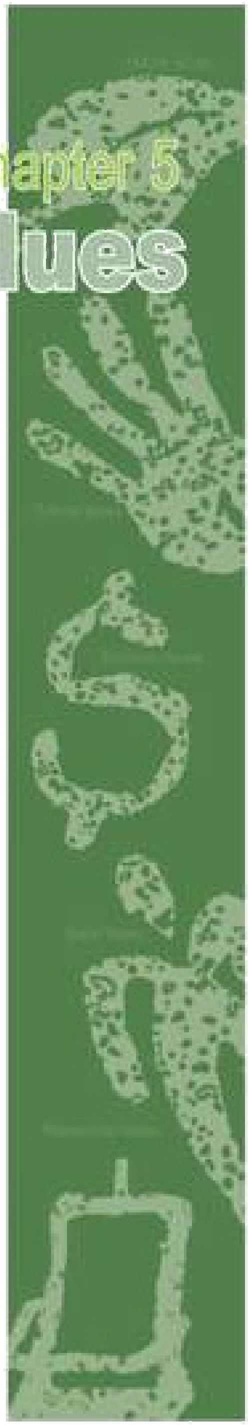
Chapter 5

earth sciences values



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Introduction

The relevant sections of the National Parks and Wildlife Act 1974 (NSW) stipulate that a primary object of the Kosciuszko National park is conservation of significant landforms, geological features and earth processes. Also, management should seek to foster public appreciation and understanding of the earth science aspects of the park and sites of scientific significance. The following discussion has been written with these management aims in mind.

Geology and geomorphology are the basis of the entire Kosciuszko National Park. The geology is well displayed by a geological map at the scale of 1:250,000 (Wyborn et al. 1990). Copies of this map may be obtained from the Australian Geological Survey Organisation (AGSO) in Canberra. There is quite an extensive scientific literature bearing particularly on the solid geology, the effects of glacial and periglacial processes and the soils.

Earth science features of the park can be conveniently divided into four time-based groups. Each is discussed here with comments on significance at national, state and park levels.

- Ordovician to Lower Devonian (approximately 430-370 million years old). These rocks form the bedrock of the entire area. The formation of these rocks was followed by a prolonged period of erosion that lasted into the Tertiary.
- Tertiary (about 50 –2 million years ago). Uplift and continued erosion were features and basalt and stream sediments formed in the Miocene (about 20 million years ago).
- Pleistocene (the last 2 million years). Great climatic changes occurred, particularly over the period 70-10,000 years ago, that produced glacial and periglacial features.
- Holocene (approximately the last 10,000 years). The climate and earth processes have been roughly similar to those of today.

Ordovician to Lower Devonian

Description

The Ordovician to Lower Devonian sedimentary rocks are mainly sandstone, siltstone and shale forming greywackes deposited in deep marine environments, but including shallow-water limestones found at Cooleman in the northeast, Yarrangobilly in the centre and Indi in the extreme southwest. Some volcanic rocks occur, chiefly in the northern third of the area, including the Mount Jagungal Basalt which is the oldest rock in the park. These volcanics were extruded mainly under marine conditions but include some sub aerial occurrences. Granitic rocks were intruded at depth in Silurian and Devonian times, and now underlie most of the southern half of the park and the Bogong Peaks wilderness area in the northwest, plus scattered occurrences elsewhere. These rocks have been extensively affected by folding and faulting. LAI Wyborn (Table 3 in Good 1992) lists the following particularly significant geological features of this age.

- Geehi Valley: metamorphic rocks with abundant garnet, staurolite and amphibolite;
- Ravine Basin: Devonian shallow water sediments;
- Mount Talbingo: Devonian lava flows forming cliffs;
- Cabramurra serpentine along major faults with nickel and chromium;
- Cooleman Plain: Silurian limestone and chert;
- widespread Ordovician marine sediments forming hard quartzites and softer phyllites and schists;
- Tumut Ponds, Tantangara, Kiandra and Byadbo areas: graptolite fossils;
- The Pilot and Byadbo: Ordovician hard, green, platy quartzite;
- Yarrangobilly: Silurian limestones, fossils, shales and tuffs;

Geology and geomorphology are the basis of the entire Kosciuszko National Park.”

- Cowombat Flat, Marble Creek and Pilot Creek: limestones and tuffs;
- Pilot Ridge and Cowombat Flat: Devonian rhyolites and breccias;
- Main Range: three types of granitoid rocks;
- Nungar: folding of Bowning tecontic episode;
- Cooleman: slump bed folding; and
- Black Perry: skarn rock with garnets.

Knowledge of the solid rocks has been enhanced by the extensive and intensive studies required for the Snowy Mountains Hydro Electric Scheme and the ski tunnel between Bullocks Flat and Blue Cow Mountain. Economic minerals, including gold, copper, tin and lead accumulated at many places but mostly as minor occurrences.

After the Mid Devonian, the area was subject to prolonged erosion for some 250-300 million years which exposed the granites and reduced the area to a lowland with ridges on more resistant rocks. Some features of this lowland have been partially preserved by the Miocene basalt: notably, a north-flowing valley near Kiandra. Part of the Great Divide that separates west and east-flowing drainage in New South Wales now occurs in the park.

Condition

These rocks are obviously robust and in their natural condition.

Trend in condition

These rocks are a permanent feature of the landscape and, assuming quarrying and mining continue to be banned, no change in condition is expected. Possibly there may be some reduction in their scenic value if additional buildings and roads are created. No special management is required to maintain their condition other than retention of the existing ban on prospecting, mining or unlicensed collection of samples.

Significance

These rocks form part of the Lachlan Fold Belt that occupies much of eastern Australia (Wyborn LAI 1977). They are of national and state significance. Areas of particular significance at state and park levels are the limestones with associated karst features (discussed by A Spate in Chapter 7). The landforms surviving from the later part of this period and on into the Tertiary are likewise of significance in understanding the evolution of much of southeastern Australia, including the history of the Great Divide.

Gold around Kiandra and the Grey Mare Range, copper and gold at Ravine-Lobs Hole and in the southwest were economically significant and formed the basis of former mining activities. The surviving associated cultural features (discussed in Chapter 13) are now of state and park significance.

Pressures

While the major rocks and landforms are immune to any conceivable pressure, large numbers of visitors can affect their scenic attractiveness by damaging the overlying soil and vegetation. This is occurring around Mount Kosciuszko. It is conceivable that pressure will arise from fossickers seeking fossils in the limestones and interesting minerals such as the garnets at Black Perry Mountain. Construction of roads and building can reduce the scenic attraction of the area.

Opportunities

There is some scope for educational signing at conveniently situated outcrops, notably the quarry on the road between Dead Horse Gap and Tom Groggin. Provision of leaflets setting out the geological story would assist leaders of educational excursions.

Knowledge gaps

There is much scope for more detailed geological mapping in most parts of the park. Research by university and state geologists will gradually meet this requirement (e.g. Wyborn, LAI 1977, Wyborn D 1983). Such future research should continue to be controlled through licensing by the New South Wales (NSW) National Parks and Wildlife Service.

Indicators

In accord with the permanency of the rocks in terms of human lifespan, indicators of changing condition are not apparent in the values themselves but there may be changes in their accessibility and visibility. A good cover of soil and native vegetation indicates good condition while bare rock surfaces, slumps and gullies indicate poor and probably deteriorating condition.

Tertiary

Description

Earth movements in the Tertiary uplifted the area, especially in the south and west, enabling stream erosion to cut deep linear valleys along lines of rock weakness, such as the Thredbo Valley aligned along the Crackenback fault. The dissection resulting from the Tertiary uplift has produced spectacular scenery – notably the mile-high drop from the summits of the Main Range to the Geehi Valley. Miocene basalt extruded over the central part of the park covered stream valley deposits of lignite, silt and clay containing alluvial gold and fossils of rainforest trees. Later erosion has reduced the basalt to scattered remnants.

Notable areas and features of the Tertiary geology as listed by LAI Wyborn (in Good 1992) include:

- Round Mountain: Tertiary basalt flows;
- Kiandra, Cabramurra and Yarrangobilly: columnar basalt pinnacles; and
- New Chum Hill, Golden Crown and Round Mountain: Tertiary sediments.

The wet and warm climate of the Tertiary favoured deep weathering. The effects are still visible in road cuttings throughout the park where granite has lost its cohesion but is still in place. Over much of the park, later erosion has removed some of this unconsolidated material to leave resistant core stones exposed as tors. Some insights into the landform history can be found – for example, the sub-basalt valley at Kiandra and the mature gentle slopes of upper valleys (e.g. Long Plain) perched above deep lower valleys cut by later erosion.

Condition

The major landforms resulting from the geomorphic history of the Tertiary are generally robust, as is the Tertiary basalt. The surviving remnants of the Tertiary stream deposits are liable to loss by erosion. The evidence of deep weathering was clear in fresh road cuts made when the Snowy Scheme was under construction, but in many places it is now obscured by rain wash, slumping and vegetation.

Trend in Condition

While the scenery will survive unchanged in terms of human lifetimes, there will probably be a gradual deterioration in accessibility and visibility of the mining evidence. However, reasonable maintenance should maintain the surviving features indefinitely. Ironically, further loss of evidence of deep weathering in road cuts will be caused by soil conservation measures.

Significance

The spectacular scenery of parts of the park, notably the Geehi Valley, is certainly of Australia-wide significance. The gentler relief typical of most of the park has state-wide significance. The rainforest fossils found in stream sediments under basalt at Kiandra are rare testimony of a time when Australia's climate and vegetation were very different and contribute to understanding the climatic evolution of the entire continent. The alluvial gold was the focus of an important gold rush around 1850, followed by half a century of placer mining. The relics of the mining are significant at state and park levels. The deep weathering of granitic rocks seen in road cuttings is a common feature in Australia and most mid- to low-latitude countries; it is of park significance only.

Pressures

Some increase in tourist pressure on the more accessible mining sites can be expected. However, because these sites are well away from the main attractions of the ski areas and the highest country, such pressures should not be unsustainable. Any attempt to resume mining would greatly increase pressure but is most unlikely to happen.

Opportunities

If major faults are exposed in road cuttings, information notices would be helpful. Public knowledge of deep weathering effects could be furthered by suitable notices.. Deeply weathered granite in place is well exposed in road cuts near Island Bend and is regularly demonstrated to geology students on field trips.

Knowledge gaps

There is always scope for more research and knowledge about these rocks and the geomorphic history. Such research is best carried out by academic researchers under park licensing.

Indicators

As was the case for the older rocks, no visible change is to be expected in the rocks themselves but access and visibility may be affected. A good cover of soil and native vegetation indicates good conditions, while bare rock surfaces, slumps and gullies indicate poor, and probably deteriorating, condition of the sites

Pleistocene

Description

During the Pleistocene, comprising about the last two million years, the world experienced remarkable climatic events, including the repeated growth and decay of immense ice sheets in North America and Europe, while glaciers developed on mountain ranges through the world. In Tasmania there were several extensive glacial events but, on present evidence, in mainland Australia only the very highest land in the Kosciuszko National Park had small glaciers during the last part of the Pleistocene. Cold-climate periglacial processes beyond the ice were more extensive and produced distinctive landforms and deposits.

Glacial features of the park include cirques, moraines, lakes, erratics and ice-scratched surfaces. The cirques formed mainly in the lee of the Main Range where accumulation of snow was maximal and melting minimal. Some 13 cirques have been identified (Galloway 1963, Barrows et al. 2001).

Both terminal and lateral moraines occur. They usually form bouldery ridges but one case of hummocky moraine exists in Mawson's cirque. Radiometric dating of boulders in the moraines has shown that there were several successive ice advances and retreats during the last glaciation (sens lat) (Barrows et al. 2002).

There are five glacial lakes. Only Blue Lake is at least partly formed by glacial erosion of the bedrock; the others are shallower features formed by morainic dams. Pollen in lake sediments has provided valuable evidence of vegetation and climate changes since the ice disappeared about 15,000 years ago (Martin 1986).

Glacial erratics are rocks ranging in size from pebbles to boulders which differ from the underlying bedrock. They are believed to have been transported to their present position by former glaciers. Erratics near the cirques provide incontrovertible evidence for glacial transport but elsewhere their significance is problematic because of imperfectly known variations in the underlying bedrock and because rocks on the surface can creep downhill from one lithology to another. Further confusion can be caused by anomalous material imported to make roads and tracks.

Ice-striated surfaces that occur on lower slopes overlooking Lake Albina demonstrate the former direction of ice movement. Ice-smoothed rock surfaces are well developed in Blue Lake cirque.

The periglacial evidence is less striking but more widespread and can be found in most areas above the 1000 m contour and possibly as far down as 600 m. Features include frost-shattered bedrock, boulder fields, solifluction deposits, stone streams, stone-banked lobes, non-sorted steps and nivation features.

Frost-shattered Ordovician sedimentary rock – evidence of former permanently frozen ground (permafrost) - is exposed in a roadside quarry one kilometre east of Mount Kosciuszko. This is almost the only evidence for past permafrost known in mainland Australia. Angular rock debris around tors at high altitude is a product of former frost-wedging.

In many parts of the park, solifluction (the downslope movement of unconsolidated rock debris by freeze-thaw processes, interstitial ice and snow melt) has produced smooth slopes. The northwest-facing slope of the Kangaroo Range is a good example. Where the debris included boulders, the fine fraction may be subsequently washed out to leave boulder fields and stone streams (Caine and Jennings 1968) which are now a favoured habitat for the Mountain Pygmy-possum. Striking block streams, dated to about 20,000 years ago occur at about 1100 m altitude near Ravine. In detail, solifluction can result in irregular low steps formed by the fronts of solifluction lobes and terraces. Sometimes these fronts are barely discernable through soil and vegetation (e.g. on the Kerrie's Range). In road cuttings, solifluction deposits can be seen to fill valleys and gullies cut in the weathered granite.

Nivation is a complex of land-forming processes found in and around long-lasting snow patches, particularly where the ground surface is bare. It includes splitting of rocks by freeze-thaw and mass movement of wet soil and rock debris. In the long term it produces shallow hollows that form incipient cirques; there are many such nivation hollows in the higher parts of the park (e.g. the Rolling Grounds).

Condition

The glacial features are generally clearly visible, although the older ones have lost much of their pristine form through natural erosion. Glacial erratics have become more difficult to find since the termination of grazing has encouraged vegetation to recolonise bare areas The periglacial deposits are best exposed in road cuttings and quarries where they gradually become less identifiable because of rain wash, growth of vegetation and soil conservation measures. A road has cut through the block stream at Ravine.

Trend in condition

Continued obscuring of relevant exposures through vegetation growth and soil conservation measures is to be expected. The quarry showing permafrost evidence near Mount Kosciuszko mentioned above will be concealed for reasons of conservation.

Significance

The glacial features are of high scientific and educational significance for Australia. They are an outstanding example of a glaciation that developed under extremely marginal conditions (Galloway 1989) and are the only occurrences on the Australian mainland. They also help our understanding of ice age climates. The Helms moraine near Blue Lake is a particularly clear example of glacial transport of one kind of rock onto another. The so-called 'Railway Embankment' moraine near Mueller's Pass is another example. It is also the site of an early estimate for the date of glaciation (David et al. 1901) and is consequently significant for the history of geology in Australia. The periglacial phenomena are amongst the most striking in Australia and demonstrate that the effects of cold climate in the Quaternary spread far beyond the limited glaciers.

Pressures

The glacial features are well outside the ski resort concessions and consequently should not experience greatly increased pressure although there will be some increase in foot traffic along and near access tracks. The more widespread periglacial features may suffer some loss through building and road construction. On the other hand, such work may expose new examples of solifluction deposits. A more immediate possible pressure is the smoothing of ski runs. In the past there has been some bulldozing on ski runs but such extreme measures are not now employed.

During early stages of constructing the Snowy Mountains Hydro Electric Scheme it was proposed to dam Spencers Creek. This would have seriously affected the integrity of the landforms, especially the ridge known as the David Moraine (whose morainic origin is very dubious). However, the proposal was abandoned and is no longer a problem although traces of disturbance by exploratory excavations still exist.

Opportunities

There is considerable public interest in the glacial history of the park but the periglacial story is less well known. Opportunities exist for informing the public with signs at appropriate locations. Existing signs may need to be updated in the light of recent research. There is a case for recording features temporarily exposed during construction of roads and buildings. It may be possible to illustrate the development of a small glacier by means of a kaolin model that could be an item in an educational video on the park.

Knowledge gaps

There is scope for further radiometric dating (Barrows et al. 2002) to increase understanding of both glacial and periglacial history. Current work in progress is successfully dating block streams. More detailed mapping of the granites and inclusions of other rocks therein should assist in resolving the question of exactly how far the ice extended and whether earlier glacial events occurred. There are probably many evidences of past vegetation such as described by Caine and Jennings (1968) still to be discovered under solifluction layers and many more periglacial features remain to be identified. All such research will need to be done carefully in view of the need to avoid damaging the environment.

Knowledge gaps more relevant for conservation include the distribution of periglacial features in relation to proposed development. Also of potential importance is the location of old gullies cut in the soft weathered granite and then later infilled by solifluncted material. The presence of one such gully may have contributed to the Thredbo landslip disaster.

Indicators

Indicators of changing condition include fresh rock surfaces stripped of their usual lichen cover, soil erosion and damaged vegetation.

Holocene

Description

By 15,000 years ago the last glaciers had melted as the climate warmed with the close of the ice age. The tree line, which had been lowered by as much as 1000 m at the glacial maximum, gradually rose to near its present level at around 1850 m. By 10,000 years ago the climate was broadly similar to that of today. Earth science phenomena in the Holocene are intimately interlinked with the development of soils and vegetation.

Holocene land-forming processes in the park include solifluction (less intense than during the Pleistocene), erosion, nivation, frost heaving of soil (Costin and Wimbush 1973), stone movement by snow pressure (Costin et al. 1973) and the formation of string bogs (narrow turf contour ridges separating elongated ponds).

At high altitudes, solifluction of frost-shattered debris and soil on the Ordovician sedimentary rocks has created non-sorted steps, lobes and terraces on slopes. These features are now largely inactive but a slight decrease in mean temperature could reactivate them (Costin et al. 1967).

Erosion of soils and other fine-textured surface materials has been significant in the Holocene. At least 7 m of sediment has been washed into Blue Lake since the ice disappeared 15,000 years ago. This process is still active today and substantial soil erosion control works have been necessary as discussed in Chapter 6 of this report.

Nivation is most active today on the upper slopes overlooking glacial cirques and in other south- and east-facing hollows where thick snow drifts accumulate in winter and survive through spring into summer. Effects of nivation include mass movement of wet unconsolidated material, movement of boulders by snow pressure, frost heaving of soils and accelerated surface wash.

Condition

Over most of the park, Holocene processes and deposits are generally in reasonably good condition but there are limited areas of concern such as the heavily impacted summit of Mount Kosciuszko and parts of ski concessions. It has been feared that 'snow farming' in ski concessions could lead to unwanted surface changes. While this may be true for vegetation and soil

(Pickering and Hill in press) the depths of snow involved are substantially less than would be required for full nivation to occur (Galloway et al. 1998). Active stream bank erosion around Blue Lake is cutting away sediments with potential value for dating.

Trend in condition

In the last century and a half stock grazing, road construction, mining and engineering works have had major impacts on the area of the park. The completion of the Snowy Mountains Hydro Electric Scheme, soil conservation efforts and walkway construction have now helped to re-establish more natural, gradual Holocene processes. On the other hand, the increasing tourism in the park and the growth of skiing have inevitably added new pressures. The effects of the 2003 fires and the associated fire-fighting measures such as bulldozing access tracks will also adversely affect the condition for years to come. In future, nivation may be reduced if snowfall decreases as a result of climatic warming. However, no significant change in snow fall is yet apparent even though there has been some warming (Osborne et al. 1998).

Significance

In the park surface processes such as soil erosion, frost heaving and solifluction can be observed under the present climate in a great variety of situations. The park can thus serve as a benchmark for processes in more heavily impacted regions elsewhere giving it state level significance. In particular, it offers comparison with alpine areas in Victoria that are subject to more stock grazing although the advent of horses in the Kosciuszko alpine zone is now tending to reduce this contrast. The pollen evidence for past vegetation and climate is of state and even national significance.

Pressures

Pressures on Holocene phenomena are inevitably linked to changes in park usage with some pressures concentrated in heavily used areas such as Perisher and the Kosciuszko summit. Pressures from bushfires, on the other hand, can occur almost anywhere. These pressures will be apparent through their effect on vegetation and soils.

Opportunities

Study of the depositional history of alluvial fans might throw light on the possibility of flood damage after exceptionally heavy rain. This is a problem in Swiss ski areas and may arise here if more intense rain results from the greenhouse effect. The evolution of alluvial flats over the last six decades could be studied using successive generations of air photographs. This air photo record could also provide a useful picture of the park not long after the great 1939 fires for comparison with what is happening after the 2003 fires.

Climate studies and observations are relevant to Holocene earth sciences. Re-establishment of the Spencers Creek climate station at the same site as in the 1950s and 1960s might be possible using solar-powered, unmanned equipment. This would enable climate change in the mountains to be tracked more effectively. It is important that the existing snow courses are maintained; their value as records of snow history increases year by year.

Knowledge gaps

Topics worth investigating include what effect will the use of artificial snow have on stream processes? How much erosion and other effects might occur in a 100 year flood? Will significant climatic change occur and, if so, what will be its effects on earth processes?

Indicators

A good cover of native vegetation and soil indicates good condition while bare earth and soil erosion indicate bad, and probably deteriorating condition. Monitoring at 10 year intervals of sediment accumulation in lakes and dams throughout the park could provide useful indication of current soil loss rates for comparison with the high rates recorded for parts of the Main Range (see Chapter 6) and with the long record of sediment accumulation in Blue Lake.

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