

Bedrock geological National Estate values of the West Coast Range

by C. R. Calver

INTRODUCTION

This report lists significant bedrock geological sites in the West Coast Range, an area originally nominated for the Register of the National Estate for its significant glacial geomorphology. At the request of the Tasmanian Evaluation Panel, the nominated values are to be extended to include bedrock geology and other values. The Panel requested that Mineral Resources Tasmania provide geoscientific information on the bedrock sites.

The most important previous geoconservation inventory is that of Eastoe (1979), which listed 28 geological and geomorphological sites within the West Coast Range area as part of a Statewide survey of 'geological monuments'. Bradbury (1995) listed three additional bedrock sites. Dixon (1995) reviewed National Estate geoconservation values on a Statewide basis, and recommended that a complete reassessment of Eastoe's localities be undertaken as part of the nomination of the West Coast Range.

A large amount of geological mapping and research has been undertaken since Eastoe's (1979) work, and significant artificial exposures have been created along new roads and canals. All but the southernmost part of the range (Mt Sorell, South Darwin Peak) has been geologically mapped at 1:25 000 scale.

This report lists 47 bedrock sites of geoconservation interest, based on a literature survey and on the field experience of the author and colleagues, particularly K. D. Corbett, who have been directly involved with the recent phase of geological mapping. This list builds on Eastoe's inventory, and it is suggested that a few of his sites are no longer considered of interest in the light of recent work. No field work was undertaken for this report and further work is required to fully appraise the significance of some sites. The integrity of some sites needs to be checked in the field, and the exact locations and boundaries of other sites need to be checked.

K. D. Corbett kindly reviewed an early draft of this report and suggested additional sites (Corbett, 1996), most of which are included below. It is understood that Dr Corbett will make a separate submission regarding National Estate geological values of the West Coast Range.

As, in general, sites must be significant in a Tasmanian or higher (national or international) context to be of potential National Estate significance (Australian Heritage Commission, 1990a, b; Duhig and Dixon, 1996), only a minority (seventeen) of the sites in this inventory are considered individually to be of National Estate significance.

The 47 sites of scientific interest have been incorporated into a large database of sites of geological importance across the State, which is used by Mineral Resources Tasmania to ensure that adequate management of the State's geological heritage takes place. However MRT does not endorse or support the enlarged West Coast Range National Estate listing.

NATIONAL ESTATE CRITERIA AND THRESHOLDS

Sites may qualify for inclusion on the Register under a range of National Estate criteria. The most relevant criteria in relation to bedrock geology are (from *Geology Geomorphology and Soils Heritage Workshop Background Information*, 1996):

Criterion A: Importance in the course, or pattern, of Australia's natural or cultural history

A1: Importance in the evolution of Australian flora, fauna, landscapes or climate, e.g. sites which demonstrate a particular phase in the evolution of the geology of a region; geological exposures that clearly demonstrate the relationships between geological units or that reflect significant tectonic events; fossil localities.

A3: Importance in exhibiting unusual richness or diversity of flora, fauna, landscapes or cultural features, e.g. sites where a diverse range of geological features or processes are represented; sites containing numerous examples of significant geological features or processes.

Criterion B: Possession of uncommon, rare or endangered aspects of Australia's natural or cultural history

B1: Importance for rare, endangered or uncommon flora, fauna, communities, ecosystems, natural landscapes or phenomena, or as a wilderness, e.g. examples of geological features or processes that are rare or uncommon.

Criterion C: Potential to yield information that will contribute to an understanding of Australia's natural or cultural history

C1: Importance for information contributing to a wider understanding of Australian natural history, by virtue of its use as a research site, teaching site, type locality, reference or benchmark site, e.g. geological sites of significance for research or education; geological type sections; fossil type localities.

Criterion D: Importance in demonstrating the principal characteristics of (i): a class of Australia's natural or cultural places; or (ii): a class of Australia's natural or cultural environments

D1: Importance in demonstrating the principal characteristics of the range of landscapes, environments or ecosystems, the attributes of which identify them as being characteristic of their class, e.g. sites that provide good representative examples of specific attributes of geological features, assemblages or processes.

Listing on the Register of the National Estate provides for recognition and understanding of the values of places and does not impose any legal restrictions on activities, unless Commonwealth approval is required, e.g. for export licenses. Section 30 of the *Australian Heritage Commission Act 1975* requires the Commonwealth not to take any action that may have an adverse impact on a place in the Register of the National Estate, unless there is no feasible or prudent alternative.

Duhig and Dixon (1996) suggest National Estate thresholds of significance for geoconservation sites in Tasmania. These sites have commonly been classified as being either of outstanding and/or representative significance, and additionally ascribed a level of significance which may be local, regional, Tasmanian, Australian, or global (e.g. Sharples, 1993). In general, sites may satisfy National Estate criteria if they are of Tasmanian, national or international significance (Australian

Heritage Commission, 1990a, b). An exception is that sites deemed significant according to sub-criterion C1 may be considered significant at a regional or higher level (Duhig and Dixon, 1996), while sites significant under sub-criteria A3 and B1 should be of outstanding rather than merely representative significance.

GENERAL GEOLOGICAL VALUES AND INTRODUCTION TO THE GEOLOGY OF THE WEST COAST RANGE

The West Coast Range is composed of a narrow Cambrian (ca. 500 m.y.) volcanic arc and overlying Cambro-Ordovician (490–450 m.y.) siliceous conglomerate that was considerably deformed (folded and faulted) by earth movements in the Cambrian and Devonian periods. Correlatives of these rocks may be found elsewhere in Tasmania, but their depositional history and structural development are particularly well illustrated in the often spectacular exposures afforded by the rugged terrain of the West Coast Range, in part enhanced by artificial exposure (roads, canals, 'Queenstown desert'). The volcanic rocks (the Mt Read Volcanics) are richly mineralised, hosting the historic Mt Lyell mineral field, the newly opened Henty gold mine, and many abandoned or unexploited deposits. The West Coast Range area is thus significant in studies of the nature and origin of volcanogenic mineralisation, as well as providing a window into the evolution of a small Cambrian submarine volcanic arc and Cambro-Ordovician surface environments.

The Mt Read Volcanics is composed of a number of narrow (a few kilometres) meridional belts that parallel the West Coast Range. The volcanic rocks are highly varied in composition but are mostly felsic (rich in silica) and were therefore characterised by explosive volcanism, lavas of considerable thickness but limited extent, and large volumes of volcanic ash. Most of the rocks were deposited in a quite deep submarine environment. The Central Volcanic Complex (CVC) is a belt that coincides roughly with the axis of the West Coast Range, and being composed almost entirely of volcanic rocks, seems to have been the locus of the most intense volcanic activity. West and east of the CVC are flanking belts of intercalated volcanic and sedimentary rocks, the 'Western' and 'Eastern' sequences. There are very rapid lateral variations and great stratigraphic complexity throughout the volcanic rocks, which later folding and faulting have made very difficult to fully unravel.

A final, more widespread phase of volcanism deposited a succession known as the Tyndall Group over the earlier belts in about the early Late Cambrian. East of the main volcanic belt, in the Sticht Range–Marble Bluff area, is a sedimentary succession (the Sticht Range Formation) probably deposited during the volcanism but largely derived

from an eroding Precambrian landmass to the east. The Precambrian rocks — low-grade metamorphosed quartzose sedimentary rocks about 1100–1150 million years old — crop out in the northeast of the nominated area.

Mineral deposits of the ‘volcanic-hosted massive sulphide’ type, related to sub-seafloor circulation of superheated seawater and deposition of ore beneath, or at the sites of seafloor ‘hot springs’, formed at a number of times and places within the lower part of the Tyndall Group as well as in the older volcanic rocks. Mineralisation may have been related to the intrusion of small, subvolcanic granitic stocks such as the Darwin Granite. Numerous examples of the mineralisation and associated hydrothermal alteration systems are exposed in the area, and have been the focus of intensive study.

Subsidence of the expired volcanic arc during the middle to late Late Cambrian led to deposition of a thick wedge of fluvial to shallow marine, siliceous conglomerate and sandstone, derived from the newly uplifted Precambrian landmass to the east — the Owen Conglomerate. The amount of subsidence, and hence the thickness of sediment deposited, was highly uneven and partly governed by faulting. Earth movements throughout the Cambrian — collectively known as the Tyennan Orogeny — are shown by unconformities between the Sticht Range Formation and the Precambrian, between the Tyndall Group and the older volcanic rocks, and beneath and within the Owen Conglomerate.

The Owen Conglomerate is erosionally resistant and makes up most of the highest parts of the West Coast Range. Folding and faulting, rugged glacial topography and poor soil development have resulted in, for Tasmania, a spectacularly well-exposed formation, ironically little studied to date. The wealth of exposure should allow detailed sedimentological study, analysis of the relationships of the constituent members — often laterally discontinuous and unconformable — and their relationship to the evolving basin geometry. The Owen Conglomerate is succeeded by Ordovician limestone (the Gordon Group) which was deposited in warm, shallow seas, and which is exposed at several localities in the area.

Two phases of folding and associated faulting in the Middle Devonian strongly affected the Cambrian and Ordovician rocks, and their effects are particularly well exposed in places. Some further mineralisation may have occurred at this time.

Mt Sedgwick is a remnant Jurassic dolerite cap underlain by a small area of Permo-Carboniferous glaciomarine sediments. It is the only outlier on the Range of the younger geology that typifies eastern and central Tasmania.

The bedrock geology of the West Coast Range is clearly significant in terms of National Estate sub-criteria:

- A1 (because it displays, better than any comparable area, the Cambrian geological history of the State);
- C1 (the area contains a number of type sections and important research and teaching sites, notably in palaeovolcanology, hydrothermal ore deposition and deformation); and
- D1 (aspects of the bedrock geology exemplify the rock types and structures of an ancient, calc-alkaline volcanic arc; the effects of volcanogenic, hydrothermal alteration and mineralisation; and syntectonic molasse-type sedimentation).

LIST OF SITES

Sites are numbered and described below (and summarised in Table 1) in approximate south to north order. Locations are shown on Figure 1. A few geomorphological and cultural features are noted, but no systematic attempt was made to cover these.

Many of the sites are strongly clustered in their distribution around Mt Jukes and the Mt Owen–Philosophers Ridge areas (fig. 1). One such area around Mt Jukes includes sites 3, 4, 5, 6, and 8, and also contains the imposing regional anticlinal structure of the Owen Conglomerate that comprises the Mt Jukes massif (Corbett, 1996). Another cluster around Mt Owen includes sites 10, 11 and 12, the spectacular exposures of Rocky Mountain-type thrust and fold structures, and a number of significant Pleistocene glacial erosion features (Corbett, 1996). Another group, centred on and to the north of Philosophers Ridge, includes sites 13 to 19, 21, 22, 23, 25, and 26.

No field work was undertaken for this report, but it is clear that more field work and research is required to properly assess the significance of many sites (in particular sites 1, 3, 13, 17, 18, and 25) and to check the integrity of sites (in particular site 9).

A number of Eastoe’s (1979) bedrock sites are not included in this inventory, because better sites are now known or the sites are no longer considered significant. These are:

- *Volcanic bombs, Intercolonial Spur [Eastoe’s site J1]:* These are no longer considered to be volcanic bombs and are of doubtful significance (Corbett, 1996);
- *Hydes Prospect, Intercolonial Spur [Eastoe’s site J3]:* this style of mineralisation is better seen at Jukes Proprietary (site 8 herein) (Corbett, 1996);
- *Columnar jointing, Proprietary Peak (Eastoe’s locality J7):* This, a natural outcrop, is superseded

Table 1*Summary of sites in this inventory and their National Estate significance.*

Site	National Estate significance
1. Darwin Granite and unconformities, South Darwin Peak	A1
2. Barite vein, Intercolonial Spur	-
3. Palaeoregolith, West Jukes Peak	A1, B1
4. Eastern Sequence lavas, Upper Lake Jukes	-
5. Owen Conglomerate section, Mt Jukes	-
6. Jukes Conglomerate, Jukesian Unconformity type area, Proprietary Peak	A1, C1
7. Mt Read Volcanics, western Mt Jukes Road	-
8. Central Volcanic Complex, alteration, mineralisation, Mt Jukes Road	C1, D1
9. Pioneer beds basal unconformity and fossil locality, Newall Creek	-
10. 'Lower Owen conglomerate' section, Mt Owen	-
11. Upper Owen Conglomerate type section, Owen Spur	C1
12. Pioneer beds and Haulage Unconformity, Horsetail Falls	-
13. 'Mine sequence' rock types and deformation, Philosophers Ridge	C1, D1
14. Iron Blow open cut	A1, A4, C1
15. Haulage Unconformity type area, Cooleys Creek Haulage	A1, C1
16. Haulage Unconformity, Bradshaws Quarry	C1
17. Various Cambro-Ordovician rock types and structures, Pioneer Spur	A3
18. Hematite-barite alteration, North Lyell	-
19. Great Lyell Fault exposure, Tharsis Ridge	-
20. Mill Unconformity, Queenstown mill	-
21. North Lyell Fault plane exposure, North Lyell mine	-
22. Main type section for Owen Conglomerate, Mt Lyell	C1
23. Conglomerate bed in 'middle Owen conglomerate', Cape Horn	-
24. Giant erratics of Siluro-Devonian sandstone, Mt Lyell	-
25. Comstock Chert	A1
26. Comstock orebody	D1
27. Comstock Tuff type section, <i>in situ</i> welded ignimbrite, Zig Zag Hill	-
28. Sticht Range Formation section, Dante Rivulet	-
29. Margaret Fault, Sedgwick Bluff	-
30. Carboniferous glaciated surface and tillite, Mt Sedgwick	-
31. Owen Conglomerate, Mt Sedgwick–Dante Rivulet	-
32. Hematite units in Owen Conglomerate, Nectar Lakes	-
33. Sticht Range Formation, Varnished Gum Hill–Lake Spicer	A1, C1
34. Sticht Range Formation unconformable on Precambrian, east of Lake Spicer	A1, C1
35. Owen Conglomerate unconformable on Precambrian, east of Lake Spicer	-
36. Owen Conglomerate unconformable on Sticht Range Formation, southeast of Lake Spicer	-
37. Fossiliferous limestone in Owen Conglomerate, Lake Margaret	-
38. Channels in Middle Owen conglomerate, Lake Huntley	-
39. Anthony Road Andesite, Anthony Road	-
40. Tyndall Group section, Mt Julia Member type section, Anthony Road	C1
41. Varied volcanoclastic rocks, massive sulphide clasts; Newton Dam spillway	C1, D1
42. Newton Creek Sandstone, Newton Creek valley	-
43. Henty Fault Zone, Howards Road	-
44. Conformable Tyndall-Jukes-Newton Creek Sandstone sequence, Mt Julia	-
45. Sticht Range Formation section, Anthony River	-
46. 'Upper Owen' unconformably overlying Eastern Sequence, Anthony Road	-
47. Owen Conglomerate section, rapid facies changes, Mt Murchison area	-

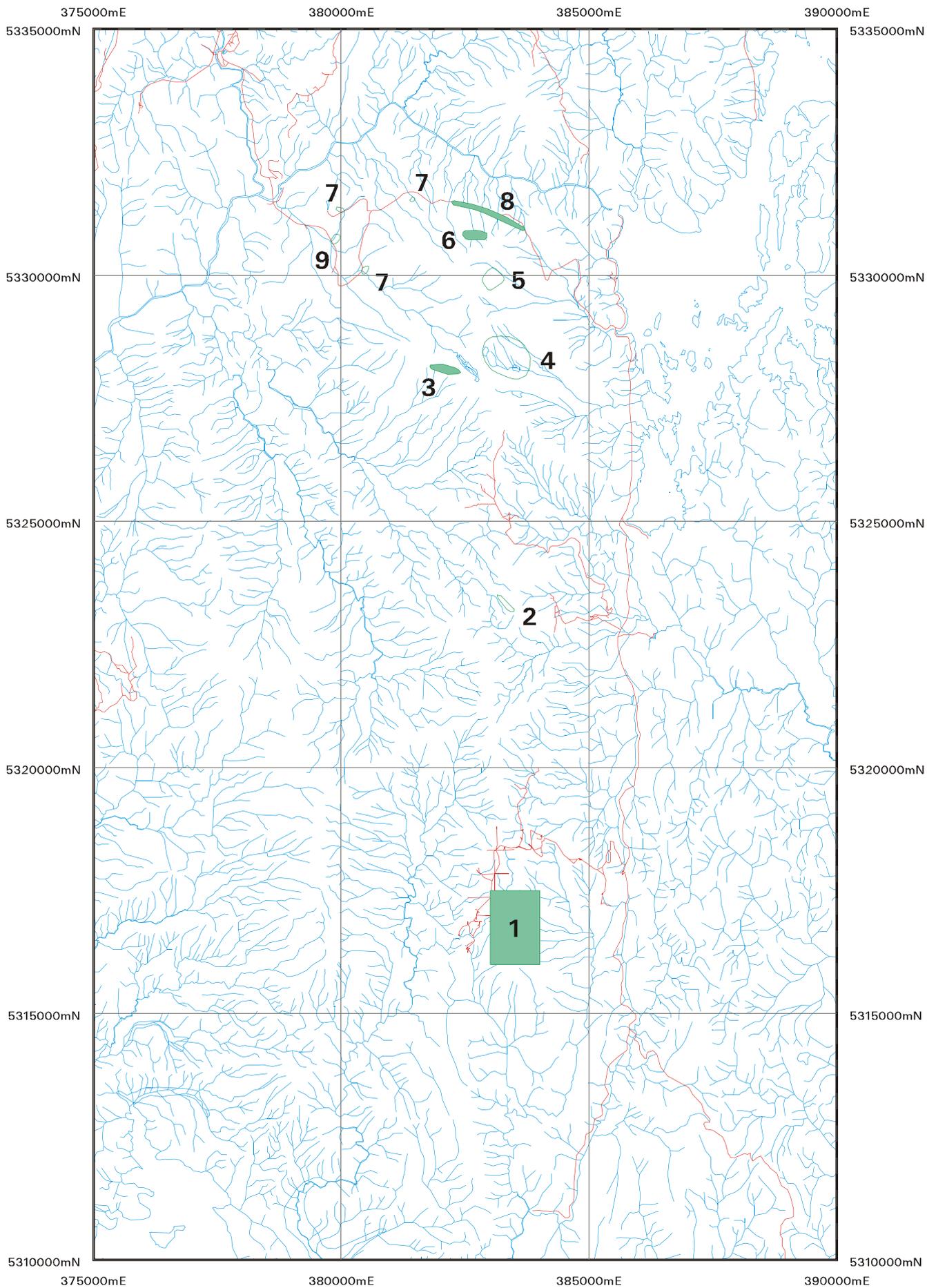


Figure 1
Location of sites (southern section)

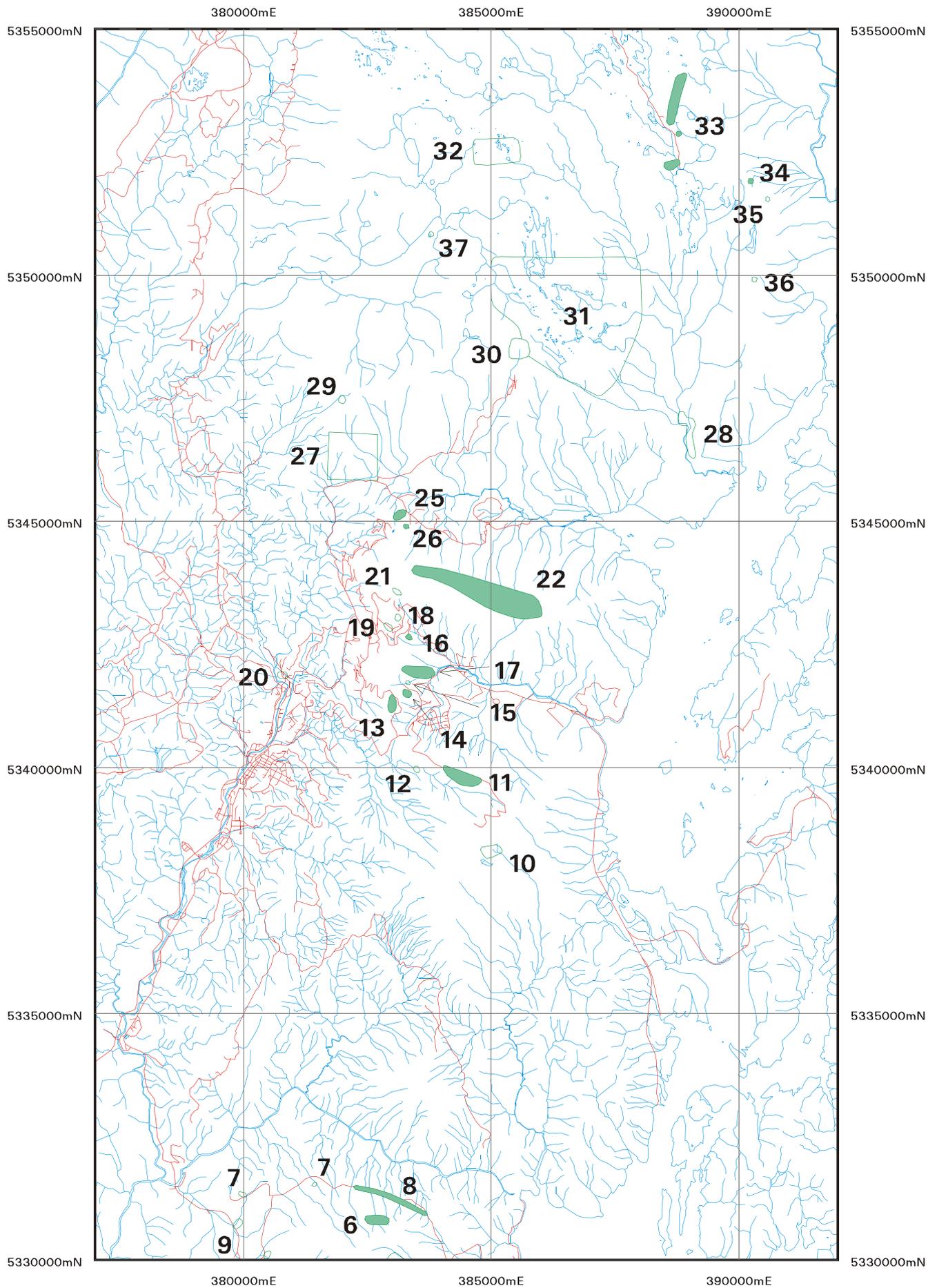


Figure 1
Location of sites (central section)

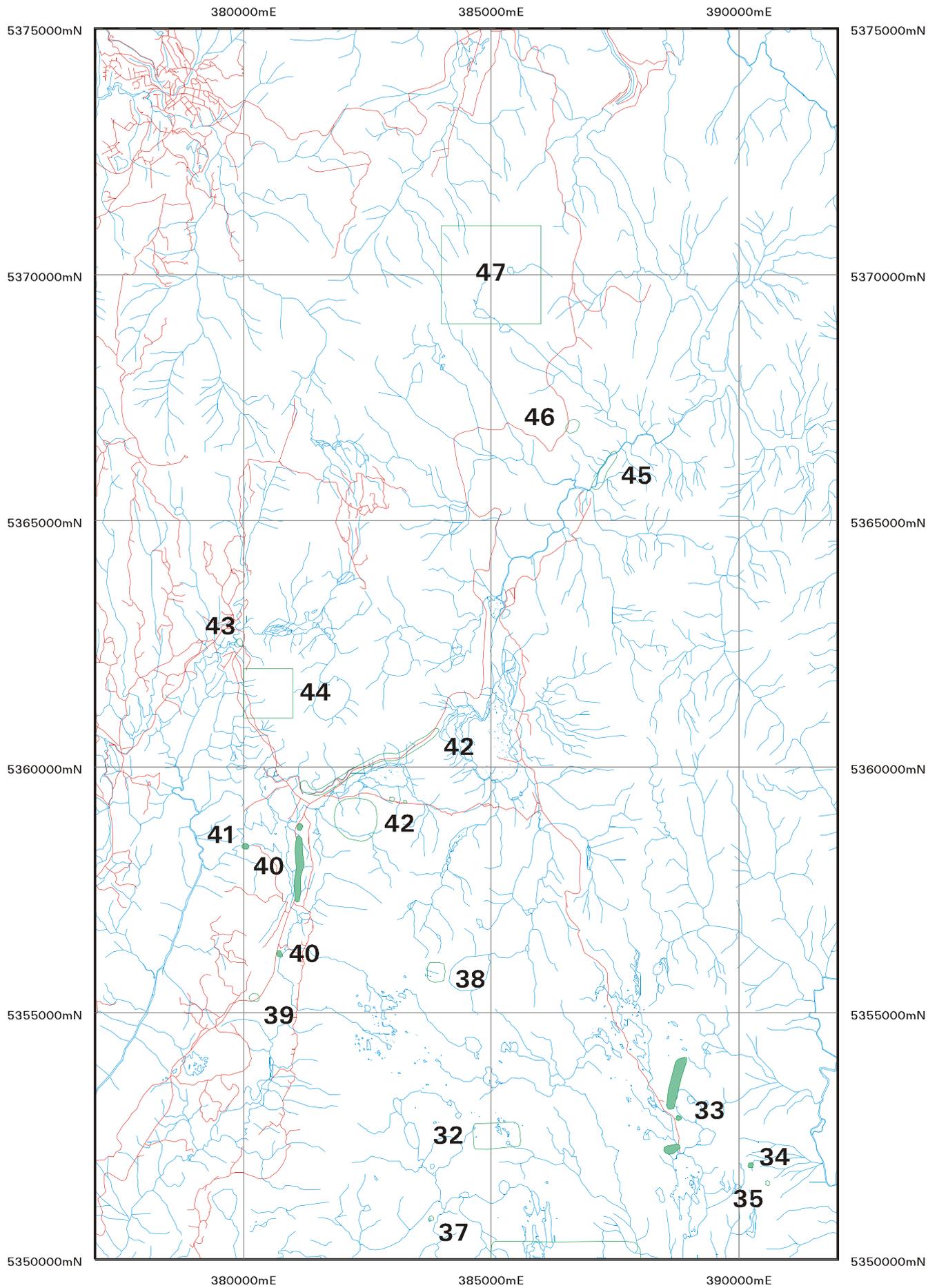


Figure 1
Location of sites (northern section)

by superior displays of columnar jointing in nearby road cuttings (site 8 herein);

- *Andesite, west side of Philosophers Ridge (Eastoe's locality L6)*: Better localities are now available elsewhere, e.g. Anthony Road (site 39);
- *Banded lava, Comstock Road (Eastoe's locality L7)*: Probably better represented at other localities, e.g. Philosophers Ridge (site 13).

Site 1: Darwin Granite, unconformities at base of Tyndall Group and Owen Conglomerate, South Darwin Peak [Eastoe's (1979) site SD]

The Darwin Granite is one of two small, Cambrian sub-volcanic granite stocks in the West Coast Range area (the other being the Murchison Granite). This site encompasses representative outcrop of the Darwin Granite and good exposures of contacts with other units, from which important age relationships can be inferred. The most detailed description is that of Corbett (1976a).

The granite is unconformably overlain by the Tyndall Group; this is clearly exposed at 'the southern end of the plateau northwest of South Darwin Peak' (Corbett, 1976a), at about CP832167. A significant period of uplift and erosion, leading to unroofing of the granite, can be inferred from this exposure, a period that is now narrowly constrained radiometrically [i.e. between 510 Ma, the age of the Darwin Granite (Adams *et al.*, 1985), and 505 Ma, the age of the Tyndall Group ignimbrite (Black *et al.*, 1997)]. Nowhere else is the magnitude and timing of this episode of uplift and erosion demonstrated so clearly.

The basal Tyndall Group contains abundant boulders derived from the granite and from volcanic rocks of the CVC and (probably) the Western Sequence, including clasts of cleaved quartz porphyry. These latter are significant in demonstrating a post-Western Sequence, pre-Tyndall Group deformation event. Proven examples of Cambrian cleavage development are rare in Tasmania, with only one other example known in the Mt Read Volcanics belt (Corbett and Turner, 1989, p. 165). Nearby, on the western flank of South Darwin Peak at around CP831163, there is good exposure of the unconformity between the Tyndall Group and the overlying Owen Conglomerate. This relationship is commonly conformable elsewhere.

Note: The rocks unconformably overlying the granite were assigned to the Eastern Sequence by Corbett (1976a), and for a time the Eastern Sequence and Tyndall Group were regarded as correlative (e.g. Corbett and McNeill, 1988). This is no longer regarded as correct (e.g. Corbett, 1992). The northern end of the Darwin Granite, not included in Eastoe's site, is covered by MRV (1:25 000 scale) mapping (Corbett *et al.*, 1993). Here

the granite is interpreted to be younger than both the Eastern Sequence and the lavas of the Central Volcanic Complex.

The site was considered outstanding at a local level by Bradbury (1995), but could be considered as a site of State-level significance, because the relationships between rock units displayed here (the unconformity between the Tyndall Group and the Darwin Granite, and the demonstration of Cambrian cleavage development) are significant in the State context. The site is therefore considered to be of National Estate significance, in terms of sub-criterion A1.

Site 2: Barite vein, Intercolonial Spur [Eastoe's (1979) site J2]

At CP832252 'A barite body, 1–2 m wide and 600 m long, is exposed on the southern part of Intercolonial Spur.' (Eastoe, 1979, p. 33).

The barite vein is about 900 m long on MRV map 13 (Corbett *et al.*, 1993), and is shown offsetting sedimentary units in the CVC. The vein demonstrates a particular style of mineralisation in the Mt Read Volcanics.

The site is of representative significance at the local or regional level, and therefore probably not of National Estate significance.

Site 3: Cambrian palaeoreolith, West Jukes Peak

Between CP815281 and CP820281 is a well-exposed example — and one of only a few known localities, all in the Mt Jukes–Snake Peak area (Corbett *et al.*, 1993) — where there is a zone of hematitic alteration in the volcanic rocks immediately beneath the unconformity at the base of the Owen Conglomerate (Calver *et al.*, 1987; Corbett *et al.*, 1993). The alteration is described by Corbett *et al.* (1993) as a 'zone of oxidised, partly brecciated rock with irregular veins of hematite and red jasper developed beneath Owen Conglomerate — probable palaeoreolith'. Clasts of the altered rock are present in the base of the Owen Conglomerate, demonstrating a pre-Owen age consistent with an origin as palaeoreolith.

The palaeoreolith demonstrates uplift, subaerial exposure and deep weathering prior to a mid-Late Cambrian marine transgression associated with Owen sedimentation (here the Newton Creek Sandstone Member correlative). The palaeoreolith may yield information on Cambrian climatic conditions. No other pre-Carboniferous palaeoreoliths are known in Tasmania.

The palaeoreolith is considered outstanding at the State level, and therefore of National Estate significance under sub-criteria A1 and B1.

Site 4: Eastern Sequence lavas, mineralisation, Upper Lake Jukes [Eastoe's (1979) sites J4 and J5]

'A superb outcrop of autobrecciated lava grading into massive lava (eastern sequence) on glaciated benches just east of Lake Jukes' (Eastoe, 1979).

Eastoe indicated another, larger (~1 km²) area around and east of Upper Lake Jukes, and wrote: 'spectacular examples of banded lavas, some with columnar jointing (J5, J7...)' and 'the link between copper mineralisation and central belt volcanics is clearly shown by the Lake Jukes (J5) ... prospect'.

This area is also noteworthy for spectacular glacial erosion features and cultural (mining history), features including several adits in Adit Knob, southeast of the lake, the remains of a stamp mill used to crush the ore (Corbett, 1976b), and an old pack track. Lower Lake Jukes was used to supply water to the old smelter at Crotty, and the water level was raised by means of a weir at the eastern end of the lake (J. Pemberton, pers. comm.).

The bedrock geological features are of local or regional significance and probably below National Estate threshold.

Note: *Pyramid Peak, geomorphological feature:* Quaternary deposits including small last-glacial moraines on the plateau northwest of Pyramid Peak (around CP824282) may be of interest (Corbett *et al.*, 1993; J. Pemberton, pers. comm.).

Site 5: Owen Conglomerate section, intraformational unconformity, Mt Jukes

The eastern face of Mt Jukes [CP829300] is a spectacular and nearly complete exposure of the Owen Conglomerate, missing only the topmost member (the Pioneer beds). The exposure is important as a local reference section, and includes good exposure of an unconformity between the 'lower Owen Conglomerate' and the 'middle Owen Sandstone' (equivalent to the Newton Creek Sandstone) — known only at one other location (Mt Owen). Here, a gentle asymmetric fold in the 'lower Owen' is transected by an erosional unconformity at the base of the 'middle Owen' (Calver, 1990). This is significant in demonstrating the nature and timing of tectonism during Owen sedimentation. The section is two kilometres west of the southern extension of the Great Lyell Fault and the stratigraphy is similar to that of the type section on Mt Owen (see below), demonstrating overlap of Owen sedimentation across the Great Lyell Fault, in contrast to the situation at Mt Owen and further north (see below).

The site is thought to be of significance at a regional level, and therefore not of National Estate significance.

Site 6: Type area of the Jukes Conglomerate; type area of the Jukesian Unconformity, Proprietary Peak [Eastoe's (1979) site J6]

The north slope of Proprietary Peak, at around CP828308, should be regarded as the type area of the Jukes Conglomerate (Corbett, 1976b), and is 'one of the few localities where there is complete exposure and where the relationships at the upper and lower boundaries are unequivocal' (Corbett, 1976b).

The lower boundary of the Jukes Conglomerate here is the type Jukesian Unconformity (Carey and Banks, 1954) and this is well demonstrated at CP828308, with the surface of unconformity truncating columnar jointing in rhyolite and truncating a quartz-porphry dyke that is intrusive into the rhyolite (Corbett, 1976b). Nearby, at CP824309, bedding in a sedimentary unit within the volcanic rocks demonstrates a steeply angular unconformity at the base of the Jukes Conglomerate (Calver, 1990). The Jukesian Unconformity defines the Jukesian Movement, a late phase of the Tyennan Orogeny (Carey and Banks, 1954; Turner *et al.*, in press).

The site is considered outstanding and representative at a State level, and of potential National Estate significance under sub-criteria A1 and C1.

Sites 7 and 8: Transect through Mt Read Volcanics, Mount Jukes Road

Cuttings along the Mt Jukes Road and the Surge Pond Road, constructed in 1986, provide an important transect across the volcanic belt, beginning in Western Sequence, crossing the Central Volcanic Complex and Eastern Sequence, and ending in Tyndall Group. Exposures in the Central Volcanic Complex (CVC) are particularly significant. Natural outcrop in the King River Gorge provides a similar, though less accessible, transect nearby. The CVC forms a large Cambrian syncline in this area (Calver, 1990; Corbett *et al.*, 1993); knowledge of both the nature and age of large-scale structure in the volcanic rocks is not common. From west to east, the following sites may be considered significant. The sites are divided into a western set (7) and an eastern set (8):

7. Western cuttings, Mt Jukes Road

[CP798313]: A section through the volcanosedimentary unit that comprises the stratigraphic top of the Western Sequence in this area, and the contact (here apparently faulted) with feldspar porphyry of the CVC (Calver, 1990).

[CP804302]: Exposure of black shale, siltstone and fine-grained micaceous sandstone. Occurrence of non-volcanic sedimentary rocks is regionally unusual in the CVC. (Black shale at The Red Hills

not as well exposed as here? McNeill and Corbett, 1992).

[CP814317]: Good representative exposure of felsic pyroclastic rocks of CVC. Typical massive, crystal-rich, pumiceous pyroclastic rocks, thought to be mass-flow deposits.

These cuttings are collectively of representative significance at the local scale.

8. Central Volcanic Complex, alteration, mineralisation, eastern cuttings of Mt Jukes Road

[CP822315–824315]: Section through volcano-sedimentary unit of the CVC. This section shows a number of interesting features: fine-grained bedded volcanic sandstones with outsized pumice fragments (foundered rafts?); grading in volcanic sandstones suggesting west-facing; anastomosing banding; devitrification spherulites (Calver, 1990; McPhie and Gemmel, 1994, p. 78).

[CP824315–830313]: Excellent representative outcrops of rhyolite of the CVC, showing well-developed columnar jointing. The best example known of columnar jointing in the Mt Read belt (Corbett, 1996). Columns plunge southeast, suggesting northwest tilting of palaeohorizontal. The western (upper) boundary of the rhyolite at CP824315 is not intrusive, suggesting that the body is a large, extrusive dome (J. McPhie, pers. comm. 1994) — a significant conclusion in view of the recent U-Pb zircon age of 503 ± 7 Ma on this rhyolite, from a sample collected from 382 910 mE, 5 331 300 mN (Black *et al.*, 1997).

[CP830313–837310]: Well-exposed representative transect of hydrothermal alteration zone and associated mineralisation in CVC volcanic rocks. East of CP832213 the rhyolite becomes increasingly intensely hydrothermally altered, initially displaying patchy alteration, passing through moderate chlorite-pyrite alteration [CP835312] into intense magnetite-hematite-tourmaline alteration within about 100 m of the faulted eastern boundary of the CVC with the Eastern Sequence [CP836311] (Corbett *et al.*, 1993). A number of disused workings lie within the intensely altered zone above and below the road (Jukes Proprietary mines). The mineralogy of this alteration zone has been interpreted to indicate a genetic connection between Cu-Au mineralisation in the Mt Read Volcanics and Cambrian granite (Large *et al.*, 1994) — hence, this locality is important in determining the timing and origin of mineralisation regionally. It is the best exposed example in the Mt Read belt of this phase of mineralisation (Corbett, 1996).

The Mt Jukes Road transect is used for teaching purposes by the University of Tasmania (e.g. McPhie and Gemmel, 1994).

The eastern road cuttings, grouped as a single site, are considered to be significant at the State level, and hence of potential National Estate significance according to sub-criteria C1 and D1.

Site 9: Pioneer beds: basal unconformity, fossil locality, Newall Creek

A short distance west of the Mt Jukes Owen Conglomerate outlier, in the lower Newall Creek valley, Pioneer beds unconformably overlie volcanic rocks with no intervening older Owen units, demonstrating rapid western wedging-out of the older units. This is similar to the Queenstown area, but the apparent absence of syndepositional faulting (the Great Lyell Fault) in the Newall Creek–Mt Jukes area makes this situation of particular interest. The unconformity of the Pioneer beds on volcanic rocks is exposed on the west bank of a creek at CP799308. Nearby [CP798307] fossils were recently collected that, for the first time, allowed a biostratigraphic age determination for the Pioneer beds (Middle Ordovician, significantly younger than previously envisaged: Laurie, 1996). Since these fossils were collected, the latter locality has been extensively modified by HEC excavation and rehabilitation, and may no longer be worth consideration; a field check is required.

The site is considered of local or regional significance; therefore probably below National Estate threshold.

Site 10: Section through 'lower Owen conglomerate', including intraformational unconformity, Mt Owen

This site comprises a spectacular exposure of the 'lower Owen conglomerate' in the cirque wall east of the summit of Mt Owen [CP852384–848383]. A boulder conglomerate unit at the top of the 'lower Owen conglomerate' displays a low-angle unconformity at its base at CP850381 (also seen at CP849392).

The site is of local, representative significance.

Site 11: Type section of the upper part of the Owen Conglomerate, Owen Spur

K. D. Corbett (pers. comm.) intends to nominate a composite type section for the Owen Conglomerate, partly on Mt Lyell and partly on Owen Spur. No fully satisfactory type section has been previously set up despite a long (if sporadic) history of investigation. The upper part of the Owen Conglomerate, including the Pioneer beds, is to be defined on Owen Spur, as in the composite type section of Banks (1962). The type Pioneer beds [at around CP848398 on Owen Spur] are conformable upon the 'upper Owen sandstone', in contrast to the situation further west, close to the Great Lyell Fault.

The site is of potential National Estate value under sub-criterion C1.

Site 12: Pioneer beds and Haulage Unconformity, Horsetail Falls

At the top of Horsetail Falls [CP835400], 1.5 km west of the type section, there is excellent exposure of the Pioneer beds and underlying 'upper Owen sandstone', here unconformable in contrast to the type section. There is an angular unconformity of up to 20° and significant erosion of the underlying 'upper Owen sandstone' has occurred (Williams, 1993).

The site is considered significant at a local or regional level, and hence below National Estate threshold.

Older Quaternary glacial sediments in Lyell Highway road cutting (Eastoe's locality L1)

'At L1 [833408], cuttings beside the Lyell Highway expose a section of till and varved mudstone in the Gormanston Moraine' (Eastoe, 1979). These are shown as Linda glaciation deposits (>730 000 years) by Fitzsimons (1988) (*in Corbett et al.*, 1989).

Site 13: Banded lavas, hyaloclastite breccias, folding and Devonian cleavages in Cambrian 'mine sequence', Philosophers Ridge

Folded, flow-banded lavas, in places autobrecciated, occur at CP830412. The folds display a wide range of orientations because of superimposition of Devonian deformation upon flow folds developed during extrusion. Devonian cleavage, quartz rods, pencil structures (Williams, 1993).

The synchronous nature of the two Devonian cleavages comprising the lenticular foliation can be demonstrated at CP830415: within the flow-banded lavas, the cleavages are symmetrical with respect to the axial surfaces of the minor, second-phase Devonian folds (Williams, 1993, p. 13).

Primary textures and structures of the 'mine sequence' — host to the Mt Lyell orebodies — are preserved and well-exposed around CP830414 (Corbett and McPhie, 1993). There are irregular lobes and pods of flow-banded rhyolite, more or less surrounded by rhyolite breccia probably of submarine hyaloclastite origin (Corbett, 1989; McPhie and Gemmel, 1994).

This locality is used for teaching purposes by CODES (University of Tasmania) (e.g. McPhie and Gemmel, 1994) and as an excursion stop (e.g. Corbett and McPhie, 1993).

The synchronous cleavages are considered outstanding at a State level by Bradbury (1995). The

site is of potential National Estate significance under sub-criteria C1 and D1.

Site 14: Historic workings, Great Lyell Fault exposure, Iron Blow open cut

The Iron Blow is the site of the first deposit discovered on the rich Mt Lyell mineral field (1883). The Great Lyell Fault bisects the open cut, with hydrothermally altered, in places mineralised, volcanic rocks (Lyell Schists) to the west and Owen Conglomerate to the east (in places also hydrothermally altered: significant in demonstrating post-Owen hydrothermal activity). The Great Lyell Fault is here clearly folded by Devonian deformation.

The site is considered representative and outstanding at a State level by Bradbury (1995), and was recommended by Dixon (1995) to be considered for National Estate listing. It is significant under sub-criteria A4 (association with historic events), A1 and C1.

Site 15: Haulage Unconformity type area, Cooleys Creek Haulage (Eastoe's locality L2)

'The Haulage Unconformity between the Pioneer beds and the [older part of the] Owen Conglomerate is beautifully exposed at L2 [833417] and L4 [833427]' (Eastoe, 1979). The former locality — Cooleys Creek Haulage — may be considered the type locality of the Haulage Unconformity. Here, angular differences between the beds above and below the unconformity are up to 130° (Williams, 1993). Style and timing of deformation in the older beds are significant (e.g. Williams, 1993, p. 9). Indirect biostratigraphic evidence has recently been shown to indicate a time break at the unconformity of about 30 m.y., much longer than previously envisaged (Seymour and Calver, 1995).

The site was considered representative and outstanding at a local level by Bradbury (1995). However, its status as a type locality, and the significance of the Haulage Movement in understanding the State's Cambrian geological history, suggests that the site is of National Estate significance under sub-criteria A1 and C1.

16: Haulage unconformity, Bradshaws Quarry (Eastoe's locality L4)

There is a spectacular and easily accessible exposure of the Haulage Unconformity in Bradshaws Quarry [CP833427]. The Pioneer beds here have native copper mineralisation (Corbett, 1996). The site is an important excursion stop and teaching locality.

The site is considered significant at the local level, but is of National Estate significance under sub-criterion C1.

17: Great Lyell Fault, Haulage Unconformity and correlative conformity, reference section in Pioneer beds, Devonian folds, 'copper clays' host; Pioneer Spur

Pioneer Spur is one of several exhumed Devonian anticlines expressed in resistant sandstone and conglomerate of the upper Owen/Pioneer beds at the western end of the Linda Valley. Fold style and associated reverse faults are of interest (Williams, 1993). Unusual, oolitic hematite-rich beds in the 'upper Owen sandstone' are well exposed on Pioneer Spur (Wade and Solomon, 1958, p.387; Corbett, 1996). At the western end of Pioneer Spur [CP833420] there is good exposure of the narrow (0.5 m) foliated shear zone of the Great Lyell Fault, here affected by Devonian folding (varying in strike from 40° to 165°) (Williams, 1993). In this area are the best known exposures of Haulage-age folds in the 'upper Owen sandstone' (i.e. folds caused by movement on the Great Lyell Fault before deposition of the Pioneer beds; Corbett, 1996). Devonian second-phase folds are superimposed on these earlier structures (Williams, 1993, p.12). There is good exposure of the Haulage Unconformity on the southwest flank of Pioneer Spur [CP833419]; at this locality the underlying beds were evidently unconsolidated although coherent (Williams, 1993). The unconformity surface can be followed eastward and within 100 m of the Great Lyell Fault, it passes into a paraconformity (e.g. at CP836419). On the south flank below this point there is a well-exposed section through the Pioneer beds (Williams, 1993, p.7). The overlying, originally calcareous, lower parts of the Gordon Group are deeply weathered and are the site of 'copper clay' deposits [CP835418] — an unusual style of native copper mineralisation perhaps resulting from neutralisation of Cu-rich acidic surface runoff during the Cainozoic (K. Wills, pers. comm.).

Corbett (1996) notes that the remains of original sluice workings of the Lyell Pioneer Gold Company, including an exposure of a ?Tertiary deposit with *in situ* tree roots, and the remains of the King Lyell copper clays sluice workings, are also significant in this area.

This site is considered of National Estate significance in terms of exhibiting an unusual diversity of geological and geomorphological features (sub-criterion A3).

Site 18: Hematite-barite alteration, North Lyell

Lenses of brecciated hematitic chert and hematite-barite occur along the Great Lyell Fault. The presence of strong barite-hematite alteration in the Owen Conglomerate close to the fault demonstrates a later (Devonian?) hydrothermal event (Hart, 1992). Corbett (pers. comm., 1996) suggests that a bedded hematite unit at the base of

the Owen Conglomerate sequence in the Lyell Tharsis–Linda Spur area is significant, being highly unusual and demonstrating an important relationship between the conglomerate and volcanic rocks.

This site is considered significant at a local or regional level.

Site 19: Great Lyell Fault exposure, Tharsis Ridge (Eastoe's locality L3)

'The Owen Conglomerate abuts against the Mt Read Volcanics along the Great Lyell Fault (L3)' [CP829429] (Eastoe, 1979).

Williams (1993, p. 9) describes a nearby exposure at the southern boundary of the Tharsis outlier [CP831428] where the fault is folded, varying in strike from 110° to 180° within a couple of metres, and the 100 mm wide fault zone is overprinted by Devonian cleavages.

This site is considered significant at a local or regional level.

Site 20: Mill Unconformity, Queenstown mill (Eastoe's locality L5)

'...to the west [of the Great Lyell Fault] Ordovician clastic rocks are represented only by the thin Pioneer beds which overlie the Comstock Tuff unconformably (the Mill Unconformity, L5)' [CP809419] (Eastoe, 1979). An angular unconformity of greater than 50°, and a lateritised zone beneath the unconformity, were noted by Williams (1993).

Corbett and McPhie (1993) described a spectacular mass-flow breccia in the Tyndall Group beneath the unconformity, and a right-angle unconformity with the Pioneer beds which contain heavy mineral bands of chromite. The Pioneer beds are here about 10 m thick.

The locality is used as an excursion stop (e.g. Corbett and Large, 1990; Corbett and McPhie, 1993).

This site is considered significant at a local or regional level, and not of potential National Estate significance.

Site 21: North Lyell Fault plane exposure, North Lyell mine

This fault plane exposure [at about CP831436], exposed largely by mine workings, is of Owen Conglomerate. Corbett (1996) suggests that it is probably the best exposure of a fault plane in the State.

This site is considered significant at a local or regional level.

Site 22: Main type section for Owen Conglomerate, Mt Lyell

The type section for most of the Owen Conglomerate (Corbett, in prep.) extends from the exposed base at the eastern end of the Mt Lyell range to near the top of the 'upper Owen sandstone' at the western summit [CP835439]. There are excellent exposures of tidal and shallow marine sedimentary structures in the 'upper Owen sandstone' around the western summit (Corbett, 1996).

The site is of potential National Estate significance under sub-criterion C1.

Site 23: Conglomerate bed in 'middle Owen conglomerate', Cape Horn

Corbett (1996) notes an exposure of a spectacular conglomerate bed above Cape Horn. This bed contains clasts of silicified volcanic rocks (chert), hematite and red jasper, demonstrating the pre-Owen age of alteration and mineralisation of the volcanics.

This site is considered significant at a local or regional level, and not of potential National Estate significance.

Site 24: Giant erratics of Siluro-Devonian sandstone, Mt Lyell

Corbett (1996) notes the occurrence of giant erratics of Siluro-Devonian sandstone on the eastern end of the Mt Lyell range.

This site is considered significant at a local or regional level, and is not of potential National Estate significance.

Site 25: Comstock Chert

A large (300 m) pod of chert with hematite-jasper veins that transgresses enclosing Cambrian units. Its origin is not entirely clear: it may be a volcanic sinter deposit, or more likely, a product of massive silicification of volcanic rocks in the heart of the footwall alteration system associated with the Comstock orebodies.

The site is considered outstanding at a State level by Bradbury (1995). It is of potential national estate significance according to sub-criterion A1.

Site 26: Comstock orebody (Eastoe's locality L8)

'At L8, a small massive-sulphide lead-zinc orebody is exposed in the face of the Comstock open-cut' (Eastoe, 1979). This is the best preserved outcropping example of this important style of mineralisation in the State, and is also significant for the preservation of *in situ* gossan (Corbett, 1996).

This site is considered of potential National Estate significance under sub-criterion D1.

Site 27: Comstock Tuff type section, *in situ* welded ignimbrite, Zig Zag Hill (Eastoe's locality L9)

Corbett *et al.* (1974) defined the Comstock Tuff with a type section on the lower slopes of Zig Zag Hill. White and McPhie (1996) recently reappraised the stratigraphy of the Tyndall Group, and exposures on Zig Zag Hill between 5 345 910 mN, 381 650 mE and 5 346 500 mN, 382 500 mE comprise one of their reference sections. A welded ignimbrite, 30–60 m thick, at the top of the Comstock Formation in this section is an indication of a subaerial (or near-subaerial) depositional environment — very rare, perhaps unique, in the Mt Read Volcanics. Other welded ignimbrite occurrences in the Tyndall Group appear to be blocks transported into deeper marine environments (White and McPhie, 1996).

The site is significant at a regional level, and therefore below National Estate threshold.

Site 28: Sticht Range Formation section, Dante Rivulet

There is a well-exposed section in the Sticht Range Formation (see site 32) in the Dante Rivulet [CP890463–888471]. Bedding dips and faces west, with a lower, conglomeratic fluvial and alluvial-fan succession passing up at about CP890470 into a finer-grained marine succession (Baillie, 1988).

This site is considered significant at a local level, and is not of potential National Estate significance.

Site 29: Margaret Fault, Sedgwick Bluff

Corbett (1996) notes that the natural exposure of the surface of the Margaret Fault, southwest of Sedgwick Bluff (at about CP820475) is of significance.

The site is unlikely to be of potential National Estate significance.

Site 30: Carboniferous glaciated surface and tillite, Mt Sedgwick (Eastoe's locality S)

This site is significant for the occurrence of Carboniferous tillite on a Carboniferous ice-scoured surface (south of the summit), and a remnant Jurassic dolerite cap.

The Permo-Carboniferous section is described in detail by Banks and Ahmad (1962). About 60 m thick, it consists of tillite resting on an irregular, glacially-striated Cambrian basement, overlain by fossiliferous marine siltstone and limestone.

This site is considered significant at a local or regional level, and is not of potential National Estate significance.

Site 31: Owen Conglomerate, Mt Sedgwick–Dante Rivulet

A complete, well-exposed section through the Owen Conglomerate occurs here, with the base at Mt Sedgwick and the top in the upper Dante Rivulet where the Owen is overlain by Ordovician limestone of the Gordon Group. Lower units of the Owen wedge out (disappear) eastwards along the escarpment east of Mt Sedgwick, until only the ‘upper Owen sandstone’ is present resting on volcanic rocks above Lake Beatrice. This is an excellent demonstration of the influence of ‘trap-door’ style, differential subsidence on Owen sedimentation, thought to have been controlled by synsedimentary, east-side-down movement on the Great Lyell Fault (Corbett, 1996).

This site is considered significant at a regional level, but is not of potential National Estate significance.

Site 32: Hematite units in Owen Conglomerate, Nectar Lakes

Corbett (1996) notes bedded hematite units at the base of the ‘upper Owen sandstone’, overlying an erosional disconformity. Corbett and Jackson (1987) show three occurrences, at CP848523, 851526 and 854524.

This site is considered significant at a local or regional level, but is not of potential National Estate significance.

Site 33: Sticht Range Formation, Varnished Gum Hill–Lake Spicer

The Sticht Range Formation is an eastern, sedimentary lateral equivalent of the volcanic belt, and was largely derived from an adjacent land area of Precambrian rocks (the Tyennan region) to the east (Baillie, 1989). The Formation has no nominated type section but is best exposed along the main reference sections measured as part of a comprehensive study (Baillie, 1989), on the southern ridge of Varnished Gum Hill [CP888540–886531] and near Lake Spicer [CP887523–885522]. There are well-exposed sedimentary structures indicative of palaeoenvironments ranging from alluvial fans and braided rivers to shallow sea. Near the former section, at CP887529, is the only known fossil locality in the Formation, with poorly preserved trilobites of Middle or Late Cambrian age (Baillie, 1989).

This site constitutes the most important exposures of the Sticht Range Formation, a unit that provides significant constraints on the palaeogeographic

setting and age of the Mt Read Volcanics (Baillie, 1989; Corbett, 1992). The site is considered to be of National Estate significance, according to sub-criteria A1 and C1.

Site 34: Sticht Range Formation unconformable on Precambrian, east of Lake Spicer

There is an exposure of the unconformity between the base of the Sticht Range Formation and Precambrian rocks east of Lake Spicer at CP901519 (Corbett, 1982, p.19). This is a manifestation of the Stichtan Movement, an early phase of the series of Cambrian earth movements known as the Tyennan Orogeny (Carey and Banks, 1954; Turner *et al.*, in press). The Stichtan Movement resulted in intense deformation and metamorphism of the Precambrian rocks in (probably) the Early Cambrian (Turner *et al.*, in press), before the commencement of filling of the Dundas Trough as shown here by the unconformably overlying, Middle Cambrian Sticht Range Formation. Thus, this is a very important stratigraphic relationship in the State’s geological history.

The exposure is regarded as significant at a State level, and is therefore of National Estate significance, under sub-criteria A1 and C1.

Site 35: Owen Conglomerate unconformable on Precambrian, east of Lake Spicer

An unconformity between Late Cambrian Owen Conglomerate and Precambrian rocks is exposed at CP905515 (Baillie, 1989). This onlap of Owen onto Precambrian basement only a short distance east of Mt Read Volcanics demonstrates that the eastern limits of the volcanic belt in the Late Cambrian were not much different to the current limits.

This site is considered significant at a local or regional level, and is not of potential National Estate significance.

Site 36: Owen Conglomerate unconformable on Sticht Range Formation, southeast of Lake Spicer

East-dipping Owen Conglomerate unconformably overlies west-dipping Sticht Range Formation at CP902499 (Corbett, 1982, p. 6; Corbett, pers. comm. 1996). This is a local manifestation of the Jukesian Movement (pre-Owen deformation of the Mt Read Volcanics).

The site is considered significant at a local or regional level, and is not of potential National Estate significance.

Site 37: Fossiliferous limestone in Owen Conglomerate, Lake Margaret

A small island at the eastern end of Lake Margaret is composed of fossiliferous, impure limestone and calcareous sandstone, thought to be part of the Newton Creek Sandstone Member (Corbett and Jackson, 1987). Limestone is rare in the Owen Conglomerate, indeed in the Tasmanian Cambrian generally.

The site is considered significant at a regional level, and is not of potential National Estate significance.

Site 38: Channels in Middle Owen conglomerate, Lake Huntley

Corbett (1996) notes that erosional channels filled with siltstone, cut in 'middle Owen conglomerate', exhumed by Pleistocene glacial erosion at the top of the cliffs west of Lake Huntley, are of geoconservation significance.

The site is unlikely to be of potential National Estate significance.

Site 39: Anthony Road Andesite, Anthony Road

Cuttings along the Anthony Road between CP795548 and CP806557 expose good representative outcrop of the feldspar-hornblende-phyric Anthony Road Andesite, a locally significant unit near the stratigraphic top of the Central Volcanic Complex. Spectacular andesite breccias at CP802552 are probably intrusive hyaloclastites or peperites (McPhie and Gemmel, 1994).

The site is used for teaching purposes by the University of Tasmania (e.g. McPhie and Gemmel, 1994) and as an excursion stop (e.g. Corbett and McPhie, 1993).

The site is considered representative at a local level by Bradbury (1995). It is not of National Estate significance.

Site 40: Tyndall Group section, Mt Julia Member type section, Anthony Road

A well-exposed section through the Tyndall Group in cuttings along the Anthony Road has been used as a reference section by White and McPhie (1996) [CP80625590–81305920]. Significant features include:

- outcrop of crystal-rich volcanoclastic sandstone of intermediate composition and laminated mudstone (Lynchford Member) [CP80955615];
- volcanoclastic lithic breccia, felsic crystal-rich volcanoclastic sandstone and mudstone comprising graded units 5–15 m thick,

incorporating allochthonous blocks of welded ignimbrite (Mt Julia Member) [CP81055730];

- pink and green alteration banding and other, more unusual alteration patterns (Mt Julia Member) [CP81055730; 81055770; 81055850];
- polymict conglomerate with graded beds (Zig Zag Hill Formation) [CP811588] (McPhie and Gemmel, 1994; White, 1995).

This section includes the type section of the Mt Julia Member [CP81055730–81045865] (White and McPhie, 1996).

The section is used for teaching purposes by the University of Tasmania (e.g. McPhie and Gemmel, 1994) and as excursion stops (e.g. Corbett and McPhie, 1993).

The site is considered representative at a local level by Bradbury (1995). However, the nomination of the type section of the Mt Julia Member by White and McPhie (1996) means the site (or part of it) could be considered of National Estate significance under sub-criterion C1.

Site 41: Varied volcanoclastic rocks, massive sulphide clasts; Newton Dam spillway

The Newton Dam spillway [CP800584] (exact co-ordinates: outcrop between 379 900 mE, 5 358 270 mN and 38 0050 mE, 5 358 350 mN) is a spectacular, continuous exposure, 200 m long and 6–30 m wide, incorporating a wide diversity of volcanoclastic facies including breccia and conglomerate, crystal-rich volcanoclastic sandstone and mudstone, and two coherent igneous bodies (dacite and andesite). The outcrop is of great importance for mineral exploration in the area because one breccia unit contains clasts derived from a Cambrian massive sulphide deposit. The outcrop is structurally complex, being cut by at least 22 faults. 'A volcanoclastic paradise' (McPhie and Gemmel, 1994).

The site is used for teaching purposes by the University of Tasmania (e.g. McPhie and Gemmel, 1994) and as an excursion stop (e.g. Corbett and McPhie, 1993).

The site is considered of National Estate significance, under sub-criteria A1, B1 (sulphide intraclasts) and C1.

Site 42: Newton Creek Sandstone, Newton Creek valley (Eastoe's localities T5, T6)

The Newton Creek Sandstone Member, locally developed in the northern Tyndall Range–Mt Julia area, is a deep-water turbiditic unit contrasting with the shallow marine to terrestrial facies of the enclosing Owen Conglomerate succession. Fossils

from this unit provide important biostratigraphic age constraints on the Owen and underlying Cambrian units. 'At T5, the Newton Creek Sandstone includes beautifully exposed sedimentary structures indicative of marine flysch-type deposition ... and marine fossils have been found at T6.' (Eastoe, 1979). T5 is an area of about 0.5 km² centred on CP823589, southeast of the Howards Road–Anthony Road junction. A variety of Newton Creek Member lithologies have been mapped here (Corbett and Jackson, 1987), including slump sheets and 'elutriation column's at CP812592. Since Eastoe's work, an almost complete transect of the Newton Creek Sandstone has been exposed nearby in a 3 km section of the Henty Canal [approximately CP812597–833603]. Road cuttings in the Anthony Road further east [CP834604–839608] continue this section through the 'middle Owen conglomerate' and 'upper Owen' units, to give an almost complete section through the Owen. A small quartz-feldspar porphyry intrusive in the Newton Creek Sandstone Member occurs in this section at CP818597 (Corbett and Jackson, 1987). Felsic intrusive rocks in the Owen are rare, being known only from two, perhaps three, other locations (McNeill and Corbett, 1992; Funnell, 1988). Eastoe's fossil locality T6 is at CP829593, on the old Lake Dora track. However, Corbett (1975) states that of five localities, that at CP832593 had the best preserved fauna.

The locality is significant at a regional level, but is probably not of National Estate significance.

Site 43: Henty Fault Zone, Howards Road

A road cutting at the Henty River Bridge has CVC lavas and mafic dykes at the western end, and the North and South Henty Faults (mylonite zones separated by a wedge of highly-sheared siltstone and shale) and volcanoclastic rocks of the Tyndall Group on the eastern side (Corbett and Large, 1990). The Henty Fault System is regionally significant, as it separates Cambrian areas (terranes?) that in some ways are distinct.

The site has been used as an excursion stop (Corbett and Large, 1990).

The locality is significant at a local or regional level, but is not of National Estate significance.

Site 44: Conformable Tyndall Group–Jukes Conglomerate–Newton Creek Sandstone sequence, Mt Julia (Eastoe's locality MJ)

On the western slopes of Mt Julia, the Tyndall Group is conformably overlain by a correlative of the Jukes Formation, which is in turn transitionally overlain by the Newton Creek Sandstone Member of the Owen Conglomerate. There is good exposure of

the Newton Creek Sandstone Member higher up on the western flank of Mt Julia (Corbett, 1975).

The Newton Creek Formation rests directly on Tyndall Group (McNeill and Corbett, 1992) in Julia Creek [CP800627].

An excellent exposure in a cutting on Howards Road shows overturned Newton Creek Sandstone overlying volcanoclastic conglomerate and sandstone of the upper Tyndall Group (Corbett and Large, 1990, *exact location not specified*).

The locality is significant at a local or regional level, but is not of National Estate significance.

Site 45: Sticht Range Formation section, Anthony River

In contrast to the type area where the Sticht Range Formation underlies Tyndall Group, here the Formation is gradationally overlain by Eastern Sequence, and is somewhat attenuated. This relationship is important in constraining the maximum age of the Eastern Sequence. The section in the Anthony River [CP874663–870656] is briefly described by McNeill and Corbett (1992, p.8).

The locality is significant at a local level, but is not of National Estate significance.

Site 46: 'Upper Owen' unconformably overlying Eastern Sequence, Anthony Road

On the Anthony Road at CP866669 the 'upper Owen sandstone' unconformably overlies fine-grained, sericitic, lithic-bearing volcanoclastic rocks and vitric tuff of the Eastern Sequence (McNeill and Corbett, 1992). The locality demonstrates easterly onlap of Owen on basement and representative lithologies of the Eastern Sequence.

The locality is significant at a local level, but is not of National Estate significance.

Site 47: Owen Conglomerate section, rapid facies changes, Mt Murchison area

The Newton Creek Sandstone Member wedges out west of Mt Murchison, perhaps across a growth fault (McNeill, 1987). The 'middle Owen conglomerate' attains its maximum thickness on Mt Murchison, and wedges out with remarkable rapidity to the south. It is overlain by a thick, well-exposed section through the 'upper Owen conglomerate', including a discontinuous basal facies characterised by soft-sediment deformation structures just west of the summit (McNeill, 1987; McNeill and Corbett, 1992).

The locality is significant at a local level, but is not of National Estate significance.

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