CASTLEMAINE'S GEOLOGICAL HISTORY

About 450 million years ago (in the *Ordovician Period*) the Castlemaine area was under a shallow sea, and gradually beds of clay, silt and sand built up. Sometimes these layers slipped and moved into deeper water in an underwater avalanche. Underwater movements of sediment are called *turbidity currents*, and the deposits *turbidites*. The sediment deposited by each current is typically about 30 cm thick. The layers of turbidites are separated by a thin layer of fine-grained rock, formed by the slow settling of material suspended in the water.

Subsequently the whole sequence was subjected to considerable regional pressure from a tectonic plate pushing from the east against the Gondwanan plate. This process resulted in steep folding and compression of the strata with a north-south strike. It also resulted in induration (hardening) of the sediments, the sandy deposits to sandstone and clays to mudstone or shale. The apex of a fold is called an *anticline* and the inverted fold a *syncline*. Fractures across the strata (usually with displacement) are called *faults*.

About 370 million years ago (in the *Devonian Period*) molten rock welled up, without reaching the surface. This rock cooled and solidified to form *granodiorite*. The sedimentary rock near the granodiorite was heated strongly. Sandstone was changed to *quartzite*, and mudstone and shale to *slate* and *hornfels*. Rocks altered in this way are called *metamorphic rocks*. Solutions of silica filled gaps in the rock structure with quartz. In places gold, often associated with iron sulphide, was remobilised and concentrated with the quartz deposits.

A long period of erosion followed. The granodiorite was eventually exposed. The metamorphic rock at the edge of the granodiorite has resisted erosion and remains as a ridge around the granodiorite. The zone of metamorphic rock around the granodiorite is called a *metamorphic aureole.*

About 250–300 million years ago (in the *Permian Period*) Australia was near the South Pole. This was a time of glaciation.

150–200 million years ago (in the *Jurassic Period*) molten rock intruded into cracks in the rock. The molten rock solidified to form seams of rock called *dykes*. There is speculation that the cracking of the local rock occurred in the early stages of Antarctica and Australia’s separatation.

Several million years ago volcanoes were active to the south of Castlemaine and poured out lava, which ran down the river valleys in long tongues. The lava cooled to form *basalt*. Since then erosion has continued, and the streams have cut down below the resistant basalt flows, which remain as plateaux. There are geologically recent volcanic cones to the south and west of Castlemaine.

Old river deposits of the *Cenozoic Period* (66–2.6 million years ago) can sometimes be seen where the streams used to flow. The deposits may now be well above the present stream level. Stream deposits are also found under the basalt flows. These are called *deep leads*, and many of the leads have been mined for gold. The river deposits have usually been deposited on Ordovician sediments. The join between rocks of different ages is called an *unconformity*.

Erosion of the steeper land has continued. Silt has been deposited in the valleys, covering the bedrock of the valleys with *recent alluvium.*

LOCAL EXAMPLES OF GEOLOGICAL FEATURES

The following text describes some of the best examples of geological features in the area. Photos and more information on these and other geological features can be seen on our website.

Please be careful when visiting these sites. Cliff and cutting edges may be unstable and are unguarded. Several sites are road or rail cuttings. Make sure that you park in a safe place and keep road safety in mind at all times. Do not enter railway cuttings – these features may be viewed from vehicle tracks at the top of the cuttings. Please do not remove material from geological sites.

1. ORDOVICIAN SEDIMENTS

Hard Hill folds and strata. [Railway Street railway bridge at Chewton.] Take care, there are steep unprotected drops. An anticline is about 40 m west of the bridge, and a steeply plunging syncline about 130 m west of the bridge. There is an angular unconformity (separating flat Cenozoic rocks from folded Ordovician strata) just east of the bridge, and tunnelling underneath the Cenozoic river gravels. Faulting (both pressure and tension faulting) and quartz veins can also be seen.

The strata are almost vertical, and variously coloured. Shades of red and brown are generally due to iron oxide. Miners made tunnels in the Ordovician rock when searching for gold-bearing quartz reefs.

Kalimna Tourist Road anticline. [200 m north of Hunter Street.] The anticline can be seen on the east side of the cutting. A fault, with a movement of a few centimetres, is at the left of the fold.

2. QUARTZ REEFS

Before the arrival of miners, many large masses of quartz were exposed, some standing a metre or more above the surface. Few still remain. The quartz often has a dark brown coating of iron oxide from the weathering of pyrite. Narrow seams of quartz (1–100 mm wide) are very common and are called veins.

Eureka quartz reef. [100 m west of the Chewton–Spring Gully Road, 2.7 km from the Highway.] This is the site of the Eureka mine. Caution: there are unprotected drops.

3. GRAPTOLITE FOSSILS

Graptolites are the most common fossil in local Ordovician rocks, and are found in mudstone rocks. However, they often only appear as pencil-like markings on bedding planes and so are difficult to find.

They are small fossils with fret saw-like arms. They were planktonic animals and are now extinct . They evolved rapidly into many different species that occurred at different time spans. So Graptolite fossils are useful for dating Ordovician sediments. Subdivisions of the Ordovician period include the Bendigonian, Castlemainian, Chewtonian and Yapeenian stages.

4. SLATE

There are many small diggings in the district where slate and sandstone have been quarried. A slate quarry still operates in Campbells Creek, near Victoria Gully.

Slate quarries, Barkers Creek. [Specimen Gully Rd, opposite Cappers Gully Tk.] The line of quarries extends for some distance from the road on both sides of the road. The quarry on the south side has been used for art exhibitions and concerts. At one time Collins Street in Melbourne was paved with slate from these quarries.

The monument commemorating the discovery of gold is a few hundred metres further east.

5. GRANODIORITE

The granitic rock that occurs in the district is granodiorite. Granite and granodiorite have slightly differing chemical compositions. The term granite is often used loosely to describe both granite and granodiorite. Granodiorite, like granite, formed when molten rock cooled and solidified below the land surface. As the rock cooled, cracks developed. These cracks or joints make quarrying easier. Weathering along the cracks has produced large boulders, which are called tors.

Dog Rocks, Mt Alexander. [Off Joseph Young Drive, Mt Alexander.] This area has excellent examples of tors.

Mt Moorul, Maldon. [East of Maldon Cemetery. The summit can be reached from a winding road leading from Church Street, 500 m past Back Cemetery Road. Signposted ‘Rock of Ages’.] The granodiorite outcrop stretches to the north. There are many tors and rock faces. The area is notable for the granite-area plants. Ordovician sediments are about 50 m to the east of the highest point. The junction of granite and Ordovician sediment shows as a gully on the south side of the picnic area and extends to Butts Reserve on Mt Tarrengower.

Nuggetty Road. [North side of Nuggetty Range, Maldon.] The road passes through a granite area landscape which has many tors. The contrast between the granodiorite and Ordovician sections of Nuggetty is evident.

Xenoliths formed when pieces of the existing rock broke off and sank into the molten granodiorite. These pieces have been metamorphosed but not melted, and can be seen as darker rocks within the granodiorite. Xenoliths can be seen in the old highway cuttings 0.2 and 1.5 km north of Harcourt and in the stonework of some buildings around Castlemaine.

6. GRANODIORITE–ORDOVICIAN BOUNDARY

The intruding molten rock baked the nearby Ordovician sediments. This process is called contact metamorphism, and the zone of metamorphosed rocks is called the *metamorphic aureole*. The metamorphic rocks are resistant to erosion and remain as hills or ridges. From the air the aureole is very prominent; the granitic areas have been cleared and the metamorphic rim is timbered. Slate has been metamorphosed to hornfels and has lost its slaty cleavage.

Some examples of the aureole are:

- West of the old Calder Highway between Elphinstone and Harcourt.
- Mt Tarrengower is metamorphic at the lookout tower. To the west it is granitic. Hornfels was extracted from a quarry at its base.
- Big Hill, on the Calder Highway, south of Bendigo.
- Tunnel Hill, Elphinstone. The railway tunnel passes through the aureole.

Aureole at Specimen Gully Road, Barkers Creek. The road rises to the ridge along the join of the Devonian granodiorite and Ordovician sediments. The join is close to the ridge and the two types of rock found on the surface are distinctive. The metamorphic aureole can be seen stretching to Mt. Tarrengower. The contrast between the granite and sedimentary landscapes is evident. The valley between the aureole and Mt Alexander can be seen. This valley is the bed of a former creek, the waters of which have been captured by Barkers and Forest Creeks.

7. GLACIAL FEATURES

Campbelltown glacial deposits. [Cutting on Newstead–Creswick Rd, 1.4 km east of Werona Rd.] The road cuts an outcrop of glacial conglomerate. The glacial origin is shown by:

- the boulders, which include rock of metamorphic and granitic origin, and which are foreign to the district;
- the sub-angular and rounded shape of the stones;
- the scratchings and markings on the stones; and
- the irregular way in which the material is deposited, showing no signs of stratification.

8. CENOZOIC RIVER GRAVELS

Since the gravels were deposited, the streams have cut new courses to a lower level. Often the sediments are strongly cemented together and have resisted erosion. The cement is usually red-coloured iron oxide.

Kennedy Street gravels. [15 m south of the corner of Kennedy and Lyttleton Streets.] The rounded pebbles are typical of a stream bed and are part of the ancestral bed of Barkers Creek. The creek is now on the other side of the railway line.

Red Knob, **Vaughan.** [The Cenozoic gravels are just north of the Vaughan–Fryerstown Road, 1 km east of Vaughan.] Much of the hillside was sluiced for gold in the late 1930s. From the road, the Ordovician bed rock, Cenozoic gravels and the basalt capping can be seen. Rounded quartz boulders were left after sluicing. The poplars in the valley were planted to 'revegetate' the area.

Gravels underneath basalt flows. The gravels can be seen along the Midland Highway between Guildford and Yapeen, especially on the east side. Gravels are also present along the edge of the Shicer Gully–Guildford Road and the Tarilta–Guildford Road. These gravels (or deep leads) were originally stream gravels that were covered by the basalt flow. Some were gold bearing and some have been mined. Miners tunnelled under the basalt from the side or mined through the basalt. Along Shicer Gully Road the mine workings can be seen at the edge of the basalt. At the Golden Lead Mine, on the south-east side of the highway at Yapeen, the mine shaft cuts through the basalt.

9. BASALT FEATURES

Basalt plains are a feature of some surrounding districts. The Moolort Plains west of Newstead and the basalt plains in the Kyneton district are examples. There are numerous small volcanic cones across the Moolort Plains, which are a northern extension of the Western Victoria Volcanic Plain.

Mt Consultation. [This extinct volcano, which is on private property, can be seen to the south-east from the Pyrenees Highway near the Castlemaine Golf Club.] Lava from the volcano flowed for several kilometres to the north-west.

Guildford Plateau. The plateau can be seen from the Midland Highway between Yapeen and Guildford, and from the Guildford–Newstead Road. Another plateau is south of the Midland Highway, and there are several more beside the Newstead–Creswick Road. The lava came from the south along the river valleys. The streams have cut new beds, and are now well below the basalt. In some cases (e.g. Loddon River, Shicer Gully Creek and Muckleford Creek) the streams have cut a course at the edge of the basalt. Streams at the edge of a basalt flow are called lateral streams. Examination of the eroding edges of the basalt shows that there were at least two flows.

Basalt columns, Vaughan. [Road cutting on the Tarilta–Vaughan Rd 200 m south of the Loddon River at Vaughan. Access via Tarilta Rd.] These small columns were formed as the result of jointing during cooling. They are mostly 5 or 6-sided. Similar effects are seen at Barfold Gorge and Loddon Falls. The stream to the west has cut through to the Cenozoic gravels, which have been mined.

10. WATERFALLS

Most waterfalls in our region form where a stream crosses a basalt lava flow, with the basalt rock breaking away along vertical joints. Two examples are:

Loddon Falls. [Access from the end of Sewells Rd, Glenlyon. 250 m walk. Caution required around cliffs.] The river has cut through basalt to the Ordovician rock, exposing basalt columns.

Trentham Falls. [3 km north of Trentham on a sealed road.] The Coliban River has cut through a basalt flow to Ordovician sediments. The drop of the falls is about 30 m. Cenozoic deposits under the basalt flow contain mammal bones and wood fragments that are several million years old. Columnar jointing can be seen in the basalt. A cross-section of the basalt can be seen in the roof of the cave.

The Cascades. [Access via Cascades Road near the boundary of Metcalfe township.] This is an example of where the river cascades over granite outcrops and boulders on a beautiful stretch of the Coliban River. Pot-holes have been worn into the base rock by the action of boulders in the swirling water.

GEOLOGICAL FEATURES OF THE CASTLEMAINE DISTRICT

This leaflet outlines the geological history of the Castlemaine district and gives a brief description of some local geological features.

Kalimna Tourist Road anticline

Original text by E. Perkins, June 2011, revised May 2024.

The Castlemaine Field Naturalists Club acknowledges the Dja Dja Wurrung community as the traditional owners and custodians of the country where we meet and study the natural environment.

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