4 GEOMORPHIC DIVISIONS OF VICTORIA

The identification and delineation of Geomorphic Divisions provides a ready framework for identifying areas with common processes and, by implication, areas of common land types and common sets of land degradation threats. It also provides a framework for simplifying the immense range of variation encountered in examining land across Victoria.

Jenkin (1991) identified and delineated twenty-seven geomorphological divisions for Victoria which have since been expanded to twenty-nine (see Figure 4.2 and Table 4.1). There is good reason to believe that geomorphic and other land-forming processes have sufficient commonality within a geomorphic unit to result in a limited range of land and soil types, and that the range will be significantly different to the range of land and soil types found in another geomorphic unit. Further, it is highly likely that the suite of management options available to land managers for sustainable land use will be common across a given geomorphic unit, and that this suite will be different to that appropriate for another unit.

These geomorphic units of Jenkin have been the basis for the first level of separation of land types in the Statewide Land Systems.

In the various geomorphic subdivisions, there are differences in land shapes, average elevations, soils, underlying geology and local climate. The different landforms and soils have developed because each region has experienced different combinations of geomorphic processes (see Figure 4.1). These factors in turn have led to different land uses in each subdivision.

Because of the great diversity of landforms, soils and land use in Victoria, it is not possible to describe every type that is found in the State. Discussion here is restricted to a few features that are typical of each geomorphic region. Some dominant geomorphic processes in each subdivision are also described.

Some landforms can occur in more than one geomorphic subdivision. For example, granitic rocks are widespread in Victoria. Therefore landforms associated with these rocks occur in more than one geomorphic subdivision. For convenience, however, granitic landforms are only described in the section dealing with the West Victorian Uplands.

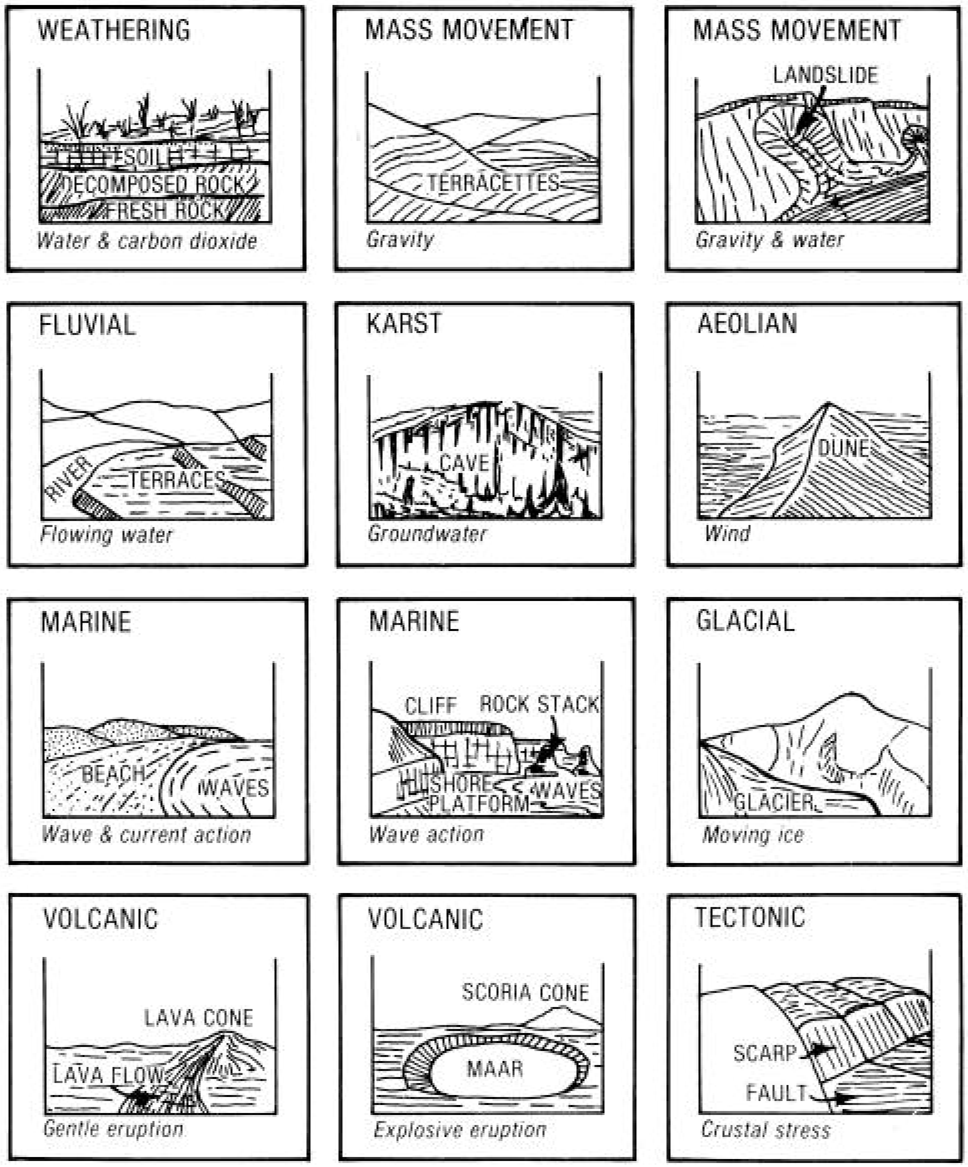


Figure 4.1 The main geomorphic processes (from Jenkins 1991*)

* The material presented in this Chapter has been extracted, with the Editors' kind permission, from Jenkin's Chapter **Geomorphology** *in* **Introducing Victoria's Geology**. *Eds*. Cochrane, G.W., Qucik, G.W., and Spencer-Jones, D., Geological Society of Australia (Victoria Division). While minor changes have been made to the material extracted for editorial reasons, the technical content remains faithful to the original.

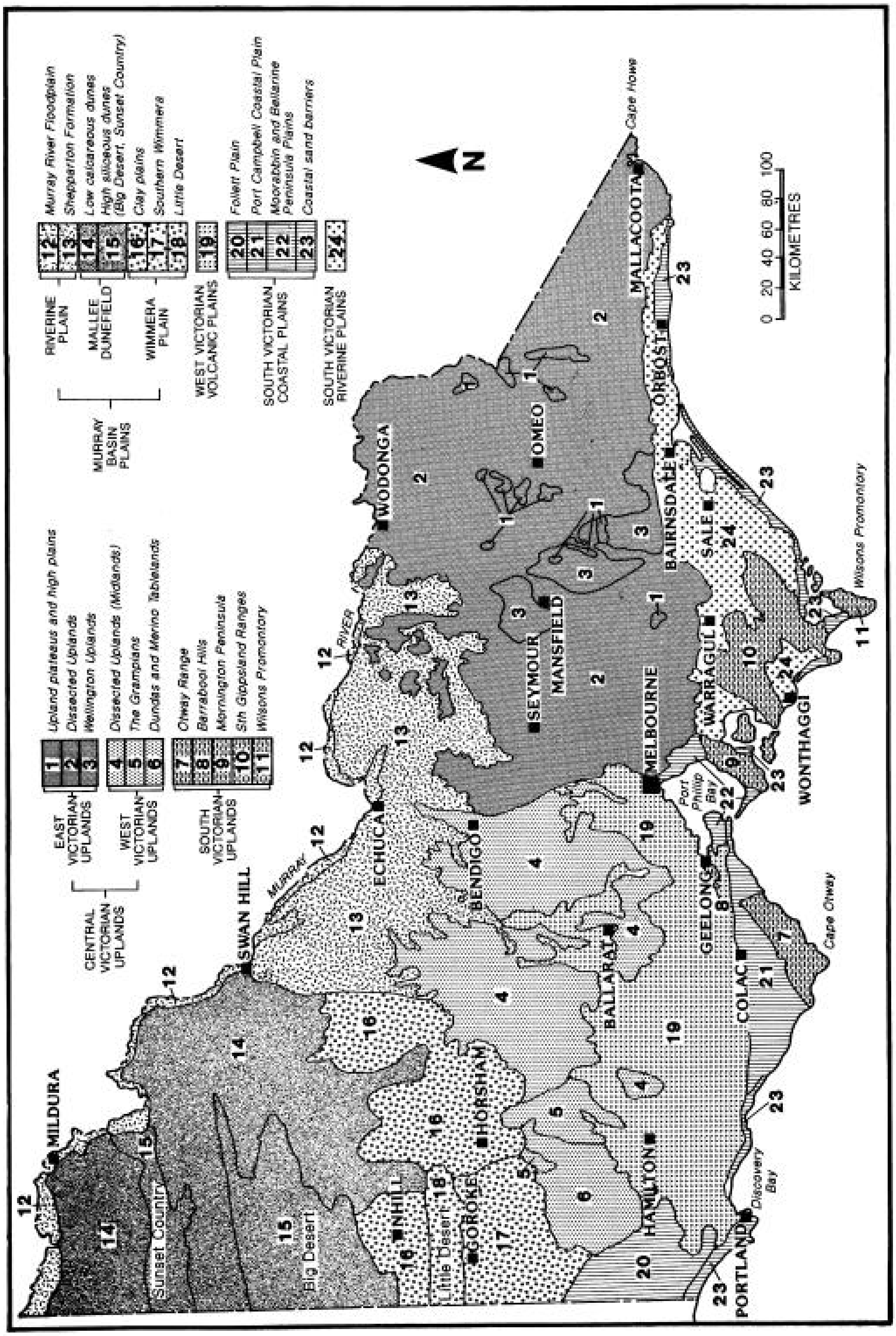


Figure 4.2 Geomorphic Divisions of Victoria (from Jenkin 1991)*.

Table 4.1 Geomorphic Divisions of Victoria.

Geomorphic Division	Geomorphic Sub-division		Geomorphic Units
CENTRAL VICTORIAN UPLANDS	East Victorian Uplands	**1.1**	Dissected Uplands
		1.2	Dissected plateaux (Wellington uplands)
		1.3	High plains (Dargo, Bogong, etc.)
	West Victorian Uplands	**2.1**	Dissected Uplands (Midlands, etc.)
		2.2	Prominent Ridges (Grampians)
		2.3	Dissected Tablelands (Dundas Tableland)
		2.4*	Dissected Tablelands (Merino Tableland)
SOUTH VICTORIAN UPLANDS		**3.1**	Dissected Fault Blocks (Otway Range)
		3.2	Moderately Dissected Block (Barrabool Hills)
		3.3	Moderately Dissected Ridge (Mornington Peninsula)
		3.4	Dissected Fault Block (South Gippsland Ranges)
		3.5	Dissected Outlier (Wilson's Promontory)
MURRAY BASIN PLAINS	Riverine Plain	**4.1**	Present Floodplain (Murray Valley)
		4.2	Older Alluvial Plain (Shepparton)
	Mallee Dunefield	**5.1**	Low Calcareous Dunes (Ouyen)
		5.2	High Siliceous Dunes (Big Desert/Sunset)
	Wimmera Plains	**6.1**	Clay Plains (Nhill)
		6.2	Ridges and Flats (Goroke)
		6.3	Low Siliceous Dunes (Little Desert)
WEST VICTORIAN VOLCANIC PLAINS		**7.1**	Undulating Plains (Western District)
		7.2	Stony Undulating Plains (Western District)
SOUTH VICTORIAN COASTAL PLAINS		**8.1**	Ridges and Flats (Follet)
		8.2	Dissected Plains (Port Campbell)
		8.3	Sand and Clay Plains (Moorabbin)
		8.4	Fans and Terraces (Western Port)
		8.5	Barrier complexes (Discovery Bay/Gippsland Lakes)
SOUTH VICTORIAN RIVERINE PLAINS		**9.1**	Present Floodplains (Gippsland)
		9.2	Intermediate Floodplains (Gippsland)
		9.3	High Terraces and Fans (Gippsland)

Note:* Additional geomorphic unit added by Jenkin and Rowan (1991)

CENTRAL VICTORIAN UPLANDS (Divisions 1 & 2)

Extending east-west through central Victoria is a belt of relatively high country, which becomes narrower and lower towards the west. This belt is commonly called the Central Highlands. Its crest forms a sinuous divide between the rivers that flow northward to the Murray River and those that take more direct southward routes to the ocean. This divide is called the Great Dividing Range on many maps. However, it is not a range in the strict sense but a complex of plateaus, ridges and corridors. There is certainly no mountainous range, for example, at the Kilmore Gap, north of Melbourne, where the divide is only 335 metres above sea-level. This feature is important, however because traffic on the Melbourne-Sydney railway and the Hume Highway passes through this low corridor.

In north-eastern Victoria, the Divide starts to swing to the north. It continues close to the coast throughout eastern Australia to the top of Cape York Peninsula. The south-eastern section of these uplands is generally quite rugged. The central zone from Mount Buller to beyond Mount Kosciusko in New South Wales is sometimes called the Australian Alps.

Bedrock throughout the uplands is made up of various Palaeozoic sedimentary, igneous and metamorphic rocks. There are many areas of bare rock at high altitudes. Most rivers flow along deep rocky valleys. Only a few, such as the Goulburn, are accompanied by alluvial flats that are more than a few hundred metres wide.

The Central Victorian Uplands are high because they have been lifted relative to the rest of Victoria by slow, periodical, tectonic movements. These involved upwarping and block faulting movements that started in the Early Cretaceous and have continued to the present day.

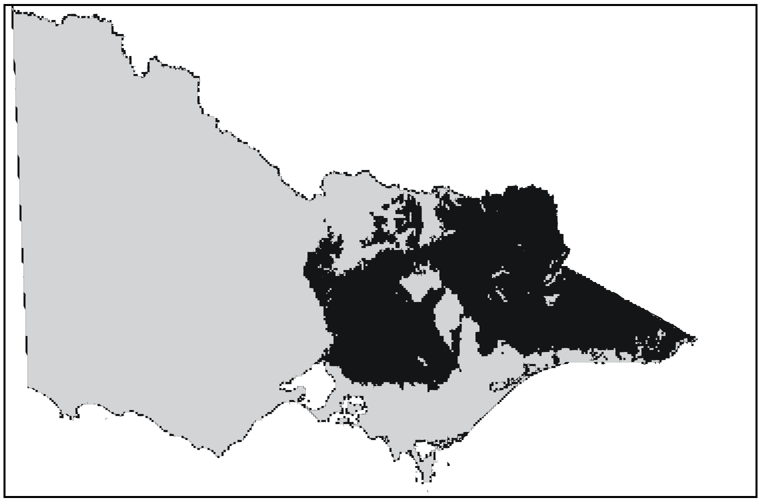
It is convenient to describe the East Victorian Uplands and West Victorian Uplands separately and in each case, there are several geomorphic units.

EAST VICTORIAN UPLANDS (Division 1)

This division consists of a great variety of landforms, which provide some of the most outstanding scenery in Victoria. The differences in the landforms result from many factors, including the past and present climate, past earth movements, structures in the rocks and variations in the erosion and weathering of rocks.

There are three geomorphic units in the East Victorian Uplands:

1.1 Dissected Uplands



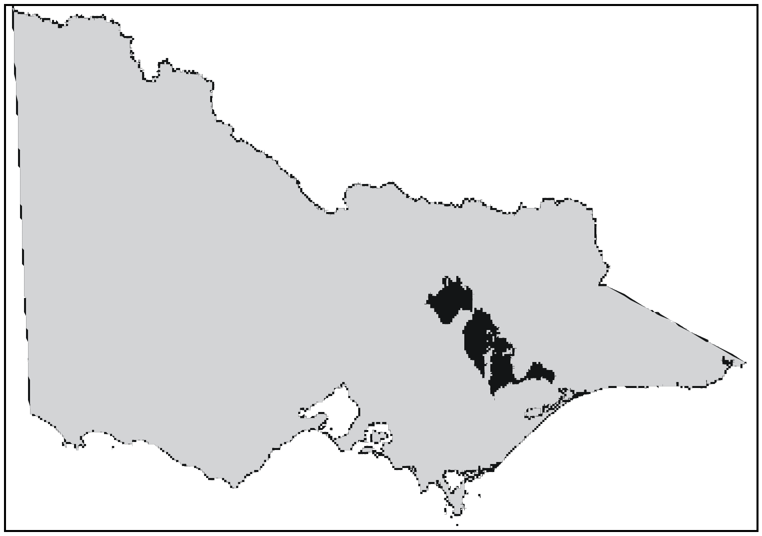
This is the largest region in Victoria extending from just east of Melbourne in a north-easterly direction to the border with New South Wales. Between about three and 150 million years ago Victoria underwent a prolonged period of erosion. This produced a generally low-lying, fairly flat land surface. After this period the land, which now forms the Central Victorian Uplands, began to rise. The former sluggish streams, crossing broad valleys on the old plain, became more active and started to cut valleys into the underlying rocks. The uplift did not occur at the same consistent rate over the whole period, with most of the movement restricted to a few intermittent faster stages. As a result, in some places a younger valley cut down into the bottom of an older and wider valley. This produced a feature known as valley-in-valley form that is common in the uplands.

In the steep country, the soils are mostly young due to the continual movement of weathered material down the slope. There are also some low granitic plateaux where the soils are dominantly red (such as the Strathbogie Ranges).

There are alluvial flats along the main valleys in the Dissected Uplands, usually with alluvial fans along their sides. The soils developed on the fans are thin, gradational and often stony as a result of the continual downslope movement. On the valley floors, the soils have developed on accumulations of alluvial material deposited during several different periods. They occur on the flood plain or on pairs of terraces, which are at the same level on opposite sides of the valley. The higher the terrace, the older the soil.

In north-central Victoria, the northern margin of the uplands meets the Riverine Plain, There, the country is lower and less steep and the climate is drier than in the north-eastern mountains. There are stony gradational soils on the steep ridges, but duplex soils dominate elsewhere. The oldest soils are duplex types containing ironstone, which were formed two million years ago in the Pliocene epoch. In places, they are partly covered by a younger soil that has older soil as its parent material. Duplex soils are also widespread in the undulating to hilly country. They have red clays on the rises and yellow clays in the valleys and on colluvial slopes.

1.2 Dissected Plateaux (Wellington Uplands)

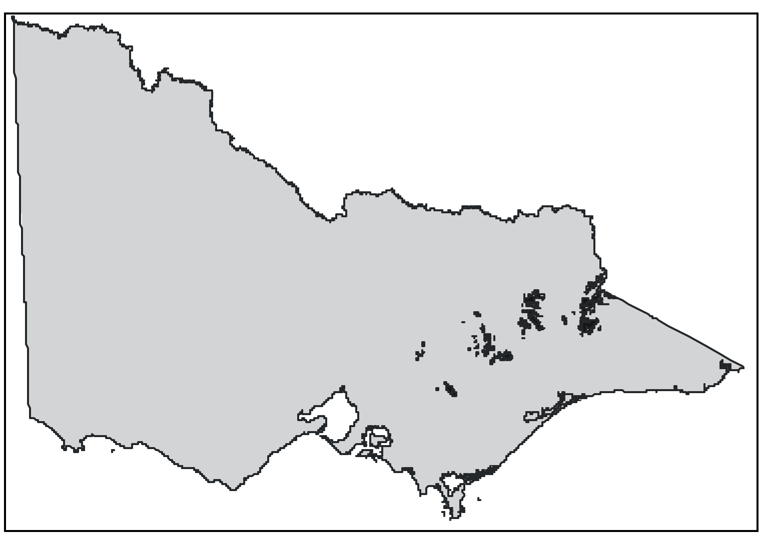


This region covers a belt of rugged country, extending from Mansfield in a south-easterly direction to ranges north of Maffra in Gippsland. Much of the area is forested, difficult to access and uninhabited. It is made up of several basin-shaped areas of massive hard upper Devonian and Carboniferous sandstones, conglomerates and acid volcanic rocks.

The geological structure of the sandstones influences the landforms developed. The rocks are mostly flat-lying or gently dipping. They often form plateaux or isolated flat-topped mountains or mesas (such as Mount Battery near Mansfield). The thick resistant rock formations often present steep escarpments on the outside of the basin. In a few places, there are razorback ridges where the ranges have been dragged up along boundary faults.

In the mountainous country, there are shallow loam soils along the ridges and scarps. Alpine humus soils are common on the high plateaux. The lower country around Mansfield in the north of the area is formed on softer red mudstones and shales of Carboniferous age. The soils are commonly red duplex types.

1.3 High Plains (Dargo, Bogong, etc.)



In some parts of the uplands, the skyline is noticeably flat over relatively small areas. There are plateaus and groups of hills with summits at about the same level. These level areas represent the remnants of ancient land surfaces that once extended over wider areas. They have been lowered a little by erosion since their original formation. The highest and oldest, flat to undulating plateaus are called high plains. Their surface was formed at least 200 million years ago.

Around Mount Baw Baw and Mount Buffalo, the plateaus are formed on granitic rocks whereas parts of the Bogong High Plains are on basalt. Granitic rocks usually display patterns of joints and fractures that follow certain preferred directions. The rocks weather most easily where air and water penetrate along the joints. Erosion commences in the weathered rocks and this leads to the development of mountain streams.

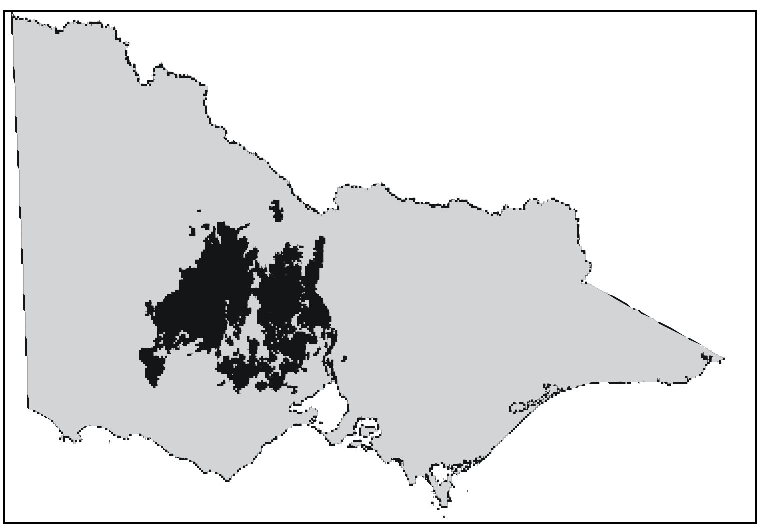
The soils on the high plains are young and immature; that is, their profiles are not divided into distinct horizons. They generally contain much decomposed plant material, or peat, giving typical organic soils. These organic soils are very important as they store a large amount of water, which is released slowly throughout the year. This ensures some water reaches catchment dams elsewhere in the uplands at all times of the year. There are also some stony gradational soils, mainly near the plateau margins.

WEST VICTORIAN UPLANDS (Division 2)

The Western Victorian Uplands were formed by similar tectonic forces to those causing the uplift of the East Victorian Uplands. The West Victorian Uplands are however, generally much lower and less rugged than the country in eastern Victoria.

There are three geomorphic units of the West Victorian Uplands:

2.1 Dissected Uplands (Midlands, etc.)



This region broadly covers the country that is usually called the Midlands of the Central Goldfields. It extends from Ballarat and Gisborne in the south to Bendigo and St. Arnaud in the north. Much of it consists of Lower Paleozoic granodiorite and folded sandstones and shales. The dominant features are the low north-south ranges and intervening broad relatively low-lying corridors of valleys, plains and undulating country. The unit is separated from the East Victorian Uplands by a major fault zone that passes through Heathcote and country east of Lancefield.

Landforms on basalt flows:

The corridors are occupied mainly by basaltic lava flows and alluvium. It is clear that, along some corridors, the divide between north and south-flowing streams in Victoria is not a range as it may not be a visible feature at all, for example, where it crosses open flat areas such as just north of Ballarat.

Tertiary lava flows which once flowed down older river valleys, occur in the hilly country, particularly around Daylesford and Trentham. The flows are often visible above the level of nearby present-day gullies. Some lava flows have been gradually eroded, leaving a series of flat-topped residual hills. The Guildford Plateau, south-west of Castlemaine, is a large isolated remnant of a basalt flow. The basalt overlies alluvial gravels, indicating a former higher level course of the Loddon River.

Landforms on granitic and metamorphic rocks:

Granitic rocks are common in the Dissected Uplands and there can be great contrasts in the landforms associated with them. They form the highest points of the landscape in some areas (such as the Langi Ghiran-Mount Cole group near Ararat, Mount Korong near Wedderburn, and Mount Alexander near Harcourt). In contrast, some granitic rocks are deeply weathered and have been excavated by streams to form shallow basins (such as the Murphys Creek area west of Tarnagulla).

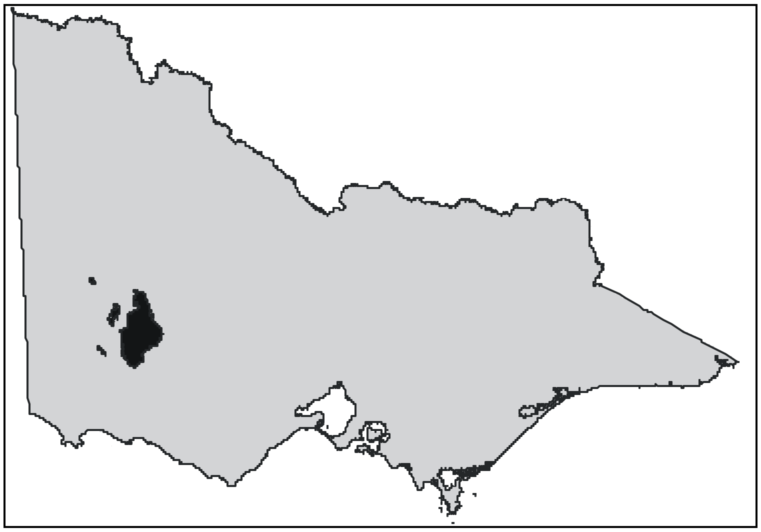
Around the granitic intrusions, the Ordovician sandstones and shales have been converted by the high temperatures of contact metamorphism to quartzites and hornfels. The very hard metamorphic rocks often form conspicuous ridges or high peaks, particularly through the country between Maryborough and Wedderburn. In this belt, the prominent peak of Mount Moligul is formed by hornfels, although the slopes are mainly granodiorite. Mount Ararat and Mount Tarrengower (near Maldon) are of similar origin.

Metamorphic aureole ridges usually have fairly steep slopes with poor stony gradational soils. Sheet erosion is likely to be common where the land has been cleared of native vegetation. The boundary between the metamorphic and granitic rocks is often a zone that is easily eroded by running water. It is therefore often marked by streams. Where these curve around granitic intrusions, the drainage pattern is known as annular.

Granitic terrain also exhibits other weathering patterns (not restricted to the dissected uplands):

- exfoliation domes where sheets of rock are separated from the main mass of granite along curved joints parallel to the surface
- tors where rounded rock forms are scattered at the surface
- rillen or deep crevices where deep gutters are formed by a combination of weathering and erosion
- caves where sheltered undercut platforms are found underneath rock overhangs.

2.2 Prominent Ridges (The Grampians)



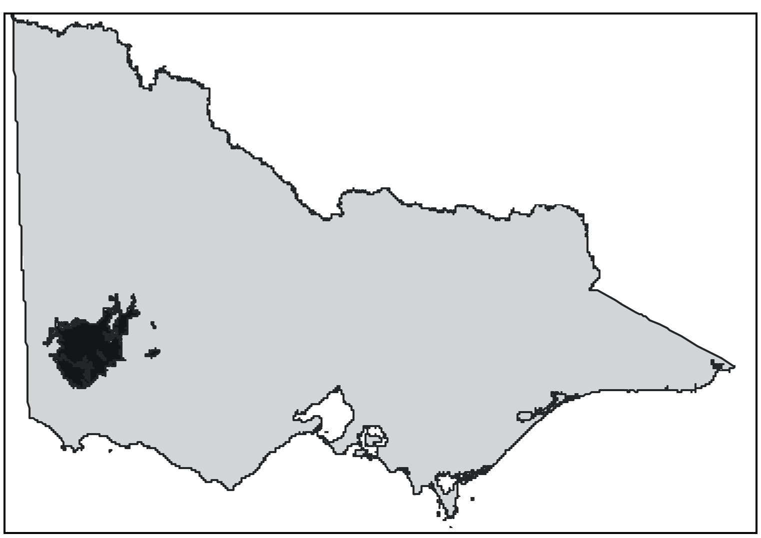
The shapes of the landforms in the Grampians have been largely determined by the geological structures. These spectacular ranges consist of prominent ridges of resistant Devonian sandstone. The intervening valleys have been cut into either soft shales or deeply weathered granite.

Where the beds dip at angles up to 45°, the resultant landform has a steep escarpment and a gentler backslope. This feature is called a cuesta. The Mount William, Serra and Wonderland ranges are the main examples.

Where the beds have been affected by boundary faults, they dip more steeply or even vertically. The result is a more-or-less symmetrical ridge (such as The Terrace, near Halls Gap) called a hogback.

The regional strike of soft and hard beds controls the overall form of the ranges and valleys of the Grampians. However jointing in the sedimentary rocks has had a strong influence in shaping the tributary stream patterns and minor landforms. A large synclinal basin surrounded by the Mount Victory Range is drained by McKenzie River.

2.3 and 2.4 Dissected Tablelands (Dundas Tableland and Merino Tableland)

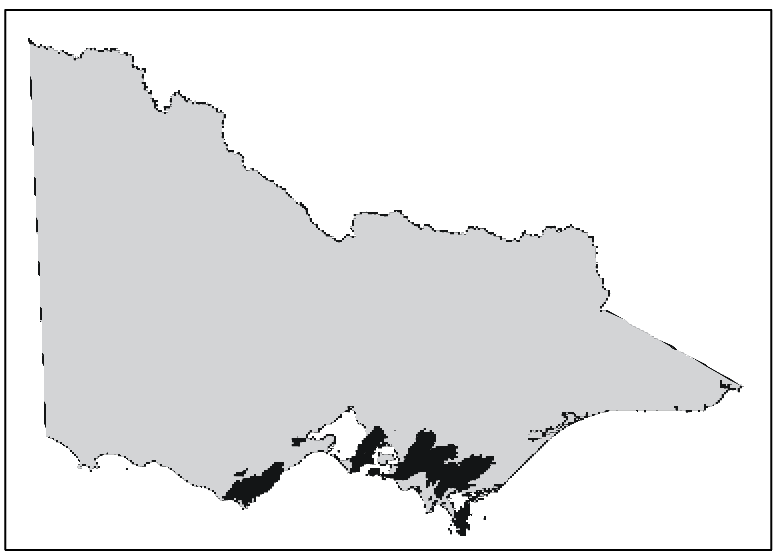


The tablelands to the west (Merino) and north-west (Dundas) of Hamilton are the extensive remnants of an ancient land surface. During the Pliocene epoch, a very thick soil developed on this surface because of deep intense weathering. The weathering affected all rock types from granite to Tertiary marine sands. A typical profile shows four different zones over bedrock: a typically duplex soil overlying ferricrete (a concentrated hard ironstone layer derived from decomposing rock), over a mottled zone with ironstone nodules over a pallid clay layer.

The hard ironstone capping is not easily eroded and much of the original flat land surface has been preserved. From the Pleistocene epoch onwards, streams have cut deep narrow valleys across the tablelands to expose a variety of parent rocks. The ironstone often forms low steep cliffs at the tops of the valleys. Open woodland vegetation grows naturally on the ironstone soils on the tablelands that have been partly cleared for pastures and some crops.

Soils on the valley sides are quite different to those on the tableland. They are mostly dark, well-structured clays called black earths. These soils support rich pastures used for sheep and cattle grazing. The steep valley slopes are subject to landslides during periods of prolonged rainfall. Gully erosion is common in the alluvium of the valley floors, where originally thick scrub held the soils in place.

SOUTH VICTORIAN UPLANDS (Division 3)



This division contains five geomorphic units and covers much of the country between Geelong and the south-west Victorian coast (Otway Range (3.1) and Barrabool Hills (3.2)), and between the south-eastern side of Port Phillip Bay and Wilsons Promontory (3.5). The South Victorian Uplands owe their elevation and shape to block fault movements during Tertiary to Recent times. For example, most of Mornington Peninsula (3.3) is an upthrown fault block. Similarly the Strzelecki (3.4) and Hoddle ranges between the Latrobe Valley and the coast are bounded by faults and monoclines, which broadly trend north-east to south-west.

Wilsons Promontory is called a granite residual range. It was formerly at the northern end of a much higher granite range that extended to north-eastern Tasmania. However, after east-west down-faulting, the level of the land between Victoria and Tasmania was reduced and Bass Strait was formed. This left a chain of granite islands between Wilsons Promontory and Tasmania.

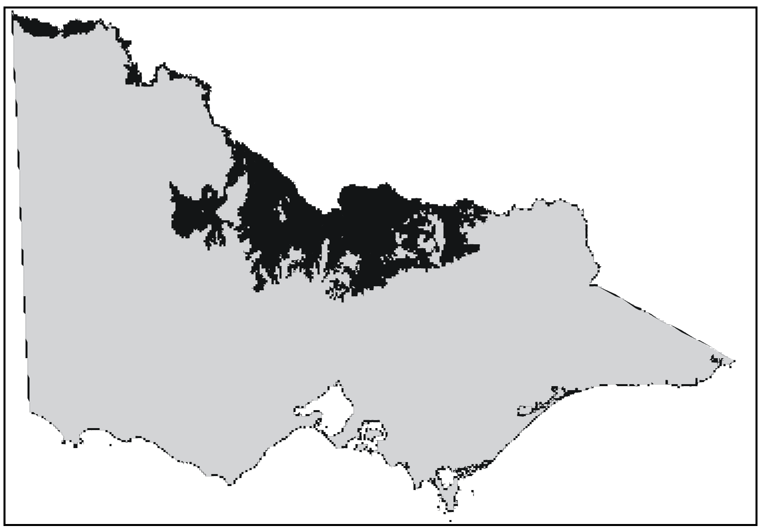
Soils in the South Victorian Uplands vary greatly, depending mainly on the nature of the underlying rock and the local geomorphic history. The Otway and South Gippsland ranges are made up of Cretaceous sandstones and mudstones. The soils on the ridges are mainly fertile gradational soils. On the lower slopes, there are yellow or red duplex soils. These areas are used for forestry, grazing and as water catchment areas.

Deep well-structured red clay soils called krasnozems occur on basalt in central Gippsland and near Flinders on the Mornington Peninsula. Soils containing ferricrete layers are common on the Mornington Peninsula and around the margins of the Otway Range. They also occur at a few places in South Gippsland.

RIVERINE PLAIN (Divisions 4, 5 & 6)

This geomorphic division covers the whole of northern and north-western Victoria north of the Central Victorian Uplands. There are three subdivisions of the Murray Basin Plains, each of which was formed by a different set of processes:

RIVERINE PLAIN (Division 4)



The Riverine Plain is dominantly of fluvial origin that is it was built from alluvium deposited by rivers. There are two main levels in the plains the **low clacareous dunes and the high siliceous dunes.**

4.1 Younger, generally narrow, lower level flood plains along the main rivers, especially the Murray River. These occur where the rivers have cut down into the older flood plain.

4.2 An extensive, older, higher level flood plain formed on an accumulation of Pleistocene alluvial sediments (known as the Shepparton Formation).

The higher level of the Riverine Plain is also crossed by various low winding ridges. These mark the meandering courses of older streams. The latter are known as prior or ancestral streams. They are generally unrelated to present streams. The meanders of ancestral streams form much larger curves than those of the existing streams because the size of a river meander is related to the amount of water flowing along the river, which in turn is related to the prevailing climate. The large meanders show that there were greater river flows during very wet periods in the past. As meanders developed, the outer parts of the bends were eroded. At the same time, sediments were deposited on the inner sides forming a succession of crescent-shaped banks called point bars. Sand dunes close to the rivers are another feature of this terrain - during dry periods, winds blow the sand from the beds of the streams to form the dunes.

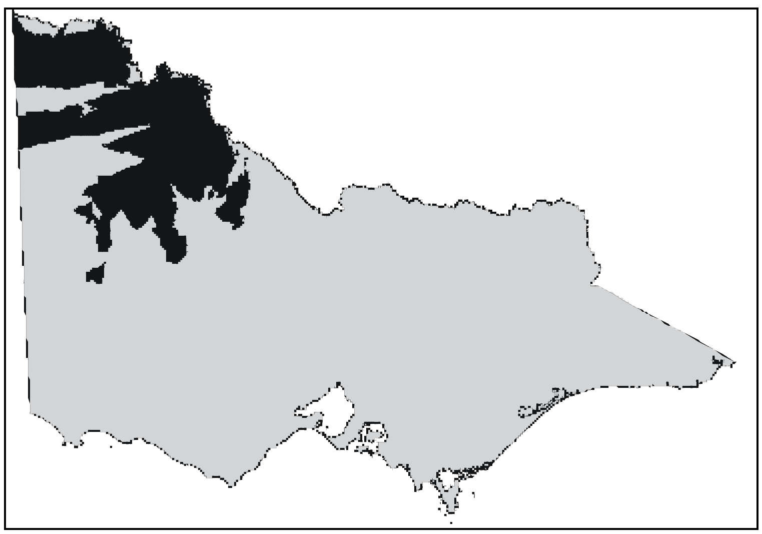
Soils called red-brown *earths* characterise the Shepparton Formation. They have duplex profiles and contain lime in the clay horizon. These soils are extensively irrigated for dairying, fruit growing and market gardening and are also used for dry farming. In recent times, salting and waterlogging have become serious problems in the irrigation areas. To try to combat these threats, extensive drainage schemes have been constructed to remove the saline waters.

The soils in the ancestral valleys and on the present flood plains are grey with high sodium contents. Their main use is for grazing.

MALLEE DUNEFIELD (Division 5)

There are two subdivisions in this region. They are dominated respectively by low calcareous sand dunes and high siliceous sand dunes formed by wind action. Calcareous dunes contain abundant calcium carbonate; siliceous dunes are made up of quartz grain.

5.1 Low Calcareous Dunes (Ouyen)



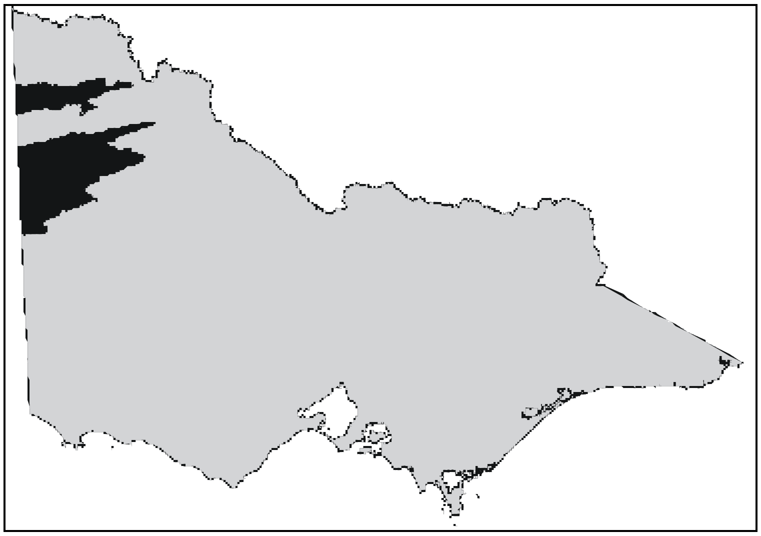
The low calcareous dunes are elongated in a west-east direction. This is about the same direction as the dominant westerly wind that moves the sand. Such dunes are said to be longitudinal. The dunes were probably formed when the climate was drier than it is today. The calcareous dunes often contain several layers of calcium carbonate. This shows the dunes were built up in stages, with alternating periods of stability and wind activity. Older soils developed during the stable periods are called palaeosols.

For many thousands of years, water has been discharging from the ground into low areas between the dunes. This water has dissolved salts from the underlying sandy materials. After it reaches the surface, much of the water evaporates, especially during the hot summer periods. This leaves salt lakes or salinas and gypsum flats.

On the eastern side of each salt lake, there is usually a low crescent-shaped ridge or lunette consisting either of clay, silt and fine sand or powdery gypsum (copi). This material has been both blown from the lake floor by prevailing westerly winds and carried by wind-generated waves. Like the longitudinal dunes, lunettes have been built up in stages and they often contain palaeosols.

The soils are dominantly reddish sands overlying a compact loam. The low west-east calcareous dunes have been almost entirely cleared for growing crops and grazing, while in the drier northern part of the Mallee, cropping is a marginal occupation.

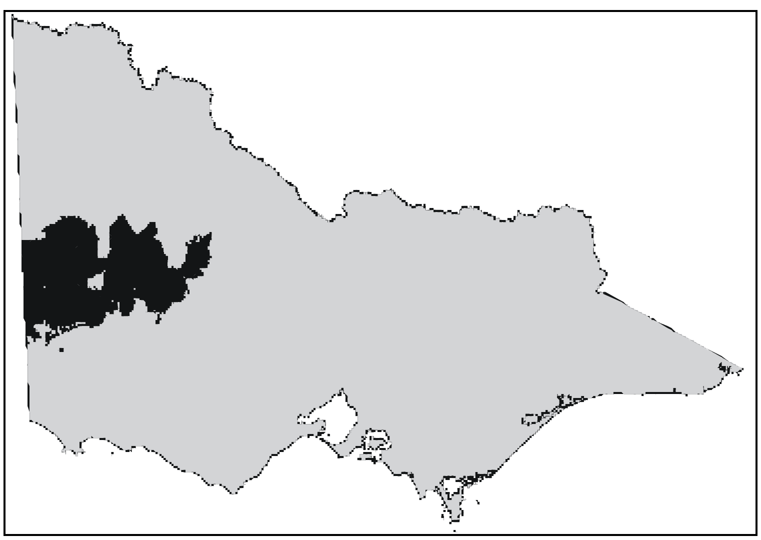
5.2 High Siliceous Dunes (Big Desert/ Sunset Desert)



High siliceous dunes are a feature of the Big Desert to the north of Nhill, and either extend at right angles across the general west to east direction of the prevailing winds, or they have the shape of a parabola.

The soils of the high siliceous dunes are infertile sands and sandy podsols. If they are cleared, they become very susceptible to wind erosion. Consequently little clearing of timber has taken place, although there is limited grazing in some areas. They do, however, carry a large variety of native vegetation. Extensive areas have been set aside as parks or as other reserves.

WIMMERA PLAINS (Division 6)



This division extends to the north and south of the Western Highway over the country between Horsham and the border with South Australia. The clay plains (6.1) of the northern and eastern Wimmera are a mixture of aeolian, lake and swamp deposits. They are flat to undulating with some low west-east dunes.

To the south of Nhill, the Little Desert is a dunefield (6.3) consisting of fine to medium-grained quartz sand. Some of the dunes have the shape of a parabola, but there are also many irregular forms.

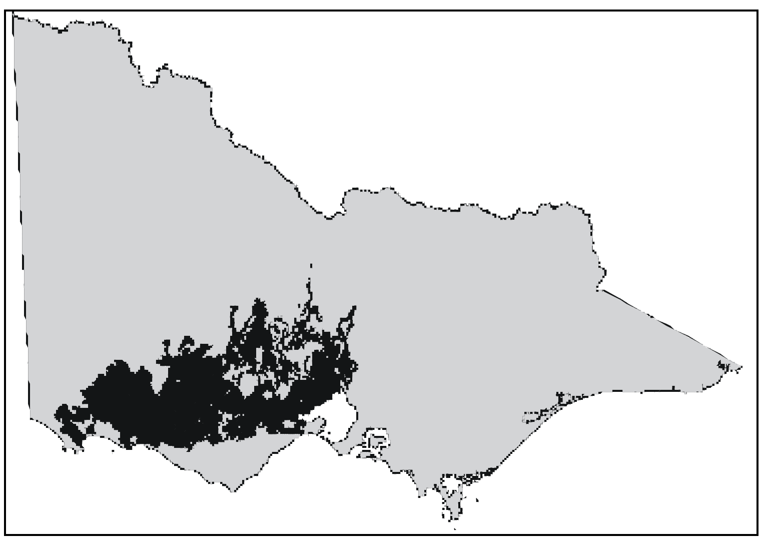
In the southern Wimmera, which extends southwards from the Goroke area towards Edenhope, there are north-west to south-east dune ridges and flats of swamp, lake and lagoon origin. There are many small lakes on the flats. Each has a lunette at its eastern edge.

Another feature of the Wimmera Plain, and to some extent of the Mallee region, is a series of parallel straight to curving ridges (6.2) that extend into the lower south-east region of South Australia. These ridges were formed along the shorelines of ancient coasts during Pliocene times. During much of the Tertiary period, a large gulf extended from the open sea across south-eastern South Australia, north-western Victoria and western New South Wales. The sea retreated in stages and each ridge indicates a temporary shoreline. Examples of slumping and bedding features associated with shoreline deposition can be seen in road cuttings along the Western Highway at Kiata and Lawloit, near Nhill.

The Wimmera Plain is covered by grey, brown and red calcareous (and often sodic) clay soils. They are highly productive and support a thriving wheat and grazing industry. On the other hand, pale acid sands of the Little Desert are not fertile, so they are used to only a small extent for farming. However, because the land naturally carries a great variety of native plants, a large area south of Nhill has been set aside as national park.

In the southern Wimmera, the sand ridges are dominated by pale acidic sands with a podsolic profile. By contrast, the intervening flats have yellow sodic duplex soils. The term sodic indicates a high proportion of sodium ions that disperse the clay subsoils when they are wet, leading to poor drainage. Grazing with some cropping is the main agricultural activity on land with these soils.

WEST VICTORIAN VOLCANIC PLAINS (Division 7)



The volcanic plains stretch westward from Melbourne almost to the South Australian border in a belt averaging about 100 kilometres wide. Arms of this plain also extend up valleys to the north of both Ballarat and Melbourne where lavas flowed from volcanoes near the present drainage divide.

The volcanic plains (7.1) are flat to undulating and dotted with many hills formed by extinct volcanoes. Numerous relatively thin basalt flows form the bulk of the plain. Volcanic ash deposits are also associated with many volcanic hills. The volcanic material was derived from eruptions that mostly occurred two to four and a half million years ago. Sporadic volcanic activity continued through the Pleistocene into Recent times. It has been calculated that the youngest volcano at Mount Napier, south of Hamilton, occurred only about 7 240 years ago. Many of the deposits from the younger eruptions and flows have not been weathered to the extent of the older flows, exhibiting stony surfaces and shallow soils and have been delineated as stony undulating plains (7.2).

Volcanoes are either quiet or explosive. About half of them were lava volcanoes characterised by gently sloping sides, such as Mount Cotteril south of Melton. These volcanoes probably erupted quietly, with streams of molten lava flowing down their sides and across the plains. Scoria cones are the other common type of volcano. These are composed of scoria, made up of irregular lumps of basalt lava full of gas bubbles. Scoria volcanoes are up to 90 metres high and have steep slopes (such as Mount Elephant north-west of Colac). These scoria cones erupted as 'fire mountains' - during these eruptions, blocks of red hot lava were continually spraying out of the mouth of the volcano to land on its slopes. These lumps of frothy lava then cooled and solidified to form scoria. At many scoria cones, there was a final period of quiet volcanic activity, when lava broke through one side of the cone. This produced a breached cone. There are about two hundred breached cones in Victoria.

The third type of volcano in Victoria is called a maar. There are about forty maars, mostly between Colac and Port Fairy. These volcanoes have large circular craters (such as Tower Hill, north-east of Port Fairy), up to two kilometres across and often filled with lakes. The raised rim of the crater is composed of layers of volcanic ash, and thin deposits of this ash can extend for several kilometres away from the crater. These volcanoes were formed by very explosive eruptions, approaching small nuclear explosions in force. As molten magma intruded the sedimentary rocks underlying the crater, it suddenly encountered water within the rocks, perhaps filling caves developed in Tertiary limestone. The water was superheated to steam and exploded with devastating force, blowing fragments of magma and pieces of limestone into the air. These fell to the ground as the layers of ash that surround the maar crater. The prevailing winds during the eruption caused most of the ash to be deposited on one side of the crater. It is notable that most Victorian maars have thicker ash deposits on their eastern sides, reflecting the dominant westerly wind direction.

Surface features of the original lava flows have sometimes been preserved, especially on the younger ones. The surface is either rough and blocky or it may be fairly smooth. Smooth surfaces have small winding or contorted ridges, which look like rope. The latter type is called ropy lava (such as Harman Valley flow from Mount Napier). After the surface solidified, molten lava sometimes kept moving inside a flow and pushed up hillocks of consolidated lava or tumuli (an example occurs near Wallacedale, south-west of Hamilton). If the lava beneath the solid crust drained away, a lava tunnel was left. Commonly, the crusts of the tunnels collapsed leaving a trough and ridge terrain known locally as stony rises. Lava tunnels and stony rises occur at Skipton, Mount Hamilton, Byaduk, Mount Eccles and Stoneyford.

Where the lava flows were thick, they usually cooled slowly and developed a regular, close pattern of joints. When viewed from the side, these now appear as columns (Organ Pipes National Park). If they are exposed in the floor of a valley, a pavement of hexagonal blocks is seen.

Lakes and swamps often formed inside the depressions produced at maars. There are also many others in shallow, generally irregular depressions on and close to the lava flows. Some formed where existing creeks were blocked by lava flows. For example the Condah and Whittlebury swamps, south of Hamilton, were formed where basalt flowed west from Mount Eccles along Harman Creek valley and blocked an ancestor of Darlot Creek and its tributaries. Extensive swampy flats also occur behind lava flows at Wallan and south of Whittlesea.

The soils on the volcanic plain are quite variable depending on the ages of the volcanic flows, their elevations, their history of erosion, the past and present climate and the nature of any sediments deposited after the lavas solidified. Typical soils range form red duplex and yellow brown sodic duplex soils to grey sodic clays and stony gradational soils.

SOUTH VICTORIAN COASTAL PLAINS (Division 8)

A coastal plain is flat-lying land near the coast and which was once beneath the sea. The plain emerged above the present sea-level because there was an uplift of the land, a fall in sea-level, or both, in recent geological times and generally accumulated material.

There are two large coastal plains in south-western Victoria and two smaller ones beside Port Phillip Bay. Large sand barriers are also included in this geomorphic division. They occur along much of the South Gippsland coast and the coast to the west and east of Portland.

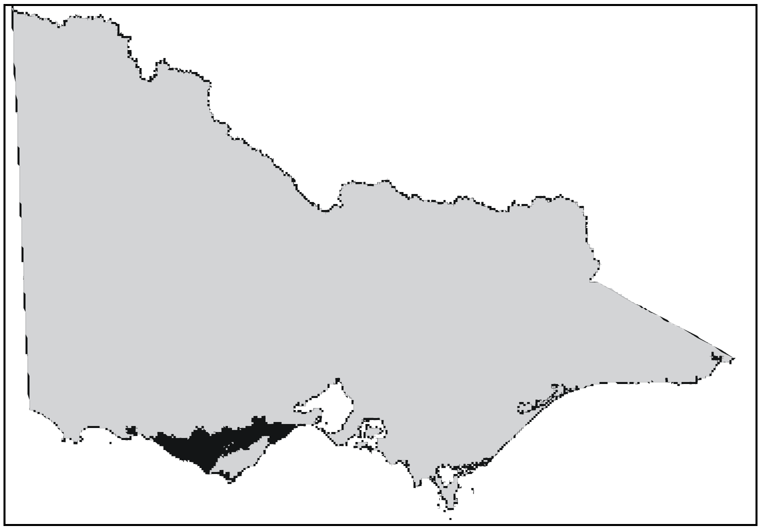
8.1 Ridges and Flats (Follet)

This is in the south-west corner of the State beyond Hamilton. It continues to the west across the lower south-east region of South Australia. It consists of a series of long low narrow ridges parallel to the present coast and separated by sandy and swampy flats. The ridges were originally dunes formed by cross-bedded wind-blown calcareous sand, made up largely of small fragments of shells. The dunes consolidated to form the rock aeolianite after the original grains were cemented together by calcium carbonate. The lower Glenelg River and its tributaries have eroded deep valleys into the plain exposing underlying Tertiary and Pleistocene sediments.

There is a variety of landforms on the plain. Consequently the distribution of soil types is also complex. The dune ridges mostly carry pale acidic sandy podsols. In some places however, there are lime-rich soils (terra rossas or red earths). The dune soils support limited grazing.

Soils on the flats are mostly humic acidic sands or mottled duplex types and are generally poorly drained. Agricultural development is therefore limited because the soils are often waterlogged. However, this landform-soil complex supports many flowering plants and a large area has been reserved as national park.

8.2 Dissected Plains (Port Campbell)



In Mid Tertiary times, this Dissected Plain extended from the coast and the Otway Range as far inland as the West Victorian Uplands. However, a large part of it was later covered by the lava flows and tuffs of the West Victorian Volcanic Plains. The coastal plain is terminated on the seaward side by spectacular sea cliffs. The flat-lying limestones and marls that form the base of the plain, were originally deposited on the floor of the sea. After uplift, they were largely covered by clays and sands laid down by rivers. Some of the sand has been subsequently reworked by the action of winds to form dunes and sand sheets. Some of the limestone areas show typical features of karst terrain (sinkholes and caves), even where they are covered by river clays.

The plain has been dissected by streams rising in the western Otway Range. The trends of their valleys have been influenced by four factors:

1. Pliocene coastal ridges, which were left as the sea retreated across the plain.

2. Tectonic movements that produced broad domes and depressions over the plain.

3. The diversion of streams by lava flows.

4. The building of sand barriers along the coast.

The soils on the coastal plain frequently contain large ironstone concretions (buckshot gravel). The gravel is mostly loose but sometimes is cemented into a massive layer. The topsoils are sandy and poor in plant nutrients. In the Gellibrand River catchment and sporadically across the remainder of the plain, there are sandy duplex soils overlying clay or a hardpan. The hardpan consists of clay cemented by iron oxides. The main agricultural activities are sheep and cattle grazing with some dairying. The Heytesbury land settlement area was developed for dairying in the 1950s in a formerly heavily-forested area to the north of Port Campbell. However, the soils are not very fertile and large quantities of artificial fertilisers have had to be applied. In addition, soil erosion and a build-up of salt have developed.

8.3 Sand and Clay Plains (Moorabbin) and 8.4 Fans and Terraces (Western Port)

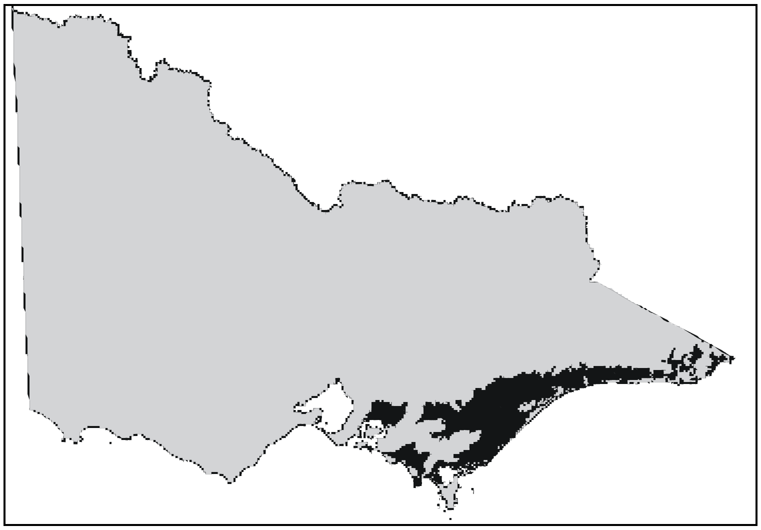
These plains beside Port Phillip Bay are made up of sandy dune ridges and sheets, with intervening clay swamps. On the Moorabbin Plain (8.3), a series of low parallel sandy ridges can be traced across the south-eastern suburbs of Melbourne. The ridges mark the positions of successive shorelines; they were stages in the retreat of the sea in Late Pliocene times. The Bellarine Peninsula (8.3) has a central core of Tertiary basalt overlying older rocks while surrounding areas consist of Tertiary sediments and Quaternary dunes, sand sheets and swamps. The fans and terraces (8.4) around Westernport Bay have been separately identified including those at the western foot of the Strzelcki Ranges and French Island.

8.5 Barrier Complexes (Discovery Bay/Gippsland Lakes)

Long accumulations of sand are common along the Victorian coast. They were built by the action of waves across bays and river mouths and have been modified by tides and winds. In East Gippsland, where they are best developed, there is a succession of barriers ranging from Late Pleistocene to Recent in age.

The sandy barriers are favoured sites for holiday developments at such localities as Loch Sport, Woodside Beach and Marlo. However considerable problems with sand blowouts have arisen where natural vegetation has been removed.

SOUTH VICTORIAN RIVERINE PLAINS (Division 9)



The riverine plains of south-eastern Victoria have been built up by alluvium deposited by rivers flowing southward from the East Victorian Uplands across Gippsland to Bass Strait. They commonly form extensive swampy flats, especially at the northern end of Western Port (such as the Koo-wee-rup Plain).

There are three levels of the riverine plains - the present flood plain (9.1) and two higher levels of terraces. The terraces are the remnants of earlier flood plains that were cut into by the rivers when the land was uplifted. These older riverine plains (9.2 and 9.3) are extensive in south-east Gippsland. The lower of the two (9.2; the intermediate terraces) carry red duplex soils. The sandy courses of earlier streams form minor rises in an otherwise extremely flat landscape. There are also slight depressions occupied by grey or pale yellow swampy soils. The colour results from iron in the soils being in the reduced state due to intermittent waterlogging. Nevertheless large areas are now under irrigated pastures and have become a major source of dairy products.

The higher terraces (9.3) represent a former extensive flood plain with alluvial fans at its inner margin. The terraces are crossed by roughly parallel sandy ridges that are separated by swampy depressions. Most of the towns in the Latrobe Valley are on these higher areas that are relatively well-drained. There are also extensive pine plantations, especially on the sandy soils south of the Latrobe River and north of Lake Wellington. Elsewhere, sheep and cattle grazing is dominant.