

Geothermal systems

Geology

New Zealand is known world-wide for its outstanding geothermal attractions. In fact, the Whakarewarewa geothermal field (in the Bay of Plenty) is the most visited tourist attraction in New Zealand. However, geothermal landscapes are far more than just visually fascinating features such as geysers and boiling mud pools. They are also important because of their cultural significance, economic value as energy sources, potential for scientific study, and as outstanding examples of geological variety and natural ecosystems that are home to many unusual plants, animals and micro-organisms.

Geothermal systems involve natural heat found within the Earth. A geothermal field is created when cool ground water from rain, snowmelt, rivers or lakes comes into contact with hot rocks underground. As the water is heated, it becomes less dense than the colder surface water and then rises to the surface via faults to discharge as geysers, fumaroles, hot springs and other thermal features.

Most intensive geothermal systems are associated with young and active volcanism, and are located in the Taupo Volcanic Zone, between Mt Ruapehu and White Island. This region contains almost 80 percent of New Zealand's geothermal systems. The most famous of these is the Rotorua geothermal field, which contains over 1200 geothermal features. Other geothermal features occur in the Far North, the Hauraki Gulf, and in scattered hot springs in the North and South Islands.

The enchanted fire

Māori legend describes the origins of 'ahi tipua', the sacred or enchanted volcanic fire. The explorer Ngatoro-i-rangi climbed Mt Tongariro to gain a good view of the surrounding land and to claim its features for his tribe. However, a bitter south wind blew at the snow-clad summit and he nearly died. He called on the fire gods Te Pupu and Te Hoata for help, and they travelled underwater from Hawaiki with the ahi tipua to save him.

First they surfaced at Whakaari (White Island), later at Rotorua and a number of other places en route, then bursting out at Tongariro to warm Ngatoro-i-rangi. At every place they emerged they left the fire, preserved in the boiling springs and mud pools of our thermal areas today.

For Māori, geothermal features continue to hold a spiritual and historic significance. They see themselves as kaitiaki (guardians) of the geothermal resource, ensuring their use for future generations. Traditional uses include bathing, cooking, washing, medicines, dyes and for rituals.

Geothermal features

A wide variety of geothermal features are formed by the discharge of heated water and steam at the Earth's surface. The variety depends on fluid temperature, pressure, dissolved constituents and gas, composition and structure of the host rock, its permeability and the age of the geothermal system. The geothermal fluids rise to the surface as steam, superheated water, water below boiling point or

mixtures. A wide range of gases and minerals can be emitted or precipitated during the discharge.

- Discharge of brines creates hot springs some of which form relatively passive pools while others release large quantities of gas.
- Geysers are formed when a pocket of groundwater accumulating and heating under pressure is finally heated to boiling point so that large volumes of steam are produced. This pushes up and out of the underground pocket carrying water with it. As it rises the pressure on it reduces so more and more steam is formed, until it ejects out at the surface as a column of steam and water. New Zealand is one of only seven countries in the world that has active geysers.
- Fumaroles, or steam vents, and steam heated ground are formed where water boils underground so that only steam reaches the surface.
- Boiling mud pools are created in places that have limited hot water but an abundant supply of steam and rock material of a type that breaks down into mud. Hydrogen sulphide gas (which creates the rotten egg smell common to thermal areas) in the steam reacts with oxygen generating sulphuric acid. This dissolves the surrounding rock into fine particles of silica and clay that mix with what little water there is to form the seething and bubbling mud pools.
- Silica terraces and flats are formed over tens to thousands of years as hot geothermal waters flow out over the land, cooling and releasing silica and other minerals. New Zealand has had



Lake Rotohama,
Waimangu Scenic
Reserve



some of the largest silica terraces in the world, including the once famous Pink and White Terraces near Rotorua, which were considered to be the eighth wonder of the natural world until they were completely destroyed by a volcanic eruption of Mt Tarawera in 1886.



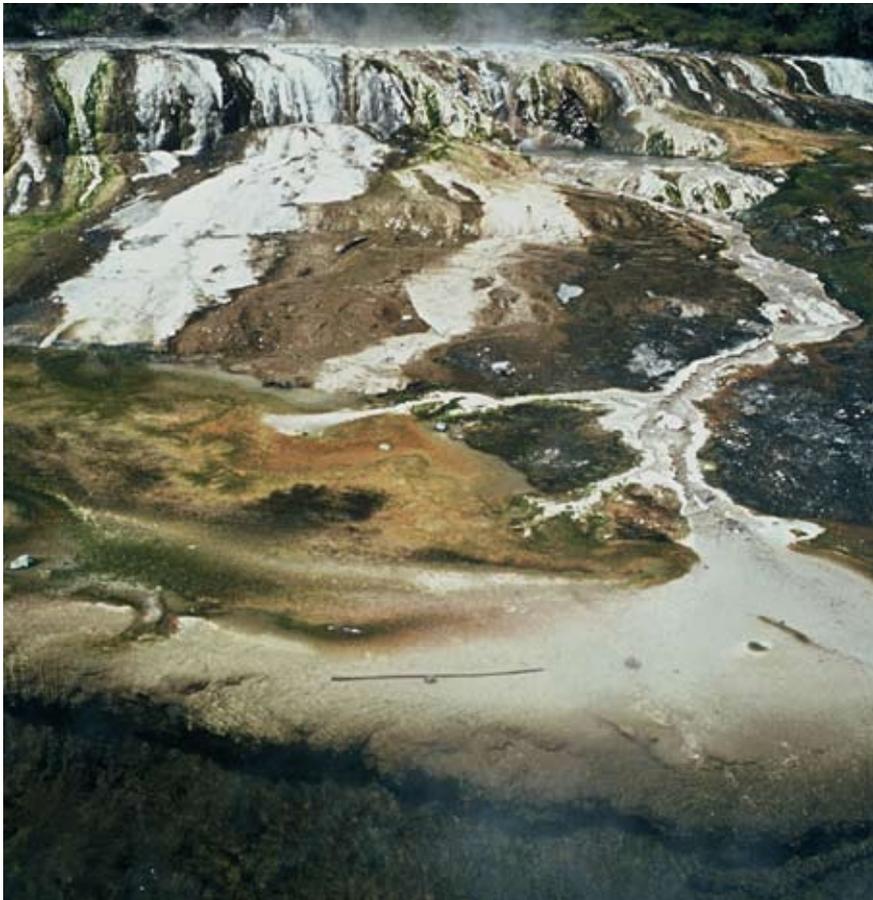
Champagne Pool,
Waiotapu Scenic Reserve

Did you know?

Many unusual plants, animals and micro-organisms inhabit New Zealand's geothermal areas. Their resilience and ability to withstand incredibly hot temperatures and extremely acidic water and soil conditions make them fascinating and special species. Some of our endemic species that live in geothermal areas include:

- A specially adapted leech that lives in the acidic waters of Lake Rotokawa.
- A midge endemic to the alpine geothermal area of Ketetahi springs.
- A low-growing variety of k nuka that grows only on the warm ground of geothermal areas.

The micro-organisms found in geothermal water are believed to be closely related to the first organisms on earth. They are known as "extremophiles" because of their ability to survive in extreme conditions, and they have a number of potential uses in industrial processes, food and medicine.



Silica Terraces, Waimangu Scenic Reserve

Threats

Geothermal features are often extremely fragile, easily damaged and usually irreplaceable. Relatively small changes in water level, water composition, pressure and temperature can be catastrophic.

Since the 1950s, more than three quarters of New Zealand's geysers have been lost, including features at Wairakei (through extraction of geothermal water) and Orakeikorako (drowned when the Ohakuri hydrodam was built on the Waikato River).

Other threats to geothermal systems

- Extraction of fluids and energy has affected and reduced the extent of geothermal features and vegetation. New Zealand extracts 18 percent of its primary energy supply from geothermal sources. This figure is expected to increase to 30 percent over the next 25 years.
- Urban and industrial development adjoining the geothermal fields has already destroyed much of the associated shrublands and rare plants.
- Concreting, pipes, trenches and other structures around thermal pools damage natural features. Surface gravel on pathways can wash onto geothermal features, sometimes permanently smothering mud pools and geysers and defacing silica terraces.
- Deliberate and accidental introduction of exotic plants (pines, bamboo, hakea, grasses and acacias) damages native ecosystems and the natural character of geothermal areas.
- Activities such as rubbish dumping, walking off marked tracks, plant removal and throwing rocks onto sensitive sites such as silica terraces may seem insignificant but collectively can cause significant damage.
- In some areas, mud from active geothermal features has been removed for therapeutic and cosmetic purposes. Geothermal mud pools do not regenerate quickly.
- Natural processes such as earthquakes, volcanic and geothermal activity and mineralization can lead to changes in pressure and temperature gradients or fluid storage, or physically disrupt them

How can you help?

When visiting a geothermal area, please remember to:

- Keep to the tracks and do not walk on silica terraces.
- Do not pick plants.
- Do not ride bicycles (unless this is specifically provided for).
- Do not drop rubbish or throw stones onto geothermal features.

Help protect our geothermal heritage and don't tolerate those who would destroy it!