SITES OF GEOLOGICAL AND GEOMORPHOLOGICAL SIGNIFICANCE IN THE VEAC CENTRAL WEST INVESTIGATION AREA

A report to the Victorian Environmental Assessment Council

Susan White
Gresley A. Wakelin-King

Wakelin Associates
October 2017
DISCLAIMER

Information contained in this report is correct as far as possible within the scope of the project and at the time of writing. It can be used to inform management practice or project design criteria, but is not intended for specific engineering design.

This report may be cited as:


Cover picture:
Google Earth image of the Landsborough Ridge and Site SR021 (the Landsborough Hill cutting) 32 km west-north-west of Avoca, Victoria.
Table of Contents

Executive Summary ................................................................................................................................. 4
1 Introduction .................................................................................................................................... 8
  1.1 Assessment of Geoheritage ................................................................................................... 8
  1.2 Geological Context of the VEAC Central West Area ............................................................. 11
  1.3 Geospatial Context of This Report: Wider Implications ....................................................... 12
2 Geoheritage Sites in the Central West .......................................................................................... 13
  2.1 Site Management Issues ....................................................................................................... 14
References ............................................................................................................................................ 20

Acknowledgements

The authors would like to acknowledge the volunteer work done in documenting sites over many years by the members of the Geological Society of Australia’s heritage subcommittees, especially the Victorian Division’s Rob King, Neville Rosengren, Lindy Cochrane and Mel Mitchell.
Executive Summary

This document, and the accompanying spreadsheet (VEAC Central West Geoheritage.xlsx) and geospatial file (VEAC Central West Geoheritage FINAL.kmz) comprise a report on the known geoheritage in the VEAC Central West investigation area (public lands within defined areas around Mt Cole/Pyrenees, Wombat/Macedon, and Wellsford). This is a desktop study based on existing registers from the Geological Society of Australia (Victorian Division Heritage subcommittee), the Australian Heritage Commission and the Victorian Geological Survey.

Within the defined areas, this investigation finds no sites of international importance, one site of national level significance, 13 state-level sites, 29 regional-level sites, 20 sites of local significance, and a destroyed site located on public land.

The state- and national-level sites are summarised in Table 1, and their locations shown in Fig. 1.

Geoheritage includes both geology and geomorphology. The sites identified in the examination area include either or both aspects of geoheritage, for example The Camel’s Hump (ML 003), which is an unusual volcanic landform whose shape is derived from its high-viscosity lava chemistry; the site has good outcrop containing uncommon amphibole minerals and a conspicuous weathering pattern of vertical cooling joints. Other valuable attributes of sites identified in this investigation include excellent exposures of uncommon or scientifically important rock sequences, fossils, an unusual development of karst in granitic lithologies, and mineral springs charged by carbon dioxide outgassed from the late Cainozoic new volcanics.

Management information for each site is provided in the spreadsheet. Broadly, effective management of geoheritage in the investigation area involves:

1. Recognition that geological and geomorphological heritage is valuable and should (like other kinds of heritage) be protected;
2. Valued geological outcrops should be protected from revegetation, rehabilitation, or on-ground works that compromise heritage values;
3. Valued outcrops and landforms should not be compromised by inappropriate development or poorly-placed infrastructure, and should be protected from damaging types or levels of visitation;
4. Resources should be protected from over-use;
5. Explanatory signage should contain correct and up-to-date geological and geomorphological information.

During this investigation, a broader issue was identified: the existing geoheritage database lacks a field for coordinate datum; the existing coordinates are likely to be a mixture of map grid systems, in some cases leading to a possible location error of up to 200 m.
Table 1 Sites of national or state levels of significance.

<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>Investigation area</th>
<th>Significance level</th>
<th>Site Description</th>
<th>Significance statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>ML 014</td>
<td>Hanging Rock trachyte volcano</td>
<td>Wombat</td>
<td>National</td>
<td>A late Cainozoic volcanic mamelon of solvsbergite (Soda-trachyte) forms a prominent landscape feature in the region. Erosion controlled by radial cooling joints in the rock has formed a pattern of radial drainage and impressive pinnacles. Wind and water erosion through weaknesses in the case-hardened exterior has resulted in caves, holes and indentations in the pinnacles. The highly viscous nature of the solvsbergite lava ensured that the volcano initially erupted as a prominent hill or mamelon, with little of the lateral movement which characterises the younger and more fluid mafic volcanics found elsewhere. When fresh the rock is greenish in colour, but weathering has generally altered the colour to a grey or brown. Phenocrysts of anorthoclase are contained in a groundmass of sanidine laths, aegirine, riebeckite, arfvedsonite, cossyrite, quartz, apatite, opaques and biotite(?). Dating of Hanging Rock volcanics and adjacent similar eruption points using K-Ar methods indicates a Late Miocene age (6 Ma) placing them in the earlier phase of the Newer Volcanics, and considerably younger than the nearby Devonian volcanics (360 Ma) of the Macedon Range (ML 329) into which they were intruded.</td>
<td>Soda- trachyte occurs at only a small number of sites in the state (e.g. Hanging Rock, Camels Hump-ML 03, and Brock Monument-ML 02) where its extrusion has resulted in the development of steep-sided rocky hills. These volcanoes, which lie in the Gisborne/ Woodend and Daylesford areas, constitute a distinctive, small volcanic province that has affinities with provinces in the Eastern Highlands of NSW and Queensland. At Hanging Rock the impact of weathering on radial cooling joints has produced particularly impressive rock outcrops. The site is an important teaching and reference site because it illustrates the influence of lava composition on volcano form and is the best example of its type in Victoria.</td>
</tr>
<tr>
<td>BL 091</td>
<td>Cave Hill rock overhang</td>
<td>Pyrenees</td>
<td>State</td>
<td>A rock overhang in granite 200 m long and 30 m high. It is open to the southwest and is visible from the Middle Creek Camping Ground.</td>
<td>The best documented example of a rock overhang in granite in the State.</td>
</tr>
<tr>
<td>BL 092</td>
<td>Cave Hill Creek cave</td>
<td>Pyrenees</td>
<td>State</td>
<td>A small cave located amongst granite boulders choking a small creek. The cave is 10-15 m long and 2 m high.</td>
<td>This cave is significant due to its unusual location amongst granite boulders.</td>
</tr>
<tr>
<td>BL 126</td>
<td>No 2 Creek waterfall</td>
<td>Pyrenees</td>
<td>State</td>
<td>Type locality of the Pyrenees Formation. The sandstone and mudstone beds are west dipping and west facing over 600m of outcrop in the creek. Well developed, subvertical cleavage and individual graded sandstone</td>
<td>Type locality of the Pyrenees Formation and an excellent and accessible site showing the complex features of the stratigraphy, structure and...</td>
</tr>
<tr>
<td>BL 128</td>
<td>View Point road cutting</td>
<td>Pyrenees</td>
<td>State</td>
<td>Type locality of the Beaufort Formation Marine turbiditic interbedded siltstone &amp; mudstone with minor sandstone; mudstone is thin-bedded, pyritic; slightly higher regional magnetic response than other sediments; gravity response mostly moderate to high; high K, moderate to high Th, U. There is intense carbonate spotting.</td>
<td>Type locality of the Beaufort Formation. The fine grained silts are characteristic of the formation and the site shows the complex features of the stratigraphy, structure and metamorphism present.</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>ML 003</td>
<td>Camels Hump (The)</td>
<td>Wombat</td>
<td>State</td>
<td>The Camels Hump lava dome (1010 m above sea level) forms a prominent feature of the Macedon Ranges and forms part of the early phase of the late Cainozoic Newer Volcanics. The structure formed when viscous soda-trachyte (solvbergite) of Miocene age (6.1 Ma) extruded through Devonian volcanic rocks and solidified into a steep sided mamelon. The conspicuous weathering pattern is greatly influenced by vertical cooling joints. When fresh the rock is greenish in colour with phenocrysts of anorthoclase, but generally it has weathered to a greyish or brownish tint. On the southern slope of the Camels Hump some of the rocks show a distinct bluish tint due to the relatively uncommon amphibole minerals riebeckite, aenigmatite and aegirine in the groundmass.</td>
<td>Camels Hump is one of a small group of prominent outcrops in the area derived from relatively silica-rich lavas of high viscosity that have formed distinctive domes or plugs at the vent. This site is one of the best examples of an unusual trachytic volcano found in this area of Victoria.</td>
</tr>
<tr>
<td>ML 032</td>
<td>Willeys quarry</td>
<td>Wombat</td>
<td>State</td>
<td>Willeys quarry is noted for the abundance and diversity of graptolites within Lower Ordovician slates and siltstones. It is particularly noted for its Yapeenian Zone 2 graptolites. Among the more notable forms are: Dichograptus octobrachiatus, Tetrargaptus quadribrachiatius, T.serra, Phyllograptus sp., Goniograptus speciosus, Trigoniograptus ensiformis, Didymograptus v-deflexus, Isograptus caduceus australis, Pseudisograptus m.manubriatus, Skiagraptus gnomonicus, Oncograptus upsilon, Cardiograptus morsus, Maeandrograptus tau. This is the best Yapeenian fossil locality in the region and is the type locality for the species listed.</td>
<td>This is the best Yapeenian fossil locality in the region and is the type locality for the species listed.</td>
</tr>
<tr>
<td>ML 071</td>
<td>Mount Franklin</td>
<td>Wombat</td>
<td>State</td>
<td>Mount Franklin is a late Cainozoic Newer Volcanics scoria cone 185 m high consisting of basaltic breccia, blocks and bombs, lapilli deposits with minor basalt flows to the north. The deep crater is breached to the southeast. The predominant rock types are potassic nepheline normative hawaiites and nepheline normative mugearites. The olivine anorthoclase basalt also forms a plug in the crater where phenocrysts of anorthoclase up to 6 cm in length have been found. Crystals of olivine, anorthoclase and black augite can be found on the road inside the crater, weathered out from the tuffs and scoria. It also contains large, metasomatised mantle megacrysts. The volcano erupted towards the end of the Newer Volcanics extrusions and a K-Ar age on a hawaiite sample yielded an age of 470,000 yr BP (Wallace, 1990).</td>
<td>Well developed pyroclastic cone with an excellent view from the summit. The crater is one of the deepest in the Central Highlands area and is most important for the study of deep crustal xenoliths.</td>
</tr>
<tr>
<td>ML 085</td>
<td>Lerderderg Gorge</td>
<td>Wombat</td>
<td>State</td>
<td>The gorge cuts through Ordovician beds and a nearly continuous 145 m section of Permian glacial sediments. The folded Ordovician turbidites have been weakly metamorphosed. The Permian deposits consist of tillite and glacial outwash sandstone and conglomerate, and contain ice-rafted erratics, possible mudflows and erosion surfaces (also see ML 294). North (1.4 km) of the swing (Morven) bridge is the uncommon feature of a glacial pavement cut into an earlier till by a glacial re-advance. Several sedimentary sandstone dykes intrude the tillite. Thinly bedded dark grey lacustrine (?) siltstone is a source of Permian spores.</td>
<td>Impressive gorge exposing excellent sections through Permian glacial sediments. The structure and sedimentology of Ordovician beds are also visible. An important excursion locality.</td>
</tr>
<tr>
<td>ML 092</td>
<td>Korkuperrimu Creek</td>
<td>Wombat</td>
<td>State</td>
<td>A thick sequence of Permian glacigene sediments, including tillites and fluvioglacial sandstones and conglomerates, is exposed along the creek. The beds are faulted against Ordovician bedrock.</td>
<td>Together with Pykes Creek (ML 221) this composite section provides an excellent section through Permian glacigene sediments. This is a classic site in Victoria’s geology. Overseas researchers interested in glacial sediment and the Permian will generally visit this site when in the State. The sequence of sediments and stratigraphic relationships exposed</td>
</tr>
</tbody>
</table>
are important in understanding the Permian in southeastern Australia. With regard to the understanding of the Permian of northeastern Gondwana they are not as significant as the Mortons quarry outcrops (ML 91). The site is used for teaching purposes.

<table>
<thead>
<tr>
<th>ML 104</th>
<th>Bacchus Marsh Council trench</th>
<th>Wombat</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The trench ~800 m along Tramway Lane exposes cross-bedded quartz sandstone, siltstone and conglomerate. The site is rather unprepossessing, but of importance to the understanding of the reconstruction of Gondwanaland. The sediments are considered to be of freshwater origin and Triassic in age on the basis of poorly preserved plant impressions recovered from weathered yellow siltstone. The Triassic unconformably overlies Permian marine sediments. This site is one of only a handful of Triassic outcrops in Victoria presumably indicating a period of erosion, with limited sedimentation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Triassic sedimentary exposures are extremely rare in Victoria and this is the only known locality with the only fossils of clearly Triassic age preserved.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ML 174</th>
<th>Hepburn Springs</th>
<th>Wombat</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mineral water springs occur in Lower Ordovician sediments. The free carbon dioxide in the waters is thought to be derived from outgassing of the late Cainozoic Newer Volcanics.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>There are a number of mineral spring sites in central Victoria of the same type with a number having significant tourist values. The springs at Hepburn Springs are probably the best known in the state and are a good accessible example of this type of feature.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ML 201</th>
<th>Lerderderg River Permian sequence</th>
<th>Wombat</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The Lerderderg River has exposed a nearly continuous 145 m section of Permian glacial sediments. A wide variety of deposits are preserved including tillite, glacial outwash sandstone and conglomerate, ice rafted erratics dropped into sandstone beds, mudflow beds and erosion surfaces. The Permian glacial sequence lies with angular unconformity on Ordovician sediments.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The glacial beds of Bacchus Marsh are part of a glacial episode that affected all of Gondwana. This site displays a wide variety of glacial depositional and erosional features. The marked unconformity in the cliffs south of the ford, provides an opportunity to compare the composition and structures of the glacial conglomerates with overlying river deposited gravels.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### ML 221

**Pykes Creek**  
Permian glacial features  

**Wombat**  
State

Permian glacial tillites outcrop in the cliffs above Korjamnunip Creek (also see ML 92). At several localities, the angular unconformity of the Permian with the underlying Ordovician sediments is exposed. The contact surface on the Ordovician varies from uneven to smooth and in places there are small striations. The exposed sections are complex and extend into the parking area in the reservoir reserve. On the southwest side of the lake, Permian fluvioglacial beds faulted against steeply dipping Ordovician, are exposed in the north face of the road cutting. On the southeast the cuttings expose Permian and Tertiary sequences. The Permian consists of subaqueous outwash of a very complex nature (eastern-most cutting), and lacustrine sediments with slump deposits, rippled sandstone and other sandstone. Overlying the Permian are Tertiary gravels displaying excellent large scale cross-bedding.

These major exposures of Permian rocks show many complex features, and cuttings by the freeway are probably the most accessible Permian sections in Victoria. Within the area, the relationship with several other geological units can be seen. The glacial pavements are good examples, but unfortunately they are located in a restricted area high on a steep slope. The sequence of sediments and stratigraphic relationships exposed are important in understanding the Permian of southeastern Australia. With respect to understanding the Permian of northeastern Gondwana, the site is not as significant as Mortons Quarry (ML 91).

### ML 043

**Upper Coliban Dam quarry**  
xenolith site  

**Wombat**  
Unknown

A quarry east of the road on the ridge overlooking the Coliban Dam, has exposed a flaggy trachyandesite(?) containing abundant xenoliths of gabbro and felsic gneiss. These represent the largest known suite of lower crustal xenoliths in Australia, but are as yet undescribed. Road cutting above Coliban Dam where a basaltic lava flow with abundant crystal xenoliths were exposed.

The xenolith suite has national significance because of its abundance and size. The site may be threatened by either restoration or roadworks. Note: This locality was a road cutting and quarry operated by the former CRB. It has been entirely removed. Samples and photographs of the xenoliths are in the Museum Victoria collections.
Fig. 1 Location of the VEAC Central West’s national- and state-level geoheritage sites.
1 Introduction

In 2017 Wakelin Associates was commissioned by the Victorian Environmental Assessment Council (VEAC) to compile an overview of geoheritage in the Central West Investigation area: three separate blocks (Mt Cole/Pyrenees, Wombat/Macedon, and Wellsford) (Fig. 2), focusing on public land as defined under the VEAC Act (Crown land and freehold land owned by government agencies/departments). The project’s goals were to –

- report on the geological and geomorphological sites of significance in the study area;
- compile an inventory of known sites;
- within the scope of the study, assess the significance of sites of state-level significance or greater;
- provide recommendations for conservation or management requirements for sites of state (or higher) levels of significance.

In this report, the most significant of the identified sites are listed in Table 1, and all identified sites are listed in Table 2. An expanded version of Table 2 is also supplied as a Microsoft Excel spreadsheet (VEAC_CentralWest_Geoheritage.xlsx). Site locations are supplied as a Google Earth file (VEAC Central West Geoheritage FINAL.kmz), and locations of sites with significance at or greater than state-level are shown in Fig. 1). Site numbers within this report are those of the Geological Society of Australia (Victoria) heritage database.

This is a desktop study. The sites reported here are those documented as at 1/9/17 within the registers and records of the Geological Society of Australia (Victorian Division Heritage subcommittee), the Australian Heritage Commission and the Victorian Geological Survey. Some additional sites are referred to in source material but are not presented here, as they have insufficient locational data to place their position, and/or insufficient other information with which to establish their nature, values, or significance. Examples of such sites, from Rosengren 1986 and Rosengren 1994, are Baird Hill (ML114), Bankin and Selward Hill (ML115), and Cataract Creek Falls and Basalt Columns (ML372).

1.1 Assessment of Geoheritage

Assessment of geological (including geomorphological) significance is undertaken in Victoria by the Geological Society of Australia (Victoria Division) Heritage Subcommittee. The GSA is a volunteer learned society, whose protocol for the assessment of geological significance (White et al. 2003) has been accepted by organisations such as the Australian Heritage Council. A recently-developed protocol for more complex or broad-scale assessments (White and Wakelin-King 2014) is partly based on the GSA process.

Information is reviewed from informed experience, fieldwork, literature review and consultation between geologists with specific knowledge and expertise. Discussion and consensus is a key part of assessment, especially for sites of International and National significance, where an extensive understanding of comparable sites outside Victoria is desirable. A site’s significance rating is periodically reassessed in the light of new information or changes to site condition.
Fig. 2: The Central West study area (Map prepared by the Victorian Environmental Assessment Council).
Geological and geomorphological significance is largely unrelated to landscape aesthetics. Some highly significant sites may be not at all aesthetic (e.g. quarry faces, road cuttings), while visually pleasing views may be of low significance. Instead, geological sites should possess at least one of the following attributes to be considered as significant:

- a type section of a geological unit
- a fossil locality
- a representative example of a geological feature or landform type
- exposure of a range of features characteristic of the rock/sediment/landform
- exposure of features unusual in the rock/sediment/landform
- an unusual occurrence of a particular feature or mineral
- an illustration of geological/geomorphic processes
- features which enable palaeoclimatic reconstruction,
- active or relict demonstration of processes of landform evolution (weathering, erosion, deposition).

In addition, sites may be considered with reference to specific criteria, such as those of the National Heritage List.

In large projects, priorities may need to be decided between an unusual place, and an excellent representative example (e.g. McRae-Williams et al. 1981, Davey & White 1986, Joyce 1996, White & Wakelin-King 2014). In this context, previous usage of the word “outstanding” in heritage assessment was ambiguous. In this report we use “unusual” for atypical or distinct features, and “outstanding” for features of excellent quality or value.

The level of geological significance is expressed in terms of spatial scale: site significance is described as being local, regional, state, national or international.

- International Significance: sites which are rare in the world, global type examples, of international scientific significance, and/or comparable with examples known internationally.
- National Significance: sites which are rare in Australia, are important nationally by virtue of their scale or state of preservation, are widely used as reference sites by the Australian geological community, or are included in the Register of the National Estate. Hanging Rock (ML014) is the only nationally-significant site in the Central West investigation area. It is an exemplary example of a type of igneous rock that is rare nationally.
- State Significance: sites which are important in defining the geology and geomorphology of Victoria, and may be reference sites or type examples; for example, sites BL126 and BL128 are the type-localities for their rock types.
- Regional Significance: these sites include landforms or geological features representative of regions of about 60 km radius; for example, Mt Blackwood (ML065) is a prominent scoria cone landform, which is an important landform in this part of Victoria.
- Local Significance: these features are representative of small areas in a region, and inform an understanding of the local area (~20 km radius); for example, the Cobaw road cuttings (ML185) are good exposures of the Ordovician rocks in the area.
- Sites may be of unknown significance due to lack of study, or from having been destroyed (their heritage values have been reduced); for example, the Upper Coliban Xenolith Site
1.2 Geological Context of the VEAC Central West Area

The geology of the VEAC Central West Investigation area is dominated by five groups of geological units. From oldest to youngest they are (Fig. 3):

- Early Palaeozoic (Ordovician to Silurian) marine sediments, which have been folded and faulted; they are part of the western Lachlan Fold Belt.
- Granite batholiths and their associated rocks which have intruded into the fold belt sedimentary rocks; these are the original source of the area’s alluvial gold.
- Permian glacial and fluvial-glacial deposits.
- Triassic fluvial sediments.
- Interbedded Cainozoic sediments and basaltic (and other) volcanic rocks; these are mostly unconformable on the Palaeozoic fold belt rocks, and on or around the granite batholiths.

In the investigation area, some key geological relationships are:

- The fold belt rocks have been faulted and re-faulted over time, which has influenced landscape response to uplift. In addition, extensive structural features developed during post-Gondwana breakup (rifting between Australia and Antarctica). The structural history has shaped present-day geomorphology, especially with respect to topography and elevation.
- In the study area, there was uplift and/or outcropping of basement rocks from the post-Devonian to the early Cainozoic. Consequently, there are almost no late Palaeozoic or Mesozoic deposits; the Permian sediments are unusual, and Triassic sediments exist in Victoria only as a single small outcrop.
- During the Cainozoic, depositional land surfaces were widespread: that is, sediments were deposited and preserved from erosion. Some palaeosols are also preserved. Intermittently during this time, volcanic activity deposited basalt flows across the landscape. Consequently, the Cainozoic geological record includes places where basalts have flowed over the top of the rivers and streams of that time. Some of those ancient stream beds included alluvial gold deposits; these alluvial + volcanic gold associations are the ‘deep leads’ which were so important to Victoria during the gold rush times.

Summaries of Victoria’s geological history are available at the websites of the Geological Survey of Victoria and the Geological Society of Australia – Victorian Division (see Reference list). A detailed central reference for Victorian geology is Birch (2003) Geology of Victoria; the sections on geomorphology of the Western Uplands (chapter 18.6), gold (chapter 13) and Cainozoic igneous activity (chapter 12) are especially relevant to the Central West area. Information on specific places is available from published 1:250,000 scale geological maps (available online from the Geological
1.3 Geospatial Context of This Report: Wider Implications

The parameters of this report, as defined by the VEAC commission, involved compiling a spreadsheet based on the existing Geological Society of Australia (Victorian division) geoheritage database, with additions from other documents and records. The database records (including grid references) are taken as being correct. Site grid references were used to create points within the Google Earth (.kmz) file that constitutes part of this report. The datum of the Google Earth file is WGS84 (which is the native datum used by Google Earth: Google Earth does not have the option of operating in other datums). WGS84 is almost identical to the datum (AGD84) used for the Map Grid of Australia 1994 (MGA94). The points generated to display in WGS84 can be imported directly into an MGA database, especially considering that the error margin of coordinates derived from hand-held GPS or reading coordinates from a paper map is considerably in excess of the slight difference between WGS84 and AGD84.

Where information from older undigitised records was added to this report’s spreadsheet, site coordinates were commonly based on AMG66. The difference between AMG66 and MGA94 is ~200 m. Consequently, the coordinates for these additional sites were recalculated to place them within WGS84.

However, it has become apparent during this process that there is no systematic record within the Geological Society of Australia (Vic)’s geoheritage database of the datum underlying the various grid references contained therein. Further, it is likely that the database contains an undocumented mixture of AGD66 and WGS84 coordinates. This is an undesirable situation for the ongoing accuracy...
of site records, and will become further complicated when Australia’s new datum (GDA2020) is released in 2017, and the Australian Terrestrial Reference Frame (ATRF) becomes available in 2020.

A lack of precision in site locations will be of only minor importance for many sites, e.g. where a single coordinate represents a large area, or where the site is of only local significance. However, specific location is important for some sites (for example, type-sections and -type locations).

It is a recommendation of this report that

- future entries into the Geological Society of Australia (Vic)’s geoheritage database include datum information with coordinate information;
- consideration be given to adjusting the geoheritage database to include a field for datum, and retrospectively adding that information to the existing sites;
- since the GSA (Vic) geoheritage subcommittee is a small body of volunteers and standardising the database’s geospatial information is likely to be a substantial task, funding be sought to engage professional assistance with the work.

2 Geoheritage Sites in the Central West

The VEAC Central West investigation area contains one site of national level of significance: the Hanging Rock trachyte volcano (ML 014). The investigation area contains 12 sites of state-level significance:

- the Cave Hill rock overhang (BL 091)
- the Cave Hill Creek Cave (BL 092)
- the Number 2 Creek waterfall (BL126)
- the View Point Road cutting (BL128)
- the Camel’s Hump (ML 003)
- Willey’s Quarry (ML 032)
- Mount Franklin (ML 071)
- Lerderderg Gorge (ML 085)
- Korkuperrimul Creek (ML 092)
- Bacchus Marsh Council Trench (ML 104)
- Hepburn Springs (ML 174)
- Lerderderg River Permian sequence (ML 201)
- Pykes Creek Permian glacial features (ML 221).

Descriptions and significance statements of these sites are given in Table 1.

The investigation area also holds 20 sites of local significance, 29 sites of regional significance and a destroyed site. A summary of their locations, descriptions and values is given in Table 2. The full information for all sites is given in the spreadsheet VEAC Central West Geoheritage.xlsx.
The existing registers also showed a small number of sites with insufficient documentation to determine their location, attributes or significance; they are not included in this report.

### 2.1 Site Management Issues

Effective management of geoheritage in the investigation area falls within one or more of the following concepts:

1. **Recognition** that geological and geomorphological heritage is valuable and can be compromised, and that geological/geomorphological information should be included in heritage registers considered in management plans. Those features that contribute to a site’s geological value should be retained or enhanced rather than obscured, damaged or destroyed. An example where this has not happened is the destroyed site ML 043, the Upper Coliban Dam Quarry site, where a nationally-important suite of lower crustal xenoliths has been entirely removed.

2. **In the relevant sites**, prioritisation of highly-significant geological attributes over other features of lesser significance. This is especially relevant where visual aesthetics is involved. Revegetation is a common threat to good rock exposures; an example of the successful application of this concept is ML 104, the Bacchus Marsh Council Trench, where a scientifically important but visually unprepossessing outcrop of Triassic rocks has been protected from inappropriate revegetation schemes.

3. **Protection** of areas from overdevelopment or inappropriate development, such as housing development on valued landforms, or poorly-placed infrastructure, such as battering or shotcreting over excavated slopes which are good rock exposures, or placing explanatory signage where it obscures outcrop.

4. **In the relevant sites**, protection from over-use of a resource may be required. For example, Hepburn Springs (ML 174) would be diminished if its water sources were drawn down by extraction; the Bacchus Marsh Council Trench (ML 104) is the only known Victorian locality with clearly Triassic fossils, so the loss of any fossil specimens would be detrimental. Similarly, quarrying volcanics for gravel or rock rubble should not take place where it compromises heritage values.

5. **Where explanatory signage is displayed**, obtaining appropriate and correct advice for the geological and geomorphological components.

Details of management goals for individual sites can be found in the spreadsheet *VEAC Central West Geoheritage.xlsx*. 

---

Geoheritage of the Central West  
Wakelin Associates 2017
## Table 2 Geoheritage sites in the Central West investigation area; full details in VEAC Central West Geoheritage.xlsx.

<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>Significance level</th>
<th>Location</th>
<th>Brief Description</th>
<th>Significant attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>ML 014</td>
<td>Hanging Rock trachyte volcano</td>
<td>National</td>
<td>Woodend</td>
<td>Volcanic landform, rock exposure, caves, scenic locality</td>
<td>Geology, geochronology, stratigraphic relationships, landform, links with national geology</td>
</tr>
<tr>
<td>BL 091</td>
<td>Cave Hill rock overhang</td>
<td>State</td>
<td>Raglan</td>
<td>Karst landform (overhang)</td>
<td>Unusual landform for this lithology</td>
</tr>
<tr>
<td>BL 092</td>
<td>Cave Hill Creek cave</td>
<td>State</td>
<td>Raglan</td>
<td>Karst landform (cave)</td>
<td>Unusual landform for this lithology</td>
</tr>
<tr>
<td>BL 126</td>
<td>No 2 Creek waterfall Pyrenees Formation</td>
<td>State</td>
<td>Avoca</td>
<td>Outcrop along creek of the Pyrenees Formation</td>
<td>Scientifically important (type locality)</td>
</tr>
<tr>
<td>BL 128</td>
<td>View Point road cutting</td>
<td>State</td>
<td>View Point</td>
<td>Rock outcrop along road cutting</td>
<td>Scientifically important (type locality)</td>
</tr>
<tr>
<td>ML 003</td>
<td>Camels Hump (The)</td>
<td>State</td>
<td>Woodend</td>
<td>Volcanic landform, rock exposure, weathering landforms</td>
<td>Geology, geochronology, stratigraphic relationships, landform, unusual mineralogy</td>
</tr>
<tr>
<td>ML 032</td>
<td>Willeys quarry</td>
<td>State</td>
<td>Macedon</td>
<td>Slate quarry</td>
<td>Scientifically important (type locality for an important suite of graptolites)</td>
</tr>
<tr>
<td>ML 071</td>
<td>Mount Franklin</td>
<td>State</td>
<td>Daylesford</td>
<td>Scoria cone with deep crater, breached</td>
<td>Volcanic landforms, phenocryst mineralogy, geochronology</td>
</tr>
<tr>
<td>ML 085</td>
<td>Lederderg Gorge</td>
<td>State</td>
<td>Bacchus Marsh</td>
<td>Gorge, deep exposure of Ordovician and Permian rocks, exposed glacial pavement</td>
<td>Scientifically important, visually impressive, teaching locality</td>
</tr>
<tr>
<td>ML 092</td>
<td>Korkuperrimul Creek</td>
<td>State</td>
<td>Myrniong</td>
<td>Deep exposure of Permian sediments, faulted against Ordovician</td>
<td>Permian glacial geology, stratigraphic relationships, teaching locality</td>
</tr>
<tr>
<td>ML 104</td>
<td>Bacchus Marsh Council trench</td>
<td>State</td>
<td>Bacchus Marsh</td>
<td>Trench exposes Triassic sediments (extremely rare in Victoria)</td>
<td>Scientifically important sedimentary exposures, geochronology, fossils</td>
</tr>
<tr>
<td>ML 174</td>
<td>Hepburn Springs</td>
<td>State</td>
<td>Hepburn Springs</td>
<td>Mineral springs, scenic locality</td>
<td>Hydrology, relationships between groundwater and active volcanics</td>
</tr>
<tr>
<td>ML 201</td>
<td>Lederderg River Permian sequence</td>
<td>State</td>
<td>Bacchus Marsh</td>
<td>River exposure of glacial sediments, features include tillite, erratic dropstones, mudflow beds, and the angular unconformity of the Permian over the Ordovician</td>
<td>Stratigraphy, sedimentological process relationships, palaeoenvironment</td>
</tr>
<tr>
<td>ML 221</td>
<td>Pykes Creek Permian glacial</td>
<td>State</td>
<td>Greendale</td>
<td>Cliff and creek outcrop of Ordovician,</td>
<td>Major exposures of important rock types,</td>
</tr>
<tr>
<td>BL 017</td>
<td>Mount Lonarch amphitheatre</td>
<td>Regional</td>
<td>Amphitheatre</td>
<td>Natural amphitheatre created by lithologically-driven differential erosion, scenic locality</td>
<td>Landform, geomorphic processes, mineralogy</td>
</tr>
<tr>
<td>--------</td>
<td>---------------------------</td>
<td>---------</td>
<td>-------------</td>
<td>---------------------------------------------------------------------------------</td>
<td>-------------------------------------------</td>
</tr>
<tr>
<td>BL 120</td>
<td>Ararat water supply &amp; road cutting</td>
<td>Regional</td>
<td>Warrak</td>
<td>Road cutting exposure of structural geology and sedimentary structures</td>
<td>Geological processes (sedimentary processes) structural geology, geological history</td>
</tr>
<tr>
<td>BL 121</td>
<td>Warrak-Raglan road cutting</td>
<td>Regional</td>
<td>Warrak</td>
<td>Road cutting exposure of turbidites</td>
<td>Geological processes (sedimentary processes) structural geology, geological history</td>
</tr>
<tr>
<td>BL 122</td>
<td>Warrak - Raglan Rd quarry</td>
<td>Regional</td>
<td>Warrak</td>
<td>Quarry walls expose rocks showing a number of structural geology features and metamorphic lithologies</td>
<td>Geological history shown in the structural geology features and metamorphic mineralogy</td>
</tr>
<tr>
<td>BL 124</td>
<td>Pyrenees Hwy Cutting 1</td>
<td>Regional</td>
<td>Eversley - Elmhurst</td>
<td>Road cutting, outcrop</td>
<td>Rock exposure</td>
</tr>
<tr>
<td>BL 125</td>
<td>Pyrenees Hwy Cutting 2</td>
<td>Regional</td>
<td>Elmhurst</td>
<td>Road cutting, outcrop</td>
<td>Rock exposure</td>
</tr>
<tr>
<td>BL 127</td>
<td>Beaufort Railway cuttings</td>
<td>Regional</td>
<td>west of Beaufort</td>
<td>Road cutting, outcrop</td>
<td>Rock exposure</td>
</tr>
<tr>
<td>BL 129</td>
<td>Donkey Hill Lead workings</td>
<td>Regional</td>
<td>Old mine</td>
<td></td>
<td>Economic geology</td>
</tr>
<tr>
<td>BL 130</td>
<td>Mt Cole - Eversley Road Cutting</td>
<td>Regional</td>
<td></td>
<td>Road cutting</td>
<td>Rock exposure</td>
</tr>
<tr>
<td>BN 011</td>
<td>Sugarloaf Range</td>
<td>Regional</td>
<td>Axedale</td>
<td>Sugarloaf Range, strike ridge of resistant sandstone, scenic locality</td>
<td>Lithologically-driven differential erosion reveals structural geology in a scenic landform</td>
</tr>
<tr>
<td>ML 024</td>
<td>Mount Bullengarook flow and cutting</td>
<td>Regional</td>
<td>Bullengarook</td>
<td>Prominent scoria cone in a plateau, possible remnant crater, basaltic flows, exposures showing bedrock blocks</td>
<td>Volcanic landforms, scientifically important megacryst site</td>
</tr>
<tr>
<td>ML 030</td>
<td>Trentham Falls</td>
<td>Regional</td>
<td>Trentham</td>
<td>Waterfall developed in basalt, Cliff face exposing Cainozoic volcanics and sediments</td>
<td>Landform processes, stratigraphic relationships between Cainozoic volcanics and sediments</td>
</tr>
<tr>
<td>ML 033</td>
<td>Salt Water Creek</td>
<td>Regional</td>
<td>Gisborne</td>
<td>Exposure of Ordovician rocks, graptolite fossils</td>
<td>Geochronology (reference locality)</td>
</tr>
<tr>
<td>ML 065</td>
<td>Mount Blackwood</td>
<td>Regional</td>
<td>Myrniong</td>
<td>Scoria cone and basalt flows along palaeodrainage channels</td>
<td>Volcanic landforms, interaction between basalt flows and palaeotopography</td>
</tr>
</tbody>
</table>
| Code  | Location                        | Region | Town          | Description                                                                                                                                                                                                 | Geology/Geology
|-------|---------------------------------|--------|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------
| ML 077 | Myrniong Creek and tributaries  | Regional | Myrniong      | Valley flows of older basalt, horizontal jointing, Permian glacial outcrops and pavements                                                                                                                                                   | Excellent exposures of local geology
| ML 084 | Lauriston Sandstone             | Regional | Lauriston     | Permian sandstone                                                                                                                                                                                                  | Good exposure, teaching site
| ML 111 | Bullengarook slate quarries     | Regional | Bullengarook East | Slate quarries, rejected overburden includes graptolite fossils, unusual efflorescent minerals                                                                                                                                   | Fossils, mineralogy
| ML 115 | Golf Course Hill (Old Racecourse Hill) and quarry | Regional | Woodend        | Good exposure of a particular basalt type, tuffs, lherzolites                                                                                                                                                 | Volcanic lithotypes
| ML 197 | Bullengarook basalt flow and lateral streams | Regional | Bullengarook  | Twin lateral streams incising at the edges of a basalt flow. The flow is now a high lenticular plateau between the streams.                                                                                              | Inverted topography and stream development
| ML 200 | Buckley Road                    | Regional | Darley         | Observation point for Pleistocene river terraces and the Rowsley Fault scarp                                                                                                                                | Landforms, tectonic history
| ML 219 | Dales Creek-Coimadai Fault      | Regional | Greendale      | Fault scarp, basic dyke in the fault plane                                                                                                                                                                      | Landforms, tectonic history
| ML 230 | Council gravel pit (Bullengarook Gravels) | Regional | Gisborne       | Quarry exposure of the Cainozoic rock                                                                                                                                                                         | Sedimentary history
| ML 231 | Merrimu Gravel Member           | Regional | Darley         | Exposure of Cainozoic gravels                                                                                                                                                                                      | Sedimentology, example of local geology, teaching location
| ML 245 | Mount Wilson                    | Regional | Bullarto       | Trachytic eruption point                                                                                                                                                                                          | Volcanic landforms, volcanic lithology, contrast with sedimentary rock landforms
| ML 328 | Mount Macedon                   | Regional | Macedon        | Acid volcanics, igneous complex                                                                                                                                                                                   | Unusual rock type for the area, different volcanic chemistry produces different landforms
| ML 371 | Antimony Mine, Pyrete Range     | Regional | Coimadai       | Antimony mine in a shear zone                                                                                                                                                                                     | Mine history, mineralogy, structural geology
| ML 380 | The Blowhole                    | Regional | Hepburn Springs | Tunnel excavated along the fault zone                                                                                                                                                                                   | Best exposure of a reverse fault
| ML 381 | Tipperary Springs               | Regional | Daylesford     | Mineral spring discharging at surface                                                                                                                                                                             | Carbonated mineral water, rare in Australia
| ML 385 | Upper Coliban Reservoir         | Regional | Lauriston      | Unconformity between glaciahs with erratics and overlying porphyritic glassy volcanics.                                                                                                                          | Stratigraphy
| BL 034 | Ben Nevis                       | Local   | Eversly        | Prominent peak, granite cliffs                                                                                                                                                                                      | Landforms
<table>
<thead>
<tr>
<th>Code</th>
<th>Site Name</th>
<th>Location</th>
<th>Town</th>
<th>Description</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>BL 035</td>
<td>Beaufort Western Highway cutting</td>
<td>Local</td>
<td>Beaufort</td>
<td>Road cutting exposing rock types</td>
<td>Good exposure local rock types</td>
</tr>
<tr>
<td>ML 093</td>
<td>Coopers quarry</td>
<td>Local</td>
<td>Darley</td>
<td>Quarry exposure of sedimentary rocks</td>
<td>Good exposure, local stratigraphy</td>
</tr>
<tr>
<td>ML 094</td>
<td>Alkemades quarry</td>
<td>Local</td>
<td>Darley</td>
<td>Quarry exposure of sedimentary rocks</td>
<td>Geochronology, stratigraphy, structural geology</td>
</tr>
<tr>
<td>ML 110</td>
<td>Sailors Creek cutting</td>
<td>Local</td>
<td>Daylesford</td>
<td>Road cutting exposes black shale, graptolites</td>
<td>Good exposure</td>
</tr>
<tr>
<td>ML 113</td>
<td>Lake Merrimu southern road cuttings</td>
<td>Local</td>
<td>Darley</td>
<td>Road cutting exposes Permian glacial sediments unconformably overlying Ordovician sediments</td>
<td>Lithology, stratigraphy</td>
</tr>
<tr>
<td>ML 152</td>
<td>Babington Hill</td>
<td>Local</td>
<td>Daylesford</td>
<td>Trachyte lava dome, eruption point</td>
<td>Landform</td>
</tr>
<tr>
<td>ML 185</td>
<td>Cobaw road cuttings</td>
<td>Local</td>
<td>Cobaw</td>
<td>Road cutting, sedimentary rocks, graptolites, contact metamorphism</td>
<td>Good exposure, diversity of features, fossils, teaching site</td>
</tr>
<tr>
<td>ML 186</td>
<td>The Sugarloaf</td>
<td>Local</td>
<td>Newham</td>
<td>Low volcanic hill</td>
<td>Good example</td>
</tr>
<tr>
<td>ML 188</td>
<td>Braemar College Road cutting</td>
<td>Local</td>
<td>Woodend</td>
<td>Devonian rhyodacite showing spheroidal weathering</td>
<td>Unusual to find this rock type so well exposed</td>
</tr>
<tr>
<td>ML 189</td>
<td>Lily Pond</td>
<td>Local</td>
<td>Woodend</td>
<td>Disused quarry showing young volcanic flow and scoria</td>
<td>Unweathered basalt</td>
</tr>
<tr>
<td>ML 193</td>
<td>Cobaw Range tors</td>
<td>Local</td>
<td>Cobaw</td>
<td>Granite tors, scenic locality</td>
<td>Landform</td>
</tr>
<tr>
<td>ML 237</td>
<td>Little Bullengaroo</td>
<td>Local</td>
<td>Gisborne</td>
<td>Relatively recent volcanic flows over alluvial sediments, silica-rich lithologies</td>
<td>Geochronology, landscape reconstruction</td>
</tr>
<tr>
<td>ML 288</td>
<td>Werribee River valley</td>
<td>Local</td>
<td>Blakeville</td>
<td>River incised into Ordovician rocks and Cainozoic basalts, cliff and road cutting exposures</td>
<td>Local geology and stratigraphy</td>
</tr>
<tr>
<td>ML 314</td>
<td>Sailors Falls</td>
<td>Local</td>
<td>Daylesford</td>
<td>Small waterfalls over basalt</td>
<td>Landforms</td>
</tr>
<tr>
<td>ML 325</td>
<td>Sugarloaf Hill (Spring Hill)</td>
<td>Local</td>
<td>Glenlyon</td>
<td>Dome-shaped eruption point</td>
<td>Landforms, stratigraphy, unusual rock type</td>
</tr>
<tr>
<td>ML 382</td>
<td>Wombat Hill Pyroclastic deposits</td>
<td>Local</td>
<td>Daylesford</td>
<td>Road cutting exposing basaltic pyroclastic fall</td>
<td>Good exposure of interesting material</td>
</tr>
<tr>
<td>ML 383</td>
<td>Yankee Reef Mineralisation</td>
<td>Local</td>
<td>Blackwood</td>
<td>Fault zone, mineralised quartz veins</td>
<td>Mining history, local geology</td>
</tr>
<tr>
<td>ML 384</td>
<td>Tunnel Point</td>
<td>Local</td>
<td>Blackwood</td>
<td>alkali-olivine basalt dyke with phenocrysts, xenocrysts, and xenoliths</td>
<td>Good exposure of a fresh dyke</td>
</tr>
<tr>
<td>SR 021</td>
<td>Landsborough Hill cutting</td>
<td>Local</td>
<td>Landsborough</td>
<td>Road cutting exposing turbidites</td>
<td>Good exposure</td>
</tr>
<tr>
<td>ML 043</td>
<td>Upper Coliban Dam quarry xenolith site</td>
<td>Destroyed</td>
<td>Upper Coliban Dam, Kyneton</td>
<td>Quarry exposure of trachytic rocks containing Australia’s largest known suite of lower crustal xenoliths</td>
<td>This exposure was of national scientific significance and was never described; it has since been removed by quarrying. Museum specimens have been retained.</td>
</tr>
</tbody>
</table>
References

Report References


Field and Site References (see spreadsheet VEAC Central West Geoheritage.xls)


Gawith, P. 1977. Geochemistry and Petrography of the Tertiary Volcanics from the Spring Hill-Tylden Area, Central Victoria. BSc (Hons) Thesis, La Trobe University (Unpubl.).


Hills, E.S. 1940. Physiography of Victoria (3rd Edn). Whitcombe & Tombs, Australia.


Norris, N.D. 1977. The Geology and Igneous Petrology of the Trentham Area. BSc (Hons) Thesis, University of Melbourne (Unpubl.).


Wallace, D.A. 1990. Petrology and Geochemistry of the Newer Volcanics of the Western Highlands of Victoria, Australia. MSc Thesis, La Trobe University (Unpubl.).


