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Mount Read Volcanics Compilation

Report on field investigations Mt Darwin–Mt Murchison Region

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SUMMARY

The southern Mount Read Volcanics, east and southeast of the Henty Fault system, is well established as a highly prospective region for volcanigenic copper-gold and gold deposits, but some aspects of the regional geology which have critical implications for future exploration are not adequately understood.

This project involved a series of field traverses which, in combination with the newly acquired WTRMP aeromagnetic and radiometric images, examined:

- the potential to discriminate between the Eastern Quartz-Phyric Sequence (EQPS) and quartz-rich volcanic facies of the overlying Tyndall Group; and
- the evidence for a link between mineralisation and intrusive granites and porphyries.

In the Jukes–Darwin area relatively unaltered quartz-rich lavas and volcaniclastic rocks, with a basal conglomerate, unconformably overlie the eastern flank of the Darwin Granite and the Central Volcanic Complex (CVC) felsic lavas and porphyries along strike to the north. The conglomerate includes clasts of granite, quartz-feldspar porphyry and felsic lava and the unconformity is interpreted as the Tyndall–CVC contact. All exposed mineralisation is hosted in the upper CVC and surrounding hydrothermal alteration has a clear radiometric signature.

There is no requirement for an EQPS in this area.

Quartz-feldspar porphyritic volcanic rocks on the eastern side of Mt Lyell underlie middle and upper Tyndall lavas and volcaniclastic rocks. No evidence of a Tyndall–EQPS contact could be found and the porphyries are considered probable correlates with lower Tyndall volcanic rocks in the Jukes–Darwin area. If this interpretation is correct then the Burbury copper-gold anomaly is located near the lower–middle Tyndall boundary, stratigraphically equivalent to the highest alteration at Henty.

At Red Hills quartz-phyric Tyndall volcanic rocks overlie CVC pink felsic lava, chloritic schist and black shale, hosting patchy copper-gold and zinc-lead mineralisation, in a setting which correlates with the Jukes–Darwin area.

Between Lake Dora and the Murchison Granite, close to the eastern margin of the Dundas Trough, the stratigraphic relationships are less clear. Relatively unaltered polymict volcanolithic conglomerates are in contact with quartz-phyric and felsic aphanitic volcanic rocks with common intrusions of granite, quartz porphyry and pegmatite veins. Patchy alteration and mineralisation is common in the quartz-phyric rocks. In the absence of more precise granite dates, and with no convincing magnetic or rock chemistry data to correlate the quartz-phyric rocks with the Tyndall Group, the current work supports an EQPS at the CVC stratigraphic level and a reduced Tyndall stratigraphy in the Lake Dora–Selina area.

From a field mapping perspective, the CVC lavas, porphyries and granites can be considered as extrusive and intrusive facies of a late Middle Cambrian rhyo-dacitic magmatic episode. The distribution of pervasive pink feldspar alteration, and vein and fracture-controlled chlorite and magnetite alteration, is approximately uniform across the various facies. The regional magnetic high which envelopes the granites can be interpreted to include substantial amounts of felsic lava and quartz-feldspar porphyry.

Demonstration of Tyndall Group cover along the eastern margin of the Jukes–Darwin area confirms greenfields exploration potential for buried Mt Lyell (and possibly Henty) style deposits along a 20 km north-south belt between South Darwin Plateau and Mt Huxley.

Under-explored prospects for gold and base metals exist near Comstock and in the Firewood Siding Fault–Henty Fault area, centred on the Yolande River.

Introduction

A program of field geology investigations was instigated by Mineral Resources Tasmania (MRT) to follow up the acquisition of new high quality seamless airborne magnetics and radiometric surveys during the Western Tasmanian Regional Minerals Program (WTRMP). The new geophysics presents an ideal opportunity to re-examine some of the key unresolved issues of the regional-scale economic geology of western Tasmania, with direct implications for future mineral exploration.

Several independent geologists and geophysicists have been contracted by MRT to contribute to projects ranging from ground checking apparent geophysical anomalies to incorporating the geophysics into regional stratigraphic and structural re-evaluations.

K. C. Morrison Pty Ltd was contracted to conduct a twenty-day project during February–April 2002, concentrating on aspects of the economic geology in the southern part of the Mount Read Volcanics (MRV). This report covers the results of that work. The project is part of a broader scoped study over the total Mount Read Volcanics north of Macquarie Harbour, being compiled by Dr Keith Corbett.

Scope of the project

Within the Mount Read Volcanics, the rocks and mineralisation lying east and southeast of the Henty Fault system exhibit some stand-out characteristics which will require consideration in any future exploration program.

1. The large majority of deposits and prospects identified to date are non-massive, copper-gold or gold pyrite, chalcopyrite systems occurring at the stratigraphic top of the Central Volcanic Complex (CVC) or its western equivalent, the Yolande River Sequence (YRS). Relatively minor zinc-lead massive sulphide deposits and prospects do occur in the region and they are usually hosted in black shale or limestone at the top of the CVC or the base of the Tyndall Group.

2. The CVC geology of the region is dominated by rhyolitic lava domes and common porphyritic and granitic intrusions ranging from rhyolitic to andesitic in composition. Extensive pink potassic alteration pervades the felsic rocks regionally and prospect-scale alteration zones dominated by some combination of sericite, chlorite, pyrite magnetite, quartz, jasper, cherty silica and barite are associated with mineralisation. At some of the main deposits and prospects, the CVC–Tyndall contact position is occupied by andesite or dacite with a characteristic potassium, rare earth and phosphorous signature. These rocks are considered by some explorers to be genetically linked to the ore deposits.

3. Outcropping Middle–Late Cambrian granites approximate the northern and southern boundaries of the belt of copper and gold deposits. The Murchison Granite and Darwin Granite intrude CVC lavas and possibly extend as high as the Late Cambrian Owen Conglomerate, although they are generally unconformably overlain by the Tyndall Group and in terms of radiometric dating are contemporaneous with the other MRV units. Magnetics indicate a near-continuous belt of subsurface granite joining the northern and southern outcrops. In some current economic geology research these granites are flagged as magmatic sources, or at least heat engines, for the copper-gold mineralisation in a genetically related spectrum of submarine deposits ranging from porphyry style, to epithermal style, to volcanic-hosted massive sulphide style (Large *et al.*, 2001).

4. Previous regional mapping by the Tasmanian Geological Survey has recognised a prevalence of quartz-rich volcanic and volcaniclastic rocks along the eastern margin of the Mount Read Volcanics in the copper-gold belt (Corbett, 1992). There has always been difficulty in determining whether these quartz-phyric rocks belong in the Tyndall Group or to an eastern subdivision, stratigraphically equivalent to the CVC (i.e. the Eastern Quartz-Phyric Sequence – EQPS), or some of both. Determination of this stratigraphic issue is critical for the exploration potential in the region because a belt of Tyndall Group rocks covering the top CVC–base Tyndall ore deposition horizon creates major exploration potential for undiscovered mineralisation along a 60 km north–south belt.

The investigations covered by this report are restricted to the region outlined above and aimed mainly at gaining a new insight into the exploration importance of the EQPS and the Cambrian granites. The investigations were primarily field based, with support from thin section petrography and rock chemistry; relatively minor literature-sourced information has been used. A combination of the new geophysical imagery, a fresh look at some of the key outcrop traverses, and information readily contributed to the project by company exploration geologists working in the area have resulted in the observations and conclusions to be discussed.

Acknowledgments

Many of the observations and interpretations recorded in this report were made during field inspections carried out jointly by Keith Corbett and Ken Morrison. The author wishes to acknowledge the benefit gained from working on the ‘Mount Reads’ with Keith Corbett, but of course takes full responsibility for any interpretations which turn out to be incorrect.

The generous input of time and geological information by Mike Vicary and Tim Callaghan (Aurion Gold Ltd) and Andrew McNeil (Pasminco Exploration) is

gratefully acknowledged. Their guidance during examination of outcrops and drill core, and the associated geological discussion, were a valuable contribution to this project. Copper Mines of Tasmania Pty Ltd (CMT) are thanked for making available their library at Mt Lyell and some thin sections. Several other colleagues at MRT, University of Tasmania and in industry have provided helpful information.

All new map prints, thin sections and analytical data used in the project were produced by staff at MRT and co-ordinated by the program manager Dr Geoff Green. Their support is gratefully acknowledged.

Field traverses

Figure 1 shows the 1:250 000 digital geology compilation of the project area and the location of the twelve main field traverses. Additional field and core shed time was spent on aspects of the Mt Lyell and South Henty alteration systems and their stratigraphic settings.

Traverse 1: South Darwin Plateau

Main findings

- The eastern margin of the Darwin Granite is overlain by felsic, typically quartz-phyric, lavas and volcaniclastic rocks with a basal conglomerate at the contact including granite clasts (384 093 mE, 5 318 553 mN; 384 084 mE, 5 319 755 mN; 384 075 mE, 5 319 114 mN).
- The Darwin Granite consists of several facies ranging from coarse holocrystalline granite with pink feldspar alteration to medium white graphic granite and quartz porphyry. Pervasive feldspar alteration and localised magnetite-hematite-chlorite-tourmaline-quartz veining is common.
- Pods of pink felsic lava within the granite mass appear to be either CVC roof pendants or xenolith rafts.

Traverse 2: East Darwin

Main findings

- The eastern margin of pink aphanitic felsic CVC lavas north of the Darwin Granite is overlain by quartz-phyric lavas and flow volcaniclastic rocks, with a basal polymict volcanic breccia at the contact (384 317 mE, 5 323 146 mN).
- The basal breccia is underlain by a felsic volcanic unit, hydrothermally altered to a sericite schist with zones of silica-pyrite. Mineralisation and intense alteration are confined to the underlying schistose volcanic rocks.

Traverse 3: Intercolonial Spur

Main findings

- The Upper Tyndall Group consists of polymict conglomerate and laminated vitric ash mudstone.
- No definite contact at the eastern margin of the CVC lavas was found but an abrupt change, from relatively unaltered feldspar-phyric and quartz-phyric volcaniclastic rocks and lavas to pervasively altered pink felsic lavas with spherulitic textures, occurs at the position of the mapped contact.
- Zones of intense chlorite, barite, jasper, hematite and quartz alteration occur within the CVC lavas and they coincide with a radiometric anomaly.
- Small patches of relatively unaltered volcaniclastic conglomerate, including clasts of probable CVC lava, overlie the CVC lavas. They are likely to be erosional remnants of basal Tyndall Group (383 528 mE, 5 324 825 mN).

Traverse 4: Jukes Proprietary

Main findings

- The eastern limit to the exposed alteration and mineralisation is a depositional contact, with relatively unaltered quartz-rich, polymict volcaniclastic conglomerate overlying the mineralised volcanic rocks (383 563 mE, 5 331 112 mN).
- The alteration and mineralisation is hosted in aphanitic felsic volcanic rocks intruded by quartz-feldspar porphyries (383 649 mE, 5 331 132 mN) in a zone of shearing and faulting.
- The centre of most intense alteration is 400 m north (downslope) of the Jukes Proprietary workings and previous exploration drill holes. This consists of massive and stockworked magnetite-hematite and barite development and sulphide stringers, which coincides with magnetic and radiometric anomalies.

Traverse 5: Miners Ridge

Main findings

- No field evidence was located for a source of the magnetic high considered likely to be an andesite.
- Gravity-magnetics modelling of known and possible andesites of various chemical signatures is needed to discriminate sites prospective for more ground follow-up.

Traverse 6: Burbury

Main findings

- Consistent correlation exists between magnetic highs and upper Tyndall Group conglomerates containing detrital magnetite. Magnetics confirms the mapped northwest-plunging anticlinal structure of the magnetic conglomerates and underlying rocks.
- No field evidence was found for a subdivision boundary. The lowermost unit in the anticline is a schistose quartz-phyric and feldspar-phyric coherent volcanic rock, probably belonging to the lower Tyndall Group (387 521 mE, 5 342 270 mN).
- The Burbury Prospect alteration sites are hosted in middle-lower Tyndall Group aphanitic and quartz-phyric felsic lavas and volcaniclastic rocks.

Traverse 7: Yolande River West

Main findings

Outcrop in the Yolande River valley, for 2000 m upstream from the Eldon Group contact, consists of a uniform interbedded association of pebbly, arkosic volcaniclastic sandstone, polymict conglomerate and laminated vitric ash mudstone. These rocks probably belong to the Tyndall Group but the sandstone and conglomerate sampled exhibit unusually low magnetic susceptibility (0–3.7 units).

- No strongly magnetic rocks were encountered. Explanation of the apparent structure defined by the strong aeromagnetic high requires further field work.

Traverse 8: Yolande River East

Main findings

- Coherent volcanic rocks comprising quartz-feldspar ± hornblende porphyries extend only for 300 m downstream from the Zeehan Highway. All other rocks encountered comprise interstratified arkosic volcaniclastic sandstone and vitric and crystal-rich ash tuffs, all of which have very low magnetic susceptibilities (0–0.2 units).
- The nature of a Yolande River Sequence–Tyndall Group contact and any related magnetic contrast has not been determined. This requires further summer field work, petrography and chemistry on the more remote rocks in the central part of the valley.

Traverse 9: Lake Dora

Main findings

- An association of quartz-phyric coherent and fragmental volcanic rocks, including intrusive facies of granite and quartz-feldspar porphyry, hosts patchy zones of chlorite, silica, pyrite and chalcopyrite (387 745 mE, 5 353 954 mN). Small bodies of magnetic biotite-phyric andesite are also present (e.g. 387 338 mE, 5 355 603 mN).
- Several obscured contacts exist between the above association and polymict volcaniclastic conglomerates, including basement quartzite clasts. This unit is an upper Tyndall Group litho correlate but its stratigraphic relationship to the mineralised volcanic rocks is unclear.

Traverse 10: Selina

Main findings

- A probable contact between Lower Owen quartzite conglomerate and very coarse quartz-rich polymict volcaniclastic Tyndall Group conglomerate exists at the Anthony Dam. Clasts in the Tyndall conglomerate include aphanitic felsic lava, sericite schist, granite, quartz porphyry, chert and abundant hematite. Locally, hematite veining occurs in the conglomerate (385 559 mE, 5 363 746 mN).
- Interbedded banded vitric ash tuff and pebbly arkosic sandstone occur adjacent to the Tyndall conglomerate but the stratigraphic relationships were not observed (385 381 mE, 5 363 308 mN).
- South of the Tyndall Group rocks, a unit of siliceous vitric volcanic rock, in part quartz porphyritic, is heavily brecciated, with magnetite chlorite veining, and is intruded with pegmatitic granite and quartz veining (385 447 mE, 5 363 039 mN).

Traverse 11: Red Hills

Main findings

- An exposure of autobrecciated, flow-banded felsic lava with a basal conglomerate, overlying a chloritic feldspar-porphyritic schist, is interpreted as a Tyndall–CVC contact (381 437 mE, 5 365 880 mN).
- The CVC rocks in the area are dominated by an extensive dome of pink felsic lavas with a characteristic blocky outcrop form. They host several small pyrite-chalcopyrite shows and show strong similarity to the Intercolonial Spur lavas and alteration.

Traverse 12: Murchison

Main findings

- At Tunnel End, Lake Mackintosh, the Murchison Granite appears to be in fault contact with ?Upper Owen sandstone. The fault zone hosts vein quartz and sulphide mineralisation which has permeated 1–2 m into both wall rocks. The Murchison Granite is fine grained and sheared and includes facies of granodiorite, aplite and quartz porphyry.
- On the main traverse (west of Anthony Road) an association of quartz-porphyritic and aphanitic felsic coherent volcanic rocks hosts patchy

sulphide-mineralised zones of intense chlorite alteration and is intruded by granite veins (385 402 mE, 5 373 469 mN). A peperitic contact between quartz porphyry and a volcaniclastic sandstone is exposed (386 152 mE, 5 373 155 mN).

Discussion and Conclusions

The Tyndall Group–Eastern Quartz-Phyric Sequence problem

This problem can be demonstrated by following the history of mapping the Mount Read Volcanics in the Darwin– Jukes area. Corbett (1976) produced the first modern era map over the south Darwin Plateau, including its western and eastern margins. He recognised three volcanic associations, including an eastern sequence of volcaniclastic rocks, conglomerate and quartz-feldspar porphyry, which unconformably overlies the Darwin Granite. These rocks would now be called the Tyndall Group, and the other associations the Central Volcanic Complex (CVC) and the Western Sequence/Yolande River Sequence (in the Clark Valley).

These subdivisions were used on the 1988 1:100 000 scale Department of Mines MRV Compilation (Map 6, Corbett and McNeill, 1988). By 1993, when the more detailed 1:25 000 scale *Geology of the Mt Jukes–Mt Darwin Area* (Map 13, Corbett *et al*., 1993) was published, and attempts to accommodate the complex interplay between facies architecture and regional stratigraphy were included, the Eastern Quartz-Phyric Sequences (EQPS) was recognised as an eastern CVC correlate, in addition to the overlying Tyndall Group. At the same time, Jones (1993) mapped coherent dacitic lavas overlying CVC and Darwin Granite along the eastern Darwin Plateau flank and assigned them entirely to the Tyndall Group.

Another Honours thesis (Gadaloff, 1996) concentrated on the East Darwin area. This work recognised the Tyndall Group–CVC contact, but regionally followed the Map 13 stratigraphy and explained the Jones (1993) map by predicting that the EQPS pinches and narrows towards the current land surface, and therefore it could be absent at East Darwin.

Wyman (2001) saw the Tyndall Group as unconformably overlying Darwin Granite and CVC between South Darwin Plateau and Jukes but mapped EQPS between the CVC and Tyndall at Jukes Proprietary.

Traverses 1–4 of the current project largely concur with the original 1976 work. At Jukes Proprietary (Traverse 5), basal Tyndall volcaniclastic conglomerate is deposited over sheared and hydrothermally altered CVC felsic lava and rhyolitic to rhyodacitic (Appendix 1) quartz-feldspar porphyry. The pink feldspar alteration and sheared fabric of the coarse porphyries gives them an apparent granitic texture. An intrusive contact exposed at 383 649 mE, 5 331 132 mN shows the coarse porphyry intruding aphanitic felsic lava. Within a few metres of this exposure basal Tyndall conglomerate outcrop includes clasts of lava, porphyry, vitric tuffaceous mudstone and abundant volcanic quartz crystals. In conclusion, no evidence was seen between South Darwin and Jukes Proprietary to justify an EQPS subdivision.

Tyndall Group lithologies exposed in this area do not correlate closely with the type area stratigraphy (White and McPhie, 1996). On the eastern side of the Darwin Plateau, Tyndall Group rocks could be subdivided into two associations; an upper association of polymict volcanolithic conglomerate and banded vitric tuffaceous mudstone (Zig Zag Hill Formation correlate), and a lower sequence of aphanitic and quartz-phyric felsic lavas and quartz-rich flow volcaniclastic units, with a thin basal polymict volcaniclastic conglomerate (in places more like a breccia). In outcrop this lower Tyndall association does not exhibit the characteristic Mt Julia Member crystal sandstone or any evidence of the shale, limestone, andesite or other 'Lynchford Tuff' associations which would permit a Lynchford Member correlation.

The only significant major element character in the selectively sampled coherent volcanic rocks from Traverses 1–5 is variation in the Na_2O/K_2O ratio (Appendix 1), which probably reflects variation in albitic and potassic feldspar alteration. There are some useful trends in the transition metals data (Appendix 1). Vanadium is depleted in the CVC samples MRV 11–12 and tungsten is elevated in both the CVC and Tyndall conglomerates rich in CVC clasts (MRV 11–14). These four samples are all from Jukes Proprietary, within the alteration zone. MRV 7 and 8 are elevated in zinc and strontium. MRV 7 is from Intercolonial Spur and MRV 8 is from East Darwin. In thin section both rocks appear to be felsic lavas with substantial sericite replacement of feldspar but there is no other obvious explanation for the anomalies.

MRV 9 has relatively anomalous strontium depletion. Thin section examination showed the rock to be texturally the most volcaniclastic of the set. Opaque and mafic grains were noted and this may account for the elevated magnesium, although it is not reflected in higher magnetic susceptibility (Appendix 1).

The lead data fall into two groups; MRV 1–5 are all close to level of detection and MRV 6–14 range from 14–67 ppm, with a uniform range. There is no apparent explanation in the geology for this pattern so it would be worth re-analysing for lead before speculating on the cause of these results.

In the Burbury prospect area, on the eastern side of Mt Lyell, the aeromagnetics are consistent with the plunging anticlinal structure mapped on the Queenstown 1:25 000 scale geological map sheet (Corbett *et al*., 1989). In particular the magnetics pick the detrital magnetite content of polymict conglomerate and sandstone, in contrast to the magnetically low volcanic rocks lower in the stratigraphy. The main purpose of Traverse 6 was to look for a contact between the crystal-rich sandstone unit Ett (Mt Julia Member correlate) and the underlying quartz-feldspar porphyritic coherent volcanic rocks. No contact was found and there is no evidence for a contrast in alteration intensity between the two units. Thin section descriptions by Tony Crawford (internal CMT report, 1998) class the porphyries as lavas and volcanic intrusive rocks with moderate sericitic alteration. The weak copper-gold Burbury prospect mineralisation and locally intense alteration is located at the base of the overlying Mt Julia Member, in quartz-phyric lavas and volcaniclastic rocks. XRF data on four samples of coherent porphyry from the lower sequence (Jaeger, 1996) are very similar to the Tyndall rocks from the Jukes–Darwin area. Zinc values range from 66–134 ppm in the Burbury porphyries, which are higher than most of the Jukes–Darwin samples, except for MRV 7 and 8 (135 and 140 ppm respectively), in which anomalous sericitic alteration was also noted.

Overall, there is no reason to assign the Etv porphyries to the EQPS and they should be considered as lower Tyndall on the existing information.

At Red Hills a flow banded quartz-phyric and feldspar-phyric lava overlies a feldspar-porphyritic chloritic schist at 381 437 mE, 5 365 880 mN. The lava has a basal polymict breccia at the contact and the lower sequence is dominated by the Red Hills pink felsic lava, with patchy chloritic alteration and associated weak pyrite-chalcopyrite shows. The geology correlates well with Intercolonial Spur and the contact is interpreted as lower Tyndall unconformably overlying more pervasively altered CVC.

The stratigraphy is more difficult to interpret in the area between Lake Dora and Murchison, sampled by Traverses 9, 10 and 12. The only rocks confidently assigned to the Tyndall Group in these three areas are the polymict conglomerate lithocorrelates of the Zig Zag Hill Formation.

Although no contacts were seen, these conglomerates appear to overlie consistently quartz-phyric volcanic rocks which are more pervasively altered than the conglomerates, and which host patchy zones of chlorite and magnetite brecciation with sulphide. Intrusive quartz porphyries, granite and pegmatite veins were observed at the three locations.

Resolution of the EQPS problem in these areas requires more precise granite dates than are available. Even the SHRIMP microprobe U-Pb dates on magmatic zircons, which have errors of ± 4 million years (a big advance on the 1985 Darwin Granite age of 510 +64 –21 Ma) are still insufficient to differentiate EQPS from Tyndall. Given that the recent Beulah Granite date of 493 ± 4 Ma sits within the MRV population of dates, and that the regional geology and magnetics provide no evidence that the Murchison Granite is post-Tyndall (in contrast to the Darwin Granite which is clearly pre-Tyndall), it appears that quartz-rich volcanic rocks of CVC age are prevalent in the Lake Dora–Murchison region. An EQPS subdivision is supported by this interpretation.

The Tyndall Group stratigraphy also appears markedly reduced in the same region, with no proven Tyndall rocks pre the major erosional event which produced the polymict volcanolithic conglomerates. On the eastern side of the Anthony Dam, Lower Owen quartzite conglomerate overlies very coarse Tyndall polymict conglomerate with apparent conformity. The conglomerate contains football-sized clasts of granite, porphyry, quartz-phyric volcanic rocks, sericite schist, basement metamorphic rocks and abundant smaller angular clasts of cherty rocks, vitric mudstone and hematite. The abundance of hematite could be indicating eroded alteration although there is also intact hematite veining cross-cutting the conglomerate.

This position (385 559 mE, 5 363 746 mN) is just south of the Jukes Conglomerate pinch-out shown on the Selina 1:25 000 scale geological map (Corbett *et al.*, 1995), and less than two kilometres from the eastern margin of the Dundas Trough. Again, the interpretation of all the quartz-phyric MRV rocks, other than the polymict conglomerate, being pre-Tyndall EQPS at Selina relies on the intrusive granites being the same age as the Darwin Granite.

Granite and related intrusive rocks — Exploration implications

The most recent and detailed study of the Darwin Granite and possible links with mineralisation is the Ph.D. study of Wyman (2001). The Darwin Granite is an I-type magnetite series Suite 1 (Crawford *et al.*, 1992) granite. Mapped contact relationships show that white micro granites, granodiorite and porphyries are later than the most abundant coarse pink granite phase, but major element and rare earth element (REE) modelling suggests that the white granite is fractionated from the pink.

Wyman concludes from the trace element and REE data that the Darwin Granite has near identical Suite 1 characteristics to the surrounding CVC lavas but that the granite was sourced from a Murchison Granite-like parent magma, which has not yet been identified.

Mass balance work explains the regional scale K_2O, Fe_2O_3 and B enrichment but it is not clear that the Jukes–Darwin mineralisation is directly related to the pervasive pink alteration and tourmaline veining. Most isotopic evidence points to a high magmatic sulphur input to mineralisation throughout the Darwin–Murchison region but it is a challenge to prove the primary source of the magmatic mineralising fluids. Wyman (2001) concludes that apatites from both Prince Lyell and Garfield have nearly identical REE patterns to both Mt Lyell Suite II andesites and to the more mafic phases of the Murchison Granite. On the basis of Nd signatures, the apatite-magnetite component of Prince Lyell ore is linked to a Murchison Granite-type parent magma, in contrast to the Garfield apatite which can be sourced from an andesite.

There is further regional geochemical evidence of a genetic link between the more mafic phases of both the granites and porphyries, and the Suite 2 andesites and dacites. Work by RGC/Goldfields Exploration (M. Vicary, pers. comm., 2002) indicates Suite 2 affinities for some YRS porphyries in the Diamond Hill area and for the Late Cambrian Beulah Granite (well to the northeast of this project area, but still in the MRV).

Linking the granites to mineralisation becomes more complicated when the distribution of the Darwin–Murchison granite, as defined by outcrop and magnetics, is considered. The granite belt projects east of Mt Lyell, under the Burbury prospect, and despite the fact that the northern (Murchison) end of the belt is an appropriate source magma according to the REE model, an additional subsurface pluton of the same chemistry is required, below or west of Mt Lyell, with connection to Mt Lyell by the Great Lyell Fault (Wyman, 2001).

Huston and Kamprad (2001) identified an inner alteration zone of pyrophyllite, topaz, fluorite and rare earth mineral enrichment, and coincident extreme potassium and cesium depletion, around the Western Tharsis ore body at Mt Lyell. This high sulphidation acid sulphate alteration assemblage has granitic affinities and is linked to the bornite-rich mineralisation style, which is prevalent at North Lyell and also present at Western Tharsis. The Huston and Kamprad study showed that the pyrophyllite-bornite style is part of the same mineralising event as the dominant sericite-chlorite-quartz-chalcopyrite association at Mt Lyell, although the former does overprint the latter. On the basis of lead isotope data from Prince Lyell and literature reports of hydrothermal alteration extending as high as the Pioneer Beds (now considered as the basal unit of the Gordon Group), they predicted that an undiscovered Ordovician granitic magma sourced the Mt Lyell ore bodies, except for the exhalative massive sulphide deposit at Tasman Crown.

Recent exploration by CMT in the Linda Valley, and detailed mapping over the mine lease by Corbett (2001), clearly shows that there is no primary hydrothermal alteration in Owen Group and Gordon Group rocks at Mt Lyell. Fossil evidence suggests that the Haulage Unconformity may represent a 30–40 million year hiatus during the Early Ordovician and that the only post-Haulage mineralisation is the copper clay deposits, which are contained in Devonian synclines and appear to be formed by Cainozoic groundwater and regolith development processes (Wills, 1995). Tasman Crown is actually the youngest known hydrothermal deposit at Mt Lyell, having a sea floor syn-volcanic origin in Lynchford Member (Middle–Late Cambrian) time. At Henty, mineralisation/alteration climbs stratigraphically as high as middle Tyndall (Mt Julia Member), reflecting the mineralising control of syn-volcanic growth faults in the MRV (Callaghan, 2001). The age issue does not diminish the importance of the Huston and Kamprad (2001) alteration study and in particular the evidence for North Lyell and Prince Lyell mineralisation being part of the same system is consistent with the new mapping (Corbett, 2001).

The evidence for a near-continuous belt of outcropping and subsurface intrusive granites is based on gravity-magnetics modelling by Leaman, Leaman and Richardson and Payne (summarised by Wyman, 2001). The Darwin Granite was interpreted as a narrow plug, not large enough to be discriminated from its host volcanic rocks by gravity alone. It is recognised that the high magnetic response of detrital magnetite in Tyndall Group volcaniclastic rocks makes granite discrimination very difficult in areas such as eastern Mt Lyell (Large *et al*., 1996), and when the envelope of magnetic highs on the new WTRMP survey is compared to the geology, it is quite likely that the regional anomaly includes felsic lavas and quartz porphyries, as well as granite. Some of the CVC intrusive porphyry at Jukes Proprietary gave relatively high magnetic susceptibility readings (Appendix 1) and on Traverse 12 at Murchison, pink felsic lava is more magnetic (5.6–11.4 units) than juxtaposed quartz-biotite porphyry with minor pegmatite veining (0.2–1.5 units).

The apparent co-existence of quartz-feldspar porphyritic intrusive rocks with granite, as noted on the South Darwin Plateau, Jukes Proprietary, Lake Dora and Murchison traverses, is consistent with mapping observations around the Murchison Granite (A. McNeill, pers. comm., 2002) and at the Selina prospect (Hunns, 1987; Godsall, 1999). The distribution and intensity of pervasive pink potassic alteration appears equivalent in both the Darwin and Murchison granites and in the rhyolite lava domes at Intercolonial Spur, Beatrice (Keratophyre Knob) and Red Hills. Similarly, the more discrete zones of chlorite and magnetite-hematite-quartz ± barite ± sulphide veins occur in the Darwin Granite and at Intercolonial Spur, Beatrice, Lake Dora, Red Hills, Selina and Murchison. Their frequency and intensity do not appear to depend on depth to granite, as modelled by gravity and magnetics.

The notion of the heat engine for the MRV orebodies relying on relatively narrow granite plugs is an unconvincing concept, given that the rocks between the Darwin Granite and Murchison Granite represent a continuous 60 km range of Cambrian volcanoes. The field distribution of coherent extrusive and intrusive facies and their fragmental equivalents suggests a genetic link between all these rocks and mineral deposits, with the granite holding no special place in the genesis of the ore bodies. In terms of key exploration criteria, the stratigraphic position at top CVC/YRS/EQPS–base Tyndall Group, near a syn-volcanic fault, and the recognition of definite hydrothermal alteration, are far more important factors than the presence of granite. If the coarse pink granite phases of the Darwin Granite were replaced by felsic lavas and quartz-feldspar porphyries, the sub-Tyndall exploration potential of the Jukes–Darwin area would not change.

The stratiform Suite 2 andesites and dacites, such as those at Newton Creek and Comstock, have the potential to be recognised chemically and magnetically, even when heavily overprinted by alteration, and therefore in prospect generation work they represent target horizons close to the CVC/YRS/EQPS–Tyndall contact ore position. As with the granites, no particular genetic link to mineralisation is required.

Exploration potential of the region

Current trends in mining company restructuring and their growth strategies suggest that exploration in the foreseeable future will be single commodity focussed and that only tenements covering larger geologically coherent domains, with potential to yield a major ore body, will attract serious expenditure on greenfields exploration.

Clearly the Mount Read Volcanics remain prospective for zinc, copper and gold (lead and silver can now be considered as by-products to the main target metals) and the region covered by this project is prospective for copper and gold. Deposits and prospects of zinc-lead-silver massive sulphide discovered to date in the project area tend to be hosted in black shale (e.g. Red Hills, Itat Creek) or limestone (e.g. South Henty, Comstock–Tasman Crown) in either the upper CVC or lower Lynchford Member, and they tend to be small or diffuse. The Tasman Crown–Beatrice area is certainly a sensible place to explore for base metal massive sulphides but, on the basis of our present geological knowledge, promotion of the exploration potential of this region should emphasise the core attractions — i.e. the potential to discover another buried Henty–Mt Julia, Comstock–North Lyell, Prince Lyell or Iron Blow.

Prospective areas should show evidence of the structural and stratigraphic settings which host the known ore bodies, and evidence of hydrothermal alteration. Total dose and potassium radiometric images from the new WTRMP surveys show excellent resolution of outcropping alteration zones from Mt Lyell to Mt Darwin. Discrete radiometric highs exist around Comstock, Cape Horn, Jukes Proprietary, Intercolonial Spur and East Darwin and other anomalous sites, as well as the major high over Mt Lyell. The resolution of the radiometrics at Jukes Proprietary is sufficient to correlate with the impressive outcropping magnetite-barite-sulphide stringer alteration observed on Traverse 4. The centre of this intense alteration anomaly is offset 400 m north of the old workings and all previous exploration drilling. It is surrounded by broad zones of altered CVC volcanic rocks, which have been studied by Doyle (1990) and Wyman (2001).

Recognition of genuine hydrothermal alteration associated with mineralisation is always a challenge in the field, particularly with respect to the pervasive potassic and phyllosilicate alteration styles and the need to eliminate diagenetic and metamorphic alteration components. At Mt Lyell a useful criterion has been to map the boundaries between schist and recognisable volcanic lithologies. Where hydrothermal feldspar destruction to sericite or chlorite is sufficiently intense, so that the Devonian foliation overprints all volcanic textures, and the rock requires mapping as a schist, it is a good indication of closeness to mineralisation. In this circumstance weathering is an aid to mapping, because the same rocks which present as schist in outcrop typically show clear textural evidence of their volcanic precursors, and appear cleaved rather than schistose in fresh drill core.

A good example of the relevance of the schistosity criterion can be seen on the East Darwin Traverse 2. A quartz-phyric volcaniclastic breccia with moderate sericitic alteration at 384 312 mE, 5 323 146 mN unconformably overlies a sericite schist with small pods of silica-pyrite alteration/mineralisation elongated into the foliation.

There may be potential to combine the airborne radiometrics with PIMA data from field samples, to fine tune the discrimination of hydrothermal alteration and map prospect boundaries.

The basal breccia–mineralised schist contact exposed at East Darwin on Traverse 2 is interpreted as Tyndall Group unconformably overlying CVC felsic volcanic rocks. The mineralisation is only exposed because erosion has removed the Tyndall cover but not the upper CVC.

Confirmation of the erosional unconformity along the eastern margin of the Darwin Plateau substantially enhances the copper-gold (Mt Lyell styles) potential of the Jukes–Darwin area. The belt of Tyndall Group rocks is large enough to cover another Mt Lyell mineral field and the small shows of alteration and mineralisation exposed west of the Tyndall–CVC contact may be the edges of a major mineralised horizon dipping east towards a sub-Tyndall Group contact between the CVC and the Owen Conglomerate.

Figure 2 is a schematic cross section depicting this play. If the CVC–Owen contact is a west-dipping reverse fault, like the Great Lyell Fault, then a Mt Lyell replica

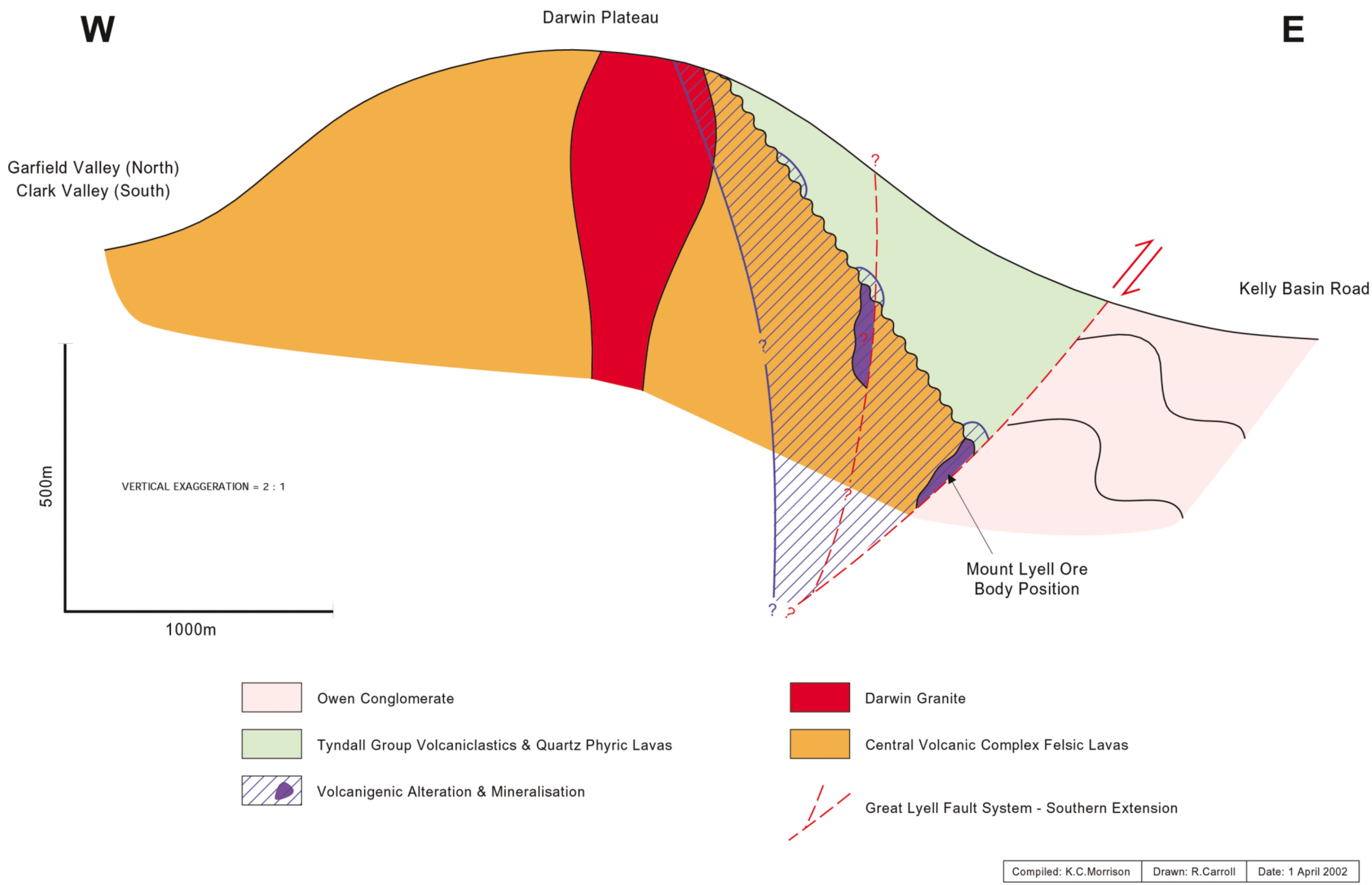

Figure 2. *Schematic cross section showing Cu-Au exploration potential of the Jukes–Darwin area, southern Mount Read Volcanics*

structural-stratigraphic setting is quite possible anywhere between South Darwin and Jukes Proprietary.

Given the effectiveness of CSAMT in seeing known pyrite-chalcopyrite ore bodies on the Mt Lyell mineral field, a series of east–west CSAMT lines from Crotty Road to the outcrop position of the Tyndall–CVC contact would be a worthwhile method to test for drill targets.

Is there any evidence for subsurface andesites beneath the Tyndall cover? Some of the magnetic images used in this project do show north-striking zones of magnetic highs east of the outcropping Darwin Granite, within the area of Tyndall outcrop. There may be scope to model these highs and narrow the list of possible sources.

Most of the mineralisation shows in the Jukes–Darwin area are pyrite-chalcopyrite containing copper-gold but there is some evidence for stand-alone gold prospectivity. Alluvial gold exists in very thin gravel overlying pink CVC felsic lavas at Allans Creek. Norgold Exploration explored the area during 1985–1989 and identified a zone of cherty silica with anomalous background gold in the CVC, approximately 700 m south of the alluvial material. Norgold interpreted this zone as the source of the alluvial gold but felt that the potential was too small (Mathison and Gardner, 1987)). At that time the Tyndall Group rocks one kilometre east of Allans Creek were mapped as EQPS, i.e. at the same stratigraphic horizon as the CVC felsic lavas. An alternative explanation for the Allans Creek alluvial gold is that it is a residual lag from the erosion of lower Tyndall mineralisation and therefore the equivalent ore horizon would still exist in the subsurface, east of the Tyndall–CVC contact. Norgold also discovered gold in a vein prospect some three kilometres south of Allans Creek and on the southern side of Mt Darwin. Norms Prospect consists of a 200 m long quartz vein hosted in CVC rhyolite. The vein yielded patchy gold in chip samples but no evidence of mineralisation in parallel veins or in the wall rocks was encountered and the prospect was abandoned (Gardner, 1988).

The Jukes–Darwin play cannot be projected far north of Jukes Proprietary with any confidence (even though prospects with outcropping copper-gold sulphide mineralisation exist between Mt Huxley and South Lyell, at Burbury, Lake Dora, Selina, Red Hills and Murchison) because of the lack of certainty regarding Tyndall Group cover. The potential of these prospects has not changed as a result of this project.

Outside of the Henty–South Henty trend, the most prospective recognised area for a new Henty-style discovery is the major development of chert and jasper alteration overprinting andesite near Comstock, on the northern margin of the Mt Lyell mineral field. This alteration system remains notably under-explored for gold, due mainly to the fact that company strategies at Mt Lyell have focussed on copper. Previous exploration has generated anomalies which remain untested and with present day understanding of the genetic links between Henty, Comstock and North Lyell, the prospectivity of Comstock is further enhanced (Corbett, 1997).

The belt of YRS and Tyndall Group rocks, which extends from the Firewood Siding Fault north to the Henty Fault, is prospective for gold and base metal exploration. The Yolande River valley cuts through the centre of this area and exposes a near-continuous section of volcanic and volcaniclastic rocks younging to the southwest. Traverses 7 and 8 crossed the southwest and northeast ends of this section, in an attempt to tie in the character of the aeromagnetic data across the valley with the stratigraphic-structural traverse down the Yolande River by Selley and Meffre (1997).

The Firewood Siding Fault is certainly a major Devonian structure, juxtaposing Eldon Group rocks against the YRS, but it has long been proposed (e.g. Berry and Keele, 1997) as a major Middle Cambrian transfer structure. Small outcrops of basaltic andesite with conformable peperitic basal contacts occur along the northern edge of the fault, near the stratigraphic top of the Lower Yolande Cycle of Selley and Meffre (1997). These rocks provide evidence in support of syn-volcanic faulting in YRS time.

Several gold shows exist between Pearl Creek and the Yolande River, in the eastern belt of YRS volcanic rocks which includes major development of quartz, feldspar and hornblende-phyric porphyries, some of which have the Suite 2 chemistry (M. Vicary, pers. comm., 2002). In the southern part of this area, close to the fault, quartz, barite and quartz-barite veining is common and some of the gold shows are within these veins. It is likely that these mineralised veins are Devonian but the presence of barite veins, and the fact that the largest gold show is confined to the YRS Diamond Hill quartz porphyry, increases the possibility of Cambrian gold mineralisation. The Diamond Hill prospect appears to be a sheeted vein system, grading in part to a quartz veinlet stockwork (Griffiths, 1998) and it has never been drilled.

Selley and Meffre picked a Lower–Upper Yolande Cycle boundary in the Yolande River at 375 500 mE, 5 345 850 mN, on the basis of an abrupt change in strike and lithofacies, suggesting a change in basin geometry. All of the porphyries, including Diamond Hill, are in their Lower Cycle. The upper YRS and Tyndall units are apparently conformable, with the basal Tyndall unit, picked as a Lynchford Member correlate, of thickly bedded crystal-rich sandstone with a high detrital magnetite content and a tholeiitic composition. Most of the rocks seen on Traverse 7 were banded ash mudstone, pumiceous volcaniclastic sandstone and polymict volcanolithic wacke and conglomerate, consistent with Zig Zag Hill Formation lithologies.

For some two kilometres upstream from the Pearl Creek intersection, the YRS–Tyndall boundary is parallel to the Yolande River on the Selley and Meffre (1997) map. At the stream junction the Tyndall rocks are interpreted as a north-plunging syncline. If the fold-like magnetic high (which coincides with a potassium low on the radiometrics) is due to Lynchford Member sandstone (it equally could be due to Zig Zag Hill Formation conglomerate), then the Tyndall rocks would appear to swing further around to the southeast and up Pearl Creek than is shown on the Selley and Meffre map. A summer traverse up Pearl Creek to the Firewood Siding Fault should resolve the question. The magnetically high fold does appear to be truncated at the mapped position of the Henty Fault, north of the Yolande River, so it is an attractive area to discover Lynchford Member rocks.

It is possible that the magnetic high is sourced from the upper Yolande River Sequence. This would be consistent with the generally low magnetic susceptibility readings encountered from outcrop on Traverse 7, where only the ?upper Tyndall polymict conglomerates (1.3–4.0 units) gave susceptibility values >0.2. Another possibility is that the Upper Yolande Cycle of Selley and Meffre (1997) is actually the lower Tyndall and the apparent unconformity mapped by Selley and Meffre at their Lower–Upper Yolande Cycle contact is actually the YRS–Tyndall boundary. More mapping, with plenty of magnetic susceptibility readings and thin section petrography, is needed to determine where the major provenance changes occur.

One outcome of this project has been the sobering reminder of the valuable role field mapping still has in MRV prospect generation, particularly if ample rock samples are taken for petrography and lithogeochemistry and if the geological compilation maps utilise the high quality aeromagnetic and radiometric data now available. It is important to understand how mapped geology evolves through successive phases of work and how cost effective it can be in generating prospect-scale targets.

References

BERRY, R. F.; KEELE, R. A. 1997. Cambrian tectonics and mineralisation in western Tasmania, *in:* Third International Mining Geology Conference. 13–16. *Publication Australian Institute of Mining and Metallurgy* 6/97.

CALLAGHAN, T. 2001. Geology and host-rock alteration of the Henty and Mount Julia gold deposits, Western Tasmania. *Economic Geology* 96:1073–1088.

CORBETT, K. D. 1976. Volcanic stratigraphy and Cambro–Ordovician relationships in the South Darwin Peak–Mt Sorell area: a preliminary report. *Unpublished Report Department of Mines Tasmania* 1976/44.

CORBETT, K. D. 1992. Stratigraphic-volcanic setting of massive sulfide deposits in the Cambrian Mount Read Volcanics, Tasmania. *Economic Geology* 87:564–586.

CORBETT, K. D. 1997. *CMT Pty Ltd, a review of geology, mineralisation and exploration at Comstock, Mt Lyell Mine Lease*. [Unpublished].

CORBETT, K. D. 2001. New mapping and interpretations of the Mount Lyell mining district, Tasmania: a large hybrid Cu-Au system with an exhalative Pb-Zn top. *Economic Geology* 96:1089–1122.

CORBETT, K. D.; MCNEILL, A. W. 1988. *Mt Read Volcanics Project Map Series. Map 6. Geological compilation map of the Mount Read Volcanics and associated rocks Hellyer to South Darwin Peak*. Department of Mines Tasmania.

CORBETT, K. D.; CALVER, C. R.; EVERARD, J. L.; SEYMOUR, D. B. 1989. *Geological Atlas 1:25 000 scale series. Queenstown*. Department of Mines Tasmania.

CORBETT, K. D.; PEMBERTON, J.; VICARY, M. J. 1993. *Mt Read Volcanics Project Map Series. Map 13. Geology of the Mt Jukes–Mt Darwin area*. Department of Mines Tasmania.

CORBETT, K. D.; MCNEILL, A. W.; JACKSON, J. C. 1995. *Geological Atlas 1:25 000 scale digital series. Sheet 3836. Selina*. Mineral Resources Tasmania.

CRAWFORD, A. J.; CORBETT, K. D.; EVERARD, J. L. 1992. Geochemistry of the Cambrian volcanic-hosted massive sulfide-rich Mount Read Volcanics, Tasmania, and some tectonic implications. *Economic Geology* 87:597–619.

DOYLE, M. 1990. *The geology, mineralisation and alteration of the Jukes Proprietary prospect, western Tasmania*. B.Sc. (Hons) thesis, University of Tasmania : Hobart.

GADALOFF, C. 1996. *Cambrian copper-gold vein mineralisation in the East Darwin area, western Tasmania*. B.Sc. (Hons) thesis, University of Tasmania : Hobart.

GARDNER, D. 1988. *EL 6/85 – Jukes Darwin. Report on exploration activity August, 1987 to August, 1988*. Electrolytic Zinc Company of Australasia Limited Mineral Resources Division Report T233 [TCR 88-2861].

GODSALL, W. 1999. *Annual Report Part 2. A review of exploration over the Lake Selina area, EL 19/98, Anthony*. Goldfields Exploration Ltd [TCR99-4358].

GRIFFITHS, A. G. 1998. *Geology, geochemistry and magnetic character of Yolande River Sequence porphyries northwest of Queenstown, western Tasmania*. B.Sc. (Hons) thesis, University of Tasmania : Hobart.

HUNNS, S. R. 1987. *Mineralisation of the Lake Selina prospect*. M.Sc. thesis, University of Tasmania : Hobart.

HUSTON, D. L.; KAMPRAD, J. 2001. Zonation of alteration facies at Western Tharsis: Implications for the genesis of Cu-Au deposits, Mt Lyell Field, western Tasmania. *Economic Geology* 96:1123–1132.

JAEGER, O. 1996. *Stratigraphy, facies analysis and structure of the Tyndall Group, east of Mt Lyell, western Tasmania*. B.Sc. (Hons) thesis, University of Tasmania : Hobart.

JONES, A. T. 1993. *The geology, geochemistry and structure of the Mount Darwin-South Darwin Peak area, western Tasmania*. B.Sc. (Hons) thesis, University of Tasmania : Hobart.

LARGE, R.; DOYLE, M.; RAYMOND, O.; COOKE, D.; JONES, A.: HEASMAN, L. 1996. Evaluation of the role of Cambrian granites in the genesis of world class VHMS deposits in Tasmania. *Ore Geology Reviews* 10:215–230.

LARGE, R. R.; MCPHIE, J.; GEMMELL, J. B.; HERMANN, W.; DAVIDSON, G. J. 2001. The spectrum of ore deposit types, volcanic environments, alteration halos, and related exploration vectors in submarine volcanic successions: Some examples from Australia. *Economic Geology* 96:913–938.

MATHISON, I. J.; GARDNER, D. 1987. *EL 6/85 — Jukes Darwin. Report on exploration activity August, 1986 to August, 1987.* Electrolytic Zinc Company of Australasia Limited Mineral Resources Division Report T226 [TCR 87-2706].

SELLEY, D.; MEFFRE, S. 1997. Structure and sedimentology of Middle and Upper Cambrian strata adjacent to the Firewood Siding Fault, *in: Structure and mineralisation of western Tasmania. AMIRA Project P.291A. Final Report* 77–102. Centre for Ore Deposit and Exploration Studies, University of Tasmania : Hobart.

WHITE, M. J.; MCPHIE, J. 1996. Stratigraphy and palaeovolcanology of the Cambrian Tyndall Group, Mt Read Volcanics, western Tasmania. *Australian Journal of Earth Sciences* 43:147–159.

WILLS, K. J. A. 1995. Open cut potential of the Copper Clays area, Mount Lyell, Tasmania, *in:* MORRISON, K. C.; WILLS, K. J. A.; CORDERY, G. R. *Linda EL52/94 Annual Report. Year 1 (13-1-95 to 13-1-96).* Copper Mines of Tasmania Pty Ltd [TCR 95-3804].

WYMAN, W. F. 2000. *Cambrian granite-related hydrothermal alteration and Cu-Au mineralisation in the southern Mount Read Volcanics, western Tasmania, Australia.* Ph.D. thesis, University of Tasmania : Hobart.

[28 April 2002]

APPENDIX 1

Rock Analyses

Rock Sample ID and Magnetic Susceptibility

Location	Tasrock/Field No.	Lithology (Field/thin section)	Stratigraphic Unit	Ti/Zr	Magnetic Susceptibility 10^{-5} SI	GPS Co-ordinates
South Darwin	010901/MRV-1	feldspar, quartz porphyritic lava	TG	12.90	0.7–1.1	385 095 mE, 5 317 940 mN
South Darwin	010902/MRV-2	quartz, feldspar porphyritic lava	TG	12.60	0.6–1.3	385 050 mE, 5 318 000 mN
South Darwin	010903/MRV-3	schistose quartz-phyric volcaniclastic	TG	11.20	0.5–1.1	384 956 mE, 5 318 041 mN
South Darwin	010904/MRV-4A	feldspar, quartz porphyritic lava	TG	11.20	0–0.02	384 755 mE, 5 318 131 mN
South Darwin	010905/MRV-4B	feldspar, quartz porphyritic lava	TG	11.60	1.1–4.1	384 436 mE, 5 318 284 mN
South Darwin	010906/MRV-5	polymict volcaniclastic breccia	TG	10.40	0.1–0.2	384 075 mE, 5 319 114 mN
South Darwin	010907/MRV-6	polymict spherulitic ignimbrite	TG	10.40	0–0.1	384 093 mE, 5 318 553 mN
Intercolonial Spur	010908/MRV-7	sericitic quartz-phyric lava	TG	9.70	0–0.05	384 446 mE, 5 324 517 mN
East Darwin	010909/MRV-8	feldspar, quartz-phyric lava	TG	9.00	0.3–1.2	385 004 mE, 5 322 990 mN
East Darwin	010910/MRV-9	quartz-phyric volcaniclastic + opaques	TG	9.20	0–0.2	384 838 mE, 5 323 051 mN
East Darwin	010911/MRV-10	sericitic polymict lava-rich volcaniclastic	TG	10.40	0.02–0.06	384 635 mE, 5 322 969 mN
Jukes Proprietary	010912/MRV-11	sheared quartz, pink feldspar porphyritic intrusive	CVC	7.40	2.7–5.0	383 563 mE, 5 331 112 mN
Jukes Proprietary	010913/MRV-12	sheared quartz, pink feldspar porphyritic intrusive	CVC	9.70	0–0.02	383 580 mE, 5 331 060 mN
Jukes Proprietary	010914/MRV-13	sericitic porphyry-rich volcaniclastic breccia	TG	11.90	0.6–1.3	383 649 mE, 5 331 132 mN
Jukes Proprietary	010915/MRV-14	sericitic porphyry-rich volcaniclastic breccia	TG	8.80	0.2–0.8	383 630 mE, 5 331 099 mN

Reg. No.	20020127	20020128	20020129	20020130	20020131	20020132	20020133	20020134	20020135	20020136	20020137	20020138	20020139	20020140	20020141
Field No.	MRV-1	MRV-2	MRV-3	MRV-4A	MRV-4B	MRV-5	MRV-6	MRV-7	MRV-8	MRV-9	MRV-10	MRV-11	MRV-12	MRV-13	MRV-14
Tasrock	010901	010902	010903	010904	010905	010906	010907	010908	010909	010910	010911	010912	010913	010914	010915
SiO_2	70.70	70.03	70.55	72.83	69.78	74.40	71.67	71.22	69.19	71.83	67.38	69.06	72.78	73.92	72.51
TiO_2	0.46	0.48	0.46	0.49	0.49	0.41	0.43	0.48	0.43	0.29	0.45	0.34	0.30	0.53	0.36
Al_2O_3	14.42	15.34	15.13	14.80	14.74	13.55	15.29	14.82	16.15	14.56	17.87	11.26	13.63	12.55	10.42
Fe_2O_3	2.66	2.76	2.14	1.36	2.45	1.53	2.00	1.75	2.57	2.65	1.63	1.89	1.18	1.76	4.88
FeO	0.70	0.38	0.83	0.70	1.09	0.96	0.58	1.35	0.90	0.96	1.35	4.93	0.83	2.18	2.24
MnO	0.01	0.00	0.01	0.00	0.04	0.01	0.01	0.05	0.07	0.04	0.06	0.18	0.01	0.02	0.02
MgO	0.56	0.18	0.70	0.25	0.85	0.56	0.64	0.59	0.71	1.06	0.82	0.57	0.27	0.57	0.56
CaO	0.09	0.06	0.05	0.06	0.14	0.08	0.04	0.58	0.51	0.02	0.25	0.09	0.05	0.04	0.02
Na_2O	4.60	5.61	2.31	3.20	5.12	2.33	0.69	1.34	0.99	0.08	0.09	0.13	0.11	0.07	0.08
K_2O	4.19	3.50	4.90	4.67	3.66	4.05	5.54	3.79	4.24	4.77	4.09	7.25	8.68	5.89	5.26
P_2O_5	0.05	0.02	0.05	0.02	0.06	0.02	0.02	0.07	0.03	0.01	0.03	0.04	0.02	0.03	0.03
SO_3	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.02	0.01	0.01	0.01	0.02
CO_2	0.29	0.17	0.35	0.19	0.21	0.28	0.26	0.68	0.21	0.22	0.41	1.58	0.12	0.28	0.37
H_2O^+	0.96	1.11	2.00	1.27	0.89	1.51	2.34	2.90	3.65	3.09	5.05	1.95	1.20	2.02	2.39
TOTAL	**99.70**	**99.64**	**99.49**	**99.85**	**99.53**	**99.70**	**99.52**	**99.62**	**99.66**	**99.58**	**99.50**	**99.27**	**99.19**	**99.85**	**99.16**
L.O.I.	1.17	1.24	2.26	1.38	0.98	1.68	2.54	3.43	3.76	3.20	5.31	2.98	1.23	2.06	2.51
Co (ppm)	<8	<8	<8	<8	8	<8	<8	<8	8	11	<8	<8	<8	<8	<8
As (ppm)	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Bi (ppm)	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Ga (ppm)	13	14	16	15	15	15	16	16	17	15	18	13	13	17	17
Zn (ppm)	34	21	27	46	56	72	69	135	140	51	80	47	26	56	71
W (ppm)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	22	<10	21	25
Cu (ppm)	6	5	19	5	5	7	12	8	<5	34	13	10	8	10	145
Ni (ppm)	5	5	5	6	5	5	6	6	7	9	5	7	5	5	6
Sn (ppm)	<9	<9	<9	<9	<9	<9	<9	<9	<9	<9	<9	<9	<9	<9	<9
Pb (ppm)	<10	<10	<10	12	<10	<10	20	67	42	12	34	30	12	14	46
S (%)	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cr (ppm)	8	13	7	10	11	<5	5	7	6	13	<5	6	7	8	10
V (ppm)	46	54	35	55	56	28	34	33	33	31	36	7	16	55	23
Sc (ppm)	<9	<9	11	11	10	<9	9	14	11	<9	10	16	<9	11	12
Nd (ppm)	28	42	32	45	24	47	36	35	62	23	43	41	42	30	35
Ce (ppm)	76	100	53	105	83	100	100	105	58	28	125	76	110	74	55
La (ppm)	38	54	43	54	26	65	54	53	105	25	67	59	78	44	46
Ba (ppm)	930	670	2900	1050	860	1050	870	1050	1300	1300	1200	3100	2800	1450	2800
Th (ppm)	<10	13	<10	<10	13	14	18	23	17	22	21	15	16	13	14
Sr (ppm)	98	66	105	105	140	110	25	180	180	8	78	99	51	34	68
U (ppm)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Rb (ppm)	89	70	145	145	90	160	220	150	145	210	145	155	195	205	110
Y (ppm)	32	20	27	35	30	34	35	30	31	29	29	53	32	35	33
Zr (ppm)	210	230	240	260	250	240	250	300	290	185	280	270	185	270	250
Nb (ppm)	13	14	14	15	14	17	17	18	19	18	20	19	17	17	17
Mo (ppm)	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	5	<5	5

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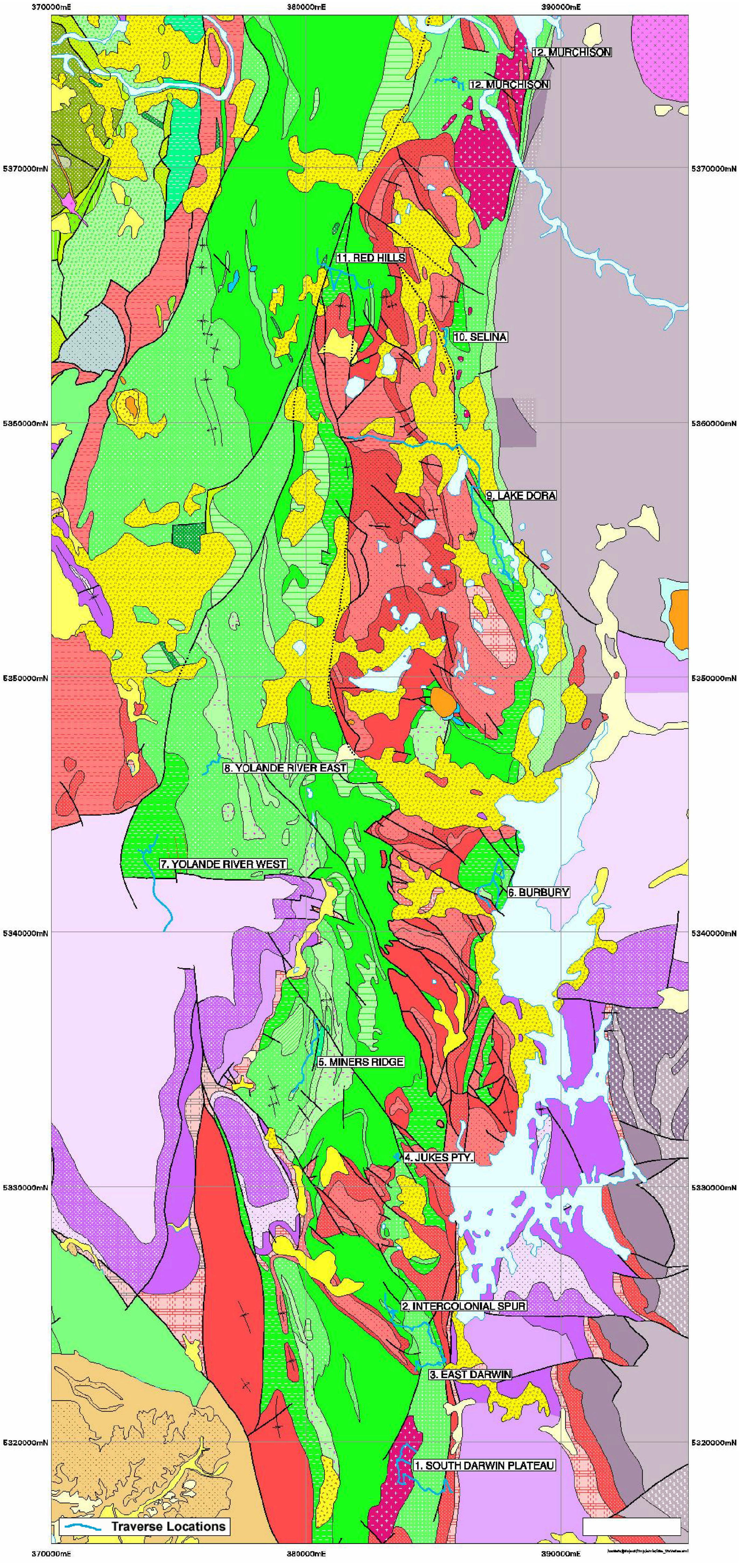

Figure 1
Location of traverses