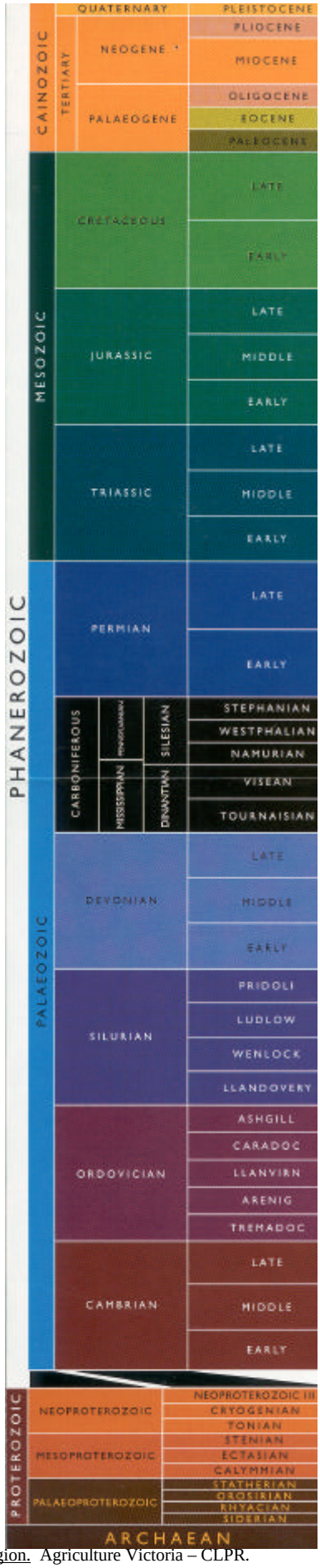
Geology of the Glenelg Hopkins region

Cambrian

The oldest rocks in the Glenelg catchment are of Cambrian age. This includes a wide range of geological material including sediments, metasediments, volcanics and granites.



<u>Cambrian coarse metasediments, Cambrian medium metasediments, Cambrian fine metasediments, Cambrian volcanics, Cambrian marine sandstone, Cambrian non-marine sandstone, Cambrian marine siltstone, Cambrian marine siltstone, Cambrian calc-silicates, Cambrian marble, Cambrian slates, Cambrian greywacke</u>

The Glenelg River Beds/Metamorphic Complex outcrops in a few of the deeply incised valleys on the Dundas and Merino tablelands. The Glenelg River Beds consist of quartz-rich turbiditic sandstone, greywacke, mudstone and occasional thin lithic sandstone beds with volcanic rock fragments and sporadic pyroclasts. Two small carbonate lenses have been identified in Nolan Creek. These sedimentary beds have been metamorphosed to lower greenschist facies in the south-west, but to higher grades in the north-east (Glenelg River Metamorphic Complex). Biotite, calc-biotite, marble, actinolite and hornblende bearing schists, along with diopside calc-silicates are prominent in this formation.

<u>Cambrian granite and Cambrian granodiorite</u>

Cambrian granites of the Glenelg Hopkins region are primarily bound to the Dundas Tablelands. Granodiorite, tonalite, diorite, monzanite, leucogranodiorite and pegmatite are believed to be a primary source along with regional heating for the metamorphism of the Glenelg River Beds. This magmatic activity is believed to have been Late Cambrian in age.

<u>Cambrian mixed metamorphics, Cambrian basalt, Cambrian intermediate metamorphics, Cambrian rhyolite and Cambrian gabbro</u>

The Mount Stavely Volcanic Complex near Glenthompson has five identified volcano-sedimentary stratigraphic units (andesite to dacite volcanics, pyroclastics, epiclastics and black shale) and intrusive units (dykes, sills and stocks). These accompany the lower greenschist metamorphic assemblages forming the greenstone complex.

Ordovician

The Ordovician period is prominent for the widespread deposition of sediments and emplacement of granites in the Glenelg Basement Sequence.

Ordovician marine sandstone and Ordovician marine siltstone

The *Castlemaine Supergroup* encompasses the Ordovician rock succession of the Bendigo-Ballarat zone. Black to grey graptolitic shale, mudstone, and quartz-rich sandstones and turbidites are the common rock types. These sediments have generally been deposited in a deep marine environment and currently are deformed into upright plunging folds and steep reverse faults.

Ordovician granites and Ordovician granodiorite

Magmatic igneous activity during the Early Ordovician period is believed to be a continuation of Late Cambrian igneous formation. This includes a wide range of granites including granodiorite, tonalite, diorite, monzanite, leucogranodiorite and pegmatite.

Devonian

Eruption of Rocklands Rhyolite and emplacement of granites from the Ararat (Grampians-Stavely Basement Sequence) and Mount Cole Suites (Stawell Basement Sequence) were the major geological events of the Devonian period.

Devonian diorite/granodiorite, Devonian granites, Devonian gabbro

The Mount Cole Suite comprises hornblende-rich to muscovite-bearing granites of 370-380 mya. The Ararat Suite comprises granites that are magnetic, have the presence of sphene and are 380-400 mya in age. Granite, microgranite, granodiorite, diorite and tonalite are common igneous rock types of these two suites that are residually very resistant to weathering.

Devonian medium metasediments, Devonian volcanic rhyolite, Devonian volcanic dacite/andesite, Devonian volcanic trachyte, Devonian conglomerate

The rhyolite covers an area of approximately 2000 square kilometres west of the Grampians mountain range. The Rocklands Rhyolite is composed of pyroclastic flows, rhyolitic ignimbrites, lava domes and flows, tuffs, agglomerates and remnants of sedimentary rocks.

Silurian

The Late Silurian-Early Devonian period is noted as the age of formation of the Grampian Group Sediments from a non-marine environment.

Silurian non-marine sediments

The sedimentary rocks of the Grampians Group comprise quartzose sandstones, red siltstone, mudstone and subordinate conglomerates. Sandstones of Mount Dundas and the Black Ranges are of the same origin and age as the sedimentary stack of the Grampians mountain range. There are also minor outcrops of the Grampians Group sediments to the west of Mount Dundas in the dissected topology of the eastern Dundas Tablelands. Upthrust of these sediments has produced landforms with sharp relief in contrast to the rounded terrain of much of the western uplands.

Permian

The Permian period is noted for the deposition of glacial origin sediments (tillite) of Late Proterozoic age.

Permian sediments

The Permian glacial, fluviatile and lacustrine sediments outcrop in valleys of the Koroite and Konong Wootong creeks near Coleraine, the valleys of the Glenelg and Chetwynd rivers east of Mooree Bridge, and isolated outcrops of glacial sediments in the Pidgeon Ponds Creek valley east of Tarrayoukyan and west of Pidgeon Ponds. Typically the successions of these sediments comprise claystone, interbedded siltstone, impure limestone, cross-bedded sandstone, pebbly conglomerate and tillite. Two glacial advances were identified in these successions with periods of quiescence when sedimentation took place in large lakes.

Jurassic

Jurassic lavas and pyroclasts where preserved are the prominent geologies of this period in the Glenelg catchment.

Jurassic trachyte and volcanics

Trachyte lavas, pyroclasts and basaltic lavas (Coleraine Trachyte) are believed to have evolved from volcanic plugs around Coleraine. Typically the rocks are medium to fine grained with the largest outcrop between Carapook and the Konong Wootong Reservoir. Current exposures suggest that these are remnants of massive lava flows.

Cretaceous

The Cretaceous sediments of the Merino Tablelands are the remaining deposits of deposition and subsidence in the Lower Cretaceous period.

Cretaceous sediments and Mesozoic conglomerates

The Lower Cretaceous sediments outcrop over 1100 square kilometres with the greatest exposures in the valleys of the Glenelg, Wannon, and Stokes rivers. As part of the Otway Group sediments, these sediments comprise lithic sandstone, siltstone, shale, minor coal, basaltic lavas, pyroclastic rocks and chloritic mudstone. The feldspathic siltstones are light grey and greenish in colour, and the claystones grey-blue-brown in colour. Highly weathered they appear white.

Cainozoic

The Cainozoic time span includes the Tertiary and Quaternary periods.

Cainozoic duricrust and Cainozoic aeolian sediments

The Cainozoic peneplain of the Dundas Tablelands is chiefly composed of a residual surface composed of duricrust over various rock types. The duricrust has become the residual product of intense iron accumulation from climatic factors acting upon a stable planar palaeo surface. This unit is defined into three horizons. This comprises an upper pisolitic laminated or massive structure, with dominant oxides/hydroxides of iron and possible aluminium and manganese. The underlying horizon is noted for its mottled yellow, orange, red and purple colours. The lowest horizon is generally a pallid horizon of cream/white colour that has experienced intense kaolinisation.

The parent material (of variable lithologies) of the duricrust is variable from sedimentary beds, metamorphosed sediments, granites, basalts, trachytes, etc. As a result the depths of the residual surface vary, depending upon the parent geology, climate and history.

Tertiary

Tertiary sediments have chiefly been deposited from continental, paralic and marine origins. The formations most evident in the Glenelg Hopkins region of Tertiary origin include the Dorodong Sands and Parilla Sands (coarse marine sediments). The Heytesbury Group Sediments including the Duddo Limestone are the common marine limestone formations. The Wangerrip Group Sediments (undifferentiated) and Brighton Group/Moorabool Viaduct Sediments/Hanson Plain Sands formations are prominent formations in the Tertiary sediments. Some infrequent deposits of White Hills Gravel are also evident south of Ararat on the Port Fairy Road.

Tertiary coarse marine sediments and Tertiary coarse unconsolidated

The Dorodong Sands are flat lying, brown to white, micaceous fine sand and ferruginous sandstone with minor basal quartz sand and gravel. Typically 6-15 m thick, the formation is generally deeply ferruginised and is a common host rock of the Cainozoic duricrust capping.

The Parilla Sands form topographically prominent subparallel ridges separated by swales. Widespread through the Murray Basin, these sandy stranded beach ridges indicate the transgression and regression of the Murray Tertiary seas across north-western Victoria. There is surfical evidence to suggest that the Parilla Sands formation vary between 40-150 m in thickness. Primarily the unit is composed of well-sorted silt and fine to coarse-grained quartz sand, with rare gravel. In weathered zones of the formation, kaolinite, gibbsite and limonite cement the quartz grains.

Tertiary marine limestone

This primarily comprises the Duddo Limestone Formation and the Heytesbury Group Sediments (Clifton Formation, Gellibrand Marl and Port Campbell Limestone).

The Duddo Limestone consists largely of grey to white, poorly stratified, bryozoan calcarenite, calcisilicate, calcirudite and occasional marl. Generally the limestone is porous and highly permeable, while far less consolidated than its South Australian equivalent, the Naracoorte Limestone.

The Clifton Formation comprises limonitic bryzoal calcarenite to limonitic calcareous quartz sand or sandstone. Occasionally the calcarenite is glauconitic.

The Gellibrand Marl is predominantly a greyish marl, varying to calcareous clay and silt, and clayey limestone. Thin beds of glauconitic limestone are occasionally present near the base of the unit.

The Port Campbell Limestone comprises limestone, clayey limestone, marl and calcareous clay with limestone predominant. Often bryzoal fossils are evident in section and the limestone can be quite variable in form (nodular, chalky, friable, or marly).

Tertiary sediments

The Wangerrip Group comprises the Pebble Point Formation and the Dilwyn Formation.

The Pebble Point Formation consists of quartz sandstone and fine conglomerates that are commonly ferruginous, but in portions glauconitic, calcareous and fossiliferous.

At Killara Bluff, south-south-west of Casterton, the formation is 16 metres thick with nine metres of yellow-brown ferruginous sand with thin layers of white silt and rounded quartz gravel.

The Dilwyn Formation consists largely of carbonaceous sandy clay and silt. The beds are micaceous and pyritic. A component of the Dilwyn Formation, the Dartmoor Formation, outcrops in the Glenelg Valley west of Killara Bridge. Here this unit is about 210 metres thick and consists of dark grey to black, interlaminated micaceous silt and fine sand passing up into interbedded dark grey clay, or mudstone and quartz sand.

Tertiary conglomerate, Tertiary alluvial and Tertiary non-marine sandstone

The Tertiary conglomerates belong to the formation known as the White Hills Gravels. These gravels are of fluvial braided plain origin, outwash fan and colluvial deposits. Typically they have well rounded pebbles and cobbles of reef quartz, some vein quartz and bedrock clasts. There is variable ferruginisation, silicification or kaolinisation to regions of this formation. Further to the south and west of the region are river and swamp deposits with minor windblown quartz sand, clay and coal.

Quaternary

Quaternary sea level changes along with climatic changes and tectonics, are chiefly responsible for the genesis of quaternary formations. This includes limestones, calcretes, lunettes, colluvium, aeolian deposits, alluvium, former lakes, swamps, basalts and volcanic derivatives.

Quaternary limestone

The Bridgewater Formation is recognised as former stranded elongate beach ridges that are dominant in calcareous sand and calcarenite. These sands vary from fine to coarse, are pale yellow in colour, fossiliferous, commonly are cross-bedded and are often poorly consolidated.

Quaternary lunettes

The lunettes can be brown, red, yellow or grey siliceous sand/silty clay, and are poorly consolidated. These lunettes in the Glenelg Hopkins region form single or multiple lunettes that concave to the west, on the eastern side of lake basins. Siliceous sands have formed sand dunes and sheets, fossil beach ridges, etc.

Quaternary colluvium

Dissected alluvial, swamp and prior colluvial deposits are the primary sources of this colluvium. A vast portion of the derived colluvium occurs in headwaters of streams disrupted by the deposition of the Newer Volcanics. This unit consists of gravel, sand, silt and clay, and contains bedrock cobbles that are generally poorly sorted, and an incipient weathering profile with pisolithic nodules.

Outwash fans and outwash aprons are common around hill bases and in gullies (e.g. granite derived colluvium, Grampians sandstone derived colluvium). These polymictic gravels, sand and clay are poorly sorted.

An example of this is minor old colluvial deposits from remnant aprons around Palaeozoic bedrock hills near Pittong and Mount Emu. The deposits are frequently

consolidated, and ferruginised deposits of sandy weathered granitic debris flank outcrops.

Quaternary aeolian
Aeolian deposits of fine to medium grained dune sand in the west of the catchment are prominent as planar topographic surfaces in the extreme west and south-west of the region. These surfaces are relatively shallow deposits (generally less than 5 m) typically overlying older lithologies of sedimentary origin.

Quaternary alluvium and Quaternary unconsolidated coarse sediments
Alluvial flood plain, point bar and channel deposits are the products of active stream systems with minor terraces. Polymictic gravel, sand and clay are variably sorted and rounded.

Alluvial terrace deposits and inactive dissected alluvial deposits are moderately sorted and are rounded, stratified, laminated or massive.

Quaternary swamps and former lakes and Quaternary unconsolidated fine sediments
The swamp deposits are associated with disrupted drainage. Silt (typically brown), clay, sand, organic matter and peat's are massive or laminated in formation and tend to be moderately well sorted. This includes paludal lagoon deposits.

Quaternary lacustrine
Lacustrine deposits of the Quaternary period include lagoonal, swamp and local colluvial deposits forming low-lying wetlands between stranded beach ridges. Sand, silt, sandy clay, peat, marl and freshwater limestone are found in these relatively unconsolidated formations.

Fluviolacustrine clays, silts, sand and gravels (unconsolidated) along with dissected flood plain alluvium terraces (1-10 m above present river channels) are also common. These terraces are usually poorly sorted, with sandy clay and fine to coarse sand in composition, and lenticular gravel in well developed soil profiles (2-3 m thick).

Quaternary basalts
Tholeiitic olivine basalt lava flows that texturally range from massive to well vesiculated have formed large amalgamated lava sheets. These flows vary from valley basalt flows, sheet basalt flows and stony rise sheet basalt flows. These lava flows have variable weathering and magnetism depending upon the age of the flows.

Quaternary scoria
Scoria deposits of near-vent accumulations of pyroclastic ash, lapilli and bombs formed prominent cones of highly vesicular, partly welded, massive to layered desposits. These beds are commonly interbedded and often disrupted by bombs of basalt, limestone and marl. Vesicular basalt ejectamenta ranging from fine ash to bombs and angular quartzite clasts up to 60 cm in width, are evident in the south-east of the catchment. A few small basanite lava flows are also found in the catchment.

Quaternary pyroclastics
The Quaternary pyroclastics are derived from pyroclastic base surge and fall deposits consisting of ash, lapilli and scoria. These are well-bedded, sorted and moderately

consolidated. Some of the phreatomagmatic pyroclastics include basaltic ash and blocks, and bedrock clasts that are angular in shape. Tuff rings are common geomorphic features derived from pyroclastic genesis.

Source: Geology of Victoria (Douglas & Ferguson 1988).