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Desktop Report on Sites of Geological and Geomorphological Significance in the Victorian Central Highlands

Dr Susan White

Wakelin Associates Pty Ltd

to

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Wakelin Associates Pty Ltd. ABN 11 002 971 262
PO Box 271, Clifton Hill Victoria, Australia 3068. Ph 03 9482 4584
www.wakelinassociates.com.au

Introduction

This Desktop Report on Sites of Geological and Geomorphological Significance in the Central Highlands area of Victoria lists sites of International, National and State significance in the large Central Highlands area delineated in the kmz provided.

It includes a significant area in the north-east and east of the designated area where very few specific sites were previously documented as sites of significance, although the area has important information on the Palaeozoic geology of the Lachlan Fold Belt. This area is predominantly native forest with difficult access. Many sites with documented information e.g. Walhalla Goldfields area, fall outside the boundaries of the area required. Access to the forest areas was possibly difficult during logging. A major Geological Survey of Victoria (GSV) report has been very valuable in untangling the complex Palaeozoic geology and sites.

Methodology

This is a desktop study that interrogated available published literature and the Sites of Significance database held by the Victorian Division of the Geological Society of Australia (GSAV). Only limited use was made of the Victoria Resources Online (VRO) website due to it being offline for a substantial period of time of the production of the report. Fortunately hard copies of the relevant Rosengren *et al* publications were eventually able to be obtained and used. Relevant reports of Geological Survey of Victoria (GSV), in particular VandenBerg A.H.M, 2006, Walhalla – Woods Point – Tallangallook special map area geological report. *Geological Survey of Victoria Report 127 I,* were consulted and other relevant available literature.

However some of this literature is very dated and the descriptions of some features is seriously out of date as the information, especially that on the VRO website and the earlier 1980s Rosengren publications, as this data is now over 30 years old. This applies particularly in respect to the significance status of some sites. One report specifically on sites of geological significance of the Central Highlands (Cochrane and Tan 1993) was unable to be found.

As this is a desktop study no verification of location was undertaken. The location data (Latitude & Longitude) is often not precise as published location data may be pre-GPS technology. The data on the site locations is therefore very variable. All the location data is provided as Latitude and Longitude in decimal degrees. However the locations for most of the more recent and accurate sites were sourced and converted to Latitude and Longitude from GSV reports where grid references are reported in GDA94 (MGA), the standard used by the GSV.

Only the high significance status sites of the area are covered in this report i.e. those with International, National and State significance. A comment is made on the large number of Regional and Local sites. Large sites, e.g. the Baw Baw Granite and plateau, have subsites, most of which are of lower significance. A short list of unassigned sites that are potentially of high status is included. These are listed with the large sites as they are important components of the overall high significance site.

No Victorian state government department maintains an up-to-date data set of sites of geological significance. The GSA(V) maintains a state-wide database but as this is reliant on volunteers, is not always up to date. GSA(V) has a robust and repeatable protocol for assessing sites (Appendix 2).

All sites are issued with a unique ID number based on the 1:250,000 Geological map series, in this case the Warburton (WR), Warragul (WL) and Melbourne (ML) map sheets are within the designated area. Numbering is in the format of WL 017 (Labertouche Cave). Some large sites e.g. Baw Baw Plateau and granite intrusion (WR 014) and has six subsites (WR 014.01, WR 014.02, WR 014.03, WR

014.04, WR 014.05, WR 014.06). Only one of these (WR 014.06) is of State significance. The subsites are assessed individually but are part of the overall major site.

The protocol assesses sites according to a structured range of criteria for International, National, State, Regional and Local significance. Sites are listed as unassigned until assessed. Destroyed sites are listed as these are often quarries or road cuttings; some have samples e.g. mineral samples or fossils in museum collections, but the actual site is recorded as important.

Regional Geology and Geomorphology

The geology of the area is dominated by the complex Palaeozoic Lachlan Fold Belt (LFB), one of the main components of the large Palaeozoic Tasman Fold Belt System that encompasses large parts of South Australia, New South Wales, and Queensland, and all of Victoria and Tasmania. The Melbourne Zone of Central Victoria of the LFB comprises folded and faulted Ordovician to Early Devonian marine sedimentary rocks and Middle Devonian intrusive rocks. It is a roughly triangular shaped area across central Victoria bounded by two major faults, the Mount William and Governor faults, west and east respectively. Situated in the eastern Melbourne Zone, the Central Highlands comprise between 30-40% of the area (VandenBerg et al 2006). The Melbourne Zone underwent significantly less regional deformation of the Late Ordovician-Silurian times (Benambran Orogeny) than the rest of Victoria and the regional deformation did not begin until the Early Devonian (VandenBerg et al 2006).

The geological history of the area can be divided roughly into three major episodes:

- Cambrian to Early Carboniferous: cycles of volcanism, marine and non-marine deposition, alternating with deformation, metamorphism, and intrusion of granites.
- Late Carboniferous to mid-Mesozoic: tectonic stability with extensive erosion resulting in low to moderate relief across south-eastern Australia.
- Mid-Mesozoic to the present day: separation of Australia from Antarctica and New Zealand (breakup of Gondwana). Rift basins formed along the Australia's southern margin of and broad uplift created the Great Dividing Range. Multiple basaltic lava flows occurred over during the mid-Cainozoic.

Much of the area lies in the Eastern Uplands (Joyce et al 2003) with steep ridges, narrow valleys, and high plateaus. Only in the west and north are wide flat valleys and undulating hills developed.

Sites of Significance

A significant area of the Central Highlands has very little up to date published material. The Walhalla GSV Report was very useful but only covered about 10-20% of the area. More problematic is the absence of any investigation having been undertaken in recent decades in the forest harvesting (RFA) areas. Reliance on material now over 40 years old, e.g. Rosengren, McRae-Williams and Kraemers (1981) is problematic. This report was limited as it only dealt with the most southerly areas and the information on the one site (WL 017, Labertouche Cave) was limited as much more in known about the processes involved.

Most of the area is on the Warburton 1: 250,000 Geological map sheet and although there are a few high significance sites listed on the eastern edge of the map, the bulk of this map area has had limited recent investigation published, especially in the area of the Acheron and Cerberean Cauldrons. The detail of the Walhalla report in the northeast and east of the area indicates that the complex Palaeozoic geology of the Central Highlands is very interesting.

For the Central Highlands area, over 200 sites were identified. Most of these are Regional and Local sites. However there are 24 higher significance sites: International (2), National (1) and State (21). There are no known destroyed sites. There are quite large number of unassigned sites. These sites

were investigated but there are many that there was insufficient information to assess their geological significance adequately. The International, National and State sites are listed in detail in this report and locations Table 1 and Figure 1. Site descriptions are provided in Appendix 1. The large number of Regional and Local sites are not listed.

There are several subsites listed in some of the large sites e.g. Baw Baw Plateau. These generally are of lesser significance than the main site but the complexity of the larger sites results in some smaller sites still being worth identifying and allocating significance as these assist in management. The large features e.g. Acheron, Dandenong and Cerberean Cauldrons and the Baw Baw Plateau and Pluton, have the subsites listed where they have been identified.

The location details for some sites have not been able to be found and work is currently underway to obtain this information. Much of the area of the study is remote and difficult to access. Also detailed location information is rarely published for fossil and some mineral sites to protect the site.

There is a number of site that have not been assigned a significance as there is insufficient information to enable this to be done. These include Jamieson Road ring dyke (WR 037), and the Walhalla Group Road cuttings (WR 107) but given the general geology of the area, have the potential for a relatively high significance. The paucity of known sites in the central and northeast of the project area probably means that there are more sites. The Walhalla Report excursion sites also need further interrogation.

Conclusions

This study has its limitations as a desktop study but is a good start on what significant sites exist in the Central Highlands. There are more known sites in the western part of the area, where there are more roads and population. However the bulk of these sites are Regional and Local, whilst not unimportant, are useable more for excursions, geotourism and other people related activities.

The highly significant sites need some further investigation and the area north, northwest and west of the Thompson Dam needs some further checking through the more obscure literature for potential sites. This area is known to have interesting Victorian geology but there is limited published material although the GSV has been working in the area.

References

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Table 1: Known International, National and state sites of Geological & Geomorphological Significance in the Central Highlands, Victoria.

Number	Site name	Significance	Location
ML 082	Limestone Road Silurian plant fossil site	International	Yea
WR 092	Sekaninaite mineral occurrence	International	Marysville
WR 014	Baw Baw Plateau	National	Approximately between Mt Whitelaw & Mt Erica
WR 014.01	Mt Baw Baw Summit	Regional	Baw Baw Plateau
WR 014.02	Mt St Gwinear	Local	Baw Baw Plateau
WR 014.03	MT Whitelaw	Local	Baw Baw Plateau
WR 014.04	Mt Erica	Regional	Baw Baw Plateau
WR 014.05	Thomson Valley Rd, Baw Baw Granodiorite	Regional	Baw Baw Plateau
WR 014.06	Marshall Spur Road: contact metamorphosed	State	Road metal Quarry on west side of Marshall Spur Rd
ML 124	Hull Road-Allenby Road cutting	State	Lilydale
ML 135	Mount Dandenong Tourist Rd (Mt Evelyn Rhyodacite)	state	Kalorama
ML 137	Mount Dandenong Tourist Rd (Mt Evelyn/ Kalorama Rhyodacite)	State	Kalorama
ML 153	Mount Dandenong Tourist Road (Kalorama - Ferny Creek rhyodacite relationship)	State	Kalorama
WL 017	Labertouche Cave	State	11km north of Princes Hwy at Robin Hood
WR 011	Cathedral Range	State	Buxton
WR 013 &	Acheron Cauldron Area	State	Mt Donna Buang area
WR 013.01	Koala Creek	Local	Marysville?
WR 013.02	Marysville – Cumberland River road cuttings	State	Marysville
WR 015	Cerberean Cauldron	State	Marysville
WR 017	Enoch's Point	State	Enoch’s Point
WR 019	Matlock Fossil localities	State	Matlock
WR 020	Woods Point dyke swarm Site 1	State	Woods Point
WR 030	Mt Donna Buang	State	Mt Donna Buang
WR 036	Eildon Reservoir Sugarloaf quarry	State	Mansfield
WR 064	Frenchman Gully Peridotite	State	3 km NNW of Aberfeldy, 2.5 km NE of Violet Town.
WR 065	Mount Easton area	State	7 km west of Aberfeldy
WR 075	Bunyip River -Soil Pipes	State	Beenak 2 kms S of the Bunyip River-Back Creek junction.
WR 094	Jordan River Group: Mt Easton area Reference no: 37 Jericho	State	Pinnacle Track:
WR 110	Rocky Peak, Rocky Peak Dyke	State	Taylors Creek track

WR 111	Boulders of Buxton Granite—rollers, drifters or stay-at-homes?	State	Taylors Creek Track near junction with Pinnacle Track

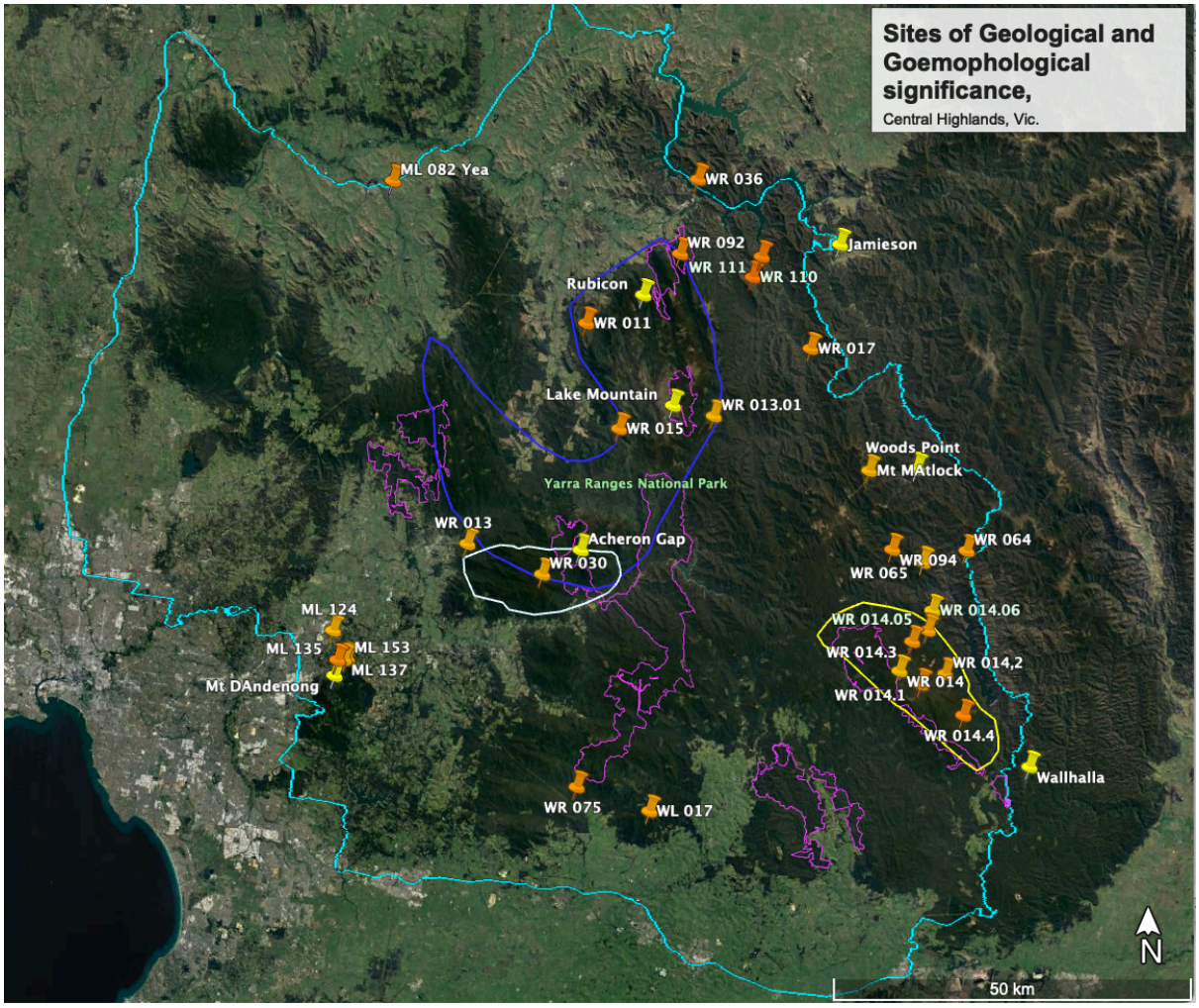

Figure 1: Distribution of sites. Orange pins indicate site locations; Yellow pins indicate other places; teal line is the boundary of the Central Highlands; purple lines indicate the RFA boundaries (note: there are very few sites in logging areas). Other lines indicate approximate boundaries of 3 large sites: Baw Baw Plateau and pluton (yellow), Acheron Cauldron (white) and Cerberean Cauldron (dark blue). Kmz files are provided.

Table 2 Site descriptions and significance statements of International, National and State sites

Number & Site name	significance	location	Lat/Long	Description	significance
ML 082 Limestone Road Silurian plant fossil site	International	Yea	-37.221733°E 145.447367°S	The steeply dipping Silurian sediments at this site contain the fossil *Baragwanathia longifolia*, which is amongst the oldest land plants yet recognised in the world. There are two principal plant bands in a well laminated buff-grey fine-grained sandstone which is split easily along laminae (each about 30 cm in width). A more restricted buff-orange band of slightly coarser sandstone forms the upper band, with a prominent marker bed containing marine fossils, principally, orthoceratids and large pelecypods. The lower plant band consists of beds containing small oval-round algae ~1-4 cm in diameter and a prominent quartz vein 10 cm thick overlain by an indurated red brown band ~5-10 cm thick occasionally bearing plant remains. The beds separating the plant bands are less well laminated and contain a prominent siltstone band 10 cm thick containing a bed with pyritic nodules that form an uneven surface on splitting.	The presence of *Baragwanathia longifolia* in Victoria has caused considerable controversy. The earliest vascular (land) plants elsewhere in the world are much more primitive and Baragwanathia is a landmark in plant evolution and formed the first forests on earth. After Australia, only a small number of highly important plant fossil localities occur in Australia that can be assigned International significance: this site provides the earliest record of vascular land plants in Australia. The plants show remarkable adaptations that helped them to make the difficult transition from the marine environment to life on land. The Yea Baragwanathia fossils are considerably older than any similar ones found in the Northern Hemisphere, and therefore this site is of international significance. Listed on the National Heritage List.
WR 092 Sekaninaite mineral occurrence	International	Marysville	Unclear where on Snobs Creek Rd Near -37.310145° 145.894023°	The cutting along Snobs Creek Road, Eildon exposes part of the Rubicon Rhyolite which contains unaltered crystals of iron rich cordierite. The Rubicon Rhyolite is a thick welded ash flow or ignimbrite within the Cerberean Cauldron Complex.	The Rubicon Rhyolite is the only known volcanic rock to contain phenocrysts of iron rich cordierite (the species sekaninaite)

WR 014 Baw Baw Plateau	National	Erica - between Mount Whitelaw and Mount Erica	-37.822996° E 146.242307°S	The Baw Baw Plateau is an alpine high plain developed on the Baw Baw Granodiorite, between 1000 and 1563 m ASL. The granodiorite is an elliptical-shaped pluton and is the easternmost of an E-W trending series of plutons (Tynong Batholith). The hornfels contact aureole is 1 - 2 km wide. A few large hornfels bodies occur within the granite, e.g. one near the northern edge of the pluton on Mt Matlock, runs parallel to the boundary, 500 m in from the pluton's edge. Several silicic dykes intrude into surrounding rocks. A wide variety of features are associated with the weathering characteristics of the granite, i.e., broadly concave valleys, peaty flats, tors, whalebacks, stepped valley heads and the very distinctive rectangular joint controlled drainage pattern. Large tors are a prominent feature of the eastern slopes of Mount Erica and Mount Mueller, stepped valley heads occur in Tullicoutty Glen, Whitelaw Creek and at the head of the West branch of the Tanjil River, peaty flats are prominent at Mustering Flat and the rectangular drainage is best developed between Mt. Baw Baw and Mount Erica. No radiometric dates are known but it is assumed to be Late Devonian as it truncates folds and cleavage formed in the Middle Devonian Tabberabberan Orogeny indicating that it is post-Middle Devonian. Subsites WR 014.01, WR 014.02, WR 014.03. WR 014.04, & WR 014.05 have good examples of features.	The significance as a geological feature lies in the preservation, resulting a combination of features which are only duplicated at one othe site, Mount Buffalo, on the Australian mainland. The associated interesting geomorphological sites such as the drainage pattern is highly significant. The type locality is around the Mt Baw Baw summit tower. The stepped valley forms are of particular interest as early workers attributed these to glaciation. Unequivocal supporting evidence of glaciation is lacking; there are no obvious moraines or striated rocks and later research indicates that these features are produced by weathering processes without the need for a glacial episode.
WR 014.01 Mt Baw Baw Summit	Regional	Baw Baw Plateau	-37.822998° 146.242301°	Highest point for the plateau at 1563 m with excellent weathering features.	Good local example.

WR 014.02 Mt St Gwinear	Local	Baw Baw Plateau	-37.839409° 146.276364°	Accessible High point with good granitic weathering features	Good local example.
WR 014.03 MT Whitelaw	Local	Baw Baw Plateau	-37.786458° 146.261935°	High point with good granitic weathering features	Good local example.
WR 014.04 Mt Erica	Regional	Baw Baw Plateau	-37.877037° 146.343823°	The very distinctive rectangular joint controlled drainage pattern which is controlled by the regular pattern of joints in the granodiorite well developed between Mount Baw Baw and Mount Erica. Large tors are a prominent feature of the eastern slopes of Mount Erica.	Best example of rectangular drainage pattern
WR 014.05 Thomson Valley Rd, Baw Baw Granodiorite	Regional	Baw Baw Plateau	-37.772537° 146.286066° E	The rock is well exposed in a cutting on the west side of the road, and as many fresh boulders lying on the east side. This is a good representative outcrop of Baw Baw Granodiorite. It is a grey, medium-grained, equigranular, biotite granodiorite with minor hornblende. Accessory zircon, apatite and opaques (probably ilmenite) are present in a thin section from here. Some hornblende grains have cores of pale green cummingtonite.	This is a good representative outcrop of Baw Baw Granodiorite
WR 014.06 Marshall Spur Road: contact meta-morphosed	State	Road metal Quarry on the west side of the main Marshall Spur Road,	-37.747775° 146.292967°	Aureole of the Baw Baw Granodiorite. The Wilson Creek Shale has been metamorphosed into a fine-grained, black hornfels. Tiny white spots of cordierite are visible, and rare samples have tiny glassy andalusite prisms. Bedding is not visible because of recrystallisation. Several fault zones are visible in the east wall of the quarry. These are weathered and stained by yellow jarosite, and also contain some fresh pyrite.	Excellent example of metamorphic aureole that complements the information on the intrusion

ML 124 Hull Road-Allenby Road cutting	State	Lilydale	-37.778963° 145.354955°	Well-jointed Devonian Coldstream Rhyolite is exposed in the cutting. The flow-banded rhyolite contains phenocrysts of quartz and feldspar set in a fine-grained groundmass.	State. Good exposure of a widespread unit and common rock type in Victoria.
ML 135 Mount Dandenong Tourist Rd (Mt Evelyn Rhyodacite)	state	Kalorama	-37.812138° 145.372031°	The lower, moderately phenocryst-rich zone of the Devonian Mt Evelyn Rhyodacite ignimbrite is exposed in road cuttings. Although generally dark and massive, moderately flattened pumice defines a weak foliation dipping at 40 degrees east. Lithic fragments (<10% of rock) occur with phenocrysts of quartz, alkali feldspar, rare plagioclase, biotite and occasional garnets. Dandenong Ranges Cauldron	State. A clear exposure of the Mount Evelyn Rhyodacite which is used as an excursion locality. Important for understanding of the Palaeozoic geology.
ML 137 Mount Dandenong Tourist Rd (Mt Evelyn/ Kalorama Rhyodacite)	State	Kalorama	-37.812717° 145.361795°	The road cutting near the broad left-hand verge exposes the Devonian Mount Evelyn- Kalorama Rhyodacite transition, including a siltstone marker band approximately 2 m wide and dipping 60 degrees east. The Mount Evelyn Rhyodacite is phenocryst rich whereas the transition to the Kalorama Rhyodacite is marked by interlayered dark fine-grained phenocryst-poor material in a zone about one metre wide. This passes into the basal zone of the Kalorama Rhyodacite ignimbrite which is similar to the fine-grained interlayered material. The unit then becomes a moderately phenocryst-rich ignimbrite. Dandenong Ranges Cauldron	State. Best outcrop in central Victoria of the contact between these two units and is used as an excursion locality. Important for understanding of the Palaeozoic geology.

ML 153 Mount Dandenong Tourist Road (Kalorama - Ferny Creek rhyodacite relationship)	State	Kalorama	-37.811120° 145.376597°	The phenocryst-rich top of the Kalorama Rhyodacite, a siltstone marker band and the fine grained, phenocryst-poor base of the Ferny Creek Rhyodacite are all exposed in road cuttings on the Mount Dandenong Tourist Road. The volcanic rocks are Late Devonian in age. Dandenong Ranges Cauldron	State. The most easily accessible locality showing relationship between these two units. Used as an excursion locality. Important for understanding of the Palaeozoic geology.
WL 017 Labertouche Cave	State	11km north of Princes Hwy at Robin Hood	-37.998213° 145.851504°	The cave is developed in the Tynong Granite, where a tributary of the Labertouche Creek flows underground through it. The cave is entered through an old stream sink located above the currently active stream passages. It has 710 m of passage in a 3-dimensional maze with up to 3 levels. it is formed from a landslide where a significant number of granite tors blocked the floor of the valley and the weathered material between the boulders has been removed by the stream. Evidence of silicious dissolution present as small opal-A and allophane speleothems.	State Although caves in granitic rocks are not particularly rare in Eastern Australia, Labertouche Cave is one of the most complex and extensive. Understanding of the processes of formation is now better understood than previously but this is a nationally recognised example. The evidence of silieous dissolution is significant.

WR 011 Cathedral Range	State	Buxton	-37.396672° 145.748350°	The Cathedral Range is made up of a spectacular steep sided strike ridge of sandstone of Middle Devonian age. The sediments are of shallow marine or partly non-marine origin (sandstone, mudstone and conglomerates) and are unconformably overlain by more sediments and the rhyolitic volcanics of the Cerberean Cauldron formed from the collapse of a caldera. The Cauldron forms part of the Central Victorian Magmatic Province (~370-350 Ma). In collapse, pyroclastic eruptions from feeders along the rim and radial fractures deposited the voluminous rhyolite (Rubicon Rhyolite).	State The contact between the Cathedral Beds and the formations of the Cerberean Cauldron is a major unconformity. The site is part of the late Devonian Cerberean Cauldron. Geomorphologically the Cathedral Range is a good example of a strike ridge.
WR 013 Acheron Cauldron Area	State	Mt Donna Buang area	-37.669133° 145.564484° :-37.706476° 145.681310°	The Acheron Cauldron is kidney shaped and forms the southern half of the Marysville Igneous Complex, the northern half being the Cerberean Cauldron. The two cauldrons are very similar in nature to the Dandenong Igneous Complex but are much more extensive. They now form a dissected highland plateau and have more considerable influence on the development of the local physiography. The Mount Donna Buang Hypersthene Rhyodacite is the most common rock type of Acheron Cauldron, forming the southern part of it. It is remarkable for its homogeneity and is thought to represent a single crystallised ash flow.	State. The site provides important information about the geological history of the state. Cauldrons are a characteristic feature of Central Victoria, although they also occur in other parts of the Tasman Fold Belt. In Victoria they are late Devonian in age and follow the Middle Devonian Tabbarabberan Orogeny. This rock unit is the uppermost part of the volcanic sequence, accompanied by collapse in the Acheron Cauldron. Mount Donna Buang Hypersthene Rhyodacite is not represented in the Cerberean Cauldron.
WR 013.01 Koala Creek	Local	Mt Donna Buang area	-37.510263° 145.947717°	Subsite: At Koala Creek and at Marysville the cauldron volcanics overlie the unfossiliferous sandstones of the Cathedral Group and the Koala Creek Beds	Local. The Cathedral Group and Koala Creek Beds are the uppermost part of the Melbourne Trough sequence, and are preserved in relatively small areas, flanking the Marysville Igneous Complex

WR 013.02 Marysville – Cumberland River Road cuttings	State	Marysville	Unknown Road NA	The road cuttings on the road from Marysville to the Cumberland River provide a complete section from the Cathedral Beds to the Lake Mountain Biotite Rhyodacite, i.e. from basement, through the pre-collapse phase to the collapse phase.	State This section gives the most complete picture of the Acheron Cauldron with a complete section of the Cathedral Beds to the Lake Mountain Biotite Rhyodacite. Such complete sequences in one exposure are not common.
WR 015 Cerberean Caldron	State	Marysville	-37.510263° 145.947717°	The Cerberean Cauldron is circular shaped and forms the northern half of the Marysville Igneous Complex. The two cauldrons are very similar in nature to the Dandenong Igneous Complex but are much more extensive. They form a dissected highland plateau and have more considerable influence on the development of the local physiography. The rocks are Middle Devonian and overlie the rocks folded by the Tabberaberan Orogeny. This is a large site and several subsites probably exist within it and need further investigation.	State. Cauldrons are a characteristic feature of Central Victoria, although they also occur in other parts of the Tasman Fold Belt. In Victoria they are late Devonian in age and follow the Middle Devonian Tabbarabberan Oregeny. The site provides important information about the Palaeozoic geological history of central Victoria.
WR 017 Enoch's Point	State	Enoch's Point	-37.425880° 146.098084°	Laminated black shale of the Upper Ordovician Mount Easton Shale here contains an Eastonian faunal sequence which includes rare straight cephalopods in a restricted outcrop.	State Ordovician sediments are restricted in outcrop in the region and Cephalopods, particularly straight species, are rare in the Ordovician.
WR 019 Matlock Fossil localities	State	Matlock	NA	Lower Devonian, Silurian and Ordovician Fossil localities; no information available	State. An important Palaeozoic fossils site: no information available but needs further investigation in the literature for details .

WR 020 Woods Point dyke swarm Site 1	State	Woods point	NA	The dyke swarm has a trend that broadly parallels the containing Silurian-Devonian sediments. The dyke swarm is located on the western limb of the Walhalla synclinorium, within and to the east of the Mount Easton Fault Belt, and extends north-south for over 150 km, with some dykes traceable along strike for >20 km. The dykes were intruded into steeply dipping fractures and have themselves been cut by numerous faults. Their composition ranges from peridotite to quartz porphyry but lamprophyres and diorite porphyrites predominate. Auriferous quartz veins have subsequently been introduced. The swarm is discontinuous in outcrop and therefore there may be several sites of state significance as well as more less significant sites.	State. The Woods Point Dyke Swarm is a significant gold bearing feature in central Victoria. The mafic to felsic dykes are associated with the Woods Point and Walhalla gold mineralisation. Its discontinuous outcrop results in several separate sites. Further investigation needed.
WR 030 Mt Donna Buang				Mt Donna Buang is composed of Donna Buang hypersthene rhyodacite of Upper to Middle Devonian age and represents the central part of the Acheron Cauldron area. The Mount Donna Buang Hypersthene Rhyodacite is remarkable for its homogeneity and is thought to represent a single crystallised ash flow. Mount Donna Buang Hypersthene Rhyodacite is not represented in the Cerberean Cauldron.	State. The site provides important information about the geological history of the state. In Victoria they are late Devonian in age and follow the Middle Devonian. The rock unit is the uppermost part of the volcanic sequence, accompanied by collapse in the Acheron Cauldron.

WR 036 Eildon Reservoir Sugarloaf quarry	State	Mansfield	-37.217943° 145.921147°	The type section for the Eildon Sandstone and the overlying Wilson Creek Shale occurs in this quarry. The latter unit the type section extends to the adjacent road cuttings between Mount Sugarloaf and Easts Lookout. The conformable contact between these two Early Devonian units occurs. The Eildon Sandstone is predominantly sandstone with interbedded siltstone and some slumped beds containing limestone boulders. The Wilson Creek Shale consists of thickly bedded black shale and siltstone containing monograptid graptolites.	State. This is the type section for the Wilson Creek Shale, the Eildon Sandstone and the contact between them. The Wilson Creek Shale is one of the most widely distributed units in the Melbourne Trough whereas the Eildon Sandstone is restricted to the northern extremity of the Mount Easton Fault Belt.
WR 064 Frenchman Gully Peridotite	State	3 km NNW of Aberfeldy, 2.5 km NE of Violet Town.	-37.673576° 146.345698°	A peridotite dyke is exposed in Frenchman Gully. The exposure is largely moss covered but is recognisable by large rounded boulders which contrast with the surrounding soils developed on Norton Gully Sandstone.	State. Peridotites are rare in Victoria and the Frenchman Gully outcrop is the largest known in the state.
WR 065 Mount Easton area	state	Aberfeldy Seven kilometres west of Aberfeldy	-37.688501° 146.277516°	The type district of the Jordan River lies between the Yarra Track and the junction of the Jordan and Thomson rivers. In this area the Jordan River Group comprises the McAdam Sandstone. Bollung siltstone, Sinclair Valley sandstone, Whitelaw Siltstone and Wilson Creek Shale contain graptolite, useful for stratigraphic correlation and dating. The age range from E. Sil to mid E. Devon. Type district over a fairly extensive area.	State. The abundance of graptolites and their use in the definition of the Eastonian stage of the Ordovician, together with the type sections of the Jordan River Group, indicate the significance of this site.

WR 075 Bunyip River Soil Pipes	State	Beenak 2 kms S of the Bunyip River-Back Creek junction.	-37.968822° 145.737047°	An area of approximately two hectares of sandy granitic soils contains numerous soil pipes. Several of the pipes are very large with entrance diameters of one metre and depths in excess of one metre. There is an extensive network of tunnels associated with the pipes and much runoff is diverted through the system.	State. The mechanism of soil pipe formation and the characteristics of the substrate prone to this process is better understood than previously as it related to dispersive clays. However it is unusual for soil pipes to occur in sandy granitic soils and this site is the only one noted in the study area on this type of material.
WR 094 Jordan River Group: Mt Easton area Reference no: 37 Jericho	State	Pinnacle Track:	-37.672952° 146.228929°	In this area the Jordan River Group comprises the McAdam Sandstone. Bollung siltstone, Sinclair Valley sandstone, Whitelaw Siltstone and Wilson Creek Shale containing graptolites, useful for stratigraphic correlation and dating. The age range from E. Silurian to mid E. Devonian. The outcrops (2200m thick) are along the Mt Easton axis from Bonnie Doon to the Thomson-Jordan confluence, at Coopers Creek, Tyers River and the Tanjil River anticlinorium and are overlain by the very thick Walhalla and Cathedral groups' condensed sequence spanning for the Llandevonian to middle Pregian (Early Devonian). Best exposures in the Mount Easton Fault Belt. The Jordan River Group extends from the top of the Mt Easton Beds to the top of the Wilson Creek shale. Coopers Creek, Wilson Creek shale – Pragian provides a link in connection between Darraweit Guim and Mt Easton Province with the Boola formation – Eildon sandstone. Whitelaw Sandstone, Sinclair Valley Sandstone, Bullany Sandstone, McAda Sandstone – Late Llanndevonian.	State. Type district is the Mount Easton Axis between the Yarra branch and the Thomson-Jordan confluence. This site includes the type area of the Jordan River Group. The Group members, McAdam Sandstone and Bullring Siltstone are exposed in road cuttings on the Thomson-Jordan Divide Road and the T-J Divide Road although the type section for the former Formation occurs outside the study area. Shales and slates of the Mount Easton Beds outcrop in numerous fault silvers to the north of Mount Easton. These are highly fossiliferous and the graptolite collections from this site form the basis of the definition of the Eastonian stage, the middle stage in the Victorian Late Ordovician. The abundance of graptolites and their use in the definition of the Eastonian Stage of the Ordovician, together with the type sections of the Jordan River Group, indicate the significance of this site.

WR 110 Rocky Peak, Rocky Peak Dyke	State	Taylors Creek track	-37.338349° 146.006925°	This cutting shows the contact between quartz–feldspar porphyry and its host rock, thinly bedded siltstone. The siltstone is spotted but bedding is still very evident. The quartz porphyry is quite fine grained close to the contact, indicating chilling after intrusion. The dyke was one of the feeders for the Late Devonian Cerberean Igneous Complex that forms the high ranges to the west, with Mount Torbreck as its highest point.	State. The western margin of the Rocky Peak Dyke, one of the feeder dykes for the Devonian Cerberean Igneous Complex
WR 111 Boulders of Buxton Granite—rollers, drifters or stay-at-homes?	State	Taylors Creek Track near junction with Pinnacle Track	-37.312840° 146.020961°	Blocks of granite, some as large as a house, are widely scattered in the forest below Rocky Peak. These are ‘foreigners’ as they overlie Walhalla Group sedimentary rock. Their closest source is the Rocky Peak ring dyke, about 400 m to the northeast and uphill. How did they get here? Uphill, the slope steepens and they may have begun their journey by rolling. At their present location the slope is too gentle to sustain rolling, so if they are still moving they are probably creeping downhill very slowly. The surrounding trees grow straight up, so perhaps the boulders are now at their final resting-place—if they were still moving downhill, the trees should be bent, with their lowest portions pointing downhill	State. Very unusual mass movement prccesses and location of 'out of context' boulders.

Appendix 1 GSA(V) protocol for assigning significance to sites

The assigning and reviewing geological significance of sites is undertaken in Victoria by the Geological Society of Australia Inc (Victoria Division) (GSAV), Heritage subcommittee. The GSA is a volunteer learned society. No state government department undertakes this although the Geological Survey of Victoria (GSV) is consulted as needed.

The GSAV has developed a methodology and protocol for assigning or reviewing geological significance (White et. al 2003), which has been accepted as reliable and repeatable by organizations such as the former Australian Heritage Commission (now Australian Heritage Council). This methodology has been used is assessing significance of the various sites around Victoria and has been used by VEAC with regard to sites on public land. It is regularly updated. The data is stored in a database which is maintained and regularly updated. Access to the database is through the chairperson of the GSAV Heritage subcommittee, currently Dr Susan White OAM, via email <*susangwhite75@gmail.com*>. As this is not a public database is not automatically free and fees may apply.

Site information is reviewed by the subcommittee from personal experience, fieldwork, literature review and consultation with other geologists with specific knowledge and expertise. The GSA subcommittee has members with a wide range of geological experience and expertise. Significance rating is achieved by consensus after considerable discussion on the merits of the site. This is particularly the case for sites of International and National significance where an extensive understanding of comparable sites outside Victoria is desirable. The international and national significance discussed here does **not equate** to World Heritage status nor National Heritage Listing for these sites.

It is important to note that geological, including geomorphological, significance may not necessarily relate to the aesthetics of a landscape. Some sites of very high significance may not be at all aesthetic, e.g. quarry faces or road cuttings whereas aesthetically pleasing views may not always be assigned a high *geological* significance. If processes are involved these can be active or relict.

Geological sites should possess at least one of the following attributes to be considered for assessment on their significance:

- a type section of a geological unit,
- a fossil locality,
- exposures of a range of features characteristic of the rock unit, or exposures of features which are unusual in the rock unit,
- an unusual occurrence of a particular feature or mineral,
- an illustration of tectonic and/or volcanic processes,
- features which enable palaeoclimatic reconstruction,
- demonstration of the effects of weathering, erosion and/or deposition on landform evolution,
- a representative example of a landform type.

The criteria for significance is related to whether a site can be regarded as important with regards to it being representative or outstanding. A choice often has to be made between the most outstanding or unusual example and an excellent representative example from a group of very similar ones.

The representative approach (McRae-Williams et al., 1981; King, 1985; Davey & White, 1986; Joyce, 1995) has been found to be the most appropriate in assessing significance but outstanding examples must be considered. Criteria used in such assessment include:

- how representative is the feature? how many representatives are justified?
- how adequately is each type of feature represented over a particular scale?
- which feature is the most appropriate to represent a particular type?
- How far would you travel with an interstate or international visitor interested in that type of site?
- How does it compare with other similar sites - regionally, in the state, in Australia, Internationally?
- Is it under threat and if so, what is the nature of that threat?
- How common or rare is the feature? National? State? Regional? or Local? Level
- Replication? Representation?
- Is it a particularly good example?

- Is it a type section or type example (for landforms).
- What use ? e.g. education, geotourism, research.

Other aspects of the site such as present and past land use, diversity of features present, access, and vulnerability to damage are also considered. Features or areas are also described according to size, physical and/or geological type and age.

The level of geological significance is classified at local, regional, state, national or international level by documentation, assessment and comparison. The significance rating assigned to a site is periodically reassessed in the light of new information and/or site condition.

More detailed criteria for classification are:

- **International Significance:** These sites are landforms, structures, rock formations or fossils which are rare in the world, and/or by the nature of their scale, state of preservation or display, are comparable with examples known internationally. They may be global type examples and are widely known as reference sites by the international geological community. A site could be included in an international register of sites of scientific significance and would rate listing on the Register of the National Estate by the Australian Heritage Commission (now Council). Forty-five features of international significance have been recognised, documented and assessed in Victoria. Tower Hill is an example of an internationally significant site due to the well-preserved evidence of phreato-magmatic volcanic processes.
- **National Significance**: Sites that are rare in Australia or are important nationally by virtue of their scale or state of preservation are assigned national significance. Widely used as reference sites by the Australian geological community, they should be included in a national register of sites of scientific significance and would be considered for listing on the Register of the National Estate by the Australian Heritage Commission (now Council). Seventy sites of national significance have been identified in Victoria. An example is Mount Buffalo.
- **State Significance:** These sites are important in defining the geology and geomorphology of Victoria and may be reference sites or type examples and would be considered for listing on the Register of the National Estate by the Australian Heritage Council. There are over 200 sites of state significance identified and documented in Victoria. An example is Mount Kororoit, Diggers Rest.
- **Regional Significance:** These sites include landforms or geological features representative of regions of about 60km radius. An example is the Royal Park railway cuttings in Melbourne.
- **Local Significance**: These are features representative of smaller areas in a region, e.g. the Ovens Valley. Such sites are usually related to an area of a local municipality or an area with a radius of 20km. A typical example is the Stony Creek Road cuttings at Halls Gap where there is a good exposure that shows the relationship of igneous rocks to the main body of the Grampians Group sediments.
- **Unknown Significance**: Sites are assigned this rating if there is insufficient data to allow a complete assessment to be made. Typically these sites are either under investigation or subject to continual change e.g. active quarry faces.
- **Destroyed Sites:** These sites are documented as they may be locations for important geological materials lodged in museums or referred to in published material.

Documentation of sites

Sites are chosen after recommendation and assessed. However many sites are large and we have found using subsites is a satisfactory way of dealing with smaller sites within a larger one. The Site ID is based on the names of the 1:250000 geological map sheets e.g. The Organ Pipes site on the Melbourne 1: 250000 sheet is ML 016. This is chronological as new sites are added. The data base is being gradually added as volunteer time permits. Subsites are used with large sites e.g. The Port Campbell NP has over 20 subsites; CL 020.01, CL 020.02 etc.

GSA(V) maintains a data base with over 2000 entries for the state. This has the following main data fields:

- Site ID and Alpha-Numeric Reference Number:
- Feature name
- Location (Nearest Town)
- Municipality
- Mapsheets (1:100000 & 1:250000)
- Site size
- Description
- Location data
- Significance
- Significance Statement
- Management statement
- References

For enquiries regarding information from the database and for any other enquiries contact the convener of the GSA Victoria Heritage subcommittee and database manager, Dr Susan White OAM, <susangwhite75@gmail.com>.