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1:25 000 Scale Digital Geological Map Series — Explanatory Report 1 —

Explanatory Report for the Maydena, Skeleton, Nevada, Weld and Picton geological map sheets

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EXECUTIVE SUMMARY

The contiguous Maydena, Skeleton, Nevada, Weld and Picton 1:25 000 scale map sheets cover 1000 km^2 of central-south Tasmania (fig. 1, 2), and were mapped between 1987 and 1999. The mapping was undertaken in order to better understand the industrial and metallic mineral potential of this previously poorly-known area. The maps cover parts of two geological provinces:

- in the west, an older province known as the Adamsfield–Jubilee region, composed of deformed, relatively unmetamorphosed Proterozoic to lower Palaeozoic rocks;
- to the east, the Tasmania Basin, of flat-lying Upper Carboniferous to Triassic sedimentary rocks (Parmeener Supergroup) which unconformably overlie the older province, and Jurassic dolerite.

The project built on earlier 1:50 000 scale mapping of adjacent areas to the west (Huntley and Pedder map sheets). Mapping was also undertaken in The Needles area (southeastern part of the Adamsfield 1:25 000 scale sheet); these results are included as Appendix 1 in Calver *et al*. (2006). Areas of the Tasmania Basin, Jurassic dolerite, and those areas incorporated within the World Heritage Area (WHA) in 1989, and unavailable for mineral exploration, were mapped at reconnaissance level only. The rest of the area was covered with 1:25 000 scale level of detail. Mapping reliability information can be obtained from the responsibility diagrams on each of the maps.

The main outcomes of the mapping are summarised below, and given in greater detail in Calver *et al*. (2006). The area contains large reserves of industrial minerals (silica, dolomite and limestone), and is prospective and under-explored for gold, base metals and platinum group elements. The geologically unusual Forster Au-Zn-Ni prospect lies in the south of the mapped area. The work described here has led to a better understanding of the Forster mineralisation, and of the geology and prospectivity of the exposed and concealed basement rocks of southeastern Tasmania.

Three major Proterozoic successions were recognised (fig. 3). Probably the oldest of these is a succession of conglomeratic and sandy turbidite, passing up into distal sandy turbidite and black slate (Harrisons Opening Formation). The base and top are unknown. Faulted against this formation is a sequence of orthoquartzite (quartzarenite), dolostone, siltstone and mudstone, known as the Clark Group, which forms large inliers at Jubilee Range, Glovers Bluff and Gallagher Plateau. Stromatolites and evaporite indicators are locally present in the dolostone and mudstone. The orthoquartzite has been prospected locally as a source of industrial silica. The Clark Group may be a correlate of the early Neoproterozoic Rocky Cape Group of northwest Tasmania.

Overlying the Clark Group with paraconformity or gently angular unconformity is a sequence of predominantly dolostone, with an upper unit of intercalated dolostone, diamictite, sandstone and mudstone (Weld River Group). Pebbly laminated siltstone, and at least some of the diamictite, are probably glacial in origin. This succession is middle to late Neoproterozoic in age, and is probably broadly correlative with the Togari Group of northwest Tasmania, but does not contain mafic volcanic rock. The Weld River Group occupies extensive areas in the Weld valley, the upper Styx valley and the Huon valley around Blakes Opening. Very large resources of industrial dolomite are present. Quartz veining and silicification are widespread in the dolostone, and much of the silicification is probably Mesozoic in age.

The Forster Au-Zn-Ni prospect (Indicated Resource of one million tonnes Au @ 0.42 g/t, Summons, 1999) is hosted in weathered magnesian skarn and siliceous breccia derived from dolostone of the Weld River Group, which forms part of the Glovers Bluff inlier in the eastern part of the Weld map sheet. The contact metamorphism, metasomatism and mineralisation within the Glovers Bluff inlier are attributed to a thick (600 m) intrusion of Jurassic dolerite that surrounds and underlies the inlier (Bottrill *et al*., 1999). This is the first recognised, significant mineralisation associated with the widespread Tasmanian Jurassic dolerite, and this recognition significantly enhances the prospectivity of the entire eastern Tasmanian region.

In faulted contact with the Proterozoic rocks is a unit of lithicwacke, mudstone, chert and basalt, a correlate of the Ragged Basin Complex of presumed Early to Middle Cambrian age. This crops out extensively west of Maydena, and as a small, newly discovered inlier at the eastern edge of the Weld map sheet. Chemically, the basaltic flows fall within the field of within-plate tholeiite and basaltic andesite. Small serpentinite bodies are juxtaposed with these rocks, and are the source of small placer deposits of platinum-group elements.

A probably-Cambrian succession of turbiditic lithicwacke and conglomerate is found west of Maydena, in the middle and lower reaches of the Weld River and in the Huon River east of Blakes Opening. These rocks were derived from a source terrain of quartzose metasediments, sedimentary rocks (including dolostone similar to the Weld River Group), mafic and felsic volcanic rocks, microgranite and ultramafic rocks. Conglomerate in the Glovers Bluff inlier, near the Forster Prospect, is predominantly mafic-ultramafic in composition and strongly talc-altered. Small areas of felsic to intermediate tuff were found in both the correlate of the Ragged Basin Complex and the lithicwacke-conglomerate succession, and are the first *in situ* Cambrian felsic to intermediate volcanic rocks to be found in the Adamsfield–Jubilee region, suggesting a genetic link to the highly mineralised Mt Read Volcanics of western Tasmania.

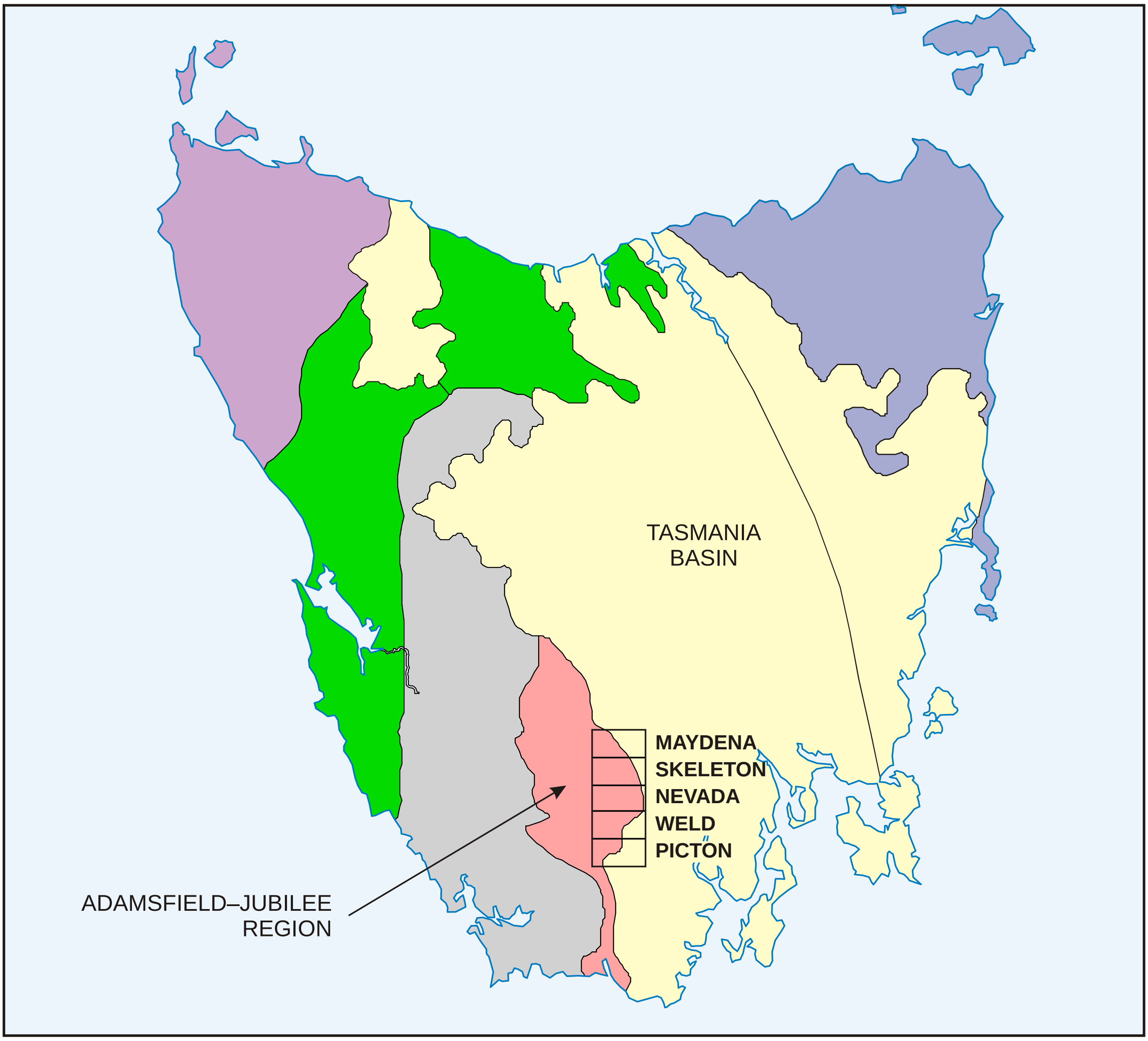

Figure 1

General location plan for the Maydena, Skeleton, Nevada, Weld and Picton map sheets, and major adjoining tectonostratigraphic elements.

The Proterozoic rocks contain evidence for three phases of deformation, which can be tentatively correlated with phases identified previously in the Pedder 1:50 000 scale quadrangle. All three phases probably belong to the Cambrian Tyennan Orogeny (Turner *et al.*, 1998) and decrease in intensity from southwest to northeast. In the Harrisons Opening Formation, tight F_1 folds plunge northwest and have a strong slaty axial planar cleavage in pelites. Later crenulations trend northeast (S_2?) and northwest (S_3?). The Jubilee Range anticline dominates the structure of a large area, and plunges northwest, with a southwest-dipping axial surface. This fold is similar in orientation to major F_1 folds in the Pedder quadrangle, but no axial planar cleavage is present and the rocks are little strained. There are minor northeast-trending cross-folds and faults that are tentatively ascribed to D_2. Structure in some areas (notably the middle Weld valley) remains poorly understood. The Cambrian successions (Ragged Basin Complex and lithicwacke-conglomerate succession) are thought to post-date D_1 but from evidence near The Needles, west of Maydena, pre-date D_3. In Tasmania, the Tyennan Orogeny (broadly equivalent to the Delamerian Orogeny of mainland Australia) is thought to have involved collision of an east-facing passive margin with an oceanic island arc. The ultramafic rocks (serpentinites) and the Ragged Basin Complex are allochthonous rocks of oceanic origin, obducted at this time.

Late Cambrian to Early Ordovician siliciclastic rocks (Denison Group) unconformably overlie the older Cambrian and Proterozoic successions west and north of Maydena, and are conformably succeeded by Ordovician limestone (Gordon Group). Limited extraction of the limestone, and some exploration for industrial purposes, has taken place in the Maydena area.

A major, open Devonian fold in Denison Group and Gordon Group rocks plunges gently northwest near Maydena. Devonian deformation (Tabberabberan Orogeny) appears to have had little effect on the Proterozoic rocks of the Adamsfield–Jubilee region. Newly discovered Gordon Group limestone outcrop dips gently east in the Huon valley downstream of Blakes Opening.

Sub-horizontal Late Carboniferous to Triassic strata, known as the Parmeener Supergroup, comprise the Tasmania Basin succession that unconformably overlies the pre-Carboniferous rocks and occupies the eastern parts of the five map sheets.

The same formations are recognised as in the Hobart and Cygnet areas. Glacigene and glaciomarine rocks form the lower division of the Parmeener Supergroup, range up to Late Permian in age, and locally reach 700 m in thickness. The succession is significantly thinner over basement highs at Weld Ridge, Mt Picton and north of Maydena. The most complete section (Styx valley) begins with glacigene diamictite and siltstone (Truro Tillite), followed by glendonitic dark grey siltstone (Woody Island Siltstone), then fossiliferous siltstone, sandstone and minor limestone (Bundella Formation) which overlaps the basement highs. The Woody Island Siltstone is a weakly petroliferous, potential hydrocarbon source rock and has been prospected for oil shale. Above the Bundella Formation, a thin interval of freshwater or paralic fine-grained sandstone and siltstone (Faulkner Group) passes up into richly fossiliferous, glaciomarine siltstone, calcareous siltstone and sandstone (Nassau Siltstone and Deep Bay Formation); sandstone, glauconitic in places (Minnie Point Formation); coarse-grained sandstone (Risdon Formation); then siltstone and mudstone (Abels Bay Formation).

Cross-bedded, carbonaceous feldspathic sandstone and siltstone, about 30 m thick, marks the base of the upper, entirely freshwater division of the Parmeener Supergroup. This interval includes thin coal seams in the Styx valley and has been correlated with the Late Permian Cygnet Coal Measures of the Cygnet area. Cross-bedded quartz sandstone and subordinate siltstone form the remainder of the Upper Parmeener Supergroup. This interval (~300 m) essentially corresponds to the Early Triassic Ross Formation, but some younger rocks could be present.

Mid-Jurassic dolerite intrusions arise from at least one feeder centre beneath Proterozoic and Cambrian rocks at Glovers Bluff. The Proterozoic and Cambrian rocks here were locally contact metamorphosed and mineralised (Forster Prospect), as mentioned above. From this feeder centre, transgressive sheets several hundred metres thick ascend through the Lower Parmeener Supergroup as stepped or moderately inclined segments and become more sill-like and extensive in the Upper Parmeener Supergroup. The eroded sheet now forms the summits of the highest mountain ranges and plateaux in the eastern parts of the map sheets, and caps the Parmeener Supergroup in most areas.

Normal block faulting of the mapped area took place in the Cretaceous to early Cainozoic, and is most in evidence where the faults displace the flat-lying Parmeener Supergroup stratigraphy and Jurassic dolerite. Faults mainly trend north to northwest, and most downthrow to the east. The Parmeener Supergroup dips gently east in most of the mapped area, and the overall effect of dip and faulting is to displace the Parmeener stratigraphy downwards by several hundred metres from west to east across each of the map sheets.

Conspicuous undissected Last Glacial moraines and cirque lakes are found on the higher mountain ranges above 800 masl. Evidence of older glaciation is seen at lower elevations in the Nevada and Picton map sheets. Slope deposits, particularly dolerite-derived Pleistocene talus, are widespread. Quaternary alluvial deposits, including some higher terrace gravels, border some of the rivers.

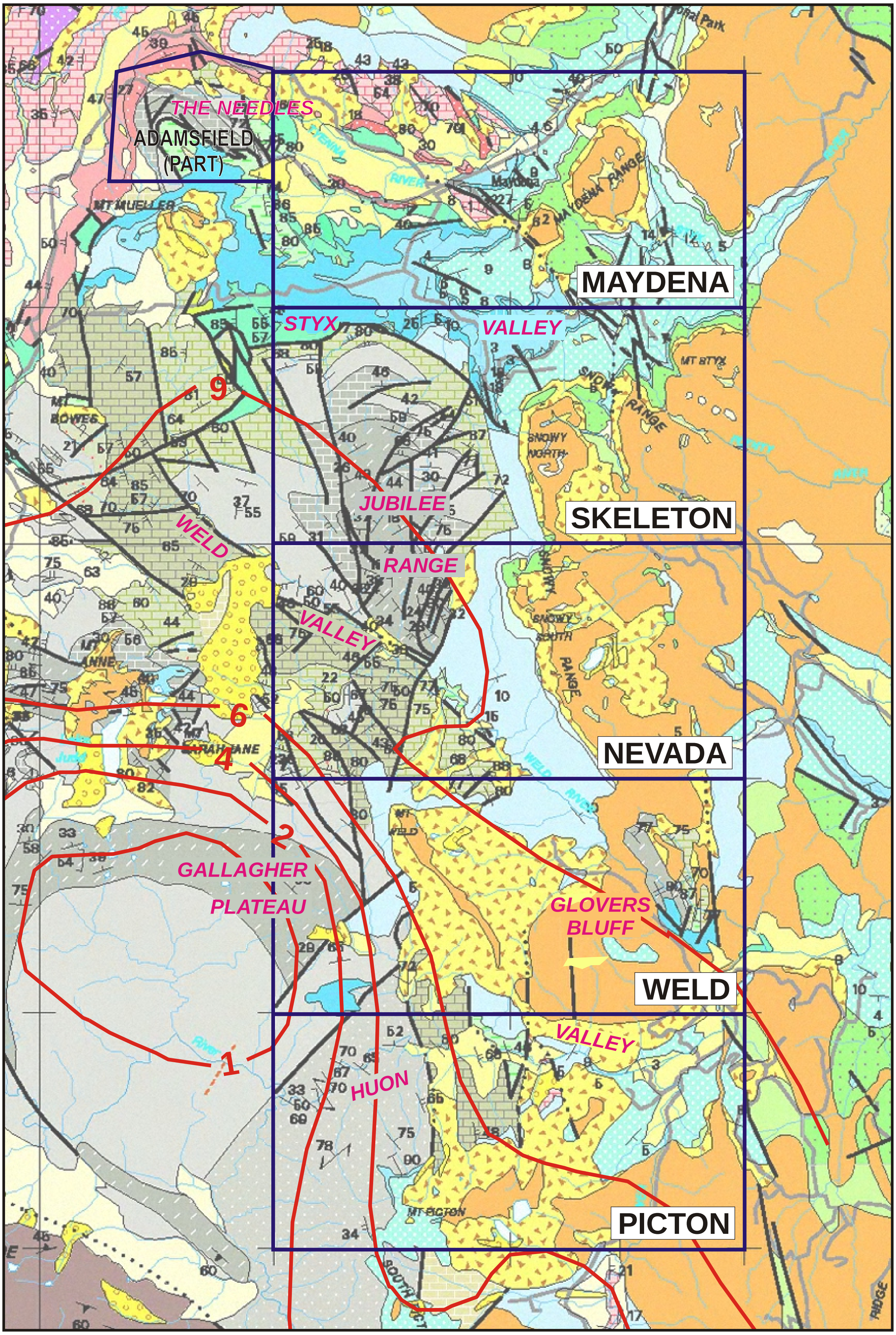

Figure 2

Map sheets on the 1:250 000 scale geology base. The red contours indicate depth to Devonian granite derived from gravity modelling.

GEOLOGICAL OVERVIEW

Previous work

Little previous work has been directed to geological mapping in the area, with the exception of Jago (1972) who mapped part of the Maydena sheet. Adjoining areas to the west (Pedder and Huntley 1:50 000 scale map sheets) are described by Brown *et al*. (1989) and Calver *et al*. (1990). Regional overviews, in the context of Tasmanian geology, are given in Burrett and Martin (1989) and Seymour and Calver (1995).

Proterozoic successions

Like the geologically similar Rocky Cape region of northwest Tasmania, the Proterozoic rocks of the Adamsfield–Jubilee region covered by this mapping have undergone relatively mild deformation and metamorphism during the Cambrian Tyennan Orogeny (Seymour and Calver, 1995; Turner *et al*., 1998). Some generalised stratigraphic correlations between the regions can be suggested, in part based on the new mapping, but there are also significant lithostratigraphic differences as discussed below.

A distinctive succession of conglomeratic and sandy turbidite, passing up into sandy turbidite and abundant shale, is found in the western part of the Picton and Weld map sheets and possibly represents the oldest succession within the mapped area (fig. 2, 3; Plate 1). No similar rocks have been previously described elsewhere in Tasmania, and the succession is here named the Harrisons Opening Formation. Its base and top are unknown. The succession has undergone polyphase deformation and lower greenschist facies metamorphism, and the pelites are generally phyllite or slate. The clasts in the conglomerate are predominantly fine-grained quartzite and chert, which lack pre-depositional cleavage. Further work west of the Picton map sheet might elucidate the relationships between the Harrisons Opening Formation and the other Proterozoic successions.

A succession consisting of orthoquartzite (quartzarenite) overlain by interbedded dolostone and mudstone is faulted against the Harrisons Opening Formation, and is also found in a number of separate inliers in all the map sheets except Maydena. This succession was first named the Clark Group at The Needles (Carey and Banks, 1954, their fig. 3). This name has priority over subsequently applied stratigraphic names (see Appendix 1 of Calver *et al*., 2006). The main Clark Group inliers (Jubilee Range, The Needles, Gallagher Plateau) are complexly faulted, north-plunging major anticlines, partly bounded by areas of a younger dolomitic sequence (Weld River Group). The Clark Group shows a similar degree of deformation to the Harrisons Opening Formation.

The new mapping has shown the presence of a distinctive stratigraphic succession that allows correlation from the type area at The Needles to the other main inliers. Cross bedding and ripple marks are characteristic of the orthoquartzite (Plates 2, 3). Stromatolites and evaporate indicators are locally found in the dolomitic part of the succession (Plates 4, 5). Dating of detrital zircons from the main quartzarenite unit, known as the Needles Quartzite, shows that most of the zircons are 1650–1750 Ma in age, with a smaller population of 1400 Ma age. This age distribution is similar to other Proterozoic quartzarenites from widespread locations in Tasmania (e.g. Strathgordon Metamorphic Complex, Detention Subgroup of the Rocky Cape Group), suggesting that these successions are broadly correlative, and early Neoproterozoic (1000–750 Ma) in age (Black *et al*., 2004).

The Needles Quartzite has been explored for industrial silica at Glovers Bluff, and small vein-hosted base metal deposits occur in dolostone and mudstone near The Needles. Modelling of sparse gravity data suggests that Devonian granite underlies Clark Group correlates at depths of one to four kilometres in the western parts of the Picton and Weld map sheets (fig. 2), but this area is unavailable for mineral exploration.

As in northwest Tasmania, the early Neoproterozoic siliciclastic succession (Clark Group) is overlain at a gently angular unconformity, or erosional paraconformity, by a dolomitic, late Neoproterozoic succession, known here as the Weld River Group (Calver, 1989). Impersistent basal conglomerate and sandstone is overlain by a thick (few kilometres) succession of shallow-marine dolostone, with well-preserved oolitic and peloidal textures in places (Plate 6). An upper subdivision of the Weld River Group, known as the Cotcase Creek Formation, is characterised by an interleaving of dolostone, diamictite (Plate 7), sandstone and mudstone, but no general stratigraphic succession for the Cotcase Creek Formation can be worked out because of structural complexity and a dearth of facing evidence. Laminated siltstone with lonestones is present in places (Plate 8), suggesting a glacial influence on deposition, and by inference a Cryogenian (850–600 Ma) age. The Weld River Group has some lithological similarities to the Togari Group (c. 750–520 Ma) of northwest Tasmania, but lacks the mafic rift volcanic and volcaniclastic rocks that occur in the middle of that succession.

The dolostones are of sufficient purity to be of interest as a source of industrial dolomite. Gravity modelling suggests Devonian granitoids occur at depths of four to nine kilometres beneath the Weld River Group over much of its mapped area (fig. 2), but most of this area is now unavailable for mineral exploration. Quartz veining and silicification are common in the dolostones of the Weld River Group, and zones of particularly intense silicification are found in many places immediately beneath the unconformity at the base of the Lower Parmeener Supergroup (Lower Carboniferous–Permian). A post-Permian, probably

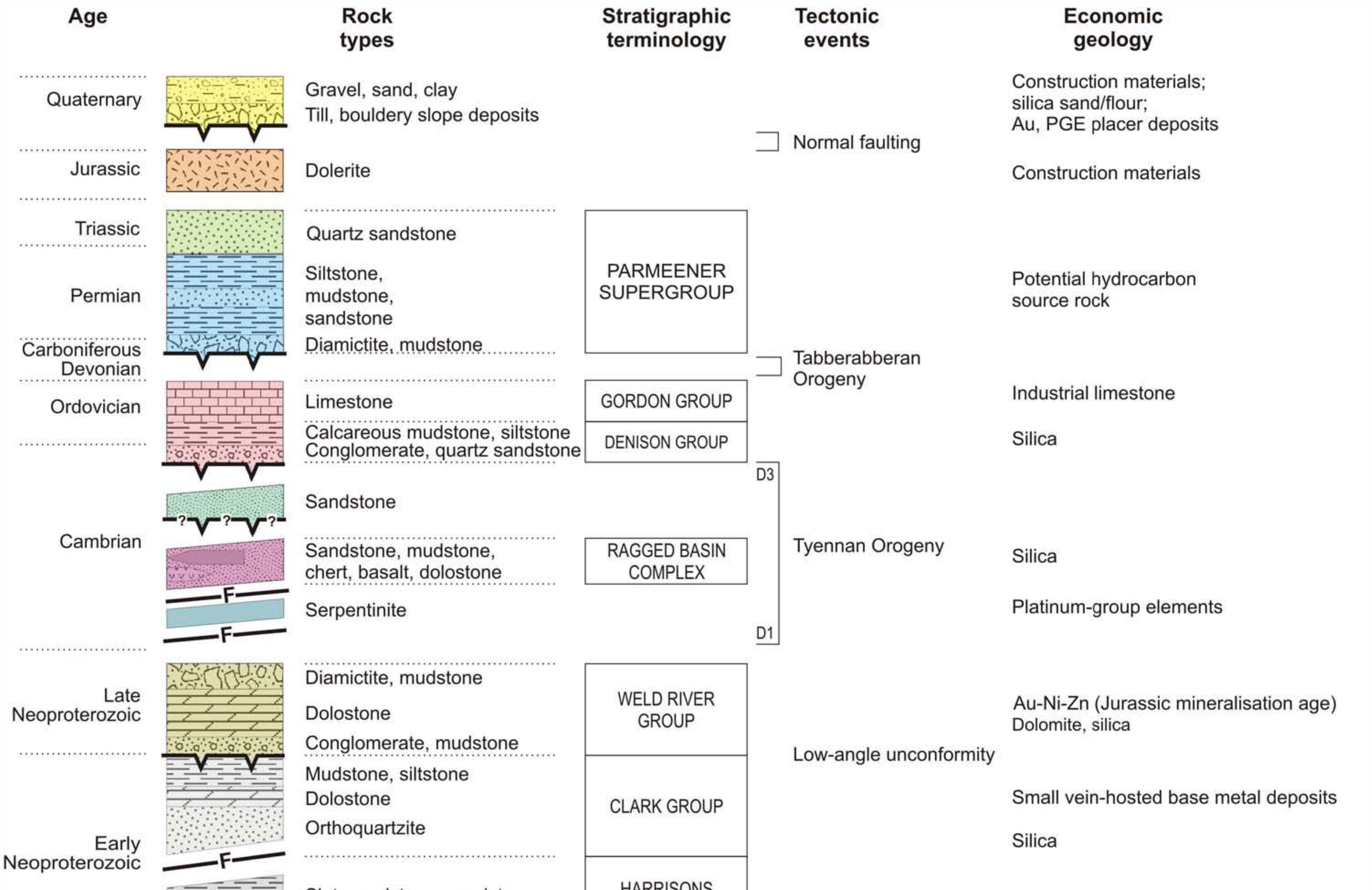

Figure 3
Schematic stratigraphic column and economic geology of the project area.

Mesozoic, regional phase of low-temperature hydrothermal fluid flow is inferred. Surficial lag deposits of bouldery quartz, and silica sand and flour of economic interest, are present in places.

The new mapping has shown that the Forster Prospect (Indicated Resource of 1 Mt Au @ 0.42 g/t, Summons, 1999) is hosted in in an unusual assemblage of magnesian skarn and siliceous breccia derived from dolostones of the Weld River Group, which forms part of the Glovers Bluff inlier in the eastern part of the Weld map sheet. The mapping showed the Glovers Bluff inlier to be surrounded, and almost certainly entirely underlain, by a thick (600 m) intrusion of Jurassic dolerite, in the form of a large cone sheet (fig. 4, 5, 9). The strong contact metamorphism, minor metasomatism and mineralisation in the inlier are almost certainly due to the dolerite. This is the first significant mineralisation to be recognised as associated with the widespread Tasmanian Jurassic dolerite. Further detail on the Forster Prospect may be found in Bottrill *et al*. (1999) and below.

Cambrian successions

Two major successions of inferred Cambrian age were mapped. One succession is a lithologic correlate of the Ragged Basin Complex of the Pedder and Huntley map sheets to the west, and of the 'Cleveland–Waratah association' and similar units in western Tasmania (Turner, 1989; Seymour and Calver, 1995). No fossils or other age control are known from these units, but some of the interbedded basalts in western Tasmania are considered to be genetically associated with mafic-ultramafic complexes of Early to Middle Cambrian age (Brown, 1989*b*; Seymour and Calver, 1995). The genetic association with the mafic-ultramafic complexes, the invariably faulted boundaries of these units, and their lithologies suggests they are ocean-basin, allochthonous sequences that were thrust on to the Tasmanian craton in the early stages of the Tyennan Orogeny (Seymour and Calver, 1995).

The Ragged Basin Complex was mapped in the western parts of the Maydena and Skeleton map sheets, and also in the Arve Plains inlier (newly discovered by this mapping) at the eastern boundary of the Weld map sheet. The complex consists of micaceous lithic sandstone, mudstone, chert, basalt and dolostone. Thin sections show the sandstone to be of mixed (mafic-volcaniclastic and metamorphic) provenance. The unit is internally faulted and no stratigraphic succession can be determined, but thicker units of chert and basalt have been mapped in places. Compositionally, the basalts are within-plate tholeiites and basaltic andesites. A large (1 km^2) lens of basaltic andesite on the Maydena sheet is a pillow lava (Plate 9). A dolostone unit on the Maydena map sheet is only tentatively assigned to the Ragged Basin Complex, as it may also be a faulted inlier of either Weld River Group or Clark Group rocks. Chert has been investigated as a source of industrial lump silica, and the problematic dolostone unit has also been assessed for industrial use near Maydena. Surficial lag deposits of silica sand and flour locally overlie the dolostone, and the largest such deposit is held under a retention licence.

Geochemically, the basalts at Maydena and Arve Plains are quite distinct (Table 1). Differences in key incompatible element ratios (e.g. Ti/Zr, Nb/Zr, Nb/Y, Zr/P_2O_5), trace element patterns (fig. 6) and degree of light rare earth enrichment (fig. 7) preclude any correlation or direct relationship. Although both groups are strongly evolved (e.g. low MgO and Ni), the Maydena samples are basaltic andesites with distinctly tholeiitic and mildly potassic affinities. The Arve Plains rocks are weakly tholeiitic and relatively sodic basalts, with lower SiO_2, K_2O and Mg#, and higher total iron (FeOt) and Na_2O, compared to Maydena. They are also higher in Ni and Cu and lower in Zr, Nb and light rare earth elements.

On tectonomagmatic discrimination diagrams, both groups mostly plot consistently with a within-plate, probably continental setting. The Arve Plains basalts in particular show some features transitional to E-MORB compositions, and a failed continental rift seems to be the most likely setting. A broad correlation with either the Cleveland–Waratah Formation basalts and the Motton Spilite, thought to have been structurally emplaced in the Early Cambrian, or the ensialic late Neoproterozoic Spinks Creek Volcanics (Smithton Synclinorium) and Crimson Creek Formation basalts (Dundas Trough) seems possible from their geochemistry. However they are unlike the oceanic arc basalts (low-titanium tholeiites) of the inferred allochthon, or the post-collisional arc basalts of the Mt Read Volcanics.

Hornblende-bearing rocks, probably calc-alkaline lamprophyre (spessartite) or appinite, are found as float in two small areas within the Glovers Bluff inlier (Bottrill and Woolley, 1996). These rocks are dissimilar to the Devonian lamprophyres of western Tasmania (Table 1), and their fine grain size and possible vesicles at one site suggests an extrusive origin, implying a Proterozoic or Cambrian age in common with the enclosing succession.

The second, and probably younger Cambrian succession consists of quartz-rich lithic sandstone, mudstone and conglomerate, and is found in the western part of the Maydena sheet, in the core of the Needles Anticline on the Adamsfield map sheet, and as small faulted areas on the Nevada, Weld (Glovers Bluff inlier) and Picton map sheets. No fossils have been found but the succession is considered, on lithological grounds, to be a correlate of sparsely fossiliferous, Middle Cambrian conglomerate and sandy turbidite (Island Road Formation, Trial Ridge beds) that are found to the west (Brown *et al*., 1989; Calver *et al*., 1990). The sequence probably also correlates with the polymict Cambrian conglomerate of the Tyler Creek beds, which crop out on the south coast of Tasmania (Berry and Harley, 1983). In the area described here, the succession is dominated by sandy turbidites (Plate 10),

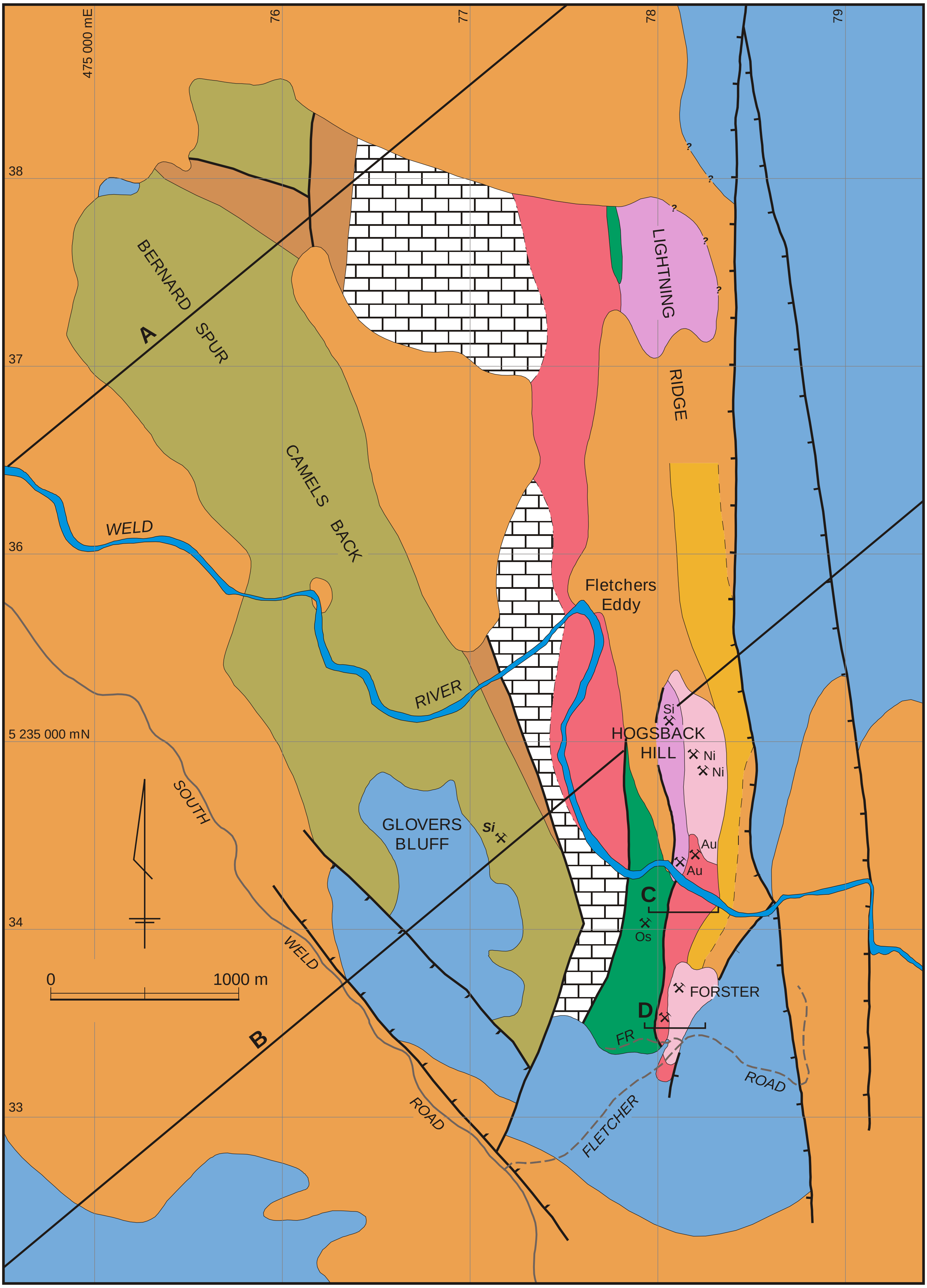

Figure 4

Bedrock geology of the Glovers Bluff inlier. Based on 1:25 000 scale mapping, ground magnetic traverses and drilling in the Forster Prospect area (Carthew et al., 1988; Summons, 1997; Young, 1997).

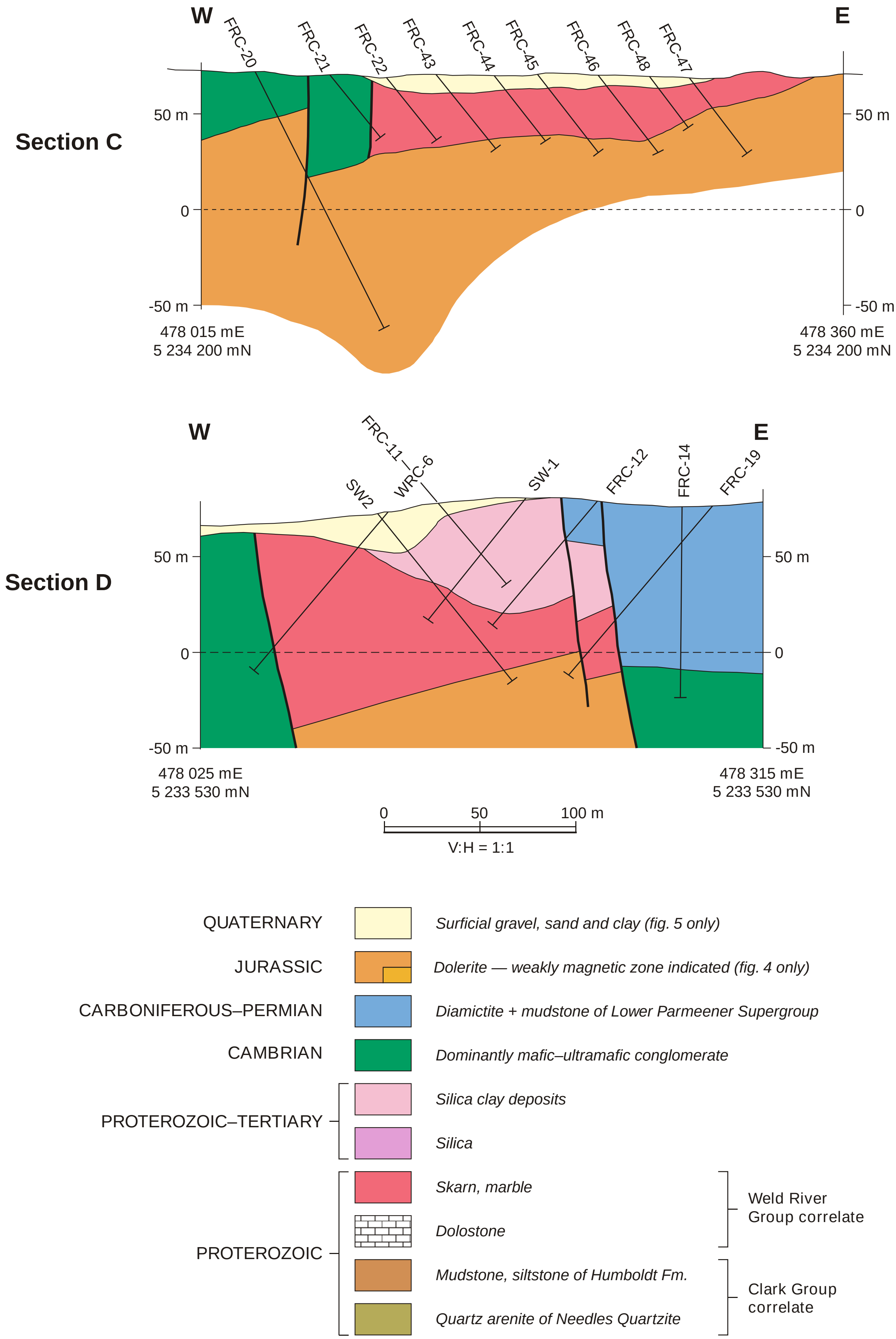

Figure 5

Cross sections, Forster Prospect area. Based on ground magnetic traverses and drilling (Morrison, 1990; Summons, 1997; Young, 1997).

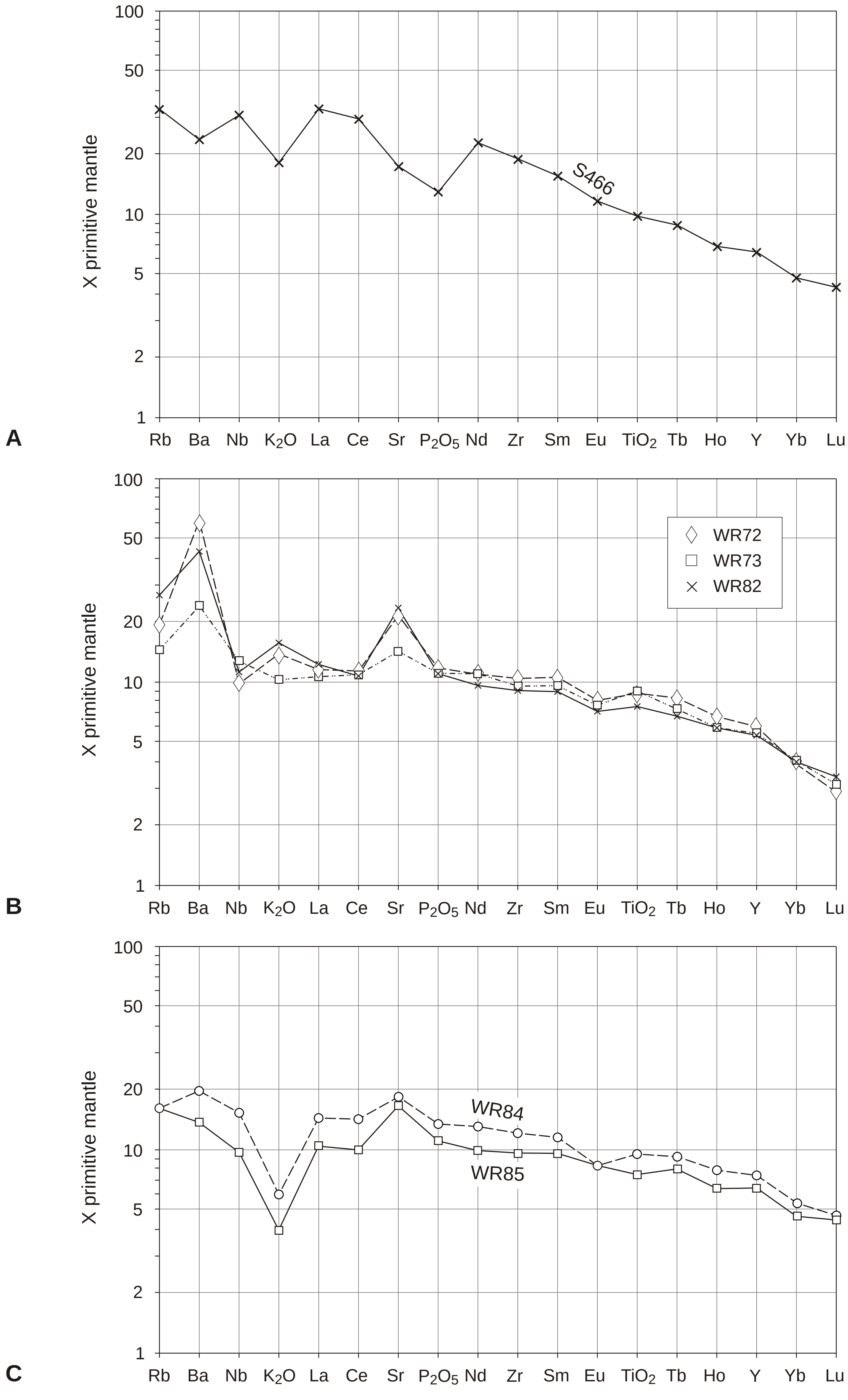

Figure 6

Incompatible element spider diagrams, normalised to model primitive mantle of Sun and McDonough (1989). INAA data for REE, XRF data for other elements. (a) Maydena basalt (sample S466); (b) Arve Plains basalts (samples WR72, WR73, WR82); (c) Arve Plains basalts (samples WR84, WR85).

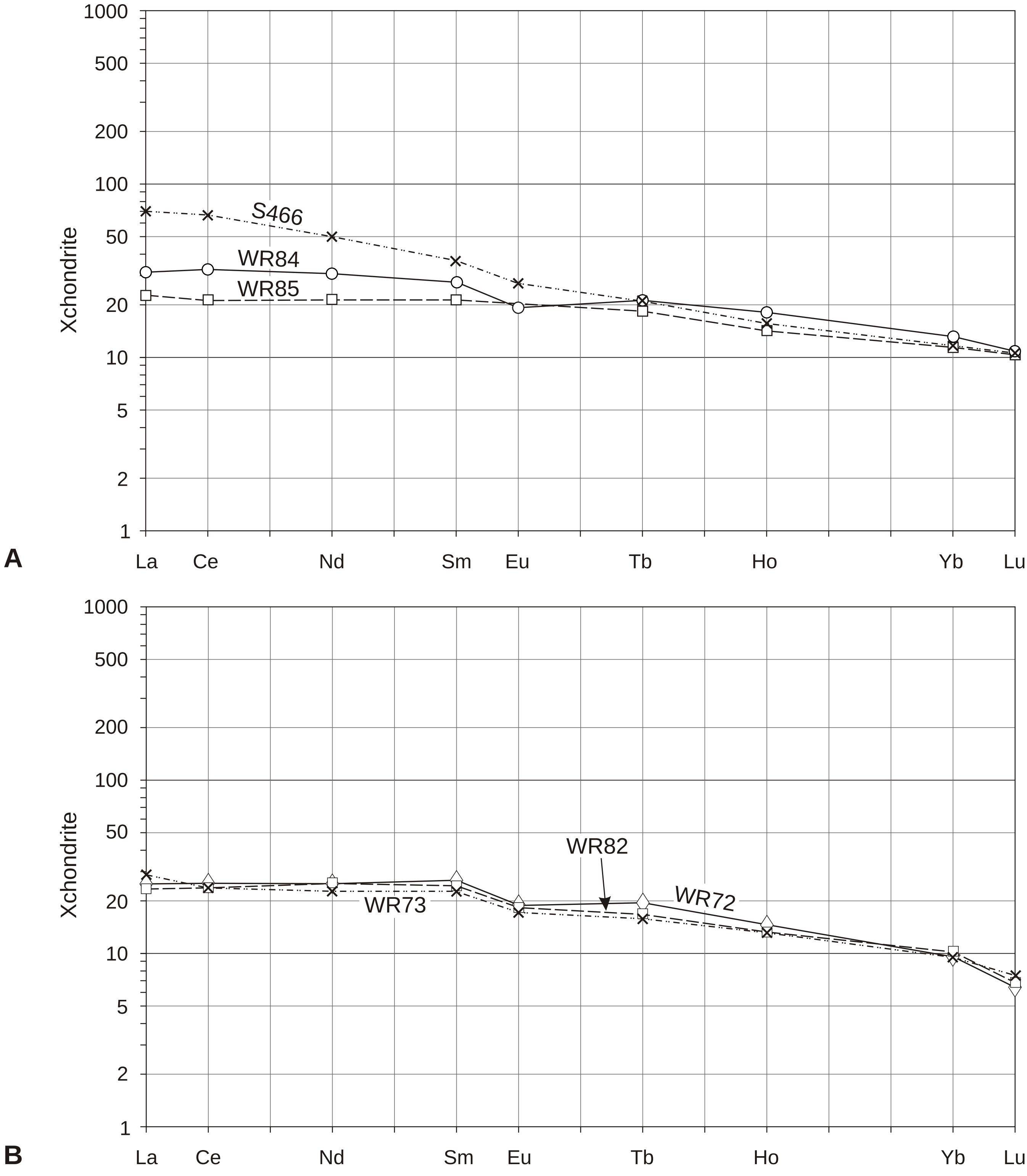

Figure 7

Rare-earth diagrams (chondrite normalising factors after Boynton, 1984). (a) Maydena (sample S466) and Arve Plains (samples WR84, WR85) basalts. (b) Arve Plains basalts (samples WR72, WR73, WR82).

and the sandstone and conglomerate are of mixed provenance; metamorphic (Tyennan?), mafic and felsic-volcaniclastic, dolomitic (similar to Weld River Group) and ultramafic. The clast assemblage suggests that this succession unconformably overlies the other Cambrian and Proterozoic rocks, but no unconformity has been observed within the map sheets described here. The sandstones lithologically resemble those of the Ragged Basin Complex, but the presence of common chert in the latter unit is a distinguishing factor in the field. Ultramafic-derived conglomerate and sandstone in the Glovers Bluff inlier (Weld map sheet) have been strongly altered to talc-hematite-chlorite rocks.

Cambrian mafic-ultramafic complexes

Two small areas of serpentinised ultramafic rocks were mapped in the southwestern part of the Maydena and northwestern part of the Skeleton map sheets, and are considered to be Cambrian on the basis of similar rocks elsewhere in Tasmania. An area of amphibolite occurs on the Nevada map sheet.

Cambrian deformation: Tyennan Orogeny

The type area of the Tyennan Orogeny is situated on the southern flank of Tim Shea in the remapped area of the Adamsfield sheet (Carey and Banks, 1954; Turner *et al*., 1998; Calver *et al*., 2006). Here, the Late Cambrian Tim Shea Sandstone unconformably overlies late Neoproterozoic Weld River Group rocks. This unconformity embraces a significant period of deformation and metamorphism throughout the pre-Late Cambrian rocks of Tasmania, broadly correlative with the Delamerian Orogeny of Victoria and South Australia (Turner *et al*., 1998). In Tasmania the Tyennan Orogeny is thought to have involved a collision with an oceanic island arc, parts of which were obducted westwards or southwestwards over the older rocks and which are preserved as the widespread mafic-ultramafic complexes (Berry and Crawford, 1988). The Ragged Basin Complex and its correlates are also probably allochthonous, although it should be noted that they are partly of continental derivation (Seymour and Calver, 1995).

There is a general northward decrease in the tectono-metamorphic grade within the mapped area, so that pelitic rocks are slate and phyllite on the Picton map sheet, but tend to be represented by uncleaved or very weakly cleaved mudstone on the Nevada map sheet and northwards. The more competent rock types (quartzarenite, dolostone) appear to be more or less unstrained throughout. Probably three phases of Tyennan deformation can be recognised in the mapped area.

- D_1 produced first-order, northwest-plunging folds west of Gallagher Plateau and probably Jubilee Range, which are upright or slightly overturned to the northeast, and which have an axial planar slaty cleavage in pelites in southern areas.
- D_2 produced rare northeast-trending minor folds and a patchy crenulation cleavage, and probably much of the N-NE trending faulting of the Jubilee Range area. A major thrust at The Needles, on the Adamsfield map sheet, juxtaposes Clark Group rocks upon Cambrian sedimentary rocks. This thrust, discovered by this mapping, may belong to this phase which would therefore post-date those Cambrian sedimentary rocks.
- D_3 comprises folding and minor cleavage formation of a northwesterly trend. The Needles Anticline may have been initiated in D_3 but was tightened in the Devonian (Lennox, *in* Brown *et al*., 1989).

Late Cambrian–Ordovician

Quartzarenite and minor conglomerate of Late Cambrian to earliest Ordovician age overlie the unconformity on Tim Shea and extend eastwards along strike to Maydena. This unit, the Tim Shea Sandstone, is conformably overlain by fossiliferous siltstone and calcareous shale (Florentine Valley Formation) of Early Ordovician age (early Tremadoc to late Arenig: Stait and Laurie, 1980), then limestone of the Gordon Group. The Gordon Group is about two kilometres thick in the Florentine Valley area, just northwest of the Maydena map sheet. It is wholly Ordovician (lower Whiterockian–Maysvillian) in age (Banks and Burrett, 1980; Banks and Baillie, 1989). The three limestone formations defined in the Florentine Valley to the north (Corbett and Banks, 1974) were mapped in the western part of the Maydena map sheet. The lowest unit, the Karmberg Limestone, is an argillaceous micritic limestone locally with chert nodules; the next unit, the Cashions Creek Limestone, is an oncolitic calcarenite; and the uppermost formation, the Benjamin Limestone, is dominated by dolomitic, micritic limestone. An assessment of the limestone of this area for industrial uses, by outcrop sampling and drilling, found that the Cashions Creek Limestone had the best $CaCO_3$ grades. This work is documented in Calver (1990, 1992) and Wrigley (1992, 1993).

Limestone of the Gordon Group is also found on the Picton map sheet, in an area newly discovered by this mapping. The same three formations were recognised.

Devonian deformation

A middle Devonian phase of deformation is widespread in Tasmania and is known as the Tabberabberan Orogeny. Major, upright NNW-trending, gently north-plunging folds affect the Late Cambrian–Early Devonian rocks of the Florentine Synclinorium, north of The Needles. In the southern part of the Florentine Synclinorium, fold trends diverge strongly about the northern limits of the Proterozoic part of the Adamsfield–Jubilee region (the 'Jubilee Block' of Corbett and Banks, 1974). Trends west of The Needles are NNE, while the trend of the major synform in the northwestern part of the Maydena map sheet is northwest. Devonian shortening in the Proterozoic–Middle Cambrian rocks in the mapped area was therefore probably significantly less than in the Florentine Synclinorium. Major northwest-plunging folds that were initiated in the Cambrian, such as the Needles Anticline, were tightened in the Devonian (e.g. Lennox *in* Brown *et al*., 1989). Gordon Group rocks on the Picton map sheet dip moderately east.

Late Carboniferous–Triassic

Late Palaeozoic to early Mesozoic rocks are widespread in Tasmania and are known as the Parmeener Supergroup (Banks, 1973). This succession comprises the sedimentary fill of the Tasmania Basin. The strata are generally sub-horizontal and unconformably overlie Devonian granitoids and older folded rocks

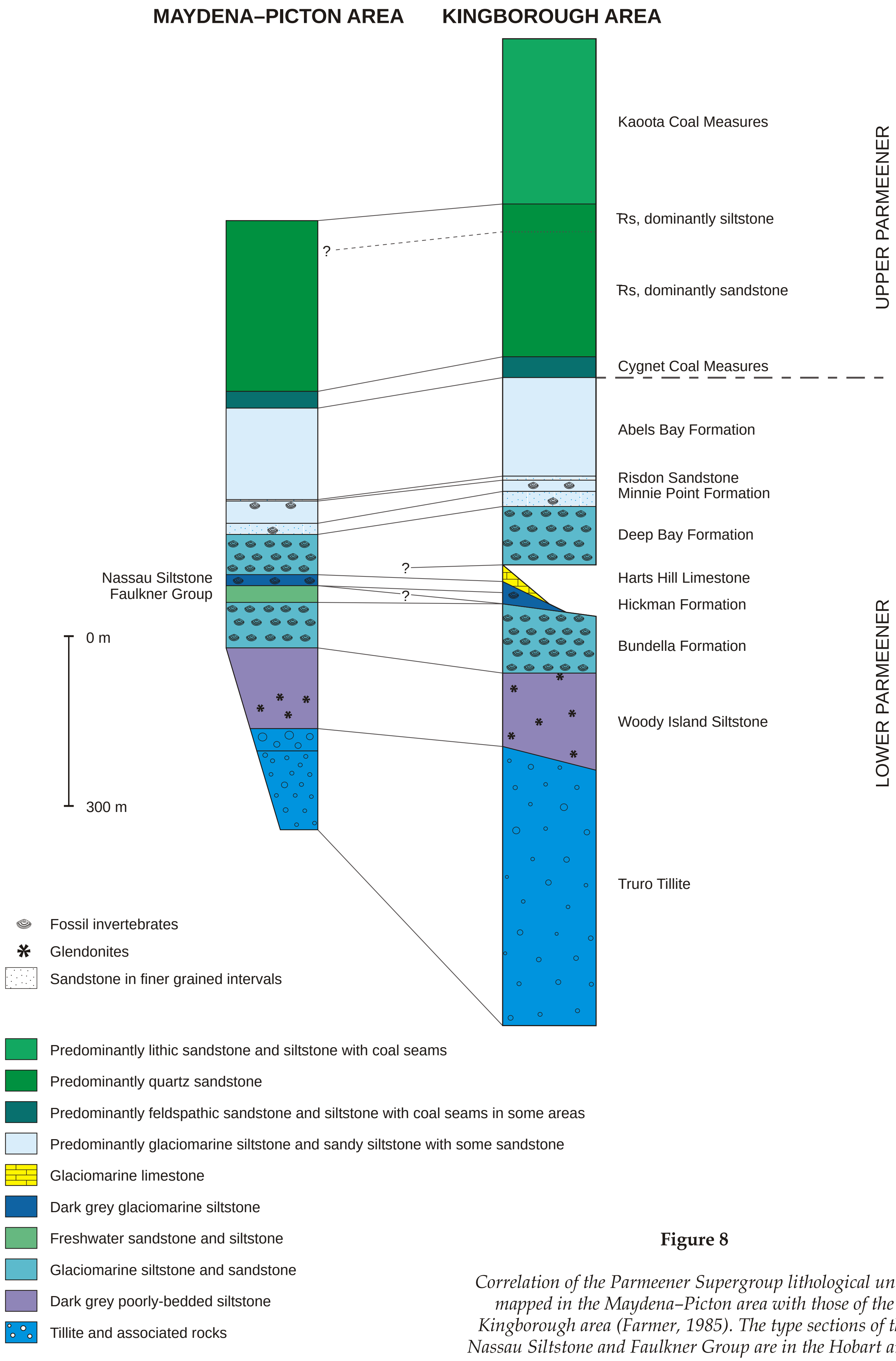

Figure 8

Correlation of the Parmeener Supergroup lithological units mapped in the Maydena–Picton area with those of the Kingborough area (Farmer, 1985). The type sections of the Nassau Siltstone and Faulkner Group are in the Hobart area.

with a basement relief of about 1000 metres. Two major subdivisions of the Parmeener Supergroup are recognised (Forsyth *et al*., 1974). The Lower Parmeener Supergroup (Upper Carboniferous–Permian) includes glacigene and glaciomarine rocks and a thin interval with coal measures, freshwater or paralic rocks (Clarke and Farmer, 1976; Farmer, 1985; Clarke, 1987, 1989, 1992). The Upper Parmeener Supergroup (Late Permian–Late Triassic) consists of freshwater rocks and includes coal measures in parts of Tasmania (Forsyth, 1989).

The Lower Parmeener Supergroup is well developed in the five map sheets described here, but at most only the lower half of the Upper Parmeener Supergroup is preserved (fig. 8). The most complete succession is found in the Maydena–Styx valley area where the Parmeener Supergroup is about one kilometre thick (Jago, 1972). The Parmeener Supergroup extends as outcrop or beneath capping Jurassic dolerite intrusions through more than half the area of the map sheets, and its present distribution is an erosional remnant of an originally much more extensive basin.

Formations mapped in the Lower Parmeener Supergroup are lithological correlates of those previously documented in the Hobart–Cygnet area (Banks and Hale, 1957; Farmer, 1985). The relatively complete Lower Parmeener succession on the Maydena map sheet consists of a basal diamictite unit, 120 m thick (a correlate of the Truro Tillite), dark grey siltstone (140 m, Woody Island Siltstone), fossiliferous siltstone and sandstone (45 m, Bundella Formation), freshwater or paralic feldspathic sandstone (30 m, Faulkner Group), fossiliferous siltstone (90 m, Nassau Formation and Deep Bay Formation), sandstone and siltstone (60 m, Minnie Point Formation), massive feldspathic sandstone (3 m, Risdon Sandstone), and unfossiliferous siltstone (150 m, Abels Bay Formation). A basement high is indicated north of Maydena by the absence of the lower two formations and the Bundella Formation rests directly on the older rocks. Similarly incomplete successions on basement highs are also seen at Mt Weld and Mt Picton.

The Woody Island Siltstone is a potential hydrocarbon source rock (Bacon *et al*., 2000). Rock-Eval pyrolysis of samples from the Styx Valley show that the formation has attained late oil window-early gas window maturation temperatures at this locality. Freshly broken surfaces have a strong hydrocarbon odour. Correlates of the Woody Island Siltstone elsewhere in Tasmania locally contain Tasmanite oil shale. The formation has been prospected for oil shale in the Styx Valley area (Maydena and Skeleton map sheets) but drilling revealed only disseminated *Tasmanites*.

In the mapped area the Upper Parmeener Supergroup consists of:

- a lower unit of freshwater cross-bedded feldspathic sandstone, micaceous siltstone, carbonaceous beds and coal lenses, about 30 m thick, that is correlated with the Late Permian Cygnet Coal Measures, and;
- an upper unit dominantly of freshwater, cross-bedded quartzose sandstone and subordinate micaceous siltstone and mudstone, roughly 300 m thick, that is correlated in part with the Early Triassic Ross Formation.

Jurassic

Dolerite is widespread in the eastern parts of the mapped area and comprises an eroded sheet 200–400 m thick that caps the mountain ranges. The dolerite has intruded at a variable stratigraphic level, generally within the Upper Parmeener Supergroup, although in areas covered by the eastern part of the Weld map sheet, the dolerite has intruded at a much lower level, at or below the base-Parmeener unconformity. Here, the Glovers Bluff inlier, of Proterozoic, Cambrian and basal Parmeener rocks, lies above the intrusion, which is in the form of a large irregular cone sheet, faulted on the eastern side. The centre of the cone sheet, under the Glovers Bluff inlier, probably overlies a major feeder. Strong contact metamorphism and minor metasomatism and mineralisation are seen in the rocks of the Glovers Bluff inlier. In the southeastern part of the Picton map sheet there is another area of low-lying dolerite, the base of the intrusion rising away from this area to cap the highlands to the west (Mt Picton) and east (Loop Hill).

Cretaceous–Cainozoic

A single small outcrop of aplite in the Glovers Bluff inlier was tentatively assigned to the Cretaceous on the Weld map legend, but it is chemically dissimilar to the Cretaceous alkaline intrusive rocks of the Cygnet district (Table 1). Its age is unknown.

Normal block faulting of the mapped area took place in the Cretaceous to lower Cainozoic, and is most in evidence where the faults displace the flat-lying Parmeener Supergroup stratigraphy and Jurassic dolerite. The most common trends for these faults lie between WNW and northwest. No faults were noted between 45° and 83°, but in contrast to this, several steep intrusive margins of dolerite have trends from 45° to 55°. Very few faults occur between 152° and 167°. Dips of bedding in the Parmeener Supergroup are commonly less than 10° and usually have an easterly component and an azimuth approximately between northeast and southeast. Locally steeper sag dips and drag dips occur near faults. An anomalous zone of westerly to northwesterly dips accompanies a fault system that extends north to NNE from Gee Creek. The overall effect of dip and faulting is to displace the Parmeener stratigraphy downwards by several hundred metres from west to east across each of the map sheets.

Undissected Last Glacial moraines and cirques are found on the Snowy Range, Weld Ridge and Mt Picton, which are characterised by maximum elevations over 1200 metres. The situation of these features, almost exclusively on the eastern flanks of the ranges, reflects the ‘snow fence’ effect of the ranges and the prevailing westerly winds. Locally, at much lower elevations, deeply weathered dolerite boulder deposits may be eroded remnants of moraines left by one or more earlier, more extensive glaciations (e.g. Colhoun and Goede, 1979). These are seen on the Huon River downstream of Blakes Opening (Picton map sheet) and on the Snake River (Nevada map sheet).

Many slopes in the mapped area — notably the flanks of the Snowy Range, Weld Ridge and Mt Picton — are mantled by dolerite-derived talus. Slope deposits derived from other resistant lithologies are also locally developed. These are considered to be mainly Pleistocene in age. Quaternary alluvial deposits, including some higher terrace deposits, border some of the rivers. Quaternary lag deposits of silica sand and flour, apparently developed by deep leaching of siliceous dolostone, are found in many locations and have been the subject of extensive investigation near Maydena.

ECONOMIC GEOLOGY (CRC)

Base metals

Maydena area

Mt Mueller and Humboldt prospects

A number of small, abandoned mine workings are hosted in Proterozoic rocks of the Clark Group, northeast of The Needles and just west of the Maydena map sheet.

The Mt Mueller mine is an adit at 457500/5268000* that has been driven northeast into a strike ridge of limestone, dolomite and mudstone (unit Pcd of the Humboldt Formation), to exploit minor vein mineralisation. Two small pits were also found nearby, about 100 m north and northwest of the adit, also dug on veins. The host rocks are interbedded dark grey dolostone, fine-grained (micritic) dark grey limestone and black mudstone dipping steeply northeast. The veins strike 071–078° and dip 45–61° south and are up to 0.5 m wide. They are filled with a gangue of milky quartz, very coarse-grained saddle dolomite (white to red in colour) and barite. Minor sulphide minerals (chalcopyrite and bornite?) are present in the veins.

Disseminated sulphides were seen in impure, fine-grained dolostone along strike from the Mt Mueller mine at 456500/5269100, and nearby at 456400/5269200 where a saddle dolomite vein in dark grey dolostone contains minor sulphides, including bornite. Saddle dolomite (a hydrothermal dolomite variety with a distorted crystal lattice giving rise to ‘saddle-shaped’ crystals; Radke and Mathis, 1980) is widespread as a vein-filling mineral in the area of Pcd northeast of The Needles.

Shafts, trenches and pits around 457800/5268600 are thought to comprise the Humboldt mine (see Twelvetrees, 1908; Henderson, 1939). The workings are in brown, puggy clay. There are boulders nearby composed of vuggy, crystalline quartz and iron oxides, interpreted as gossan by Twelvetrees (1908). Along strike nearby (458000/5268300) are minor sulphides in nodules, around 100 mm in size, of fine-grained quartz in shale of the Humboldt Formation. In thin section (R007619) the quartz consists of displacive masses within mudstone, a texture suggesting replacement of evaporites.

There is a four metre pit in clay at 459400/5268000, and two adits in riverbank chert outcrops of Ccwc at 459800/5268600.

Modern exploration

The Broken Hill Proprietary Company Ltd took out EL8/79 and later EL9/83 over a large area southwest of Maydena, to search for Renison-style carbonate replacement tin mineralisation. Reconnaissance stream-sediment, rock-chip and soil sampling was undertaken. No significant tin or tungsten anomalies were found, but other base metals were mildly anomalous in places, for example copper near Maynes Hill. An airborne electromagnetic survey located three Dighem II anomalies in the upper Styx and upper Weld valleys. One of the anomalies was drilled. DDH SX-1 was collared in correlatives of the Ragged Basin Complex near Mueller Road, just west of the western boundary of Maydena map sheet (at 459625/5260575). The hole intersected pyritic, graphitic black shale that explained the anomaly.

Weld River area

In 1917 a reward lease for nickel and cobalt was granted on Fletchers Plain, east of Hogsback Hill. Disused shafts at 478250/5235025, 478320/5235000 and 478325/5234980 are thought to be associated with this lease. No production was recorded.

In a recent phase of exploration, anomalous chrome and nickel were found in a belt of talc-hematite-magnetite schist south of the Weld River (Carthew *et al.*, 1988). Disseminated sulphides of nickel, zinc, lead and copper occur in the talc schist (altered ultramafic rocks) and associated skarn-altered rocks (1997 Annual Report, Sedimentary Holdings NL). This exploration has been focussed predominantly on gold, and so is described in the next section.

All grid references are AGD66 datum and are AMG co-ordinates in Zone 55. Grid references quoted in this report are in the form xxxxxx/yyyyyyy, where the first six numbers are metres east and the last seven numbers are metres north.

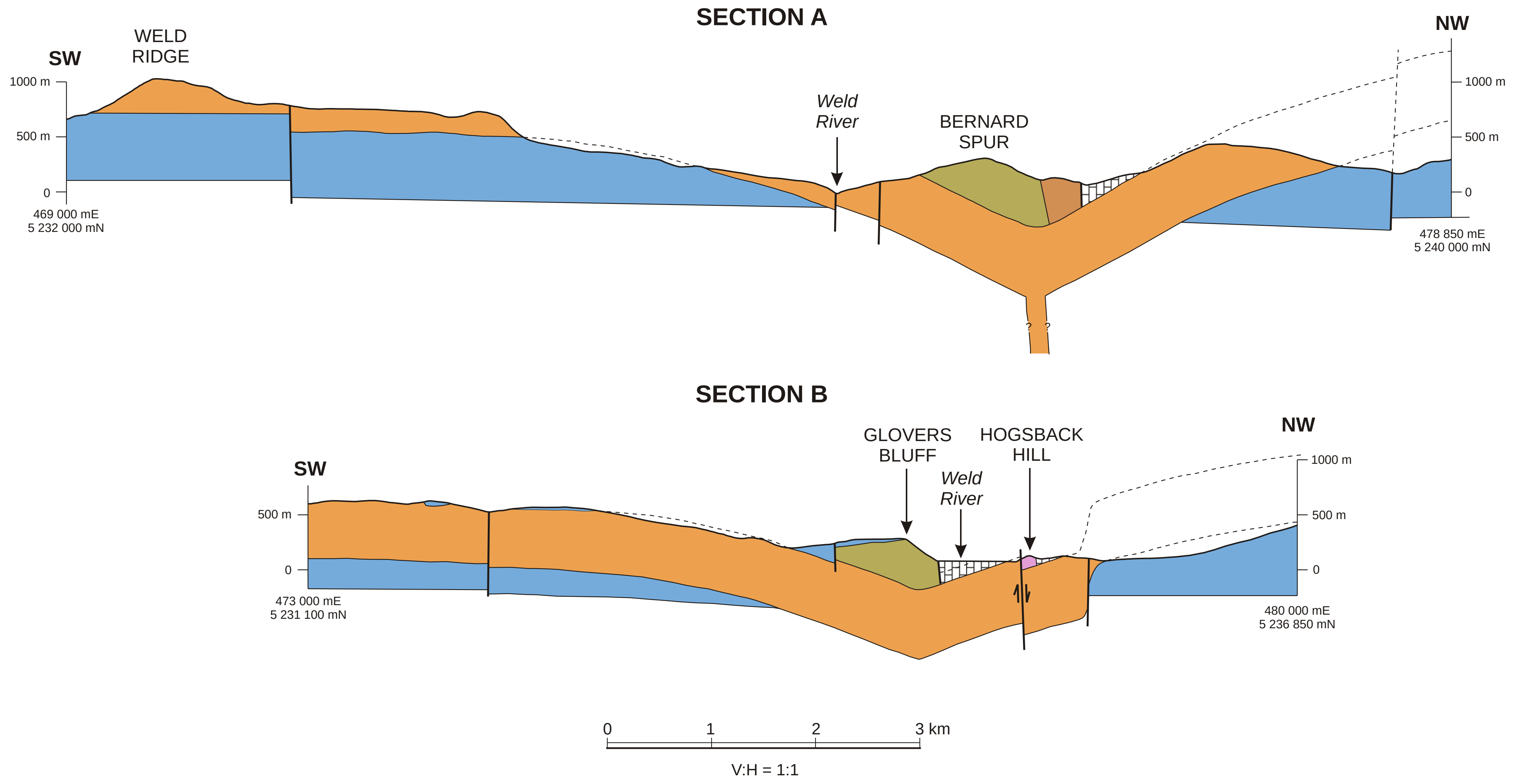

Figure 9

SW–NE cross sections of Glovers Bluff inlier, showing interpreted cone sheet geometry of Jurassic dolerite intrusion.

Gold

Maydena area

Amoco Minerals Australia Co. took out exploration licence EL14/84 to search for Carlin-style gold mineralisation in an area west of Maydena. Reconnaissance stream-sediment, rock-chip and soil sampling failed to yield results worthy of follow up.

Forster prospect

History

In the late 19th and early 20th centuries, gold was reported at a number of places in the valleys of the Weld River, the Snake River and Manuka Creek, but there has been no recorded production (see Bottrill *et al*., 1999). A reward lease for osmiridium just south of the Weld River, in the vicinity of the present-day Forster gold prospect, was granted in the 1920's. A number of shallow shafts and pits in the area may date from this time, but no production was recorded. An old adit on the north bank of the Weld River (at 478150/5234450) may have been for gold (Bottrill *et al*., 1999).

EL11/84 was taken out over the Glovers Bluff area by M. C. Forster to search for silica, but the focus later shifted to gold and PGE's with the recognition of Cambrian rocks, including altered ultramafic rocks, near the Weld River (Summons, 1988). Gridding, ground magnetics and systematic bedrock sampling from Wacker percussion drilling were carried out north and south of the Weld River in the vicinity of Hogsback Hill and the present Forster Prospect (Carthew *et al*., 1988). Anomalous platinoids, Cr and Ni were found in a belt of talc-hematite-magnetite schist (corresponding to unit Calct, see Calver *et al*., 2006). Anomalous gold and arsenic were found in siliceous rocks to the east (corresponding to the 'silica-clay zone' of later work, and see Calver *et al*., 2006). Fourteen reverse circulation holes and one diamond-drill hole were drilled in 1989/1990, with encouraging results (e.g. 20 m @ 0.8 g/t Au, Morrison, 1990). Renewed interest from Sedimentary Holdings NL has resulted in an extensive exploration program including 37 reverse circulation holes (Summons, 1997; Young, 1997). Gold mineralisation intersections included 18 m @ 2.01 g/t Au (Sedimentary Holdings NL, Special ASX announcement, May 9, 1996).

Geology and genesis

The Forster Au-Zn-Ni prospect is situated in the Glovers Bluff inlier on the eastern part of the Weld map sheet and lies close to the intersection of NW-trending and sub-meridional lineaments discernable in topographic and regional geophysical data (Bottrill *et al*., 1999; Summons, 1999). It is a shallow sheet-like body, defined by gold assays, hosted in a silica-clay (halloysite) alteration zone developed in weathered magnesian skarn and siliceous breccia derived from dolostone of the Weld River Group (Bottrill *et al*., 1999). Silica-clay alteration and sporadic enriched gold values extend into unconformably overlying Permian mudstone and local auriferous quartz veins have been noted in Jurassic dolerite (Summons, 1999).

The deposit has an Indicated Resource of one million tonnes @ 0.42 g/t gold. There are also zones of nickel and zinc enrichment with Indicated Resources of 251 000 t @ 0.11% Ni and 221 000 t of 0.15% Zn (Summons, 1999). These partly overlap and partly lie on the western fringe of the gold resource. The zone of nickel enrichment extends into the ultramafic clast conglomerate that abuts the dolostone to the west along a faulted contact.

The Glovers Bluff inlier is surrounded, and almost certainly entirely underlain, by a thick (600 m) intrusion of Jurassic dolerite, in the form of a large cone sheet (fig. 9). Several ground magnetic traverses were undertaken in the course of this mapping to help elucidate the structure of this area (see Appendix 2, Calver *et al*., 2006). The position of the Proterozoic rocks of the Forster Prospect above a major dolerite sheet and feeder zone can adequately explain the localisation of strong contact metamorphism and minor metasomatism and mineralisation within the inlier (Bottrill *et al*., 1999), although the genesis of the mineralisation is in dispute.

Summons (1999) has noted similarities to both skarn-hosted and sediment-hosted (Carlin-style) gold mineralisation models and considers the Forster mineralisation to be genetically related to a hypothetical felsic Cretaceous intrusive body at depth, similar to that cropping out at Cygnet in southern Tasmania and related to gold mineralisation there. Lead isotope compositions of galena from the Forster Prospect have a Jurassic to Cretaceous model age (Boyd, 1996). A small aplite outcrop, of unknown age, was found on the Weld River at the western edge of the Glovers Bluff inlier (shown as Kp on the map), but the significance of this outcrop in relation to the genesis of the Forster Prospect mineralisation is not known.

Despite this, the bulk of evidence suggests that the deposit was formed by hydrothermal fluids of surface origin driven by heat generated by Jurassic dolerite emplacement, with a contribution to the gold enrichment produced by later surface weathering processes (Bottrill *et al*., 1999).

[For more detailed information on the petrology, geochemistry and genesis of the deposit, see Bottrill *et al*. (1999). For more detailed information on the geological setting, see *Altered dolostones of the Weld River Group* section in Calver *et al*., 2006)].

Industrial minerals

Silica

Maydena area (Maydena map sheet)

Cambrian chert (Ccwc) and the Tim Shea Sandstone (COlt) near Maydena have been explored as sources of lump silica, and high-purity silica sand and flour are known from thick sandy surficial deposits (Qs) overlying Cambrian or Proterozoic siliceous dolostone.

Pioneer Silicon Industries took out EL14/88 over Pine Hill, a strike ridge composed of Cambrian chert and Tim Shea Sandstone, in 1988. Initial exploration was encouraging (Jones, 1989) and in 1990 a large bulk sample (1000 t) from the chert deposit was successfully tested at the Electrona silicon works south of Hobart (Paterson, 1990), but this plant closed in 1991. An analysis of this material returned 0.084% Al_2O_3, 0.028% Fe_2O_3, 0.020% TiO_2, and 0.031% CaO.

At the eastern end of Pine Hill (near Styx Road: around 466600/5263700), analyses from pits and 22 shallow drill holes (5 to 20 m) in a residual quartz sand deposit showed high silica grades (c. 99.8%) suitable for tableware glass manufacture (Forster, 1992*b*) but too high in Fe_2O_3 (mostly >50 ppm) for optical glass (Forster, 1994). Indicated reserves of sand are of the order of two to three million tonnes. Best grades appear to be at shallow depths (<10 m). A Department of Mines hole in this area intersected 55 m of quartz sand and gravel before reaching dolostone. An origin for the quartz sand as a leached residuum from weathering of the dolomite, like the high-grade silica flour deposits of the Corinna area, seems likely. This deposit is currently held under RL2/2003.

Glovers Bluff area (Weld map sheet)

Glovers Bluff is part of a strike ridge of Proterozoic orthoquartzite, a correlate of the Needles Quartzite. It is accessed from a short side road off the South Weld Road.

The potential of the quartzite as a source of silica for ferrosilicon production was first recognised by Forster (1973). Consolidated Gold Fields Australia Ltd drilled four diamond and four percussion holes in 1974/1975. A resource of 15 million tonnes with less than 1.5% Al_2O_3 was defined. Best grades are in the higher parts of Glovers Bluff, a result of leaching of impurities (Consolidated Gold Fields, 1974, 1975). A small quarry was opened in 1975 to provide a 1000 tonne bulk sample for a test production run of ferrosilicon at Electrona.

A further six holes drilled by BHP (TEMCO) in 1980 proved a resource of 1.5 million tonnes with less than 0.9% Al_2O_3 (Hassel, 1981).

Seven short percussion holes in orthoquartzite on 'Pyramid Hill', one kilometre northwest of Glovers Bluff, were drilled in 1985 by Pioneer Silicon Industries Pty Ltd (Summons, 1986*a*). Grades were relatively poor except for a near-surface (<10 m) leached zone.

'Hogsback Hill' is a strike ridge of massive, fine-grained quartz rock of uncertain origin, probably mostly silicified Proterozoic dolostone (see previous section). Test pits and 21 short percussion holes showed that the quartz is of limited depth (about 5 m), and that a resource of approximately 100 000 tonnes of high grade silica is present (Summons, 1986*b*).

Limestone

Limestone of the Ordovician Gordon Group in the Maydena area is the closest industrial limestone resource to Hobart, with the exception of low-grade Permian limestone.

Early reconnaissance surveys and analyses are documented in Hughes (1957). Small-scale extraction was undertaken from a quarry in Benjamin Limestone (at 466100/5269000), beginning in 1953, for use by Australian Newsprint Mills in paper manufacture. More recently this quarry has been used as a source of road-making gravel. An abandoned quarry in Karmberg Limestone is situated at 469400/5266900.

In the early 1990's, the then Division of Mines and Mineral Resources undertook a survey of industrial limestone resources in the Maydena area. The aim of this work was to locate an alternative to Newlands Quarry at Lune River, which at that time was the supplier of limestone to the Pasminco-EZ zinc plant at Risdon, and about to be shut down. This survey is documented by Calver (1990, 1992) and Wrigley (1992, 1993). An initial reconnaissance survey, based on widespread outcrop sampling, showed the Cashions Creek Limestone to have the most consistently high grades (Calver, 1990). Further work was focussed on the Risbys Basin area, which is visually relatively secluded and isolated from the major karst systems known to exist northwest of Maydena. A diamond-drill hole at 468919/5264350 intersected a best interval of 50 m (true thickness) in the Cashions Creek Limestone of 94.9% $CaCO_3$ and 0.64% Mg (Calver, 1992). A subsequent eight-hole percussion drilling program delineated a reserve of 5.5 million tonnes at 92.9% $CaCO_3$ and 0.59% Mg. Within this reserve are two lenses that together comprise one million tonnes at 94.5% $CaCO_3$ and 0.38% Mg (Wrigley, 1993).

Dolomite

Investigations for dolomite at 'Kallista Hill' (463300/5264200) were carried out by the North West Bay Co. Pty Ltd in 1992. Excavations, chip samples and three drill holes to 20 m depth showed that high-grade dolomite occurred on the southern slope of the hill. Drill-hole assays averaged 30.5% CaO, 20.5% MgO, and 1.9% SiO_2 (i.e. approximately 98% dolomite). A quarriable reserve of 355 000 t was indicated (Forster, 1994). A mineral lease and licence to operate a quarry were granted in 1993, but have since lapsed.

Proterozoic dolostone is extensive around Blakes Opening on the Picton map sheet. Twenty-three samples were collected by G. R. Green from outcrop in the Huon River and on Red Rag Scarp in 1972. These samples averaged 28.3% MgO, 19.5% CaO and 8.9% insoluble. As quartz veins are abundant in these rocks, SiO_2 is probably the main insoluble component.

Talc

A belt of talcose schist, shallowly covered by surficial deposits, was found by Wacker drilling during gold exploration south of the Weld River (Carthew *et al.*, 1988). These rocks are thought to be predominantly highly-altered conglomerate of predominantly ultramafic derivation (unit Calct, see Calver *et al.*, 2006).

Test pitting to assess the quality of the talc resource was carried out by Forster (1992*a*, 1993*b*). Four samples analysed by XRD were 19–88% talc (average 58%) (Forster, 1992*a*).

Fuels

BHP Co. Ltd took out EL37/79 to search for oil shale in the Lower Parmeener Supergroup in the area south of Maydena. Two diamond-drill holes in the Styx Valley (S1 and S2) intersected most of the thickness of the Woody Island Siltstone correlate. Maximum oil yield by Fischer pyrolysis was seven litres per tonne. Disseminated *Tasmanites* was found near the base of the Woody Island Siltstone correlate (Anon., 1981). *Tasmanites* is a fossil alga that comprises the bulk of the organic matter in oil shale within correlates of the Woody Island Siltstone in northern Tasmania.

The Woody Island Siltstone correlate in the Styx valley was recently sampled by Mineral Resources Tasmania for Rock-Eval pyrolysis analysis, a technique to assess petroleum source potential. Together with results from elsewhere in Tasmania, the results indicate that the Woody Island Siltstone correlate is a lean, but oil and gas-prone, thermally mature, potential source rock (Bacon *et al*., 2000). Freshly broken surfaces of Woody Island Siltstone here have a petroliferous odour.

Construction materials

Marble

Reverse-circulation drilling for gold south of the Weld River on EL11/84 intersected subsurface marble deposits, white, green and grey-blue in colour (Morrison, 1990). Two cored holes were later drilled to test this resource (Forster, 1992*a*; 1993*a*). Analyses showed the marble in drill hole BC5 to be dolomite marble (Forster, 1992*a*). Contact-metamorphic, calc-silicate minerals are also abundant (see Bottrill *et al*., 1999; Calver *et al*., 2006).

Gravel and sand

Construction materials, chiefly for road making, have been extracted at a number of localities. Locations are indicated on the maps and details are available on MRT's deposits database. Notable current operations are situated in Cambrian basalt at Maynes Hill (462400/5262900), in Permian mudstone (Woody Island Siltstone) on Styx Road (465550/5261900), in Jurassic dolerite on Picton Road (474850/5220650) and in siliceous Quaternary gravel near Riveaux Road (475850/5227500).

Prospectivity

The mapped area has large reserves of some industrial minerals, notably silica, dolomite and limestone. The area is also prospective for a variety of metallic mineral deposit types, and remains highly under explored. Much of the area is unavailable for mineral exploration, but significant unassessed prospectivity remains in available areas, including the concealed basement under Tasmania Basin cover.

The thick, essentially unmetamorphosed Neoproterozoic and Ordovician carbonate successions (Weld River Group, Gordon Group) are considered moderately prospective for Irish and Mississippi Valley-type carbonate-hosted base metal deposits. Proterozoic rocks — the older Clark Group as well as the Weld River Group — are considered to have low to moderate potential for SEDEX deposits, but at a relatively low level of certainty. The Ordovician limestone is thought to be of moderate potential for SEDEX deposits. The Proterozoic rocks are thought to have a low potential for sedimentary copper deposits (Public Land Use Commission, 1996).

Interpretation of gravimetric data suggests that Devonian granitoids are at relatively shallow depths (1–4 km) under the western parts of the Weld and Picton map sheets (fig. 2; Leaman and Richardson, 1989). These areas are therefore rated as of moderate to high potential for granite-related vein deposits (Ag-bearing polymetallic veins; Sn, W, Mo, Bi etc). The belt of Weld River Group dolostone in the central parts of these map sheets should be of moderate to high potential for skarn and replacement tin (Renison type) deposits.

About half of Tasmania's historic production of Platinum Group Elements (PGE) came from alluvial placer deposits in the Adamsfield district, west of the Maydena map sheet (Bacon, 1992). Small areas of ultramafic rocks cropping out in the southwest part of the Maydena map sheet and northern part of the Skeleton map sheet, and ultramafic-rich conglomerate in the Glovers Bluff inlier (Weld map sheet), have potential for ultramafic-related (Cu-Ni-PGE-chromite) mineralisation. Placer deposits of osmiridium are associated with all these areas.

Small areas of felsic to intermediate tuff have been mapped in the Cambrian successions. Felsic detritus is common in the Cambrian sedimentary rocks, and raises the possibility of more substantial areas of felsic to intermediate volcanic rocks in unmapped or concealed areas. Altered, intermediate volcanic rocks underlie the Tasmania Basin in a drill hole near Hobart (Everard, 1976). By analogy with the Mt Read Volcanics of western Tasmania, such areas would be highly prospective for Kuroko-type massive sulphides, VHMS-related gold and epithermal gold deposits.

Gold mineralisation at Glovers Bluff is associated with silicification and skarn alteration of Neoproterozoic dolostone and Cambrian rocks. The mineralisation is probably genetically associated with Jurassic dolerite intrusion, and is of a style unknown elsewhere in Tasmania (Bottrill *et al*., 1999). Parts of the Glovers Bluff area remain untested for extensions of this mineralisation, for example, the ridge east of Eddy Creek and most of the area concealed by Permo-Carboniferous tillite south of the Forster Prospect. The Arve Plains inlier of Cambrian rocks (480000/5232700) probably occupies a similar setting, exhibits some similar alteration, and remains unexplored. There is evidence for widespread

Mesozoic hydrothermal activity in the form of quartz veining and silicification in Proterozoic dolostone and superjacent basal Parmeener Supergroup; the regional mineralising potential of this event remains unassessed.

The mapped area has a large potential for industrial minerals. There are huge reserves of silica in Proterozoic quartzite and Cambrian chert. Silica flour deposits are associated with Proterozoic dolomite near Maydena, and this rock type is rated of moderate potential for this type of deposit. Siliceous gravel and sand are widespread in the Huon Valley (e.g. Weld Plains, Arve Plains) and are a potential source of silica, aggregate and sand for concrete. There are very large reserves of dolomite in the Neoproterozoic Weld River Group, and of limestone in the Ordovician Gordon Group.

Dolomite/diopside marble at Glovers Bluff has potential as dimension stone.

The Gordon Group in the southern part of the area has not exceeded 'oil-window' burial temperatures, and may be prospective for hydrocarbons. Potential source rocks are also present in the Woody Island Siltstone, low in the Tasmania Basin succession (Bacon *et al*., 2000).

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Table 1

Analyses of igneous rocks

	Maydena (Maynes Hill area)				Weld and Huon Rivers (Arve Plains Inlier)					Weld River aplite	Glovers Bluff area		*Comparative W Tas lamprophyres* Varna B*	Nielson R*	Mt Lyell#
Field No.	S189	S190	S191	S466	WR72	WR73	WR82	WR84	WR85	WRS	402040	107639	MH111a	MH258a	101698b
Anal. No.	881499	881500	881501	960777	960778	960779	960780	960781	960782	970009	970373	970399	820300	830645	851325
mE	462300	462050	462050	462050	480775	480825	480450	480700	480725	475950	477600	478200	355700	357200	382500
mN	5263200	5263750	5263750	5263750	5233100	5233050	5232775	5232750	5232750	5235880	5234800	5234100	5294900	5301600	5342600
SiO_2	52.45	52.30	52.94	51.16	48.40	50.72	48.88	49.07	49.03	71.33	48.00	47.53	48.12	45.93	48.14
TiO_2	1.77	1.81	1.75	2.13	1.91	1.64	1.89	2.07	1.63	0.09	1.26	1.33	1.17	0.51	0.89
Al_2O_3	15.00	14.27	14.00	13.87	13.54	13.76	13.60	14.30	13.99	15.10	14.01	14.00	10.52	20.77	10.94
Fe_2O_3	1.85	1.28	1.59	2.03	2.00	5.70	1.50	6.40	5.19	1.37	1.95	2.07	2.51	2.07	2.24
FeO	7.54	7.96	7.53	8.13	10.35	7.71	10.49	8.13	7.99	0.49	6.65	8.85	5.05	5.55	5.69
MnO	0.16	0.16	0.16	0.17	0.21	0.18	0.19	0.19	0.18	0.04	0.16	0.21	0.11	0.16	0.19
MgO	6.45	6.58	6.78	6.97	7.82	5.61	7.43	6.12	5.82	0.28	10.72	10.43	11.64	7.87	13.8
CaO	8.35	7.36	8.20	7.76	6.88	6.46	7.15	4.27	8.18	0.26	8.88	6.07	5.09	9.68	7.47
Na_2O	2.49	3.50	2.75	3.37	4.02	4.62	4.16	5.33	4.42	5.13	2.26	3.15	1.49	2.73	0.89
K_2O	0.85	0.54	0.71	0.54	0.41	0.47	0.31	0.18	0.12	4.07	2.04	1.40	3.11	0.20	3.59
P_2O_5	0.23	0.23	0.25	0.28	0.25	0.24	0.24	0.29	0.24	0.03	0.33	0.34	0.75	0.19	0.34
SO_3	0.13	0.13	0.14	0.10	0.16	0.08	0.10	0.08	0.08	0.07	0.10	0.15	0.20	<0.05	0.17
CO_2	0.07	0.05	0.12	0.15	0.07	0.16	0.08	0.26	0.26	0.00	0.00	0.64	5.88	0.15	1.78
H_2O^+	3.35	3.54	3.27	3.18	3.86	2.44	3.72	2.93	2.82	0.74	3.18	3.73	3.69	4.49	3.62
TOTAL	100.69	99.71	100.19	99.81	99.89	99.77	99.74	99.61	99.94	99.00	99.53	99.43	99.33	100.32	99.75
FeOt	9.21	9.11	8.96	9.96	12.15	12.84	11.84	13.89	12.66	1.72	8.40	10.71	7.31	7.41	7.71
Mg# (0.20)	59.58	60.3	61.41	59.55	57.51	47.89	56.89	48.1	49.16		72.85	67.18	77.01	69.07	79.02
Li	na	na	na	na	na	na	na	na	na	6	na	na			
B	na	na	na	na	na	na	na	na	na	<25	na	na			
F	na	na	na	na	na	na	na	na	na	<100	na	na			
Sc	31	31	33	36	36	37	32	49	35	<9	38	39	33	40	23
V	300	300	260	320	340	370	340	430	410	6	280	270	210	120	165
Cr	195	185	195	165	195	63	180	90	87	47	620	320	560	580	830
Co	39	40	41	32	53	40	48	41	37	<8	39	43	38	27	45
Ni	30	29	31	42	125	65	120	64	66	6	230	140	81	120	460
Cu	5	<4	<4	<5	140	125	210	180	84	6	84	15	81	23	78
Zn	86	77	79	96	99	92	95	100	91	40	75	94	50	91	79
Ga	nd	nd	nd	20	18	16	17	16	19	20	18	18	12	9	13
As	nd	nd	nd	<20	<20	<20	<20	<20	<20	<20	<20	<20	<10	<10	30
Rb	29	19	24	21	12	17	9	10	10	120	57	41	185	8	130
Sr	360	360	370	360	440	490	290	380	340	51	390	125	100	490	320
Y	29	28	29	30	27	24	25	34	29	28	18	20	26	14	28
Zr	195	195	195	210	115	100	105	135	105	195	135	98	170	42	200

													Comparative W Tas lamprophyres		
	Maydena (Maynes Hill area)				Weld and Huon Rivers (Arve Plains Inlier)					Weld River aplite	Glovers Bluff area		Varna B*	Nielson R*	Mt Lyell#
Field No.	S189	S190	S191	S466	WR72	WR73	WR82	WR84	WR85	WRS	402040	107639	MH111	MH258	101698
Anal. No.	881499	881500	881501	960777	960778	960779	960780	960781	960782	970009	970373	970399	820300	830645	851325
mE	462300	462050	462050	462050	480775	480825	480450	480700	480725	475950	477600	478200	355700	357200	382500
mN	5263200	5263750	5263750	5263750	5233100	5233050	5232775	5232750	5232750	5235880	5234800	5234100	5294900	5301600	5342600
Nb	19	18	18	22	7	8	9	11	7	51	20	17	7	17	10
Mo	na	na	na	<5	<5	<5	<5	<5	<5	5	<5	<5	<2	<2	bd
Sn	14	25	54	<9	<9	<9	<9	<9	<9	<9	<9	<9	<3	<4	nd
Ba	140	130	135	155	440	310	165	135	94	420	420	210	2000	42	2600
La	<25	<25	<25	<20	<20	<20	<20	<20	<20	36	<20	<20	33	19	60
Ce	50	53	41	54	36	<28	<28	30	<28	59	47	42	110	64	125
Nd	36	26	32	39	<20	<20	<20	31	21	25	21	23	41	15	46
W	88	110	195	<10	<10	<10	<10	10	<10	<10	<10	<10	nd	nd	nd
Pb	<11	<11	<11	<10	<10	<10	<10	<10	<10	15	10	<10	<4	4	45
Bi	<6	<6	<6	<5	<5	<5	<5	<5	<5	<5	<5	<5	nd	nd	bdl
Th	<10	<10	<10	20	10	19	14	12	13	19	15	13	20	4	18
U	<12	<12	<12	<10	<10	<10	<10	<10	<10	<10	<10	<10	6	<4	5
inaa data															
La	na	na	na	22.30	7.77	8.40	7.32	9.70	7.15						
Ce	na	na	na	52.10	19.90	19.20	19.10	24.70	17.60						
Nd	na	na	na	30.30	14.30	13.00	14.30	17.30	13.00						
Sm	na	na	na	6.77	4.60	3.94	4.19	5.02	4.14						
Eu	na	na	na	1.92	1.35	1.19	1.29	1.40	1.41						
Tb	na	na	na	0.97	0.89	0.73	0.78	1.00	0.86						
Ho	na	na	na	1.14	1.09	0.96	0.96	1.30	1.05						
Yb	na	na	na	2.43	1.90	1.91	2.00	2.73	2.33						
Lu	na	na	na	0.33	0.21	0.25	0.23	0.35	0.33						
key element ratios															
Ti/Zr	54.4	55.6	53.8	60.8	99.6	98.3	107.9	91.9	93.1		56.0	61.2	41.3	72.8	26.7
Nb/Zr	0.097	0.092	0.092	0.105	0.061	0.068	0.086	0.081	0.067		0.148	0.174	0.041	0.405	0.050
Zr/Y	6.72	6.96	6.72	7.00	4.26	4.17	4.20	3.97	3.62		7.50	4.90	6.54	3.00	7.14
Ti/Y	366	388	362	425	423	410	453	365	338		420	399	307	501	109
Nb/Y	0.66	0.64	0.62	0.73	0.26	0.33	0.36	0.32	0.24		1.11	0.85	0.27	1.21	0.36
Zr/P_2O_5	0.085	0.085	0.078	0.075	0.046	0.042	0.044	0.047	0.044		0.041	0.0288	0.0227	0.0221	0.0588
P_2O_5/TiO_2	0.130	0.127	0.143	0.133	0.133	0.144	0.129	0.142	0.150		0.262	0.256	0.641	0.373	0.382
(La/Yb)N				6.19	2.76	2.97	2.47	2.4	2.07						

* McClenaghan & Findlay (1993)

\# Baillie & Sutherland (1992)

Plate 1

Graded bed of small-pebble to coarse-sand grade, with basal part of a second graded bed in upper right. Clasts are flattened in S_1. Harrisons Opening Formation, Huon River (462300/5227200).

Plate 2

Thick crossbed set in Needles Quartzite correlate, Jubilee Range.

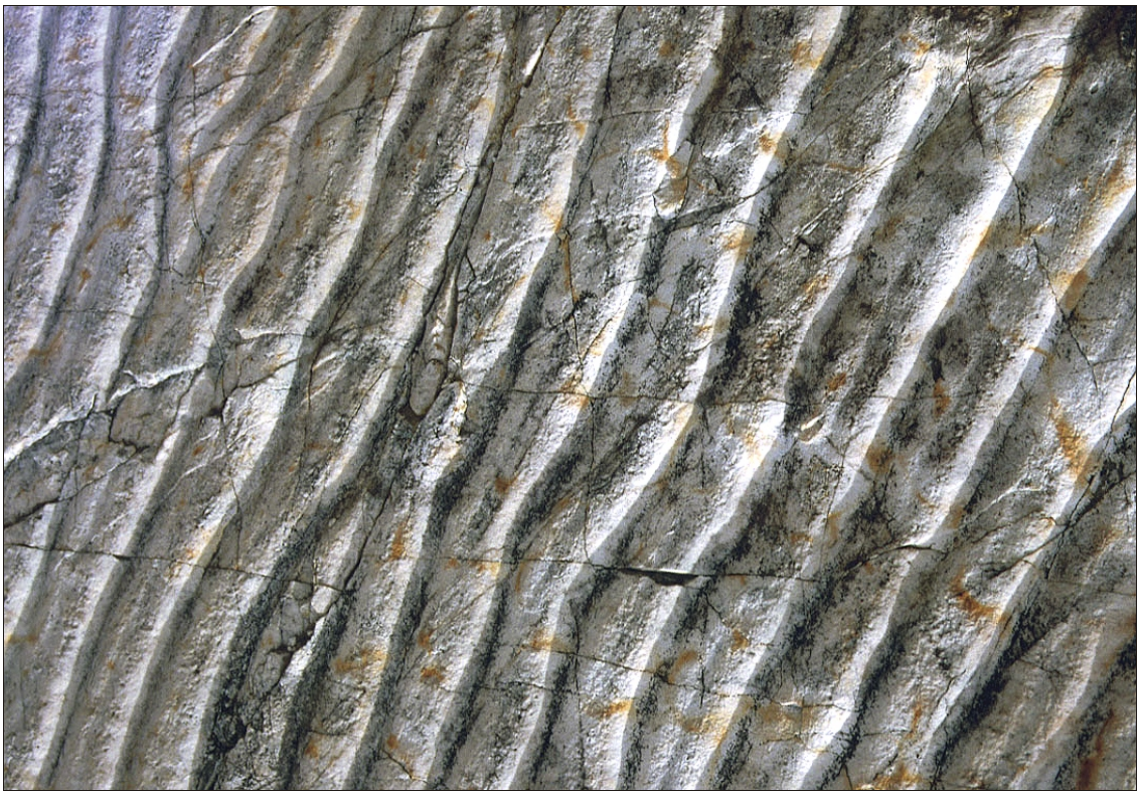

Plate 3

Symmetrical ripples in Needles Quartzite correlate, Glovers Bluff quarry (477200/5234600).

Plate 4

Desiccation cracks and probable halite moulds in unit Pcdc from 466650/5250200, near Jubilee Range (Skeleton map sheet).

Plate 5

Stromatolites in unit Pcdos, South Styx River.

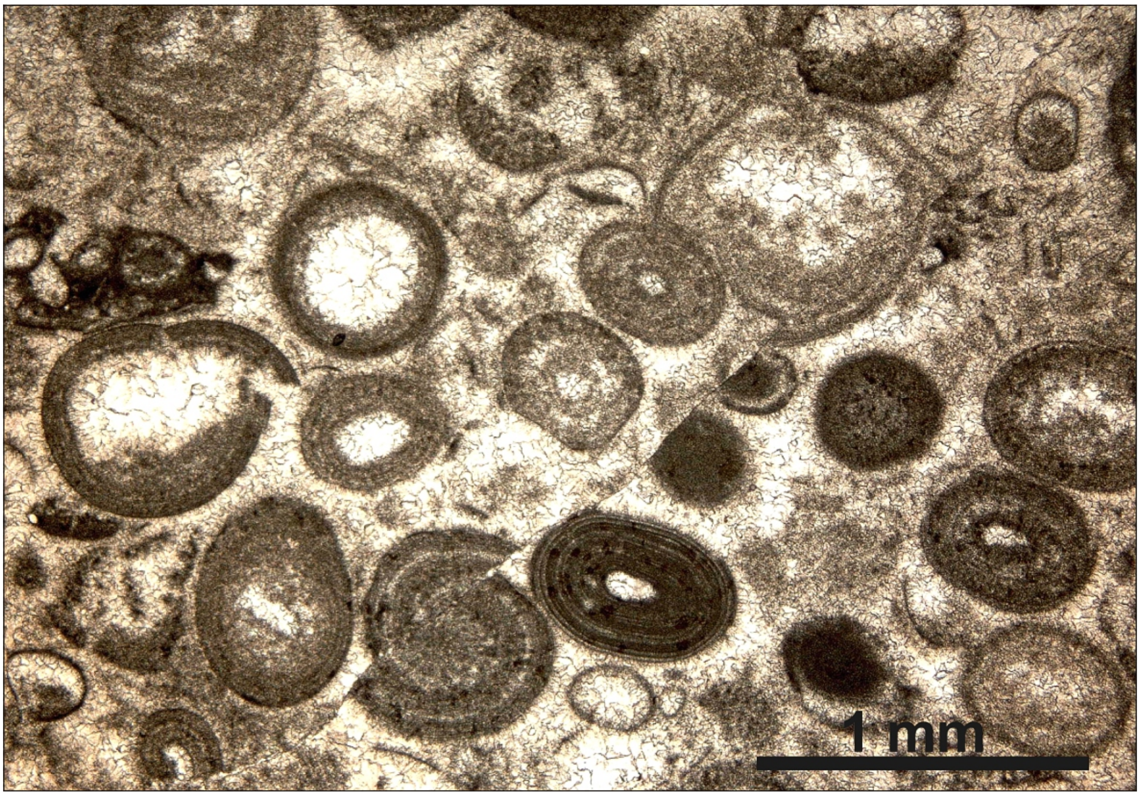

Plate 6

Photomicrograph of oolitic dolograinstone, unit Pwtg, Weld River Group. Many ooid cores have been replaced by clear, void-fillling cement. Note geopetal filling and fractured cortex of ooid on left. (Sample R007707) (467550/5249700).

Plate 7

Outcrop of diamictite (unit Pwcx) on the Huon River (466600/5228400). Clasts are quartzite (grey, prominently weathering) and dolostone (yellow-brown, recessively weathering). [Photo: Rob Reid].

Plate 8

Outcrop showing lonestone in laminated dolomitic siltstone, unit Pwcg, Huon River (467300/5228500). [Photo: Rob Reid].

Plate 9

Exposure of ?Cambrian pillow lava (unit Ccwb) in quarry at Maynes Hill, west of Maydena (462200/5263200). [Photo: David Gatehouse]

Plate 10

Outcrop of ?Cambrian volcaniclastic lithicwacke and siltstone (unit Cals) on the Huon River (470000/5228400).