A.2 Geology and Physiography

The study ares as characterised by extensive plains in the north and south, with rises and hills on Palaeozoic sedimentary and igneous rocks bordering the eastern and western sides. The southern plains are basaltic, and extended north as far as Bridgewater. Numerous volcanic cones rise above these plains, and islands of granite protrude from the basalt west of Clunes. The northern plains are alluvial, and form part of the extensive riverine plain of the Murray-Darling system.

Granitic plutons, usually with hilly terrain, occur in a number of areas. The largest, the Harcourt (Granodiorite) Batholith, also contains the highest peak of the catchment – Mount Alexander (741 metres).

Rises and hills on sedimentary rocks comprise almost 50% of the study area and occur extensively along the eastern and western sides of the catchment. These sedimentary rocks are most dissected in the east near Castlemaine.

Landform Patterns

The terrain within the study area has been classified using the system outline in the Australian Soil and Land Survey Field Handbook (McDonald et al 1984). In this system, relative relief and modal terrain slope are used to calculate the types of erosional landform patterns as shown in the table.

Simple types of erosional landform pattern characterised by relief and modal slope.

Relief	Modal terrain slope			
	Level <1%	Very gently inclined 1%-3%	Gently inclined 3%-10%	Moderately inclined 10%-32%
High 90-300 m (about 150m)	-	-	HILLS – undulating Hu	HILLS – Rolling Hr
Low 30-90m (About 50m)	-	-	LOW HILLS – Undulating Lu	LOW HILLS- Rolling Lr
Very Low 9-30m (About 15m)	-	RISES – Gently undulating Rg	RISES – Undulating Ru	-
Extremely low <9m (About 5m)	PLAIN – Level Pl	PLAIN – gently undulating Pg	PLAIN – Undulating Pu	-

Source: McDonald et al. (1984)

Some landforms, such as volcanoes, occur in individuals rather than patterns and do not fit the broad categories used in the table. These are listed separately.

Plains – level to gently undulating

Plains, which comprise almost 45% of the study area, extend from south to north along the centre undulating and formed on basalt and extend northwards along the Loddon valley as far as Bridgewater. The basaltic plains are frequently dissected by lateral streams and may remain as small, flat-topped remnants. Notable examples occur along the Loddon River valley between Guildford and Daylesford.

In the north, level plains on alluvium predominate, forming a small part of the extensive riverine plain of the Murray-Darling system. The plains are generally featureless, however, occasional features include channels, levees, prior-stream levees, ox-bows and swamps. Where the alluvium narrows and extends up the valleys the plains are frequently gently undulating.

Rises – gently undulating to undulating

About 30% of the study area consists of rises, mainly on sedimentary, granitic and basaltic terrain, but also on colluvial fans near Mount Hooghly. While most common in the western and central areas of the study area, they also occur on sedimentary terrain in the north-east and on basalt in the south.

Low hills to hills – undulating to rolling

Extensive areas of hilly dissected sedimentary terrain occur in the south-east from Castlemaine to Daylesford. The steeper terrain is characterised by short, steep slopes, numerous drainage depressions and common surface stone or rock outcrop. Stream pattern is influenced by faulting and by differential erosion of the steeply dipping resistant sandstones and softer mudstones. Smaller areas of sedimentary hills also occur in the south-west near Lexton and occasionally within the undulating sedimentary rises in the centre.

Hills of metamorphosed sedimentary rock surround most granitic areas; notable ridges and peaks include the Black, Bealiba and big Hill Ranges, Mount Tarrangower, Mount Hooghly, Mount Moliagul and Mount Brenanah.

Hills on granitic rock occur at a number of locations, the largest being the Harcourt (Granodiorite) Batholith containing Mount Alexander on the eastern study area boundary. Other major occurrences are Mount Kooyoora, Mount Korong, Mount Egbert and Mount Beckworth. Massive rock outcrop and boulders characterise these areas.

Volcanic hills

Numerous volcanic hills, derived the partial dissection of volcanic cones and vents, are found in the southern half of the study area. They typically rise abruptly from the surrounding basaltic plain and have rounded summits.

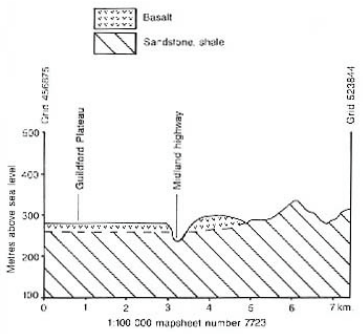
Enriched valleys

Narrow valleys bounded by steep scarps created by stream incision frequently occur within and on the edge of the basaltic plains in the central and southern areas. These valleys are most prominent along Tullaroop and Creswick Creek valleys south of the Tullaroop Reservoir, and have been mapped separately.

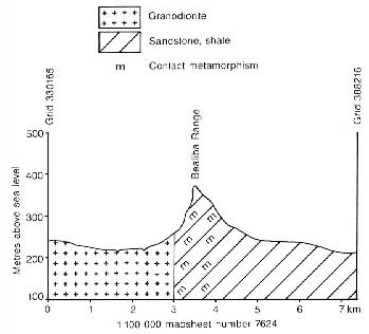
Geomorphic processes influencing landform patterns

Differential erosion

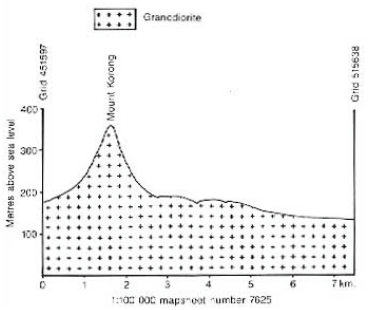
Soil parent materials vary in their resistance to erosion, thereby influencing landscape development. In the study area the basalt flows, for example, are usually more resistant than the adjacent terrain. The flows were generally restricted to prior stream valleys, displacing stream flow to one or both sides of the basalt (Ollier 1967). Subsequent stream incision into the surrounding terrain has left the basalt as flat-topped ridges following the ancestral stream valley and overlying the stream-bed gravels. Examples include the flows near Lillicur and Talbot. More extensive stream dissection ins some areas has left the original basalt flow as a series of separate basalt-capped hills, as has occurred along the Loddon River between Glenlyon and Guildford (see diagram). In the south the basalt flows overtopped the ancestral valleys and covered extensive areas. This basalt largely retains its original form, with numerous volcanoes protruding above the undulating basaltic plains. Where streams have cut through the basalt into the softer underlying sediments, they have produced narrow steep-sided valleys up to 30 cm deep.



Intrusions of granite during the Devonian resulted in contact metamorphism of the enveloping sedimentary rocks. Erosion since then has frequently left the more resistant metamorphosed rocks as raised ridges around the granitic plutons. Numerous examples occur throughout the study ares, notably the Bealiba, Black, Big Hill and Green Hill ranges, and the ridges associated with the peaks of Mount Tarrangower, Mount Hooghly, Mount Brenanah and Mount Gaspard. The diagram shows a cross-section through the Bealiba Range.



The granitic masses often weather into two forms of terrain: steep hills with abundant rock outcrop, and gentler rock-free slopes. These contrasting terrains often occur together; for example, the Mount Alexander-Mount Prospect hills contrast with the gentler Ravenswood area, Mount Korong and its surrounding gentle, deeply weathered terrain, as shown in the diagram, and Mount Beckworth similarly had a surrounding gentle terrain. According to Ollier (1965) the granite has been subject to deep weathering, and the weathering front was probably irregular, with ridges and pinnacles of fresh rock still occurring within the weathered zone. Subsequent erosion had removed most of the weathered regolith and left the resistant fresh rock as raised areas in the landscape.

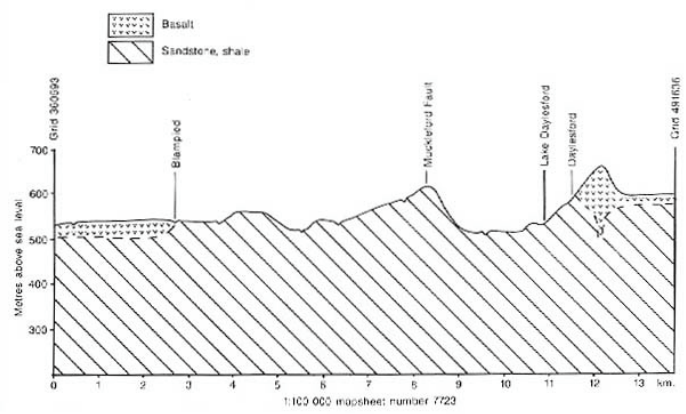


In areas of sedimentary rock, stream pattern is influenced by the strike of the steeply dipping resistant sandstones and the intervening softer mudstones, with a pattern of parallel streams often forming in the latter material. Parallel bands of outcropping sandstone strata are also visible in many places.

Drainage modifications

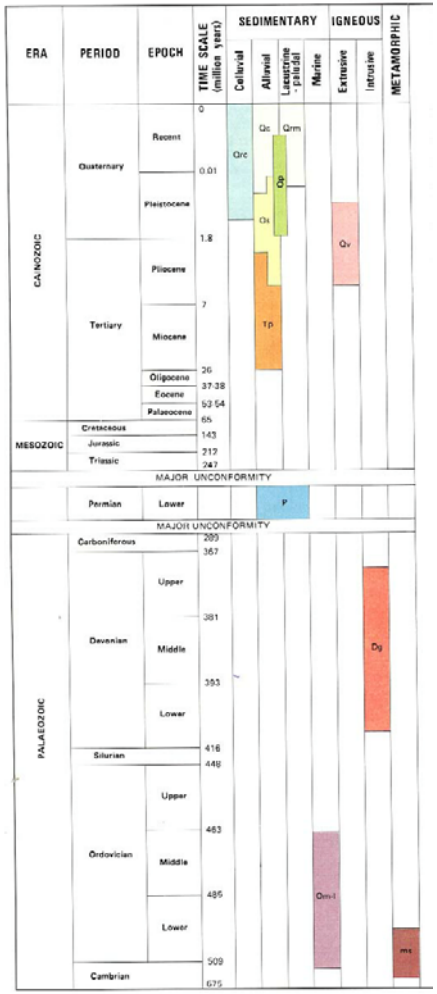
Extrusion of the basalts in the late tertiary caused some disruption to streams, although the general northerly direction of stream flow was largely unaffected. Most streams were displaced to one side of the basalt flow, but some have been forced to cross the broad basaltic plains. The original drainage pattern can be determined by tracing the ancestral stream-bed gravels (known as ‘deep leads’) that underlie the basalt. The pre-volcanic catchment divide was probably near Ballarat, but subsequent basaltic emanations, together with a general upwarping, have moved the catchment divide northward to its present location. The ‘deep leads’, however, still originate from the Ballarat area.

The basalts sometimes restricted stream flow, resulting in accumulation of alluvium. One notable example occurred near Castlemaine where the Muckleford Creek was dammed back by the basalt of the Guildford Plateau. The basalt itself was probably restricted by the western upthrust side of the Muckleford Fault.



Faulting

Muckleford Fault, the most significant one in the study area. Extends from near Ravenswood in the north, southwards to beyond Daylesford. In some areas, especially to the west of Daylesford, a pronounced fault scarp occurs. Thomas (1935) estimated a vertical displacement of at least 1200 metres across the Fault since its inception, although only about 15 metres since the basalt of the Guildford Plateau was extruded in the late Tertiary. In this position the western side has been upthrust. The Fault has also contributed to the linear nature of Muckleford Creek. The accompanying cross-section through the Muckleford Fault represents the land west of Daylesford.



Information derived from the Department of Minerals and Energy 1 : 250 000 Geological map series; Ballarat, Bendigo, St Arnaud and Melbourne sheets

Qc Clay, sand and sandy clay, often grey, slight soil development; terraces with scroll pattern or plains with a network of channels; stream alluvium floodplain deposits; sand, silt, clay, minor gravel

Qrm Swamp and lagoonal deposits; clay, silt, peat, mud.

Qrc Fan deposits, hillwash, scree, high-level alluvium; gravel, sand, minor silt.

Qp High level river terraces, older alluvium and colluvium, floodplain deposits, abandoned swamps and ridges; silt, gravel, sand, clay

Qs Clay, silt, sand, gravel; surface with numerous levee traces, soil often red-brown. Minor inclusions of Qrm and Qu (lunette deposits).

Qv Olivine Basalt, with alkaline derivatives; limburgite, scoria, minor tuff and sand. Minor trachyte (Babbington Hill).

Tp Gravel, sand, silt and clay in old stream courses, often ferruginous or lateritic. Includes most deep lead gravels.

P Glacial tillite and fluvioglacial conglomerate.

Dg Granite, granodiorite, microgranodiorite, often porphyritic. Minor 'hornblendic rock' at Rheola. Surrounded by metamorphic aureoles (m).

Om-l Monotonous sequence to thinly bedded shale, slate and sandstone. Metamorphisim (m) in aureoles around granitic rocks.

ms Schist, sometimes gneissic, schistose hornfels, quartzite, phyllite, associated with granite intrusions as metamorphic aureoles.

Map B: Geology map