic sedimentary rocks in the Cethana and Lake Barrington areas suggests that these occurrences are part of a proximal volcanic centre developed in the upper parts of the Gog Range Greywacke sequence near the southern margin of the Fossey Mountain–Dial Range Trough. The felsic sequence is noticeably thinner and interbedded with the Gog Range Greywacke in the Firetower and Montana areas. The sequence in the Belstone Road area on the Gog map contains abundant pumice and shard fragments and rare ignimbrites, suggesting that this volcanism was partly explosive. Quartz-feldspar crystals and rhyolitic pumice are also common in the overlying Tyndall Group, which may indicate that this phase of volcanism probably continued during Tyndall Group deposition.

In the Bell Mount area, to the west of the Cethana alteration zone, the Cambrian sequence consists of interbedded ashy-tuffaceous siltstone, greywacke and quartz-feldspar phyric volcaniclastic sedimentary rocks. Several large quartz-feldspar porphyry intrusive bodies and interbedded feldspar phyric dacite and quartz-feldspar-hornblende phyric lavas have been recognised (Pemberton and Vicary, 1989). The relationship between the Bell Mount sequence and that of the Cethana alteration zone is poorly known. The description above suggests some similarities although there is a noticeable increase in the abundance of ashy siltstone in the Bell Mount area and feldspar phyric dacite lava has not been recorded from the Cethana alteration zone. Many of the uncertainties are a consequence of a boundary between different MRT mapping programs in the vicinity of Cethana Bridge. To partly resolve some of the problems additional information from Murphy *et al.* (1999) and Temby (1985) has been added to the map although the result is poorly constrained.

The available evidence suggests that the Bell Mount sequence may be a strike continuation of the Cethana alteration zone (Corbett and McClenaghan, 2003) and a correlate of the Gog Range Greywacke. The presence of the feldspar phyric dacitic lavas and the increase in ashy siltstones suggests that a correlation with the Alma formation, which outcrops in the Castra area, may also be possible. If this latter correlation can be proven, then the Bell Mount sequence may underlie the Cethana alteration zone. Additional mapping in the Cethana Bridge and Bell Mount area is highly recommended.

The Bull Creek Formation is general poorly described and the internal geology quite complex; this is partly due to the previously mentioned boundary between two MRT mapping projects in the vicinity of Lake

Cethana and partly due to strong, texturally destructive quartz-epidote-actinolite alteration of the Cambrian sequence adjacent to the Dolcoath Granite. A review of thin sections collected in the Bull Creek area has been made and a simplified geological interpretation is presented on the map, as many of the established geological boundaries and rock types could not be verified.

A generalised stratigraphy of the Bull Creek Formation of interbedded quartz-feldspar-biotite phyric lava, autoclastic breccias and volcaniclastic sedimentary rocks overlain by an epiclastic sequence of quartz-feldspar-biotite phyric volcaniclastic sandstone, lithic-rich sandstone and siltstone can be established. This sequence is intruded by quartz-feldspar-biotite phyric intrusive rocks correlated with the Bonds Range Porphyry (Ꞓqfbp). Thin sections from the sequence suggest that the intrusive rocks, lavas and sediments are closely related. A common feature of the formation is the high abundance of biotite and common occurrence of accessory apatite. The presence of glass shards and abundant pumice fragments indicate local explosive activity.

In general the Bull Creek Formation dips and faces to the southwest and is dislocated by the Bismuth Creek Fault. The sequence to the southwest of the Bismuth Creek Fault has been reinterpreted, following a review of available thin sections, as a structural repeat of the Bonds Range Porphyry with local interbedded sediment horizons. Towards the base of the sequence the Bull Creek Formation is locally interbedded with the underlying Back Peak Beds. A belt of Cambrian rocks to the south of the Bismuth Creek Fault consists of quartz-feldspar phyric volcaniclastic sandstones and siltstones and has been correlated with the Back Peak Beds.

Correlates of the Bull Creek Formation also occur in the Iris River and Solomons Dome area.

Conclusion and implications for mineralisation

This report documents revisions to six 1:25 000 scale digital geological maps in the Deloraine to Cethana area (fig. 1) with emphasis on the stratigraphy of the Cambrian Mt Read Volcanics. It extends and refines the previous study of Corbett and McClenaghan (2003).

The Cambrian Mt Read Volcanics in the Deloraine to Cethana area can be divided into two main stratigraphic units; the Western Volcano-sedimentary Sequence and the Tyndall Group. The Western Volcano-sedimentary Sequence is a complex sequence of interbedded basement-derived sedimentary rocks with interbedded volcanic units. Sparse fossil occurrences from the sequence range in age from late Templetonian to Florian in the Isandula area to early Boomerangian in the Paradise and Sugarloaf Gorge areas. This suggests that deposition of the Western Volcano-sedimentary Sequence in northern Tasmania is largely contemporaneous with deposition of the Que River Shale and Southwell Subgroup in the Hellyer area of western Tasmania.

The overlying Tyndall Group is a bimodal sequence of andesitic to rhyolitic volcanic rocks. Minor interbedded fossiliferous units range in age from Boomerangian to early Mindyallan. A regionally extensive pyroxene-feldspar phyric crystal-rich volcaniclastic sandstone unit forms a distinct marker horizon at the base of the Tyndall Group in the Deloraine–Cethana area, and is a possible correlate of the Lynchford Member in western Tasmania.

A zone of variable sericite-pyrite alteration (the Cethana Alteration Zone) underlies the basal Lynchford Member in the Cethana–Gowrie Park area and is hosted in the upper felsic volcanic-rich parts of the Western Volcano-sedimentary Sequence. The overlying contact with the Tyndall Group has been considered to represent a favourable horizon for VHMS-style mineralisation (MacDonald, 1993; Stockwell, 1997; Denwer, 2000) with the underlying Cethana Alteration Zone representing a large zone of footwall style alteration. Lead isotope data from the Cethana Alteration Zone supports a Cambrian age for this mineralisation (Carr and Dean, 1989*a*).

This review has shown that the basal Tyndall Group volcaniclastic facies (the Lynchford member) is more regionally extensive than previously mapped and can be traced to the Lake Barrington, Beulah and Gog areas (fig. 4, 5). Significantly, alteration at the Firetower, West Gog and Stonebridge prospects is located at or near the inferred favourable horizon. Vein style mineralisation (remobilised Cambrian alteration?) at the Lake Barrington prospect is hosted in a similar sequence to the Cethana Alteration Zone and may represent a zone of footwall style alteration.

Several prospects (Days Road, Atkinsons, Mt Roland, Staverton, Claude Road, Lower Beulah Barite) occur at higher stratigraphic levels than the favourable horizon at the base of the Tyndall Group. Lead isotope data suggest that some of these prospects (Lower Beulah Barite and Mt Roland) may be of Cambrian age, although there is also evidence of a later Devonian overprint (Carr and Dean, 1989*b*; Crawford *in* MacDonald, 1993).

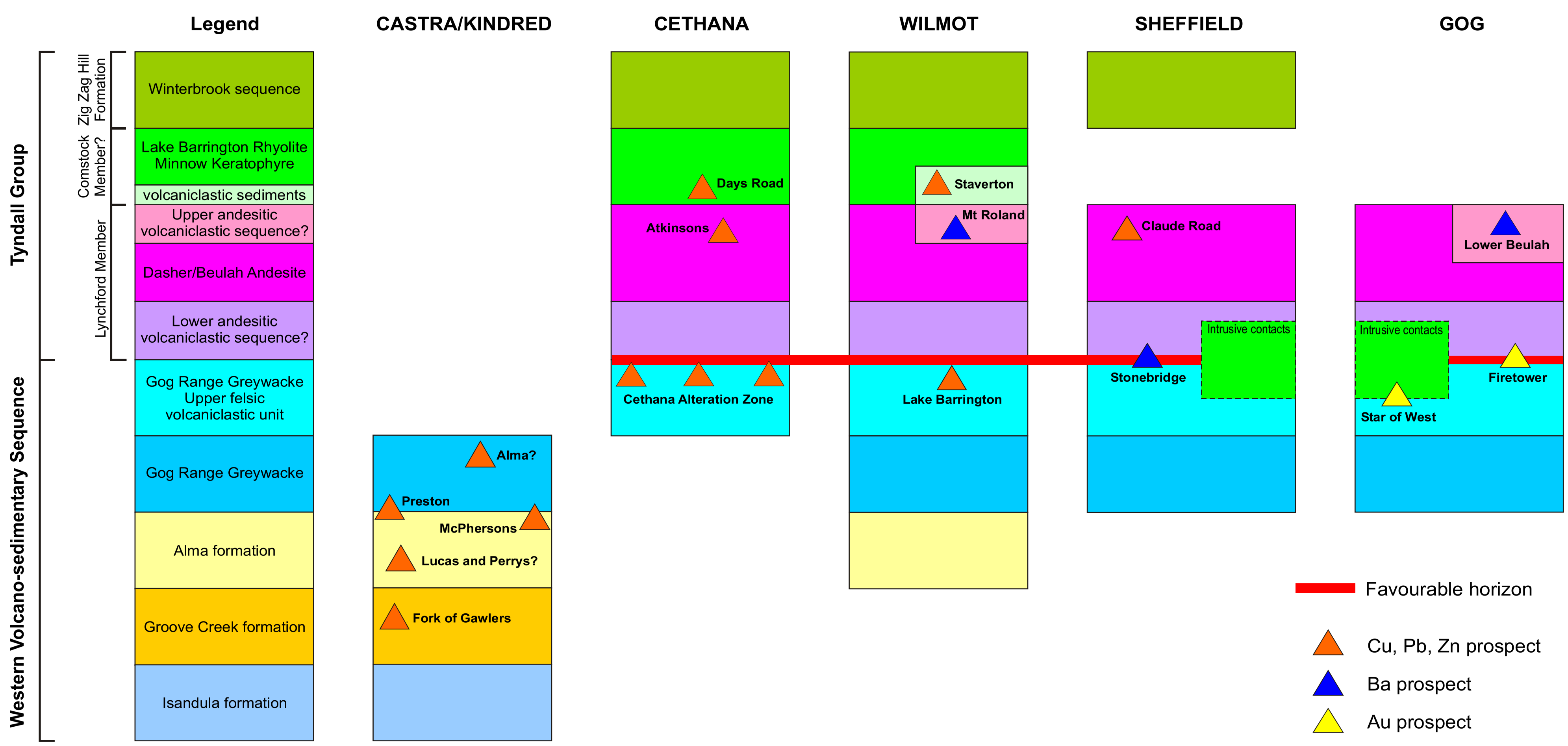

Figure 4

Cambrian stratigraphy and mineralisation in the Castra–Gog area.

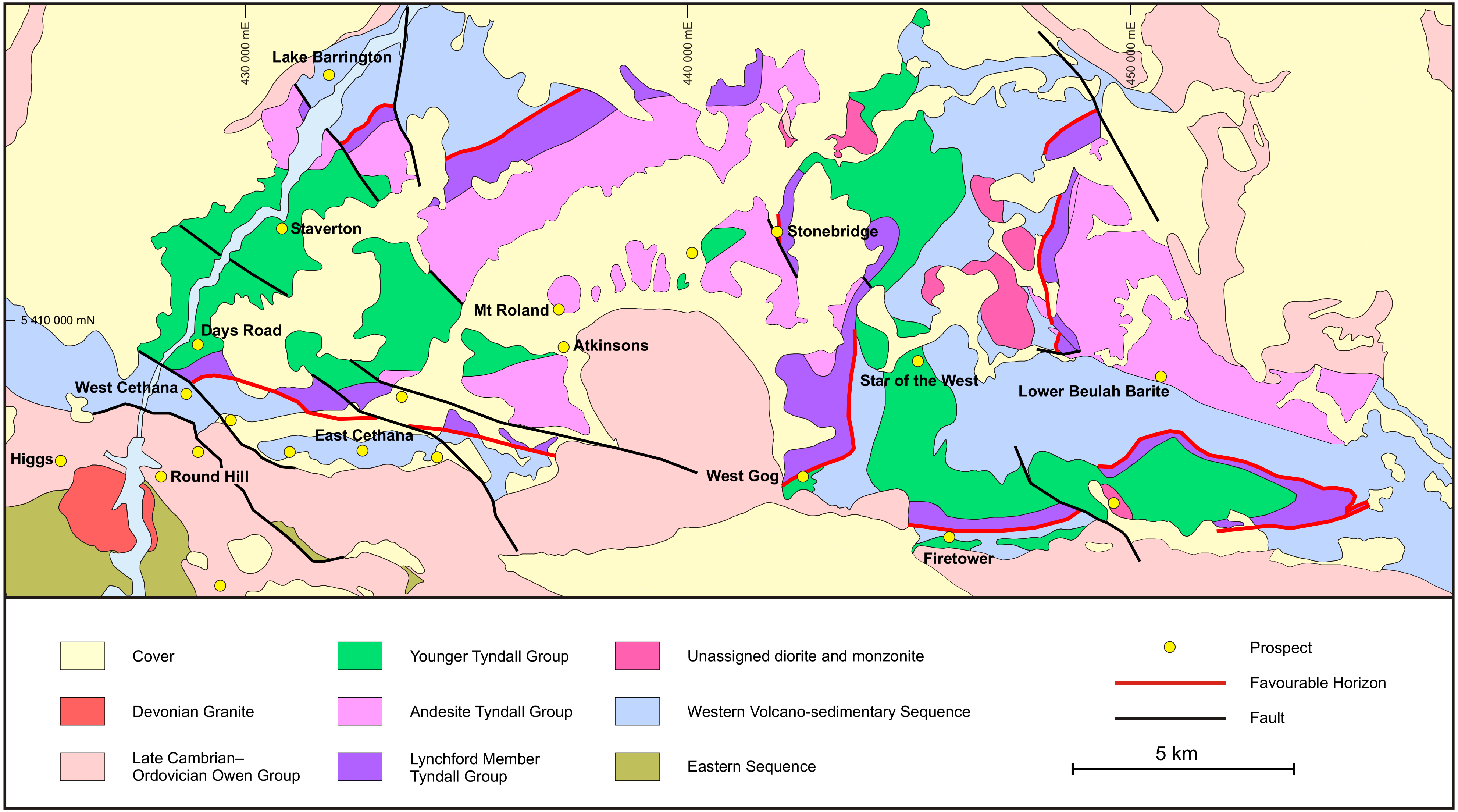

Figure 5

Simplified geology of the Cethana–Gog area.

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[9 July 2008]