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GEOGRAPHY

PROTECTION OF THE ENVIRONMENT

Ministry for Conservation

Introduction

One of the significant aspects of public administration during the past decade has been the rise of interest in conservation and environment protection. Victoria in the 1960s saw an unprecedented expansion in conservation activities; several new organisations were established and major legislation was passed, as the State prepared to face a range of problems, the importance of which was previously little recognised. In January 1973, these activities were drawn together with the formation of the Ministry for Conservation.

Since 1900, there have been a number of government departments in Victoria with an interest in specialised aspects of conservation, but by the early 1960s it had become apparent that the main problem was one of organisation. There were too many separate bodies and too much miscellaneous legislation to provide a co-ordinated approach to those " quality of life " issues which were increasingly becoming a matter of public concern. To provide this co-ordination, the Ministry for Conservation was established by bringing together the experience and knowledge of six major government agencies which had previously worked separately in the field of conservation and environment protection. These agencies are: the Environment Protection Authority, Fisheries and Wildlife Division, Land Conservation Council, National Parks Service, Port Phillip Authority, and Soil Conservation Authority.

The responsibilities of the Ministry are to achieve protection and preservation of the environment and to ensure proper management and utilisation of land and living aquatic resources of the State. To meet these responsibilities it co-ordinates the activities of its component agencies, each of which is engaged in a number of areas of environmental activity. The work of these agencies is also assisted by a central co-ordinating group which has been developed since the Ministry was formed in 1973, and whose activities include environment assessment, conservation planning, and broad-based regional environmental studies of those areas of Victoria where major development is likely to occur.

There is also recognition that conservation problems frequently transcend departmental, State, and political boundaries, thus requiring the Ministry to integrate and co-operate in work with a wide range of persons and organisations.

Environment assessment and studies

Among the most significant responsibilities of the Ministry's central co-ordinating group is that of environment assessment. In many parts of the world, the management tool of " environmental effects studies " (sometimes referred to as " environmental impact statements ") has become established; in Victoria, legislation is being prepared to create a system to provide environmental

assessments of the likely effects of major government and private development projects. Already, government departments throughout Victoria, as well as some private development groups, have recognised the need for a proper understanding of the environmental effects of their activities. They have voluntarily accepted responsibility for studying the likely environmental effects of their projects and are co-operating with the Ministry for Conservation during the course of these studies.

The assessment team offers advice to developers at an early stage to ensure that the framework for an environmental effects study is sufficiently comprehensive. This may need to take into account the potential of land and water resources affected, the sociological implications, and possible alternatives. On completion, the study report is examined by the Ministry and a recommendation is made to the Victorian Government.

A key factor in making valid environmental decisions is an adequate knowledge of the ecological effects of development proposals. At present two broad-based regional studies—of Port Phillip Bay and Western Port Bay—are being undertaken by the Environmental Studies Section of the Ministry, and a major new study is currently being planned for the Gippsland Lakes area in eastern Victoria. The object of these studies is to provide comprehensive scientific information for planning and decision making purposes.

Conservation planning

Associated with the Environmental Assessment Group and the Environmental Studies Team, is the Conservation Planning Group. Still in its formative stage, the group is already contributing useful advice to government, local councils, and others, so that environmental aspects will be taken into account at an early stage of planning for new projects.

The background to conservation in Victoria is a realisation that man is always an integral part of, and dependent on, his environment for his survival. When there is failure to understand or respect this dependence, severe consequences can follow. Avoidance of such failure lies in an attempt to resolve environmental problems in the rational use and management of resources to provide for human needs, both now and in the future, and in a way which satisfies the requirements of ecological balance.

This may well affect community attitudes to the use of resources and imposes on scientists and technologists the task of integrating technical information into working systems. It also imposes on governments the responsibility to ensure that the use and management of resources is soundly based and in the long-term interests of the community.

Further reference, 1975

Environment Protection Authority

The Environment Protection Authority operates under the *Environment Protection Act* 1970, which gives it responsibilities in the fields of air and water pollution, land waste management, litter, and environmental noise. The three-member Authority is responsible to the Minister for Conservation, and has a professional, technical, and administrative staff numbering about 190. It is one of several Victorian Government agencies within the Ministry for Conservation, which has its headquarters in Victoria Parade, East Melbourne.

The EPA controls air pollution by regulating the amount of waste discharged from such sources as boiler stacks and chemical processes. Industrial undertakings and other sources of airborne pollutants are required to control their emissions through the provisions of the Environment Protection and Clean Air Acts which are both administered by the EPA.

The EPA is responsible for protecting the water quality of Victoria's beaches, lakes, streams, and waterways. There are numerous water quality problems,

some being of industrial origin and others caused by insufficient availability of sewerage services.

The EPA's Land Waste Management Branch works with councils and health officials to ensure that garbage disposal is carried out according to good management practice. The Branch has also helped establish regionalisation programmes, in which groups of councils join together to plan their future garbage disposal needs on a regional, rather than local, basis.

The EPA is responsible for environmental noise which affects the community in general. Major causes are traffic, industry, sports meetings and entertainments, aircraft, and construction noise. As a first step towards establishing noise control policies for Victoria, the Authority has issued a draft policy for the City of Richmond, one of Melbourne's most densely populated areas.

Environmental planning needs to be based on long-term objectives. Under the Environment Protection Act, these are set out in State Environment Protection Policies, which are established by the Government on the recommendation of the EPA. Before being finalised, the draft policies are made available for public review and comment. In April 1975 the first State Environment Protection Policy was prepared in accordance with the Environment Protection Act. The Policy, covering the waters of the whole of Port Phillip Bay, was recommended to the Government by the Environment Protection Authority after consideration of many submissions from the community, and after circulation of a draft policy. The Policy sets out eleven beneficial uses of the waters of Port Phillip Bay—such as bathing, preservation of aquatic ecosystems, industrial water supply, and aesthetic appearance—together with definitions of the areas where these uses are to be protected, and the water quality standards needed to make them possible. The Policy sets a target date of July 1982 for full attainment of the programme, but this depends on the completion of very costly sewerage facilities in the Port Phillip Bay catchment, including the virtual elimination of unconnected premises.

Licensing is the basic method used by the EPA to ensure that waste discharges do not cause pollution. A licence is required for all discharges to air, land, or water, unless the discharge has been specifically exempted. Licence conditions may require that the discharge is treated to meet set standards: these and other decisions are open to appeal. The EPA's waste licensing provisions apply to all wastes discharged in Victoria unless they have been specifically exempted. Licensing decisions are open to appeal. The licence applicant and affected third parties can appeal within thirty days against the granting, amendment, or the removal of a suspension of a waste discharge licence. Appeals against licensing decisions are heard by an independent body, the Environment Protection Appeal Board.

An appeal to the Supreme Court on points of law is possible after a case has been heard by the EPAB. Penalties of up to $5,000 for a single offence and $2,000 a day for a continuing offence can be imposed for causing pollution. Penalties of up to $500 for a first offence, $5,000 for a subsequent offence, and $2,000 a day for a continuing offence can be imposed for breaches of licence conditions or an unlicensed discharge.

Further reference, 1975

Land Conservation Council

The Land Conservation Council was established in February 1971 with the proclamation of the *Land Conservation Act* 1970. The Council of 12 members is composed of an independent chairman appointed by the Governor in Council, and the heads of the following government agencies: the Soil Conservation Authority, Department of Agriculture, Forests Commission, Department of Crown Lands and Survey, Mines Department, State Rivers and Water Supply Commission, Fisheries and Wildlife Division, and the National Parks Service.

The other three members are persons with experience in various aspects of conservation and are appointed by the Governor in Council.

The functions of the Council are:

(1) To carry out investigations and make recommendations to the Minister on the use of public land in order to provide for the balanced use of land in Victoria (public land being defined as land which is not within a city, town or borough; and which is unalienated land; and includes land permanently or temporarily reserved under the Land Act, State forest, land vested in any public authority other than a municipality or sewerage authority, and land vested in the Melbourne and Metropolitan Board of Works);

(2) to make recommendations to the Governor in Council on the constitution and definition of water supply catchment areas; and

(3) to advise the Soil Conservation Authority concerning policy on the use of all land in any water supply catchment area.

The legislation provides for consideration of land for all purposes, but it specifically requires that uses which tend to have been given less consideration and even a low priority since first settlement, should not be neglected in the future. In making any recommendation the Council must take into account the present and future needs of the people of Victoria in relation to the preservation of areas which are ecologically significant; the conservation of areas of natural interest, beauty, or historical interest; the creation and preservation of areas of reserved forest; the creation and preservation of areas for leisure and recreation, and in particular of areas close to cities and towns for bushland recreation reserves; the creation and preservation of reserves for the conservation of fish and wildlife; the preservation of species of native plants; and land required by government departments and public authorities in order to carry out their functions.

Victoria illustrates the problem of how modern civilisation demands land for various purposes, some compatible, others conflicting or competitive. Where there are conflicting or competitive demands for land, decisions must be made on the basis of significant scientific and other criteria.

The Council has divided the State into 17 study areas. However, before the Council can make recommendations for a study area it must conduct an investigation and publish a factual report describing the resources and the forms of land-use in the area. Notices of intent to commence an investigation in an area are published in the Government Gazette and in newspapers, including those circulating within the districts concerned.

The report is compiled by the research staff of the Council from information supplied by government departments, universities, various organisations including local groups, and from information arising out of research commissioned by the Council. The report is a factual description of the resources of the area and contains chapters on the physical characteristics of the land such as the geology, physiography, climate, soils, flora and fauna. The report also describes the ways in which land in the study area is used. These uses include nature conservation and recreation, the production of food, fibre and timber, minerals and road making materials, and the provision of transport and power distribution systems. An account is given of these uses in terms of their physical requirements and the demands that each use places on the resources of the Study Area are assessed. The hazards to which the land may be prone such as soil erosion, salting, fire and pests, and their effects on land-use are also described.

When investigation of the study area is completed, notices are published indicating the availability of the report and inviting the public to make submissions to the Land Conservation Council on how the public land can best be used to serve the needs of the community. The publication of the report ensures that both the Council and members of the community will have the same information available for their consideration. It also enables all interested parties to

participate, in an informed fashion, in the process of considering how public lands should be used. It is hoped that in making submissions, members of the community will use as a basis the information provided by the study. The Council makes its recommendations only after due consideration of all submissions.

Of the 17 study areas, the Land Conservation Council has published descriptive reports for South West District 1, South Gippsland District 1, North East District 1, North East District 2, North East Districts 3, 4 and 5, Melbourne, East Gippsland, Mallee, Corangamite and the Alpine Study Areas. Of these, Final Recommendations have been published for South West District 1, South Gippsland District 1, North East Districts 1 and 2, Melbourne, and North East Districts 3, 4 and 5. Proposed Recommendations have been published for the Mallee and East Gippsland.

The final recommendations for the Melbourne Study Area are of particular significance as about 3 million people, representing nearly 80 per cent of the population of the State, are surrounded by or live in the area covered by these recommendations. In addition to making specific recommendations about individual areas of land, this report includes recommendations on general policies regarding the use of public land on coasts, water frontages, and road reserves, and for land used for the production of sand and gravel. The 16 colour maps accompanying the recommendations are of particular value as they show, in considerable detail, the public land in the vicinity of Melbourne and clearly indicate the nature and location of all recommendations.

To date, the Land Conservation Council has recommended the creation of numerous national, State, regional, and multi-purpose parks. The Council has also established several new categories of land-use and has recommended that land be set aside for the following purposes:

Reference Areas.—Areas of land which are typical or important examples of a particular land type and which should be preserved in their natural state as far as possible, in order to serve as a standard against which altered or manipulated parts of the land type can be compared.

Education Areas.—These are areas of land containing major land types to be used for environmental education.

Bushland Reserves.—Relatively small and frequently isolated areas of land carrying remnants of native vegetation which provide diversity in predominantly agricultural regions and which should be used for passive recreation such as picnicking and walking.

Uncommitted Land.—Areas of land of known or unknown capability which have been set aside to provide for the future needs of the community, both foreseen and unforeseen.

In addition to the above, the Land Conservation Council has reserved areas for the preservation of flora and fauna and set aside many small areas of public land to be used for recreation at a varying intensity according to the condition of the remaining natural vegetation. Areas have also been recommended to be used for timber production, mining, public utilities, and agriculture.

Further reference, 1975

Soil Conservation Authority

Under the *Soil Conservation and Land Utilization Act* 1958 and associated legislation, the Soil Conservation Authority has wide responsibilities involving mitigation and control of erosion; the promotion of soil conservation; the determination of land-uses to achieve these objectives; the provision of advisory and technical services to landholders and other government authorities, directed towards the efficient use and development of land and on-farm water resources; the protection of water catchments; supervisory responsibility over all activities which may cause disturbance of the soil at altitudes over 1,200 metres; and the control and prevention of erosion along the Victorian coastline. In meeting these

responsibilities, and in setting its aims and objectives, the Authority has to recognise the range of characteristics and capabilities of widely differing land types which are involved. These are determined by the interactions of climate, geology, topography, hydrology, soils, and flora and fauna.

Under natural processes, a continuing interaction between these environmental factors ensures a dynamic stability, which is still displayed in the ecosystems of many of Victoria's more remote areas. Much of Victoria, however, has some fundamental weakness in these ecosystems. These weaknesses were not taken into account when early settlement and subsequent development took place and consequently soil erosion, caused by wind or water, resulted.

In the north-west Mallee districts, for instance, the inherent weaknesses are the dry climate and the sandy nature of the soil. The natural Mallee vegetation adapted to the dry climate, while its dense growth protected the soil from wind erosion. Large areas of that vegetation were cleared and replaced by a cropping system requiring regular cultivation. This type of land-use renders it prone to the vagaries of the climate and leaves it in a state of high erosion hazard. In recent years, land-use systems and techniques have been developed which allow a safe level of productivity, using both stock and crops, while maintaining a new long-term balance of the Mallee environment.

Another area which has inherent weaknesses is the alpine country in the north-east of Victoria. The weaknesses there are the cold climate with its high precipitation, much of it as snow, resulting in a short growing season for the highly specialised indigenous plants. This vegetation can be readily damaged as a result of overgrazing by stock or excessive movement by man or his vehicles. In this delicately balanced environment, careful management of any land-use is essential to prevent soil erosion. The application of soil conservation techniques is necessary when any disturbance of the soil takes place.

In the south-west of Victoria in the Coleraine–Casterton area, the original red gum eucalypts used a large portion of the moisture absorbed by the soil from rainfall. After settlement, the replacement of these trees by low water-using vegetation created a situation of excess moisture in the subsurface. This in turn aggravated an inherent geological weakness of the area, for underlying the soil are deep clay layers which overlie hardened impermeable bands of ironstone. These clays become very slippery when wet. The excess soil moisture lubricates the clay above this impermeable band and so leads to landslides and general soil movement of the valley sides. If the early settlers had understood these ecological factors, much of the present erosion and siltation of streams would not have occurred.

Over the Central Highlands area, the amount of rainfall and the needs of the natural vegetation balanced and runoff was infrequent. When excessive grazing and clearing interfered with the natural association of vegetation, low water-using plants became predominant, but could not absorb the quantity of water once used by the natural association they replaced. When this excess moisture is combined with the soils of the area, the inherent weakness of the soil and topography becomes apparent. The soils mainly have layers of marked textural contrast. The lower layer is usually impervious clay and any excess subsurface water is therefore contained above it.

With the change in vegetation, subsurface flow increases, causing a significant transfer of the once evenly distributed salt. With the increase in subsurface flow, the salt is concentrated into depressions at the base of slopes, resulting in toxic concentrations, with consequent loss of vegetation and soil erosion. In order to return to an equilibrium, farming systems must include practices which will use up this excess water. Greater use of deep rooted perennial pastures and fertiliser, combined with longer cropping rotations and other soil conservation techniques, overcome the problem and at the same time improve productivity.

It thus becomes essential to develop systems of land-use which are designed to handle such inherent weaknesses in the environment. When soil conservation is successfully practised, the result is a landscape free from the scars of erosion, where the land is used in accord with its capability to produce, in perpetuity, a sustained yield of the products desired by man.

Further reference, 1975; Destruction of vermin and noxious weeds, 1963; Soil, land-use, and ecological surveys, 1966; Farm water supplies, 1968; Group conservation, 1969; Land Utilization Advisory Council, 1970; Land Conservation Council, 1975

Port Phillip Authority

The Port Phillip Authority was established in 1966 to advise the Victorian Government on methods of co-ordinating development within, and preserving and improving the condition of, the Port Phillip area. This area is defined as a belt of public land 200 metres to 800 metres wide and the inshore waters and sea bed approximately 600 metres wide around the coastline of Victoria from Barwon Heads in the west to Cape Schanck in the east including Port Phillip Bay.

Around this coastline live two thirds of the population of the State and in very hot weather crowds of up to 300,000 people can be expected to visit its many beaches. Besides its recreational importance the bay provides this population with some of its food, many of its commercial facilities, and the two main ports of Melbourne and Geelong through which the largest proportion of Victoria's sea trade is conducted.

The government agencies represented on the Authority are the Town and Country Planning Board, Public Works Department, Soil Conservation Authority, and the Department of Crown Lands and Survey.

Attached to the Authority is a Consultative Committee which comprises representatives from the Ministry of Tourism, Municipal Association (four councillors), State Rivers and Water Supply Commission, Victoria Police, Melbourne and Metropolitan Board of Works, Fisheries and Wildlife Division, and other bodies and organisations.

A number of studies aimed at providing data from which guidelines can be determined for the optimum use and enjoyment of the coastline have been completed or commenced. These include existing facilities, beach use, beach population, Swan Bay, flora of Port Phillip Bay, and a shoreline unit classification.

While these guidelines are being prepared the Authority also exercises an overview of all developments within its area. No structures can be erected or works commenced without its consent. Its approach to granting consent is based on the criteria of permitting those activities which must be located near the shoreline.

To assist the Authority to understand the impact of crowds on sensitive coastal areas, an experimental project is being conducted on the foreshore at Seaford, some 40 kilometres from the City of Melbourne. The problem of this locality has been the destruction of the primary dunes resulting from the unrestricted access of pedestrian traffic to and from the beach. It is hoped that the results of the investigation will aid successful coastal management and serve as a benchmark for similarly threatened coastal areas.

Further reference, 1975; Port Phillip Bay Environmental Study, 1975; Western Port Bay Environmental Study, 1975; Gippsland Lakes Environmental Study, 1975

National Parks Service

The National Parks Authority and its successor, the National Parks Service, have by their Acts been only involved with the traditional national parks, and many of these parks were run or partly run for the Service by Committees of Management.

In carrying out the Government's policy that not less than 5 per cent of the State be reserved as parks or other forms of conservation or recreation reserves, the Land Conservation Council is making recommendations for a large number of new and varied parks and in some cases recommendations to change the management authority responsible for particular parks. It is also recommending large additions to some existing parks. This means that confining the National Parks Service to running traditional national parks and continuing the joint system of the Service plus Committees of Management is no longer adequate or appropriate.

A new National Parks Act has been passed which widens the scope of the Service. The Act is not just an amendment of the preceding Acts, but is completely rewritten. It provides, inter alia, for clear objectives in the management of traditional national parks and also for other types of parks. It will also provide for a National Parks Advisory Council and Advisory Committees to retain the local involvement and assistance previously supplied by the Committees of Management which will be disbanded. The entire management responsibility of parks of all categories is to belong to the Service.

For some years the number of parks and the area managed by the Service and/or its Committees of Management have been fairly static, but a very big increase in both number and area is to occur in the next few years as the parks recommended by the Land Conservation Council are declared. The change from joint management by the Service and the Committees of Management, the widened responsibilities covering parks of many types, the increased workload, and demands by the community for higher standards of performance requires reorganisation of the Service.

A start has been made already in creating a regional organisation on similar lines to those of the other land and resource managing agencies. The head office has been re-grouped and divided into five branches—management, administration, resources and planning, protection, and interpretation.

The backbone of the Service, and generally its first and always its most frequent contact with the public, is the Ranger Service. The attributes of the ideal Ranger must be considerable—the ability to manage and organise in various situations, patience and tact with people, an interest in, and knowledge of, his park, the ability to communicate, and all-round resourcefulness are but a few desirable attributes. Recruiting, training, and induction play an important part in the expansion of the Service.

The Service operates a number of camps of different categories; these range from fully serviced accommodation, e.g., Tidal River, Wilsons Promontory National Park, to simpler camps which can be reached by ordinary motor vehicles, e.g., Wyperfeld, Hattah, and Mount Buffalo, and to campsites which can only be reached by walking. The demand for these camping facilities and the pressure on some individual parks is increasing rapidly. It is estimated that the rate of growth of visitors to national parks is about 10 per cent compound each year. This increasing visitor pressure presents considerable problems in planning and management policies. There are two community views about the functions of national parks. Some people wish to see the national parks kept sacrosanct, unroaded, undeveloped, and accessible only by foot; on the other hand, there are those who want open access and full scale camping facilities and the like. The rapid enlargement of many parks will help defer at least for a while a general crisis of capacity, but some parks are shortly bound to face serious problems through overuse.

No matter how specific the objects and requirements of any Act are, there is always this problem of preservation or development. The National Parks Service, with advice and help from all branches of the community, is responsible for finding a sensible answer and harmonising its management policies and plans accordingly.

The Service proposes to embark on some new fields of endeavour in its national parks—park interpretation and education. The public has shown considerable interest in a wider knowledge of the park environmental systems. Also at least one of the new types of parks—Haining (a dairy farm near Yarra Junction in the Yarra Valley, given to the State) will be used principally for school children as a first contact with the country environment and will be maintained as a farm for this purpose. There are still many children in Melbourne who have never had any first hand experience on a farm and Haining will be able to provide this. It will play an important part in environmental education, as does another national park near Melbourne—the Organ Pipes.

The Service has so far had limited involvement in research. The involvement is to increase in the next few years because the Service cannot carry out its planned duties until it has a deeper understanding of the mechanisms and systems controlling the various environments in the parks. The present policy is to use outside bodies, including universities, to undertake the required research.

Under the amended Forests Act it is now the duty of the Forests Commission to undertake fire prevention and suppression in parks under the control of the Service. The Act also provides that preventative works be undertaken only by agreement with the Service. The Forests Commission and the Service have set up a joint Fire Protection Committee. Park protection, however, embraces much more than fire protection; a continuing problem is control of exotic plants and animals.

The national parks declared prior to the new Act, parks declared for the first time in the new Act, and parks not yet declared but already being managed by the Service by arrangement with the Department of Crown Lands and Survey are given in the following table:

VICTORIA—PARKS

National park	Declared under *National Parks Act* 1956 or subsequent legislation	Area	Principal features
		hectares	
1 Alfred	1956	2,300	Example of sub-tropical rain forest and containing many rare ferns.
2 Bulga	1956	36	Ash forest and fern gullies.
3 Captain James Cook	1969	2,750	Immense dunes, virgin forest, and unspoiled beaches. Sighted in 1770 in Cook's epic voyage off south-eastern Australia.
4 Churchill	1956	193	Wooded hills near Melbourne. Mainly for recreation.
5 Fern Tree Gully	1956	450	Scenic views, recreation, fern gullies.
6 Fraser	1957	3,100	Fauna, scenic views, and boating on Lake Eildon.
7 Glenaladale	1963	163	Dry forest country near the Mitchell River, whose deep gorges contain sub-tropical vegetation. Includes the "Den of Nargun".
8 Hattah Lakes	1960	17,800	Mallee flora and fauna, aquatic bird life.
9 Kinglake	1956	5,700	Forested mountain country, waterfalls, fern gullies.
10 The Lakes (Spermwhale Head)	1956	2,100	Coastal flora and bird life.
11 Lind	1956	1,166	Gippsland rain forest, flora and fauna.
12 Little Desert	1968	35,300	Includes Kiata Lowan Sanctuary, open country with poor soil. Wide variety of flora and birds. Wimmera river frontage.

VICTORIA—PARKS—*continued*

National park	Declared under *National Parks Act* 1956 or subsequent legislation	Area	Principal features
		hectares	
13 Lower Glenelg	1969	27,300	Scenic river features and limestone gorge. Wide variety of native flora and fauna.
14 Mallacoota Inlet	1956	5,250	Coastal scenery, flora, and fauna.
15 Morwell	1967	140	Tall forest with magnificent fern gully, epiphytic orchids, and good bird habitat.
16 Mt Buffalo	1956	11,000	Alpine scenery and flora, distinctive rock formations and skiing.
17 Mt Eccles	1960	400	Scenic crater lake and lava " canal ".
18 Mt Richmond	1960	1,700	Example of coastal flora and fauna in western Victoria.
19 Organ Pipes	1972	65	Basalt columns known as " Organ Pipes ". Tessellated pavements.
20 Port Campbell	1964	700	Narrow coastal strip of some 24 kilometres with many scenic and rock-stack features.
21 Tarra Valley	1956	140	Mountain Ash forest and magnificent fern gullies.
22 Wilsons Promontory	1956	49,000	Excellent scenic features. Good fishing, swimming, surfing, and camping facilities. Rich botanical and bird area.
23 Wingan Inlet	1956	1,900	Coastal scenery, littoral bird life, and " jungle " flora. First landing place of George Bass in Victoria in 1797.
24 Wyperfeld	1956	56,500	Mallee flora and fauna (especially the Mallee Fowl).

Areas which will be added by the *National Parks Act* 1975 :

VICTORIA—NEW PARKS

National park	Area	Principal features
	hectares	
Brisbane Ranges	1,132	Wide range of flora and fauna. Recreation. Relic of goldmining days.
Cape Schanck	900	Coastal vegetation. Spectacular littoral scenery and recreation.
Warrandyte	135	Natural areas close to Melbourne. Recreation.

Areas which the Service manages by arrangement:

VICTORIA—PARKS MANAGED BY PARKS SERVICE

National park	Area	Principal features
	hectares	
1 Werribee Gorge	222	Spectacular gorge in natural surroundings. Interesting geological features.
2 Rotomah Island	386	Large island system in Gippsland Lakes.
3 Coastal Reserve (Gippsland, near the Lakes)	15,150	90 Mile Beach and coastal lakes.
4 Melba Gully	51	Attractive beech forest in Otway Ranges.
5 Mount Worth	322	Remnant of the once extensive Strzelecki Forest.
6 Haining	163	Dairy farm at Launching Place used for environmental education.
7 Cape Nelson	176	Coastal scenery. Natural forest of Soap Mallee.
8 Westerfolds	123	Recreation and Conservation Park on Yarra River at Templestowe.
9 Green's Bush (Mornington Peninsula)	600	Large area of natural bushland.

VICTORIA—PARKS MANAGED BY PARKS SERVICE—*continued*

National park	Area	Principal features
	hectares	
10 " Seawinds " (Arthur's Seat)	35	Farmland and formal garden, outstanding views.
11 Warby Ranges	2,150	Important scenic and conservation values.
12 Coastal Reserve (Western Victoria, Discovery Bay)	8,097	Coastal scenery ; extensive coastal sand dunes.
13 Burrowa–Pine Mountain	16,720	Rugged wilderness encompassing important conservation values.

In addition to the new parks derived from public lands, the State has been given, by private citizens, Haining and Melba Gully, near Lavers Hill, on the west of the Otway Ranges. The Government has also been buying back key blocks of private land. This acquisition includes Westerfolds, Rotamah Island, Cape Nelson, land around Fern Tree Gully National Park, and land on the Mornington Peninsula.

Further reference, 1975

PHYSICAL FEATURES

Boundaries and area

Creation of Victoria

The boundaries of the *Port Phillip District* of New South Wales were defined in *Imperial Act* 5 & 6 Victoriae c.76 of 30 July 1842 (" An Act for the Government of New South Wales and Van Diemen's Land ") as follows :

'. . . the Boundary of the District of Port Phillip on the North and North-east shall be a straight Line drawn from Cape Howe to the nearest Source of the River Murray, and thence the Course of that River to the Eastern Boundary of the Province of South Australia.'

Previously, by *Imperial Act* 4 & 5 William IV c.95 of 15 August 1834, *Letters Patent* of about 19 February 1836, and *Imperial Act* 1 & 2 Victoriae c.60 of 31 July 1838, the eastern boundary of the Province of South Australia was fixed as '. . . the One hundred and forty-first Degree of East Longitude . . .'.

By *Imperial Act* 13 & 14 Victoriae c.59 of 5 August 1850 (" An Act for the better Government of Her Majesty's Australian Colonies "), the District of Port Phillip was granted the right to separate from New South Wales, and was designated as the Colony of Victoria.

Boundaries

On 2 May 1851 " The Victoria Electoral Act of 1851 " was passed (*New South Wales Act* 14 Victoriae no. 47) which provided for the division of the Colony of Victoria into electoral districts. A schedule to the Act set forth the boundaries of the electoral districts, being based on the boundaries of the counties then in existence. Those boundaries of the electoral districts which formed the boundaries of Victoria were described as :

'a line running in a westerly direction from Cape Howe to the source of the nearest tributary of the Murray' ;
'the River Murray' ;
'the South Australian frontier' ;
'the 141st meridian being the line dividing the Colony of New South Wales from South Australia' ;
'the sea' ;
'the sea shore' ;
'the sea coast' ;
'including the Lawrence and Lady Julia Percy's Islands' ;
'including all the islands at Port Fairy' ;
'Port Phillip Bay' ;
'the shores of Port Phillip Bay' ;
'the waters of Port Phillip' ;

'including the small islands near the channels at the mouth of Port Phillip and those of Geelong Bay';
'including French and Phillip Island and the small islands in Western Port Bay'.

Writs for the Legislative Council in Victoria were issued on 1 July 1851, and thus the Colony of Victoria was established on this day.

Murray River

The separation of Victoria from New South Wales in 1851, and the successful navigation of the Murray by steam vessels, encouraged widespread evasion of New South Wales customs duties on articles taken across from Victoria and South Australia. The question arose as to which Colony had jurisdiction over the waters of the Murray River. The position was finally clarified with the passing of the New South Wales Constitution Statute (*Imperial Act* 18 & 19 Victoriae c.54 of 16 July 1855) which decreed that the whole watercourse of the Murray River from its source to the eastern boundary of the Colony of South Australia was within the Territory of New South Wales, thus fixing the left bank as the boundary between Victoria and New South Wales.

Cape Howe to the Murray River

In 1866 following the discovery of gold on the tributaries of the Snowy River near where the boundary was thought to be, it became evident that the remaining portion of the New South Wales–Victoria boundary should be marked on the ground. A definitive point at Cape Howe was agreed upon by the two Colonies following an on-site conference between the New South Wales Surveyor General (P. F. Adams) and the Victorian Government Astronomer and Superintendent of Geodetic Survey (R. L. J. Ellery). This point was marked and named Conference Point.

Late in 1869, Alexander Black, a Victorian geodetic surveyor, was commissioned to determine the headwaters of the Murray River. This he identified as a certain spring near Forest Hill. Black then proceeded to clear and mark the western portion of the boundary while another Victorian geodetic surveyor, Alexander C. Allan, marked the eastern portion. The marking was completed in early 1872 and the line, which extended some 115 kilometres through extremely rugged country, passed within 5.6 metres of the provisionally established Conference Point.

The official technical description of the boundary gave as the initial azimuth 116° 58′ 09″.42 from the spring to Station No. 1 on Forest Hill (452.6 metres away), while from a point on the coast at Cape Howe, 176,492.1 metres from the spring, the azimuth of the same line extending out to sea was given as 115° 53′ 41″.76 to a point distant one league (that is, 5.56 kilometres) from high waterline at Cape Howe.

The total length of the New South Wales boundary including the Murray River is about 1,937 kilometres.

Victoria–South Australia border

The boundary between South Australia and Victoria has had an interesting history, involving heroic work by surveyors and later much litigation between the Colonies which culminated in an appeal to the Privy Council.

Prior to the creation of the Province of South Australia, New South Wales covered all of the mainland of Australia as far west as the 129° east meridian. South Australia was established in the 1830s, the boundaries being '. . . . on the North the Twenty-sixth Degree of South Latitude, on the South the Southern Ocean, . . . , and on the East the One hundred and forty-first Degree of East Longitude . . . '. Thus the western boundary of New South Wales between the 26° south parallel and the coast was made the 141° east meridian.

By the late 1830s it had become apparent that the south-eastern corner of South Australia would need to be located and marked on the ground, as the Hentys of Portland Bay had extended their pastoral activities over the Glenelg River to Mount Gambier and there were disputes as to which Government (South Australia or New South Wales) had jurisdiction there.

Late in 1846 surveyors Henry Wade from New South Wales and Edward R. White from South Australia commenced the marking of the 141° east meridian. Their starting point was some 2 kilometres west of the Glenelg River which had previously been determined to be the most likely position of the meridian. In July 1847 after completing 198 kilometres of the boundary, the party was forced to discontinue the survey due to sickness. Subsequently both Colonies issued proclamations adopting the boundary as marked. Surveyor Edward White was requested to proceed with the survey and in December 1850 reached the Murray River after suffering months of incredible privations which contributed to his early death.

Doubts about the accuracy of the determination of the 141° east meridian (upon which Wade's and White's surveys were based), were expressed in the 1840s and grew in the 1850s, but no action was taken until the late 1860s. Although there was no conclusive evidence, the Governments of South Australia and New South Wales were agreed that it was desirable to verify the longitude of the line marked by Wade and White, before proceeding with the marking of the boundary between those two colonies north of the Murray.

There was reason to believe that a more accurate location of the 141° east meridian could be established. Since the surveys of 1839 to 1845 there had been increases in scientific knowledge, larger and more accurate instruments were available, and there was the advent of the electric telegraph. Furthermore, as the result of the appointment of government astronomers in Sydney and Melbourne, there were more accurate values for the longitudes of these cities. In May 1868 a temporary observatory was established at Chowilla and as a result of careful observations, and with the aid of the newly-developed electric telegraph, George Smalley, New South Wales Government Astronomer, and Charles Todd, South Australian Superintendent of Telegraphs, determined the 141° east meridian to be approximately 3.60 kilometres east of the boundary marked by White.

After many years of vain efforts asking Victoria to relinquish the land between the marked boundary and the more accurately determined 141° east meridian, the South Australian Government in 1911 appealed to the High Court of Australia. When this appeal failed, it appealed to the Privy Council which ruled in favour of Victoria in 1914. Thus ended the dispute; the boundary as marked, approximating to a longitude of 140° 58′ East, was confirmed as the State boundary.

Offshore boundaries

The *Imperial Act* 13 & 14 Victoriae c.59 of 5 August 1850 which separated the Colony of Victoria from New South Wales described only the land boundaries of the new Colony; no southern boundary was defined. However, the northern boundary of Van Diemen's Land (Tasmania) was defined in 1825 as the latitude 39° 12′ South and this has generally been accepted as the southern limit of Victoria's jurisdiction. It lies about 7 kilometres south of Wilsons Promontory. The lateral offshore boundaries between Victoria and the adjoining mainland States have not been defined.

Depth

Although no depth limitation for Victoria was given in the Imperial Statutes defining the boundaries of Victoria, it has always been accepted that the Crown has sovereignty to the centre of the earth. The Land Act of 1891 imposed a depth limit in new Crown Grants, and since 8 August 1892, 99 per cent

of Crown Grants issued have been limited to the surface and down to a depth of 50 feet (15.24 metres) below the surface. Since 3 July 1973 the depth limitation for new Crown Grants has been 15 metres. A well or spring to obtain water from the ground is not necessarily subject to the depth limitation imposed in the Crown Grant.

The exceptions to the 50 foot depth limitation on freehold tenure are:

(1) In areas close to coal mines, gravel deposits, etc., where the depth limits were fixed in 1909 at 25 feet (sometimes 20 feet or 30 feet)—e.g., Wonthaggi, Kirrak, Korumburra, Woolamai, and Tarwin. Crown Grants issued since 3 July 1973 in Wonthaggi and Kirrak are to be the same as elsewhere, namely 15 metres.

(2) On sites for buildings with deep foundations—e.g., 100 feet, 200 feet.

(3) Some land at Morwell and Hazelwood—1,000 feet.

(4) Lands vested in the Commonwealth. The depth limitation is usually 250 feet (occasionally 50 feet) but by Sections 8 and 10 of the *Lands Acquisition Act* 1955–1973, the Commonwealth can compulsorily acquire Crown Lands to unlimited depth, thus implying that the State of Victoria extends to the centre of the earth.

Height

Although no height limitation for Victorian territory was given in the Imperial Statutes defining the boundaries of Victoria, it has generally been accepted that the Crown has complete and exclusive sovereignty over the air space above its territories.

The Convention on Civil Aviation of 1944 (the Chicago Convention), to which Australia is a party, recognises that every Contracting State has complete and exclusive jurisdiction over the air space above its territory. Territory is defined for the purposes of the Convention as being the land areas and territorial waters adjacent thereto under the sovereignty of the Contracting State.

The Commonwealth Parliament has the constitutional power to legislate to give effect to the Chicago Convention and in relation to air navigation with respect to trade and commerce with other countries and among the Australian States.

The Victorian Parliament has power to make laws relating to the control and use of the air space above its territory which are not inconsistent with laws made by the Commonwealth Parliament on the matter.

In pursuance of its constitutional powers the Commonwealth Parliament has passed legislation regulating air navigation within the air space over the whole of Australia. The Victorian Parliament has passed the Air Navigation Act of 1958 which provides that the Air Navigation Regulations made under the Australian Air Navigation Act, to the extent that they do not apply to the air space over Victoria of their own force, apply to air navigation within that air space as Victorian law.

Geographic position and area

The most southerly point of Wilsons Promontory, in latitude 39° 08′ S., longitude 146° 22½′ E., is the southernmost point of the mainland of Victoria and likewise of the Australian continent; the northernmost point is where the western boundary of the State meets the Murray, latitude 33° 59′ S., longitude 140° 58′ E.; the point furthest east is Cape Howe, situated in latitude 37° 31′ S., longitude 149° 58′ E. The westerly boundary lies upon the meridian 140° 58′ E., and extends from latitude 33° 59′ S. to latitude 38° 04′ S.—a distance of 451 kilometres.

Victoria covers an area of about 227,600 square kilometres. It is, therefore, slightly smaller than Great Britain which (if inland water is included) contains 229,900 square kilometres.

The following table shows the area of Victoria in relation to that of Australia :

AUSTRALIA—AREA OF STATES AND TERRITORIES

State or Territory	Area	Percentage of total area
	sq kilometres	
Western Australia	2,525,500	32.88
Queensland	1,727,200	22.48
Northern Territory	1,346,200	17.52
South Australia	984,000	12.81
New South Wales	801,600	10.44
Victoria	**227,600**	**2.96**
Tasmania	67,800	0.88
Australian Capital Territory	2,400	0.03
Australia	7,682,300	100.00

Mountain areas

A wedge of mountainous country extends across Victoria; it tapers from the high peaks of the north-east and far east of the State to the western limits of the highlands at the lower Dundas Tableland near the South Australian border. This belt of high country, which includes the Great Dividing Range, separates the Northern, Wimmera, and Mallee plains from the plains and uplands of the coastal areas and forms the watershed dividing the northern flowing tributaries of the Murray River from the southern flowing streams.

Considerable physiographic and geological variation occurs in the highlands with granitic intrusives, volcanic complexes and sedimentary, metamorphic and tectonic structures all in evidence. Broad plateaux, high plains, and extensive ridge and valley terrain are the chief topographic characteristics with only occasional high peaks and deep gorges occurring. A broad low pass to the north of Melbourne (the Kilmore gap) provides an easy route across the highlands and this is utilised by the major road and rail links to the north. The Kilmore gap provides a convenient reference point at which to divide the highlands into eastern and western sections.

Eastern section

The highlands of eastern Victoria consist of strongly dissected and steeply sloping forested country with narrow ridges and deep V-shaped valleys. The area which includes the highest peaks is contiguous with the Kosciusko massif in New South Wales, but the Victorian mountains lack the clear evidence of past glacial activity that can be found in limited areas of Kosciusko. Frost weathering has been intensive at higher elevations and some spectacular accumulations of weathered rock occur as block streams or rock rivers such as at Mt Wombargo near the headwaters of the Murray River.

The high country is not typically alpine in character: sharpened peaks and precipitous bluffs are rare although the Cobberas, The Bluff, and the Mt Buffalo gorge all have impressive cliffs. One distinctive feature of the generally dissected mountain landscape is the High Plains country. Flat to gently undulating topography at elevations of 1,300 metres and above occurs, for example, as the Nunniong, Bogong, and Dargo High Plains, and the High Plains of the Snowy Range. These plains are remnants or residuals of formerly more extensive upland surfaces and include many different rock types—the basalts of the Bogong and Dargo High Plains being two of the best known.

Although snow capped for the winter season with a snow line at about 1,000 metres, even the highest peaks—Bogong (1,986 metres) and Feathertop (1,922 metres)—become snow free in summer.

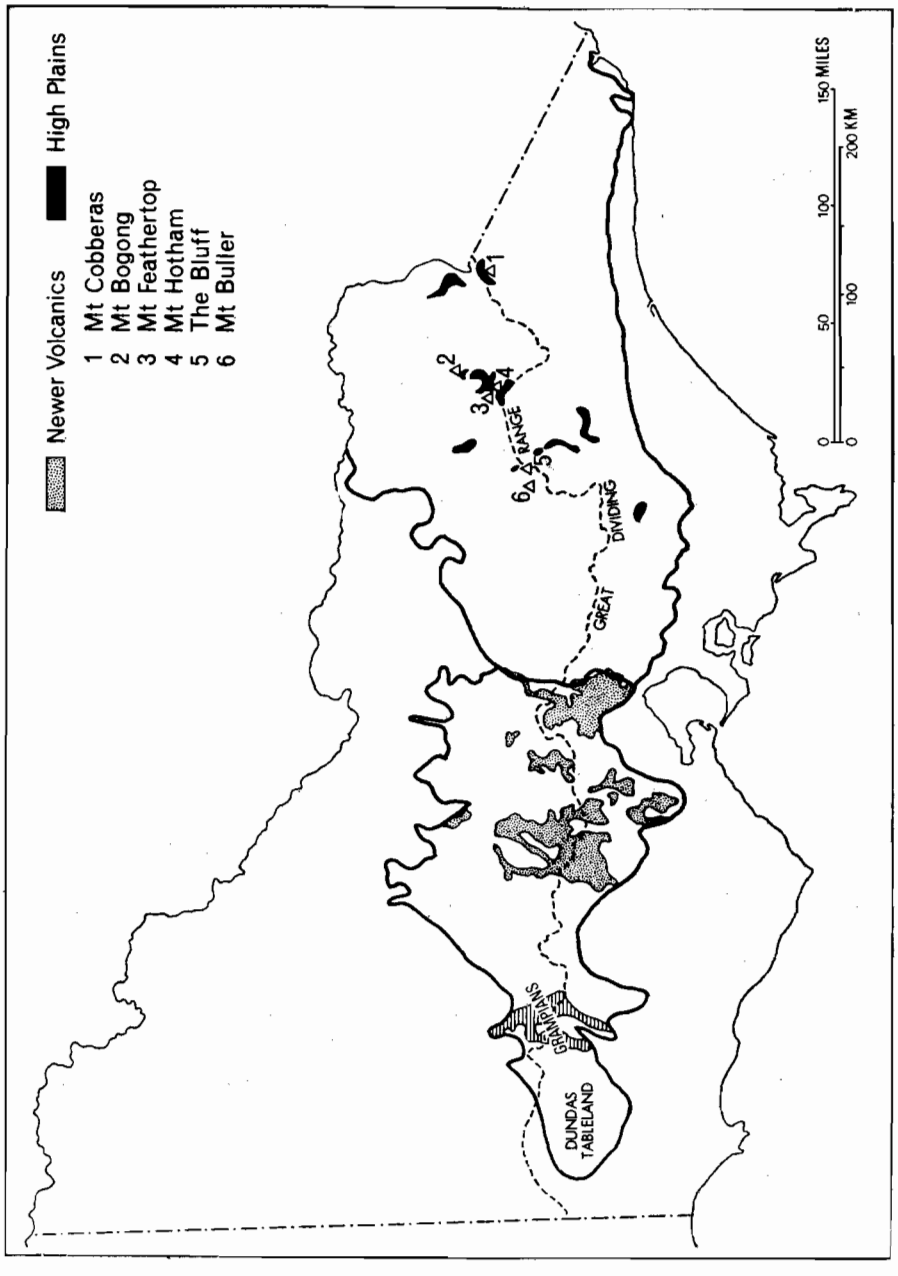


FIGURE 3. Mountain areas of Victoria.

Western section

The highlands here are of much lower relief than the eastern section and in places lack the clearly defined watershed of the eastern ranges. A notable feature is the concentration of volcanic activity (Newer Volcanics) extending from just north of Melbourne to the Ballarat district in the west. Over 200 eruption points have been identified with many of the lava flows now forming ridges which bury the pre-volcanic stream channels and give rise to auriferous deep leads (gold-bearing gravels). Diversion and modification of river courses by lava flows has led to the formation of waterfalls, for example, on the Coliban River at Trentham Falls where the river runs across lava and cascades over 20 metres onto bedrock.

The following table lists some of Victoria's highest mountains:

VICTORIA—HEIGHT OF SELECTED MOUNTAINS
(metre)

Mountain	Height	Mountain	Height
Bogong	1,986	Niggerhead	1,843
Feathertop	1,922	McKay	1,843
Nelse	1,884	Cobboras	1,838
Fainter	1,877	Cope	1,837
Loch	1,875	Spion Kopje	1,836
Hotham	1,862	Buller	1,804

The most rugged section of highland in western Victoria is the Grampians, a series of resistant sandstone ridges etched out by differential weathering and removal of softer siltstones and shales. The highest peak, Mt William (1,167 metres), has a spectacular easterly facing escarpment and a broad plateau-like summit surface. The Grampians form a major water catchment for the Wimmera and Glenelg systems and provide recreation and wildlife preservation opportunities.

Coastline

The Victorian coastline comprises many types of environments. Broad sandy beaches and impressive cliffed headlands along the ocean coast contrast with mangrove-fringed mudflats and marshland of the sheltered embayments and estuaries. There are approximately 1,200 kilometres of ocean coast between Cape Howe and the South Australian border; in addition three large embayments —Port Phillip Bay (260 kilometres), Western Port Bay (140 kilometres), and Corner Inlet (80 kilometres)—partially enclose protected waters and provide opportunity for port and harbour development.

Much of the ocean coast is exposed to high wave energy from strong and regular ocean swells and storm wave activity generated in the Southern Ocean. In western Victoria swells arrive predominantly from the west and south-west, while the coastline of eastern Victoria (particularly east of Wilsons Promontory) is subject to swell from the south-east across the Tasman Sea. The shape of the long gently curving Ninety Mile Beach from Corner Inlet to Lakes Entrance is determined by wave action from this swell.

Three general coastal types may be recognised: cliffed coasts, sandy coasts, and salt marsh and swamp coasts. The most extensive cliffed section is west of Port Phillip Bay from Torquay to Warrnambool, including a zone where the Otway Ranges lie adjacent to the coastline. The sandstone rocks of the Otways generally dip seaward and form steep cliffs, commonly with a level rock bench called a shore platform lying between high and low tide marks. Intricate weathering and erosion forms develop, etching out details of rock structures in the cliffs and platforms. Along this sector, sandy beaches are rare, being confined to small embayments or river mouths and often containing a high component of gravel.

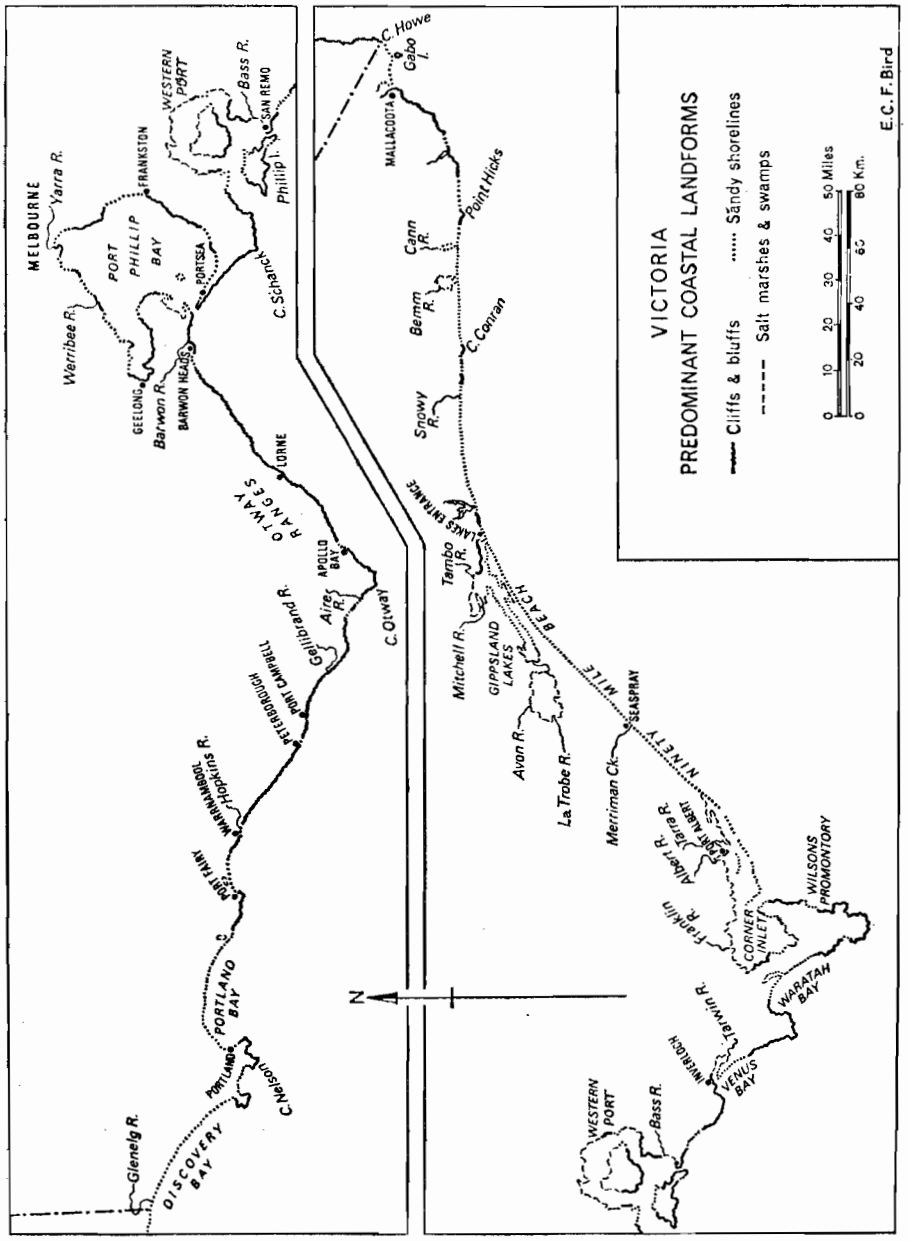


FIGURE 4. Predominant coastal landforms in Victoria.

West of Cape Otway to Warrnambool and particularly from the Gellibrand River to Peterborough is a spectacular cliffed coastline cut into soft horizontally bedded limestones and clay rocks. Wave action has eroded along fractures and weaknesses in the rock to produce near-vertical cliffs up to 60 metres high and forming blowholes, arches, and isolated rock stacks. Many of these features may be observed in the Port Campbell National Park.

High cliffed sectors are formed in volcanic rocks near Portland where Cape Duquesne and Cape Bridgewater illustrate many of the features associated with volcanic explosions and lava flows. As well, the coast at Cape Schanck and the ocean coast of Phillip Island is cliffed into layers of early Tertiary lava flows. Along the Gippsland coast sandstones form high cliffs at Cape Paterson and Cape Liptrap, while the plunging cliffs of Wilsons Promontory are of granite. Shore platforms occur in both the sandstone and the volcanic rocks but no such feature is found along the granite sectors.

Sandy beaches backed by extensive dune topography extend around Discovery Bay in far western Victoria. In many places these sand ridges are actively eroding and sand is spilling and blowing inland to cover coastal vegetation. Similar erosion is noted along the Ninety Mile Beach and on the sandy beaches and dunes further east between Lakes Entrance and Cape Howe.

Estuary and lagoon systems occur at river mouths or where embayments have been partially or wholly enclosed by sand. Rivers such as the Snowy, the Barwon, and the Glenelg have lagoons occupying their lower reaches and the river mouth may be constricted by the growth of sandy spits. These may be breached and modified by flood discharge: in the floods of early 1971 the Snowy shifted its outlet over one kilometre to the west by breaking through the dune-capped barrier that deflects the entrance eastward of Marlo.

The Gippsland Lakes are an extensive lagoon system enclosed behind broad sandy barrier systems. In the sheltered lake waters deposits of silt and mud have accumulated among the reed swamps at the mouths of rivers to form long silt jetties or deltas. The largest of these, the Mitchell delta, and its companion at the mouth of the Tambo are no longer extending but are subject to erosion by wave action.

In the shallow and sheltered waters of Western Port Bay and Corner Inlet, mangrove swamps and salt marsh form a broad coastal fringe. Creeks and channels cross the soft, sticky mud-flats exposed in front of the mangrove fringe and form intricate patterns of tidal drainage. Smaller areas of mud and mangrove occur in the estuaries of the Barwon River and the Tarwin River; in the latter, the rapid spread of an introduced, salt-tolerant plant (*Spartina anglica*) is of particular interest.

Survey and mapping

The Survey and Mapping Division of the Department of Crown Lands and Survey is responsible for the development of the National Geodetic Survey within Victoria; the preparation of topographic maps in standard map areas; the survey of Crown lands under the provisions of the *Land Act* 1958; the co-ordination of surveys throughout the State under provisions of the *Survey Co-ordination Act* 1958; surveys for the Housing Commission, the Rural Finance and Settlement Commission, and other departments and authorities; and the documentation of these surveys.

An Australia-wide primary geodetic survey was completed in 1966, and in Victoria this is continuously being extended to provide a framework of accurately fixed points for the control of other surveys and for mapping. A State-wide network of levels was completed in 1971. The datum, based on mean sea level values around the whole coast of Australia, is known as the Australia Height Datum (AHD), and its adoption obviates the multitude of local datums formerly in use throughout the State. Issued lists of level values on the AHD are in metres.

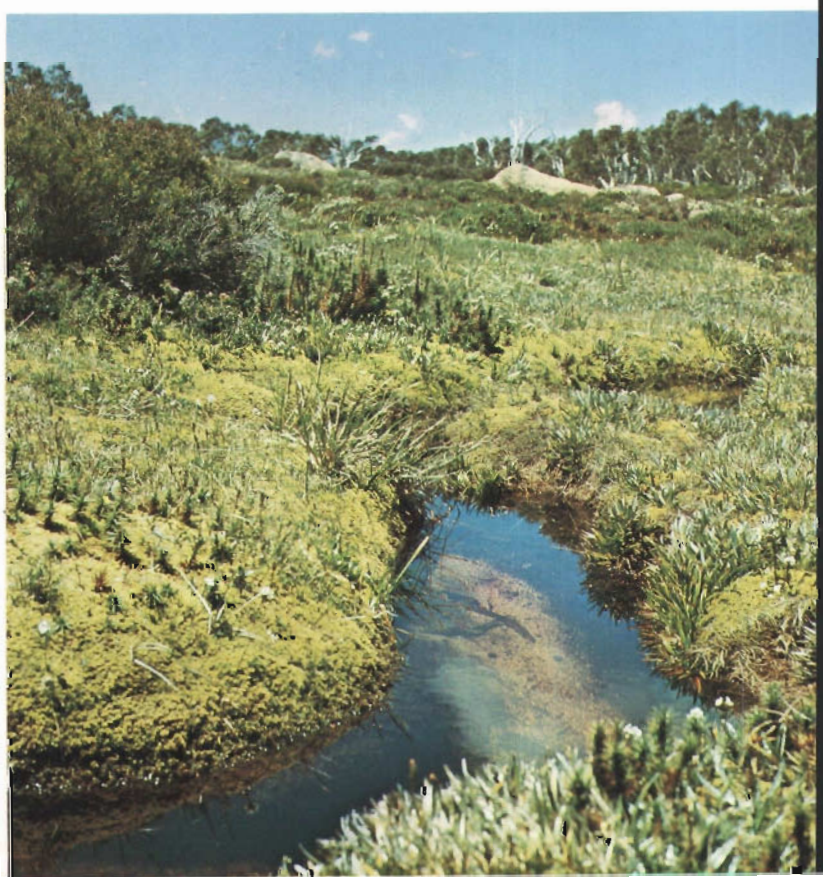
Today, Victoria's land resources are studied carefully in order to conserve those resources which still retain the essentials of their original character.

Where past damage has occurred, projects over the last thirty years have rehabilitated large areas. The water catchments, and increasing urbanisation of rural areas, demand care to ensure that permanent damage does not occur to the land.

Roots of planted willows stabilise this creek bed, banks and gully head near Coleraine in western Victoria.

A. Mitchell, Soil Conservation Authority

Farm dam across previously eroding gully at Eppalock in western Victoria.
Soil Conservation Authority



Heath sphagnum moss bed protects water supply catchment on the Baw-Baw Plateau in the Great Dividing Range.
A. Mitchell. Soil Conservation Authority

An official map of Victoria showing highways, roads, railways, watercourses, towns, and mountains, together with other natural and physical features, has been published in four sheets at a scale of 1:500,000. A less detailed map of Victoria is also available in one sheet at a scale of 1:1,000,000. Topographic maps at a scale of 1:250,000 providing a complete map coverage of the whole State have been published by the Division of National Mapping of the Department of National Resources and the Royal Australian Survey Corps. A joint State–Australian Government mapping project, commenced in 1966, is proceeding with the production of topographic maps at a scale of 1:100,000 with a 20 metre contour interval. A number of these maps has been published, and it is expected complete map coverage of the State in this series will be available by the end of 1976. The Mines Department and the Forests Commission also contribute to State mapping by publishing maps for geological and forestry purposes.

A series of 26 maps at a scale of 1:25,000 showing streets, rivers, creeks, and municipal boundaries in Melbourne and its suburban area including the Mornington Peninsula has been produced. A long-term programme for production of general purpose standard topographic maps, at 1:25,000 scale with a 10 metre contour interval, has been planned to extend this map coverage over the greater metropolitan area, and to embrace many of the larger provincial centres. Other maps of urban and suburban areas at 1:10,000 scale, showing full subdivisional information, are being prepared of the Mornington Peninsula area; similar maps of various rural centres are on programme in conjunction with Australian Government maps at the same scale required for census purposes.

Large scale base maps have been prepared for rapidly developing areas throughout the State, including the outer metropolitan area, Mornington Peninsula, Ballarat, Geelong, Bendigo, Phillip Island, and a number of other rural areas. These maps were originally compiled at a scale of 1:4,800 (400 feet to 1 inch) with a 5 foot contour interval. However, with the introduction of the metric system, all new maps will be prepared at a scale of 1:5,000, generally with a 2 metre contour interval. The publication *Official Map and Plan Systems Victoria* has been issued setting out the standard format size and numbering systems which have been adopted for the production of maps and plans at the standard scales of 1:20,000, 1:16,000, 1:10,000, 1:5,000, 1:2,500, 1:1,000, 1:500, and 1:250. The systems are based on the Australian Map Grid (AMG), which fulfils the basic principles necessary for the complete integration of surveys.

The Division carries out cadastral surveys of Crown lands for the purpose of defining boundaries and for determining dimensions and areas of reservations and of allotments for the subsequent issue of Crown grants. This information forms the basis for the compilation of county, parish, and township plans, which are published at various scales and show details of the original subdivision of Crown lands. Recently further investigations have been made with the object of introducing a fully integrated topographic-cadastral map and plan system. Although cadastral requirements may result in the publication of plans using an additional range of scales, it will be a fundamental principle that the Australian Map Grid will be the basic framework of their compilation.

As part of its mapping activity the Department provides an aerial photography service, and maintains an aerial photography library of approximately 300,000 photographs from which prints and enlargements may be obtained. Maps, plans, and aerial photographs are available for purchase from the Central Plan Office of the Department.

Further reference, 1975; Hydrography, Coastline, 1966; Coastal physiography, 1967; Plant ecology of the coast, 1968; Marine animal ecology, 1969; Marine algae of the Victorian coast, 1970; Erosion and sedimentation on the coastline, 1971; Conservation on the Victorian coast, 1972

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Physical divisions

This article should be read in conjunction with the articles on geographical features, area, climate, and geology.

The chief physical divisions of Victoria are shown in Fig. 5 on page 67. Each of these divisions has certain physical features which distinguish it from the others, as a result of the influence of elevation, geological structure, climate and soils, as is recognised in popular terms such as Mallee, Wimmera, Western District, and so on. The following is a table of these divisions:

1. Murray Basin Plains:
   - (*a*) The Mallee
   - (*b*) The Riverine Plains
   - (*c*) The Wimmera
2. Central Highlands:
   - A. The Eastern Highlands
   - B. The Western Highlands:
     - (*a*) The Midlands
     - (*b*) The Grampians
     - (*c*) The Dundas Tablelands
3. Western District Plains:
   - (*a*) The Volcanic Plains
   - (*b*) The Coastal Plains
4. Gippsland Plains:
   - (*a*) The East Gippsland Plains
   - (*b*) The West Gippsland Plains
5. Southern Uplands:
   - (*a*) The Otway Ranges
   - (*b*) The Barabool Hills
   - (*c*) The Mornington Peninsula
   - (*d*) The South Gippsland Highlands
   - (*e*) Wilsons Promontory

Murray Basin Plains

These plains include the areas commonly known as the Mallee, the Wimmera, and the Northern Plains or Riverine Plains. The plains are effectively subdivided by a north-south fracture known as the Leaghur Fault which runs sub-parallel with the Loddon River immediately west of Kerang.

From the Murray River to the Central Highlands, eastwards of the Leaghur Fault is the remarkably flat landscape of the Riverine Plains, which are coalescing alluvial plains of the Murray, Loddon, and Campaspe Rivers, formed by fluvial sedimentation. Crossing the Riverine Plains is an extensive system of dry former stream courses now choked with sand, and known as prior streams.

West of the Leaghur Fault is a very different landscape and soil. Here the *Mallee* country starts, with its irregular surface of undulating sand ridges, mainly of fine sand, which largely trend north-south and appear to be stranded coastal ridges and dunes left on the margin of a retreating sea. The Mallee is in fact the marine plain from the former Murray Basin, with a mere veneer of wind-blown sands overlying fossiliferous Tertiary marine sands and silts, which reach eastwards to the Gredwin Ridge on the Avoca–Loddon divide near Kerang. Westward of the Loddon River, all the Mallee streams, because of low flow volumes, percolation and high evaporation, fail to reach the Murray River and terminate in brackish or saline shallow lakes commonly bordered with lunette ridges.

The *Wimmera* is essentially the low alluvial fans, alluvial plains and abandoned river channels lying between the Western Highlands and the Murray Basin or the Mallee, as the sand-strewn surface of this basin is commonly known.

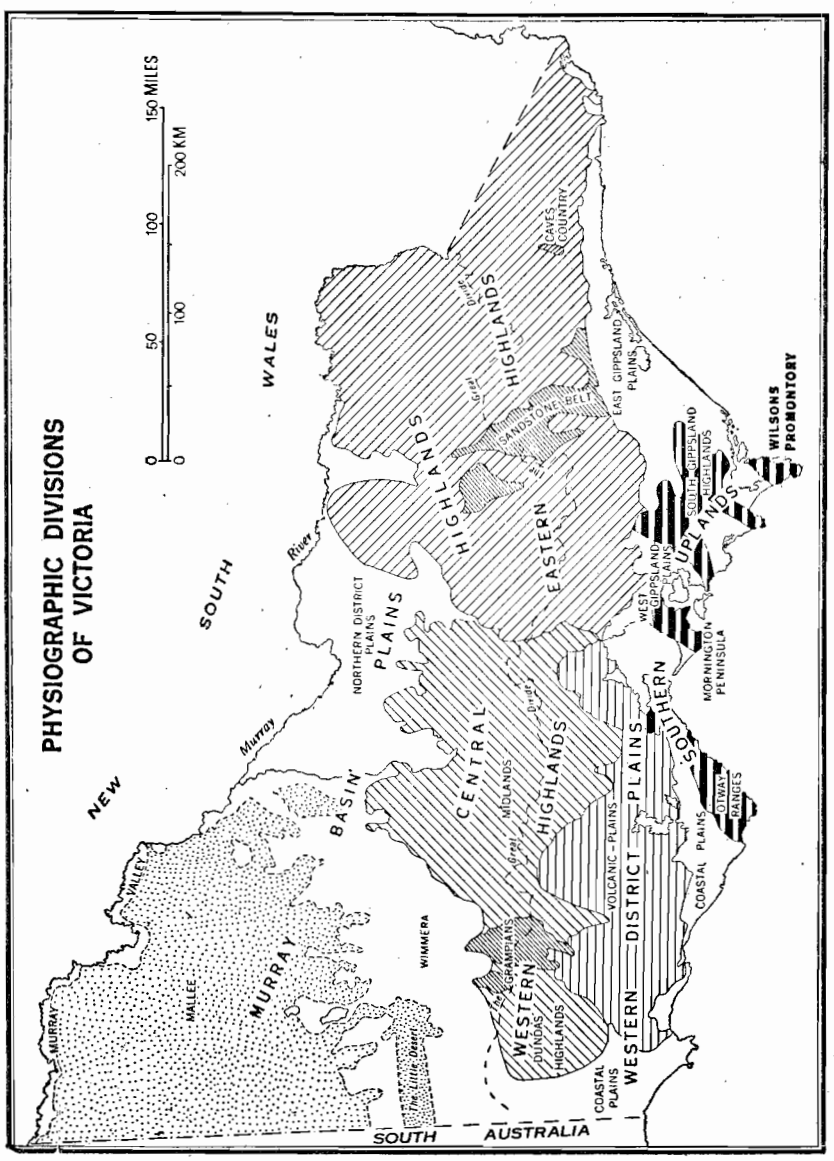

FIGURE 5. Physiographic divisions of Victoria.

Central Highlands

Extending east to west across Victoria is a mountainous and hilly backbone known as the Central Highlands. In eastern Victoria, it is rugged and mountainous, and with plateau-like features commonly capping elevated mountain areas. Known as the *Eastern Highlands,* these mountains in eastern Victoria attain elevations of above 1,800 metres at the highest points such as Mt Bogong and Mt Hotham, and elevations of at least 1,200 metres are common. The major rivers of Victoria with high flow-rates, with the exception of the Glenelg River, all rise in the Eastern Highlands, and characteristically show steep-sided deep and narrow valleys. Residuals of Lower Tertiary basalts occur in the Eastern Highlands, filling old valleys as at the Dargo High Plains and the Bogong High Plains.

The topography in the Eastern Highlands has been strongly influenced by the variety of rock types and structures present. Thus a flat-topped and step-like landscape is found in the hard almost flat-lying Upper Devonian sandstones and rhyolites between Briagolong and Mansfield; plateaux are preserved in granite at Mt Buffalo and the Baw-Baws; and lower elevations with dendritic drainage are generally seen in areas of folded Lower Palaeozoic mudstones.

The *Western Highlands,* in contrast to the Eastern, are much lower in elevation and generally are subdued hills rather than mountains. Rugged areas are mostly found only near fault scarps. The general elevation reaches a maximum of about 600 metres at Ballarat, but elevations are mostly considerably less. Resistant masses of igneous rocks such as Mt Macedon and Mt Cole rise well above the general level, but fall well short of the main peaks in the Eastern Highlands. Extensive flat and only slightly dissected areas of basalt from the Upper Tertiary cover parts of the Western Highlands, conspicuously in the Ballarat area where they have yielded rich soils, and above the basalt flows rise prominent eruption points such as Mt Warrenheip near Ballarat.

The Grampians, sharp-crested strike ridges of hard sandstone reaching 1,200 metres in height, are prominent mountains rising far above the declining general level of the highlands as they trend westwards. The westerly extremity of the Western Highlands is the Dundas Tablelands, a warped plateau reaching to Dergholm, formed in contorted Lower Palaeozoic rocks capped with laterite and dissected by the Glenelg River System.

Valleys in the Western Highlands are generally broad rather than deep, apart from where rejuvenating movements have occurred along fault scarps to cause, in some cases, gorges.

The Central Highlands owe their elevation—and relief caused by resultant erosion—to varied upwarping movements and faulting during late Tertiary time.

Western District Plains

The Western District Plains stretch westwards from Werribee to Camperdown, Hamilton, and Portland. They subdivide naturally into volcanic plains and coastal plains.

Volcanic Plains

With an area of 2,300 square kilometres, the volcanic plains are the third largest volcanic plains in the world. They begin at an east-west line through Colac and Warrnambool and reach northwards to the foot of the Grampians.

The Volcanic Plains are almost horizontal, with only a slight southward inclination, and are composed of Pliocene to Holocene basalt flows and some basaltic ash. The Camperdown area shows extensive minor irregularities known locally as "Stony Rises", formed by lava collapse during solidification: these are so young that they are unmodified by erosion and soil formation. Volcanic cones, frequently of scoria, rise sharply from the plains as at Mt Elephant (394.4 metres) and Tower Hill (98.4 metres), and to some cones can be traced

extensive areas of basalt. Much of the scoriaceous basalt of the "Stony Rises" can thus be linked with Mt Porndon (289.2 metres). Crater lakes in some cones occupy craters formed by explosive vulcanism.

The plains are crossed by some streams such as the Hopkins River with narrow incised valleys, but much drainage is internal, with precipitation finding its way to shallow lakes and underground.

Coastal Plains

Coastal plains, interrupted by the Otway Ranges, extend from Torquay to Warrnambool and northwards to Colac. They are flat or undulating, and are essentially the uplifted surface of Tertiary sedimentary rocks, including limestones, partly dissected by streams and commonly veneered with Quaternary dune limestone and sands. The limestones beneath the plains are cavernous, and are high yielding aquifers for groundwater.

Gippsland Plains

As a planar surface, the Gippsland Plains begin near Yallourn and Port Albert, and spread eastwards to the Bairnsdale area, between the ocean and the Eastern Highlands. Further east, through Orbost to Cann River, they form coastal downs—a dissected coastal plain—rather than a plain.

West of Yallourn, the Gippsland Plains continue, but they are fractured by late Tertiary block faulting to give the Moe Swamp and the Western Port Sunklands, down faulted blocks, and uplifted areas such as the Drouin block and the Haunted Hills which are now maturely dissected. Faulting is responsible for related plains bordering the South Gippsland coast in the Wonthaggi area and landward from Cape Liptrap.

The present plains are the upper surface of a Tertiary and Quaternary basin, in which have accumulated thick sequences of marine and fresh-water sediments, including the major brown coal seams of the Latrobe valley. The plains are generally covered with piedmont-type sands, sandy clays and gravels, which originated from the Eastern Highlands during the final late Tertiary movements which elevated them to their present height, and into these gravels the streams have cut broad alluvium-filled valleys with flights of terraces that can be traced back into the Highlands.

A former coastline can be recognised behind the present coastline in the Bairnsdale–Lakes Entrance area. The conspicuous Ninety Mile Beach is a barrier bar which has cut off some of the Gippsland Lakes from the sea, and both spits and islands inland from the beach betray a complex history of barrier formation and erosion related to changed sea levels. Present-day coastal dunes are prominent along sections of the Ninety Mile Beach, and earlier dunes and beach ridges are found on the barriers; earlier dunes are even found north of Woodside and east of Stratford.

Southern Uplands

South-west of the Gippsland Plains is a steep mountainous region, the Southern Uplands, formed by upwarping and faulting, and separated from the Eastern Highlands by the westerly extension of the Gippsland Plains appropriately named by J. W. Gregory as the "Great Valley of Victoria". These mountains, together with the Barrabool Hills near Geelong and the Otway Ranges, are formed of freshwater Cretaceous sandstones and mudstones, and all display a characteristic rounded topography, due in part to very extensive land-slipping and structural weakness in these rocks.

Areas of weathered basalt from the Lower Tertiary are found on the Uplands in plateau-like form at Thorpdale and Mirboo North in South Gippsland, and many smaller remnants are found elsewhere in these ranges; the basalts yield rich soils.

The Otway Ranges likewise originated by upwarping and faulting during Tertiary time.

A further element in the Southern Uplands is the Mornington Peninsula, which is a raised fault block of Palaeozoic granites and sedimentary rocks separating the downwarped Western Port Sunklands and the Port Phillip Sunklands. A subdued spit of calcareous dune rock extending westwards from the Peninsula to Portsea almost closes Port Phillip Bay.

Land surface of Victoria

The present topography of Victoria is the result of interaction between the rock types present, themselves events in geological history, changes in elevation and deformation recorded in that history, processes such as weathering and erosion—including climatic effects—and the stage of development reached by these processes. Hard resistant rocks, for example, will after prolonged erosion tend to stand out in relief, whereas softer more weathered rocks will topographically be more depressed. Over extensive lengths of geological time without major sea-level changes, erosion will tend to wear down a land mass to a surface of low relief—known as an erosion surface—not far above sea-level. In the highlands of Victoria remnants of several such erosion surfaces can be recognised as plateau-like features raised to elevations of hundreds or thousands of metres by uplifts.

Jurassic erosion surface

In the Eastern Highlands, plateau remnants are widespread, as for example the Cobboras, the Mt Hotham area, Mt Buffalo, the Snowy Plains, Mt Wellington, and the Baw-Baw Plateau: they are all in hard rocks such as granite, rhyolite, and massive sandstone. These plateau remnants, and ridge tops at similar levels, are relics of the most ancient landscape or erosion surface preserved in Victoria. They are the surviving parts of a sub-planar surface which was close to sea-level in Jurassic time, before uplift and warping late in the Jurassic commenced its destruction, and began to form troughs or sedimentary basins in which the sediments represented in the Otways and the South Gippsland Highlands were deposited during Cretaceous time. These upwarps had already begun to define the Central Highlands.

Later evolution

Uplift and downwarping continued intermittently during Tertiary time, with the development of sedimentary basins such as the Murray Basin in north-west Victoria and the Gippsland and Otway Basins in southern Victoria. In the basins was deposited detritus carried down by streams from the rising Highlands, and in swamp conditions great thicknesses of brown coal were laid down in the Gippsland Basin. Deep valleys were cut into the Central Highlands, which were then lower than their present height; in some of these valleys gold-bearing gravels were deposited. Parts of the landscape and some of the valleys were filled with Lower to Mid-Tertiary basalts.

Erosion proceeded to advanced stages during parts of the Tertiary Period, as attested by remains of younger erosion surfaces, preserved at lower levels than the Jurassic erosion surface on the Kinglake Plateau, the hill summits immediately east of Melbourne and around the Dandenong Ranges to Gembrook, and elsewhere in the Central Highlands.

By Miocene time, downwarping movements were at their maximum. Embayments of the sea covered much of Gippsland, the Port Phillip Basin, an extensive area of western Victoria south of Lismore and the Grampians (the Otway Basin), and north of the Grampians the Murray Basin spread as far as Broken Hill, New South Wales. The record of this transgression is left in limestones and other sedimentary deposits. Retreat of the sea towards its present position during the

Pliocene was accompanied by further uplift of the Central Highlands, leading to further erosion, valley deepening and the accumulation of extensive sheets of sands, clays and gravels both on the lowland plains and as piedmont gravels on the spurs leading down to the lowlands.

The Upper Tertiary and even Quaternary saw vast volcanic activity in central and western Victoria. From Melbourne to Hamilton basalts and tuffs were outpoured and ejected. Flows followed pre-existing valleys in the Western Highlands, burying auriferous gravels as deep leads in the Ballarat district.

Final downwarpings, assisted by the melting of glacial ice at the end of the Pleistocene, led to the drowning which has given Port Phillip Bay and Western Port Bay their present configurations, and concomitant upwarps in the Central Highlands elevated them to their present level.

Changing climate has played a role in this physiographic evolution. Thus the mid-Tertiary, with the rich flora evident in the brown coals, appears to have been a time of higher rainfall than at present, with the resultant of larger streams with more erosive power, and changing Quaternary climates are recognised in the changing regimes evident in the former lakes and prior streams of the Riverine Plains.

Geology

Topographically Victoria consists of an east-west highland ridge stretching from the Australian Alps in the east to the Dundas Tableland near the South Australian border. To the north-west the Highlands grade down to the fluviatile and aeolian plains of the Murray Basin, and to the south into the volcanic and coastal plains of the Otway and Gippsland Basins. The Highlands are composed of sedimentary and igneous rocks ranging in age from Lower Cambrian to Permian with the exception of surficial basic extrusive rocks and sand, gravels and clays of Mesozoic to Cainozoic age.

The Murray, Otway, and Gippsland Basins are broad depressions developed by post-Carboniferous epeirogenic earth movements and subsequently these Basins have been filled with younger sediments and volcanics.

The Palaeozoic rocks, which constitute the basement rocks of the State, are dominated structurally by thin meridional belts of Cambrian rocks. These belts are structurally complex and from east to west the following are the most important: the Mt Wellington Axis (Dookie–Mt Wellington–Waratah Bay Belt), the Heathcote Axis (Colbinabbin–Heathcote–Mt William Belt), and the Mt Stavely–Mt Drummond Belt.

Palaeozoic era

Cambrian

These rocks are the oldest known in Victoria and have been studied in detail in the Colbinnabin–Heathcote–Mt William Belt. The succession consists of a thin sequence of greenstone (Heathcote Greenstones) which represent ancient, altered basic lavas and intrusives. They have been described as a typical spilite–keratophyre suite of rocks. They are overlain by unfossiliferous shale and mudstone (Goldie Shales). North of Heathcote a thin sequence of marine shale, conglomerate, and volcanic tuff contains dendroid and trilobite fossils. Near Monegeeta, south of Lancefield, the shale contains a rich dendroid fauna. The trilobite assemblages are Middle Cambrian in age and on this evidence the greenstones are regarded as Lower Cambrian in age.

Within the intensely faulted Dookie–Mt Wellington–Waratah Bay Belt, greenstones, chert and shale are the dominant lithologies, but in the Dolodrook River successions, lenticular limestones are interbedded with tuffaceous rocks. The limestone contains trilobite and brachiopod fossils of Middle–Upper Cambrian age.

The Mt Drummond–Mt Stavely Belt in western Victoria immediately east of the Grampian Ranges, consists of a discontinuous belt of outcrops of

greenstone and chert. No fossils have been found in these rocks. Another narrow belt of greenstone outcrops along the axis of the Black Ranges south of Horsham and greenstones are recorded from a water bore near Dimboola in the Wimmera.

The area of basement rocks west of the line between Ballarat and Wedderburn, which are shown on the Geological Map of Victoria as Ordovician, are now regarded by many geologists as being of Cambrian age. Although no fossils have been found to confirm this age, the lithological and structural differences from the Ordovician successions of Central Victoria seem to support the older age.

The Cambrian rocks are strongly folded and sheared in some areas and the main belts are bounded by high angle reverse faults representing considerable stratigraphic displacement.

Ordovician

Ordovician rocks consisting of sandstone, shale and slate form the bedrock over large areas of Victoria. The rocks are tightly folded with steeply dipping fold axes and strong fissuring and cleavage. In central Victoria, immediately west of the Heathcote Axis, the folding takes the form of broad, complex anticlinoria and synclinoria.

In central Victoria, between the Heathcote Axis and the Wedderburn–Ballarat line, a rich graptolite fossil assemblage has enabled detailed stratigraphic and structural mapping. On the basis of the graptolite assemblage the following stage nomenclature has been adopted:

	Stage
Upper Ordovician	Bolindian
	Eastonian
	Gisbornian
Middle Ordovician	Darriwillian
Lower Ordovician	Yapeenian
	Castlemainian
	Chewtonian
	Bendigonian
	Lancefieldian

There is a conformable sequence in the Lancefield District from the Goldie Shales (Upper Cambrian) into the lowermost Ordovician graptolite zones; continuing through to the uppermost Upper Ordovician near Sunbury, where massive grits appear. The lithologies are monotonous and it has not been possible to map individual rock units.

The age of the thick succession of basement rocks west of the Wedderburn–Ballarat line, where the last Lancefieldian graptolites have been recorded, remains in doubt.

Within the Melbourne Trough, which is the area between the Heathcote Axis and the Mt Wellington Axis, the Ordovician (Lancefieldian to Bolindian) rocks outcrop in an anticlinorium on the Mornington Peninsula and as infaulted slices and wedges in the Walhalla Synclinorium sequence. The slices of Ordovician rocks are also found associated with the Cambrian successions in the main structural belts, for example, Heathcote, Howqua River, Dolodrook River, and Waratah Bay.

East of the Mt Wellington Axis the Ordovician rocks consist of a monotonous sequence of slate and sandstone yielding only rare fossil occurrences. The rocks are highly folded and cleaved. Graptolites have been found in localities

such as Nowa Nowa, Wombat Creek, Dart and Gibbo Rivers, Cape Conran, and Deddick in eastern Victoria. Where identifiable these fossils have indicated an Upper Ordovician age.

Metamorphism of Cambrian and Ordovician rocks

On the Dundas Tableland of western Victoria, near Chatsworth in the Western District, near Charlton and in the north-east of Victoria, areas of regionally metamorphosed rocks occur. The original sediments of the western metamorphosed areas may have been Cambrian in age, but the metamorphic rocks in the north-east pass into sediments of Upper Ordovician age.

The rocks include schist and gneiss and in the north-east the western boundary is a major thrust fault and shear zone against unaltered Ordovician sediments. The metamorphic rocks are intruded by batholiths which have been given an Ordovician age from datings by radiometric methods. The intrusion of the granites is attributed to a period of tectonic activity known as the Benambran Orogeny.

Silurian—Middle Devonian

Central Victoria

The greatest development of Silurian–Lower Devonian rocks is in the Melbourne Trough between the Heathcote and Mt Wellington Axes. The sequence ranges in age from Lower Silurian to possibly Middle Devonian and north-west of Melbourne it conformably overlies the Upper Ordovician rocks.

The succession is predominantly of marine origin and includes sandstone, siltstone, mudstone and conglomerate without contemporaneous vulcanicity. The upper limits of the succession may be non-marine in character, i.e., the sandstones and siltstones of the Cathedral Range and the sandstone at Cave Hill, Lilydale. Lenticular limestones of limited extent occur at Lilydale, Waratah Bay, and in the Tyers River–Coopers Creek area.

Lower Silurian rocks, consisting of massive siltstone, sandstone and occasional conglomerate, outcrop to the north-west of Melbourne and to the east of Heathcote. Horizons contain the graptolite fossil, *Monograptus,* which provides a means of dating the sediments. Shelly fossil assemblages can be found within the sequence. Upper Silurian conglomerates occur near Heathcote and widespread sandstone and shale of this age occurs throughout the central and eastern part of the Trough.

Lower Devonian siltstones occur throughout the Trough with nearshore sandstone outcroppings east of Heathcote. As mentioned previously, shallow water limestones of this age occur at Lilydale and Waratah Bay.

In the central part of the Trough a widespread shale sequence contains a plant (*Baragwanathia*)—graptolite (*Monograptus*) assemblage. Shelly fossil assemblages can also be located in the sequence. To the east a thick sequence of sandstone, shale, and some coarse sandstone forms the Walhalla Synclinorium and these sediments represent the upper part of the Lower–Middle Devonian sequence.

Folding

The intensity of folding within the western portion of the Melbourne Trough is less than that in the Cambrian–Ordovician rocks to the west of the Heathcote Axis. Folds are open with arcuate to sinusoidal axial lines, but farther east the folding is tighter with shearing and cleavage becoming more intense towards the Mt Wellington Axis. This period of folding is attributed to the Tabberabberan Orogeny in late Middle Devonian time.

Western Victoria—Devonian (?)

In western Victoria a thick sequence of quartzose sandstone, red siltstone, and sandstone and conglomerate (the Grampians Group) overlies with sharp angular unconformity the Cambrian (?) basement rocks. The massive sandstones of this

group form the rugged Grampian Ranges, Black Ranges, and the Dundas Range. Other isolated outcrops occur in the Willaura Syncline north of Wickliffe, near Woorndoo and on Mt Arapiles.

At the base of the succession, to the west of the Grampian Ranges, is a thick sequence of acid volcanics (Rocklands Rhyolites) and at the base of the Willaura Syncline sequence a thin formation of the Wickliffe Rhyolites occurs.

The Grampians Group was deposited in a north-westerly trending graben under predominantly non-marine conditions, although at least one marine transgression occurred in the upper part of the Silverband Formation, in the middle of the main sequence. The sediments are typical continental-type deposits with red bed sequences, laid down under fluviatile conditions. Fossil occurrences are rare. In the upper part of the Silverband Formation there is a persistent fossil horizon containing a small brachiopod (Lingula), fish teeth and spines, and ostracods. Elsewhere in the succession, poorly preserved fossil plants have been recorded. None of these fossils are diagnostic enough to establish the age of the sediments. For many years an Upper Devonian–Lower Carboniferous age had been assigned to the Grampians Group on the basis of limited fossil evidence and by lithological comparison with more reliably dated rocks of this age in eastern Victoria. Recent radiometric datings obtained for granitic rocks which intrude the Grampians Group have given ages suggesting that the rocks are at least of Lower Devonian age, which means that the sediments are Lower Devonian or even older.

The rocks are folded and tilted into broad open structures which are genetically related to the major faulting along the margins of the outcrop areas. Along the north-east margins of the Grampian Ranges there are strong drag and overturning effects involving many hundreds of metres of sediments.

Eastern Victoria—Silurian to Middle Devonian

East of the Mt Wellington Axis the Silurian rocks are confined to small grabens or basins downfaulted into the Ordovician basement rocks.

In the Mitta Mitta–Gibbo Rivers area, a Lower Silurian sequence of acid volcanics (Mitta Mitta Volcanics) overlies unconformably the Upper Ordovician basement. The Volcanics are overlain in turn by a thick marine conglomerate, sandstone, siltstone, and limestone sequence of Middle to Upper Silurian age (Wombat Creek Group). In the headwaters of the Buchan, Indi, and Tambo rivers, a thick sequence of similar sediments outcrop (Cowombat Creek Group).

In the Mitchell River area near Tabberabbera, Lower to Middle Devonian marine sandstone, shale, conglomerate, and limestone (Wentworth Group) are preserved in a synclinal structure infaulted into the basement rocks.

North of Buchan a sequence of non-marine conglomerate, sandstone, siltstone, with associated pyroclastics (Timbarra Formation) overlies unconformably the Upper Ordovician basement. These sediments are succeeded by a great thickness of Lower to Middle Devonian acid volcanics and pyroclastics (Snowy River Volcanics), outcropping throughout the Snowy River district. Minor intercalations of non-marine conglomerate, mudstone and sandstone are associated with the volcanics.

After the extrusion of the Snowy River Volcanics, there followed a period of faulting and erosion and during the Middle Devonian period deposition of richly fossiliferous sequences of limestone, dolomitic limestone and mudstone (Buchan Group) in downfaulted, synclinal structures such as Buchan and Bindi. An isolated outcrop of acid volcanics overlain by fossiliferous limestone which occurs at Boulder Flat on the Errinunderra River is believed to be of similar age.

Folding and igneous intrusions

In eastern Victoria a period of folding occurred in the Late Silurian during the time of the Bowning Orogeny which has been well documented in New

South Wales. During this phase granite masses were intruded into the bedrock of eastern Victoria and elsewhere, and some of these masses were exposed by erosion prior to the extrusion of Lower Devonian Snowy River volcanics.

The granitic rocks intruding the Grampians Group have been dated by radiometric method as Lower Devonian and other granite masses in north-west Central Victoria and eastern Victoria have been given a corresponding age. The Lower Devonian period was a time of intense igneous activity and this was followed in the Late-Middle Devonian by the widespread Tabberabberan Orogeny which resulted in the folding of the Siluro-Middle Devonian succession of the Melbourne Trough and the intrusion of the Woods Point dyke swarm into the eastern part of the Trough. The period of folding was well documented in the Tabberabbera area where it was first recognised.

Upper Devonian–Lower Carboniferous

Central Victoria

Deposition in Victoria of rocks in this period followed the widespread deformation of the Tabberabberan Orogeny and a sustained phase of erosion and uplift. The deposition represented the final phase sedimentation in the Tasman Geosyncline with a resurgence of acid vulcanicity and the deposition of massive continental-type sediments in graben structures.

In Central Victoria the period was marked by dominantly acid volcanic activity with the development of cauldron subsidences into which were extruded great thicknesses of acid volcanics and pyroclastics. The Cerberrean Cauldron and the Marysville Igneous Complex are typical of these structures where a central pile of rhyolite, rhyodacite, and ignimbrite is surrounded by a granodiorite porphyrite ring dyke. The lava sequences have been intruded by co-magnetic granodiorite batholiths. Similar lava accumulations, representing modified cauldron subsidences form the Dandenong Ranges, Strathbogie Ranges, and the Tolmie Highlands near Tatong. Other Upper Devonian lava residuals form the Macedon Range and an isolated occurrence on Arthur's Seat near Dromana. Occasional basal conglomerates and interbedded thin tuffaceous sediments are found within the lava successions and near Taggerty one of these tuff bands contains a rich Late Devonian fossil fish assemblage.

East of the Macedon Range a sequence of coarse sandstone and conglomerate (Kerrie Conglomerate) unconformably overlies Upper Ordovician rocks. The conglomerates are intruded by granodiorite. An Upper Devonian age has been given to these sediments without any positive indication of their upper age limit.

Eastern Victoria

Immediately east of the Mt Wellington Axis there is a wide belt of Upper Devonian–Lower Carboniferous sediments with associated acid volcanics, extending from north of Maffra in Gippsland to the Mansfield Basin in the north. The sediments occur in a graben structure bounded by high angle faults. The succession contains a large thickness of continental-type non-marine conglomerate, quartz sandstone, siltstone, and mudstone (Avon River Group). Redbed horizons are common throughout the succession. The basal beds in some areas are massive conglomerates overlying the Lower Palaeozoic basement rocks with sharp angular unconformity and interbedded with them are acid volcanics and pyroclastics (Wellington Rhyolites). In the Freestone Creek and the Iguana Creek areas, fossil fish and plants have been found and positively identified as Upper Devonian in age. In the higher units of the succession lenticular meta-basalt flows occur.

Although no positive age evidence is available it is believed that the upper parts of the Avon River Group may extend into the Lower Carboniferous.

In the northern part of the belt increased vulcanicity is represented by a large thickness of acid volcanics which outcrop in the Tolmie Highlands. These

volcanics are overlain by conglomerate and followed by more volcanics which in turn are followed unconformably by the red sandstone, siltstone, and mudstone of the Mansfield Basin. The redbeds contain an Early Carboniferous fish fauna in the South Blue Range south of Mansfield. Lower Carboniferous conglomerate and redbeds unconformably overlie Upper Devonian sediments.

In the Mt Tambo–Bindi area a sequence of non-marine conglomerate, red shale, and mudstone unconformably overlies the basement. The sediments have been given an Upper Devonian age without positive age evidence.

In far eastern Victoria small, synclinal structures faulted down into the Ordovician basement, contain successions of quartzose sandstone, red, green, and purple siltstone, and mudstone. Some fish scales and plant fossils have been found and in recent years amphibians' footprints were located in the sandstones of the Genoa River valley. Based on the plant remains, the sediments are regarded as Upper Devonian in age and may represent the landward equivalent of the marine Merrimbula Group of south-east New South Wales.

Folding and igneous intrusions

The sedimentary sequences are folded into broad open structures which are probably genetically related to the intense faulting along the margins of the grabens. In some areas high angle reverse faults have produced pronounced drag and overturning of strata, i.e., along the western edge of the main Upper Devonian–Lower Carboniferous belt in the Eastern Highlands. Similar effects are noted on a smaller scale along the margins of the grabens in far east Gippsland.

The close of the Upper Devonian saw the last extensive acid igneous activity in Victoria. Granitic masses intruded the lava sequence of the cauldron subsidences in central Victoria and large massifs such as Harcourt and Cobaw batholiths were intruded. The Upper Devonian intrusives are massive multiple intrusions which are discordant cutting across the regional trends of the basement rocks. Around the margins narrow contact metamorphic aureoles are present, but little disruption of structure is obvious. The mode of emplacement was probably by stoping and assimilation.

Permian

During the Early Permian most of Victoria was a land mass subject to ice age conditions with some minor marine sedimentation. The western part of the State and north-east towards Wangaratta, was covered by ice sheets which resulted in the deposition of glacial and fluvio-glacial sediments. This sedimentation is today represented by widespread remnants preserved by down faulting into graben structures. From the directional measurements made on glacial pavements, it is estimated that the dominant movement of ice was to the north-east.

The sediments are unconsolidated with the exception of parts of the main successions in the Bacchus Marsh area, and consist of flat-lying glacial tillite and fluvio-glacial conglomerate, sandstone, and siltstone.

The most important exposures are near Bacchus Marsh in the valleys of the Werribee River, Korkuperrinul, Pykes, Coimadai, Pyrete, and Goodmans Creeks, where the streams are deeply incised into the upthrown block of Rowsley Fault. The succession includes a thick series of tillite, conglomerate, sandstone, siltstone, and mudstone with some shale of lacustrine origin. Pebbles and boulders including a great variety of rock types, many of them faceted, striated, and polished, are present. The strata has a general dip of 25 degrees to the south-south-west.

Plant spores of Early Permian age have been found in the sequence and the fossil plant Gangamopteris is found. Brachiopods have been found in basal sediments in Coimadai Creek and a marine invertebrate, Conularia, was located near the top of the Permian sequence in the vicinity of Bald Hill. The presence of

these marine fossils indicates that some marine transgression occurred in the Bacchus Marsh area during the ice age period.

Another area of outcrop occurs in the Derrinal area north-west of Heathcote where tillite, sandstone, and siltstone outcrop in the headwaters of Mt Ida and Meadow Valley Creeks. Some massive erratics are seen in this area and excellent glacial pavements carved on the Ordovician bedrock surface, can be seen around the shoreline of Lake Eppalock. Permian glacial and fluviatile sediments occur in the Ovens Valley graben and are known to extend towards the Jerilderie district in New South Wales.

On the Dundas Tableland of western Victoria, glacial tillite, fluvio-lacustrine varved clay, sandstone, siltstone, are exposed in the valleys of the Chetwynd and Glenelg Rivers and in Koroit Creek near Coleraine. Glacial sediments are also penetrated by Netherby Bores Nos 1 and 2 in the Wimmera and Yalimba No. 1 Bore near Penshurst in western Victoria. Recent work has established the presence of glacial sediments beneath the old deep lead system of the ancestral Avoca River.

Non-marine Permian sediments were penetrated by the Duck Bay oil exploration bore in Gippsland and are known to occur at depth north of the Murray River in the Wentworth area of New South Wales.

Mesozoic Era

Triassic

The Triassic rocks of Victoria are of very limited extent and outcrop as a thin succession of sandstones in a Council Trench near Bacchus Marsh. In addition, Triassic sediments were intersected by a mine adit near Yandoit Hill and some granitic rocks near Benambra which have been dated as Triassic by radiometric method. The sandstone near Bacchus Marsh and at Yandoit Hill contains identifiable plant fossils.

Jurassic (?)–Early Cretaceous

After the Triassic period an east-west rift developed across southern Victoria initiating the sedimentation in the Otway and Gippsland Basins. These two basins are separated by the Mornington Peninsula horst, a ridge of Palaeozoic rocks. The southern margin of the rift has been established by geophysical surveys out on the continental shelf where a basement high occurs. Recent research has attributed the formation of the rift structure to plate tectonics. Broad epeirogenic movements also resulted in the formation of the Murray Basin in the north-west of Victoria.

Basic igneous rocks, penetrated by the Casterton No. 1 and Heathfield No. 1 oil exploration bores in western Victoria and the Duck Bay bore in Gippsland, have been dated as possible Jurassic. However, the bulk of the Mesozoic sedimentary and volcanic successions infilling the onshore and offshore parts of the Otway and Gippsland Basins are believed to be of Early Cretaceous age. The successions are referred to as the Otway Group and the Strzelecki Group, respectively.

They consist of a large thickness of greenish grey feldspathic sandstone, mudstone, and shale of fluviatile origin. Local basal conglomerate is exposed along the margin of the outcrop area north of Casterton in the Wando Vale district, along the northern edge of the Barrabool Hills, and in the Tyers River–Rintouls Creek area in Gippsland. In the Otway Basin basic volcanics and pyroclastics are interbedded with the sediments, for example, in oil exploration bores such as Moyne Falls No. 1, Pretty Hill No. 1, Casterton No. 1, Woolsthorpe No. 1, and Hawkesdale No. 1.

Radiometric dating has given a Late Jurassic–Early Cretaceous age for trachytes and basalts on the Dundas Tableland, basalt flows in south Gippsland, and the monchiquite dykes of the Bendigo goldfields.

The Early Cretaceous succession underlies all of the Cainozoic sequences in the two southern Victoria basins, but in the Murray Basin they appear only in the north-west corner of the State and in a small outcrop on Kadnook Creek, west of Harrow.

The main outcrop areas occur as updomed blocks forming the triangular area in the Casterton–Coleraine–Merino district, the Otway Ranges, the Barrabool Hills, and the Strzelecki Ranges of southern Gippsland. The succession contains abundant plant fossil remains and a very rich fish and insect fossil assemblage was located near Koonwarra in South Gippsland. The Early Cretaceous succession also contains the only black coal deposits in Victoria. The black coal was mined economically in the Korumburra–Wonthaggi area and thin, non-economic coal seams occur in the Otway Ranges and near Coleraine.

The sediments in the outcrop areas are generally folded into domal structures with drag along marginal faults. The successions are extensively block-faulted making the mining of coal in Korumburra–Wonthaggi and other coalfields difficult and uneconomic. The feldspathic sandstone forms massive beds which are strongly jointed and along the coast of the Otway Ranges the rocks form rugged scenery. The physical nature of the sandstone is remarkably uniform throughout the sequence and when slightly weathered it has a characteristic speckled appearance.

Late Cretaceous

No Late Cretaceous sediments outcrop in Victoria, but in subsurface they are widespread in the southern onshore and near offshore parts of the Otway Basin. They have also been penetrated by bores in the Gippsland Basin. The Upper Cretaceous sediments consist of sandstone, siltstone and mudstone and unconformably overlie the Early Cretaceous. The sediments are predominantly of marine origin and represent marine transgression and regression which characterised the major sedimentation cycles throughout the Tertiary period.

Some of the formations are richly fossiliferous, particularly in foraminifera content, and this has permitted detailed palaeontological and biostratigraphic studies.

Cainozoic Era

Tertiary

The marine and non-marine sedimentation in the Late Cretaceous continued into the Lower Tertiary and the facies changes, resulting from regressions and transgressions, continued throughout the Tertiary period in the Otway, Gippsland, and Murray Basins. As a result of contemporaneous earth movements, the main sedimentary basins were split into embayments or sub-basins with different depositional environments. However, in general, the sedimentation during the Tertiary followed the pattern given below:

(1) Non-marine sedimentation with fluviatile gravels, sands and lacustrine siltstone, clay and brown coals were deposited.

(2) A marine anaerobic environment in which carbonaceous and pyritic sand and clay were deposited. Plant pollens and spores were common with some foraminifera.

(3) A normal marine limestone-marl succession, rich in macro- and micro-marine fossils, which reached the maximum transgression of the basins in the late Miocene.

(4) Non-marine gravel and sand deposition during the regressive period in the late Tertiary and erosion of gravels and sands from an upfaulted highland area.

While this oversimplifies the extremely complicated tectonic and depositional history of the Tertiary period it does define the dominant environments. Phase (1) is represented in the Gippsland Basin by the Latrobe valley Coal Measures, which includes sandstone, clay, basalt lava, and the extensive brown coal of the

Yallourn–Morwell coalfields. The age of the formation extends from the Palaeocene possibly up into the Miocene. Similarly, the Eastern View Coal Measures in the Anglesea district consist of gravel, sand, and brown coal seams.

Phase (2), because of the unconsolidated nature of the sediments, is rarely seen in outcrop but is the result of a marine deltaic environment and is represented in the Anglesea district by the purplish grey silt of the Demons Bluff Formation. This deposition took place during the Eocene.

Phase (3) is represented by the Waurn Ponds limestone, the Batesford limestone and the Fyansford Clay of the Geelong District, the Portland limestone in western Victoria and the Gippsland limestone. The age of these sediments ranges from Lower Oliogocene to Upper Miocene.

Phase (4) includes the widespread Moorabool Viaduct Sands of the Anglesea-Geelong Areas and the Haunted Hill Gravels of Gippsland. These sediments are generally of Pliocene age.

Throughout the Tertiary period volcanic activity, resulting in the extrusion of large volumes of basic lavas with associated pyroclastics, took place in the Highlands areas and into the sedimentary basins. The vulcanicity for many years was thought to be in two distinct phases : first, the Older Volcanics Series which was attributed to Palaeocene-Eocene times, and second, the younger Newer Volcanics Series ranging in age from Pliocene through to early Recent. However, as more radiometric age data are being obtained on the basaltic lavas and plugs, it is apparent that the vulcanicity persisted throughout most of the Tertiary period. Most of the older basalt plugs and lava residuals are to the east of Melbourne and this includes an area of basalt outcrop on the western side of the Mornington Peninsula and on Phillip Island. Some of the older basalts occur west of Bacchus Marsh and near Aireys Inlet.

The many volcanic centres along the Great Divide in the western part of the State and the extensive volcanic plain of the Western District are from Pliocene to Recent in age. The lava plain of the Western District including the lava domes, scoria cones, calderas, and maars, is one of the largest in the world. The basalts in the highland areas flowed down and filled the ancient valleys existing at that time and buried the alluvial gravel and sands in the valley floor. Many of these alluvials contained " placer " deposits of gold referred to as " deep leads ". These deposits were mined extensively in the latter half of the nineteenth century.

Faulting

Throughout the Tertiary period differential earth movements, mainly as a result of block faulting, took place within the sedimentary basins and in the highland areas. Most of the block faulting within the Mesozoic successions and the elevation of such areas as the Strzelecki Range and the Otway Range is attributed to Tertiary movement. Within the basins themselves the earth movements control trangressions and regressions of the sea and consequently influenced the sedimentation within the various parts of the basins.

Quaternary

During the Pleistocene and Recent periods the following types of formations were deposited:

(1) Dune limestone (aeolianites) and sand forming coastal dunes up to 90 metres in elevation.

(2) Outwash deposits from fault scarps and highland areas and deposition of stream alluvial including gravel, sand, and clay.

(3) Swamp deposits including sand, silt, and peat. Lake deposits resulting from damming by lava flows or coastal dunes. Some of the large lakes contain buried marsupial and other vertebrate animal remains. Aboriginal artefacts and skeletons have been discovered.

(4) Siliceous dune and sheet sand; lake deposits of gypsum and salt in the semi-arid centres of the Mallee country.
(5) Recent siliceous sand in coastal dunes with barrier beaches, sand bars, and sand spits.

Eustatic changes in sea level during the Pleistocene ice age resulted in stranded coastlines, raised beaches and terraces in stream valleys.

The basaltic vulcanicity continued through the Pleistocene into the Early Recent with the extrusion of lava flows and the development of more scoria cones, calderas, and maars in the Western District.

Hydrology

Water resources

The average annual rainfall over Victoria is about 660 mm. As the area of the State is 227,600 square kilometres, the total precipitation is, therefore, about 148 million megalitres. Only 21 million megalitres appear in the average annual flow of the State's river systems. It is not known as yet how much of the remainder soaks underground to recharge groundwater resources, but this will be elucidated by a long-term programme of investigation being carried out by the Victorian Mines Department.

Victoria's surface water resources are unevenly distributed in both space and time. Their distribution in space can be conveniently described by considering the State as being divided into four segments, by an east-west line along the Great Dividing Range and a north-south line through Melbourne. The north-west segment contains 40 per cent of the State's area, and the other three segments 20 per cent each. Surface water resources, represented by average annual river flow, are heavily concentrated in the eastern segments, each accounting for about 40 per cent of the total. The western segments account for only 20 per cent of total flow, with only 3 per cent in the north-west segment.

Quality of stream flow also deteriorates from east to west. Waters of the eastern rivers mostly contain less than 100 parts per million of total dissolved solids. In the western rivers the figure is generally above 500 parts per million, except near their sources, and increases downstream to figures in excess of 1,500 parts per million.

River flows in Victoria exhibit a marked seasonal pattern, and marked variability in annual flow from one year to another and from place to place, affecting the usability of the transitory local surface supplies of fresh water.

Over the State as a whole, about 60 per cent of the average annual flow is accounted for between July and October. In western streams this percentage approaches 75 per cent. Everywhere, flows typically recede in the summer and autumn, at the time of year when water requirements for most uses are at a peak.

Rivers

Stream discharges

Water is a limited resource and a major factor in the development of the State, hence a knowledge of its water resources is essential to their optimum use. Tabular data giving the mean, maximum, and minimum discharges at selected gauging stations are published by the State Rivers and Water Supply Commission in *Victorian River Gaugings to 1969,* containing records of 299 gauging stations.

An average value such as the mean annual discharge is a useful relative single measure of magnitude, but variability is equally important. A crude measure of variability is given by the tabulated values of the maximum and minimum annual discharges; however, the difference between these extremes, termed the "range", will increase with increasing length of record.

Drainage areas and lengths

Other characteristics relating to streams are the size of the catchment and the lengths of the rivers. Drainage areas of gauged catchments are given in *Victorian River Gaugings to 1969*, and the lengths of 230 rivers are tabulated on pages 31-5 of the *Victorian Year Book* 1963.

Drainage areas may be regarded as the hydrologically effective part of a "basin", or the area from which there is "run-off" to the stream. Thus, the whole of any area may be subdivided into basins, but parts of some basins may be regarded as non-effective, being either too flat or the rainfall too small to contribute to normal stream flows. There is little or no contribution in the north-west of the State where the annual rainfall is less than 457 mm to 508 mm. Above this amount, roughly half the rainfall appears as stream flow.

Total flow

The current estimate of mean annual flow is 20,910 million cubic metres each year, about half of which flows into the Murray, the other half flowing southward to the Victorian coast. The geographic distribution of flow is heavily weighted towards the eastern half where the total flow is about 17,220 million cubic metres (with about 9,840 million cubic metres in the north-east and 7,380 million cubic metres in the south-east), hence leaving 3,690 million cubic metres in the western half.

VICTORIA—MAIN STREAM FLOWS

Div.	Basin	Stream	Site of gauging station	Drainage area (square kilometre)	Year gauged from	Annual flows in million cubic metres			
						No. of water years	Mean	Max.	Min.
IV. Murray-Darling	1	Murray	Jingellic, N.S.W.	6,527	1890	80	2,368	6,123	675
	1	Mitta Mitta	Tallandoon	4,716	1935	34	1,269	3,214	273
			Tallangatta	5,058	1886	49	1,411	4,256	250
	2	Kiewa	Kiewa	1,145	1886	84	632	2,071	166
	3	Ovens	Wangaratta	5,827	1941	29	1,572	4,143	221
	4	Broken	Goorambat	1,924	1887	84	247	1,091	19
	5	Goulburn	Murchison	10,772	1882	88	2,139	7,369	145
	6	Campaspe	Elmore	3,212	1886	78	236	820	1
	7	Loddon	Laanecoorie Reservoir	4,178	1891	78	231	740	9
	8	Avoca	Coonooer	2,642	1890	80	76	395	3
	15	Wimmera	Horsham	4,066	1889	77	128	589	..
II. South East Coast	22	Snowy	Jarrahmond	13,421	(*a*) 1922	33	1,814	4,002	381
	23	Tambo	Swifts Creek	943	1965	5	58	121	21
	24	Mitchell	Glenaladale	3,903	1938	32	921	2,188	193
	25	Thompson	Cowwarr	1,088	1901	50	400	680	175
	25	Macalister	Lake Glenmaggie	1,891	1919	51	496	1,533	45
	26	La Trobe	Rosedale	4,144	(*b*) 1901	55	940	3,240	271
	28	Bunyip	Bunyip	661	(*c*) 1908	47	153	304	69
	29	Yarra	Warrandyte	2,328	(*d*) 1892	52	804	1,494	176
	30	Maribyrnong	Keilor	1,303	(*e*) 1908	39	107	327	4
	31	Werribee	Melton Reservoir	1,155	1917	53	79	314	7
	32	Moorabool	Batesford	1,114	(*f*)1908	24	70	221	1
	33	Barwon	Inverleigh	1,269	1966	4	58	102	7
	35	Carlisle	Carlisle River	78	(*g*) 1930	33	38	87	6
	36	Hopkins	Wickliffe	1,347	(*h*) 1921	38	32	127	1
	38	Glenelg	Balmoral	1,570	(*i*) 1889	60	144	540	3

Source: *Victorian River Gaugings to 1969*, State Rivers and Water Supply Commission.

NOTE. Years excluded in estimating mean:

(*a*) 1949–50 to 1963–64
(*b*) 1919–20 to 1928–29 and 1934–35 to 1936–37
(*c*) 1951–52
(*d*) 1933–34 to 1958–59
(*e*) 1933–34 to 1955–56
(*f*) 1921–22 to 1958–59
(*g*) 1943–44 to 1946–47
(*h*) 1933–34 to 1943–44
(*i*) 1933–34 to 1938–39

Location of streams

The location of about 2,500 streams in Victoria may be obtained by referring to the *Alphabetical Index of Victorian Streams* compiled by the State Rivers and Water Supply Commission in 1960. Owing to the replication of names for some

streams, there are over 2,900 names; these have been obtained by examining Department of Crown Lands and Survey and Royal Australian Survey Corps maps, so as to include names which have appeared on them. There are, in addition, many unnamed streams, those with locally known names, and those named on other maps or plans. No attempt was made in the *Index* to suggest a preferred name; this is a function of the committee appointed under the *Survey Co-ordination Place Names Act* 1965.

Stream reserves

In 1881, under the then current Land Act, an Order in Council created permanent reserves along the banks of streams where they passed through Crown land. These are scheduled in the *Township and Parish Guide* reprinted by the Lands Department in 1955. This schedule indicates the location and width of reservations for 280 streams which (except for the Murray) are 20, 30, or 40 metres wide on *each* bank of the stream. The areas thus reserved were not fully delineated until subsequently surveyed prior to alienation.

Further reference, 1964

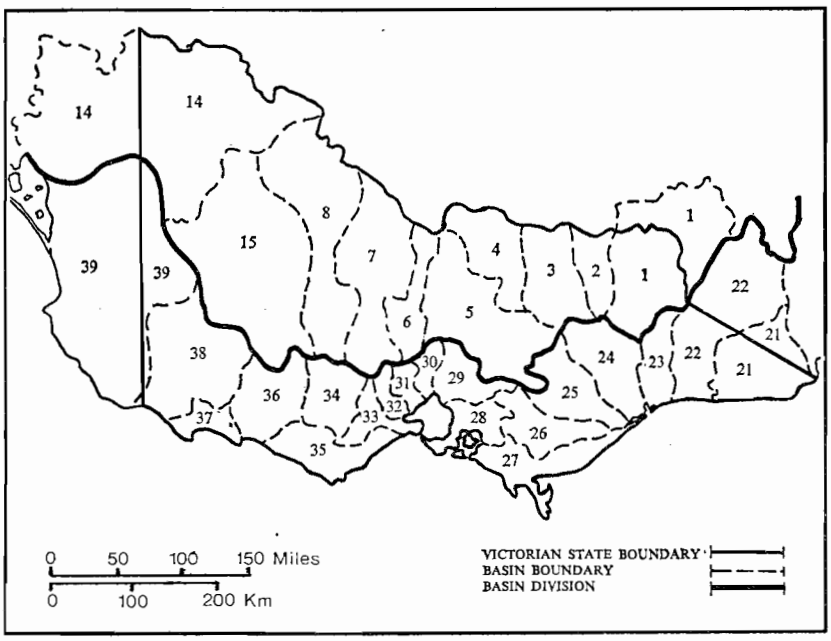

FIGURE 6. Relevant basins of the two Divisions (South East Coast Division and Murray–Darling Division) which include Victoria and some adjacent areas. The basins are numbered as shown on Map 3 (Sheet 2) in *Review of Australia's Water Resources,* published by the Department of National Development, 1965.

SOUTH EAST COAST DIVISION

21. East Gippsland
22. Snowy River
23. Tambo River
24. Mitchell River
25. Thomson River
26. La Trobe River
27. South Gippsland
28. Bunyip River
29. Yarra River
30. Maribyrnong River
31. Werribee River
32. Moorabool River
33. Barwon River
34. Lake Corangamite
35. Otway
36. Hopkins River
37. Portland
38. Glenelg River
39. Millicent Coast

MURRAY–DARLING DIVISION

1. Upper Murray River
2. Kiewa River
3. Ovens River
4. Broken River
5. Goulburn River
6. Campaspe River
7. Loddon River
8. Avoca River
14. Mallee
15. Wimmera–Avon River

Lakes

Lakes may be classified into two major groups: those without natural outlets which are called closed lakes, and those with a natural overflow-channel which may be termed open lakes. For closed lakes to form, annual evaporation must exceed the rainfall: this is the case over most of Victoria.

Closed lakes occur mainly in the flat western part of the State. They fluctuate in capacity much more than open lakes and frequently become dry if the aridity is too high. Lake Tyrrell in the north-west is usually dry throughout the summer and can consequently be used for salt harvesting.

The level of water in an open lake is more stable because as the lake rises the outflow increases, thus governing the upper lake level and partially regulating streams emanating from it. This regulation enhances the economic value of the water resources of open lakes, but Victoria does not possess any natural large lake-regulated streams. However, there are small streams of this type in the Western District, such as Darlots Creek partly regulated by Lake Condah and Fiery Creek by Lake Bolac.

Salinity is often a factor which limits the use of lake water; even the use of freshwater lakes is not extensive in Victoria due to the cost of pumping. The average salinity of closed lakes covers a wide range depending upon the geological conditions of the catchments and the water level.

Lake Corangamite is Victoria's largest lake. It can be regarded as a closed lake, although during the wet period in the late 1950s it rose to within 1.2 metres of overflowing. The total salt content is about 16.32 million tonnes, giving the lake a salinity somewhat higher than seawater under average water level conditions.

The Gippsland lakes are a group of shallow coastal lagoons in eastern Victoria, separated from the sea by broad sandy barriers bearing dune topography, and bordered on the ocean shore by the Ninety Mile Beach. A gap through the coastal dune barrier near Red Bluff, which was opened in 1889, provides an artificial entrance to the lakes from the sea. However, seawater entering this gap has increased the salinity of some lakes, which in turn has destroyed some of the bordering reed swamp and led to erosion. The Gippsland lakes have been of value for commercial fishing and private angling and also attract many tourists. Coastal lagoons of this type rarely persist for more than a few thousand years and as deposition of sediment proceeds and bordering swamps encroach, the lakes will gradually be transformed into a coastal plain.

A number of Victorian lakes and swamps have been converted to reservoirs. Waranga Reservoir is an example of this, as are Lake Fyans, Batyo Catyo, and Lake Whitton in the Wimmera. A good example of lake utilisation is the Torrumbarry irrigation system on the riverine Murray Plains near Kerang in north-west Victoria.

Groundwater resources

Groundwater resources move slowly through pores and cracks in soil and rock and respond sluggishly to seasonal and annual fluctuations in recharge. For this reason, groundwater can be regarded as a generally more reliable source of water through drought periods. However, mapping of resources in terms of depth, yield, and quality is much more complex than the mapping of visible surface resources.

The present position, very broadly stated, is that there are groundwater resources of reasonable quality and yield for domestic and irrigation purposes over about 4,000,000 hectares or about one sixth of Victoria's area, mainly in the far west and south-west and in alluvial valleys in the north and south-east.

On the other hand, there is about half the State's area, in the central and western sectors, where groundwater is generally not available at qualities better than 3,000 parts per million of total dissolved solids.

Groundwater has played a very important part in providing supplies of water for domestic and stock use in pastoral settlement. It is also used for some isolated town supplies, and is being increasingly used for irrigation, the area irrigated from groundwater now being about 12,000 hectares.

For the future, there are prospects of generally increased use for irrigation, and for the augmentation of town water supplies on the south-west coast, in the Barwon Valley, and in Gippsland. However, these prospects can only be clarified by continuing investigation.

Floods

There is a great variation between average and flood flows in Victorian streams and consequently works to prevent total flooding are seldom justified economically, except where large cities are involved. However, it is often possible to prevent damage over a wide range of floods, and even to lessen the damage by large floods which cannot be completely controlled.

Reservoirs built solely to control flooding would have to be of enormous size to be fully effective and would be economically unjustifiable. Suitable sites are also rare along those rivers where flooding is severe. The numerous reservoirs on Victorian rivers, designed for storage of water for irrigation and water supply purposes, also serve to reduce flood peaks, even to some extent by a ponding effect when full.

The construction of levees—to prevent overflow of floodwater from rivers—has been used with varying success in Victoria.

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