USES FOR GEOTHERMAL FLUID

The two main ways geothermal resources can be utilised are power generation and direct use of heat. The choice between the two depends on the features of the geothermal fluid, such as temperature and geochemistry.

- **Electricity generation:** In flash steam geothermal power stations, steam extracted from a geothermal reservoir via production wells is used inside turbines to generate electricity. After leaving the turbine, the steam condenses, is injected underground, and returns to the geothermal reservoir for production. In this way, geothermal power plants are considered "renewable energy" as the water is not wasted, and the heat in the system is constantly being renewed by the heat source.
- **Direct use – heating:** There are two ways to use geothermal fluid for heating: using the geothermal fluid directly, e.g. in hot pools, or transferring the heat to another fluid such as clean water via a heat exchanger, e.g. for space heating and industrial heating processes.

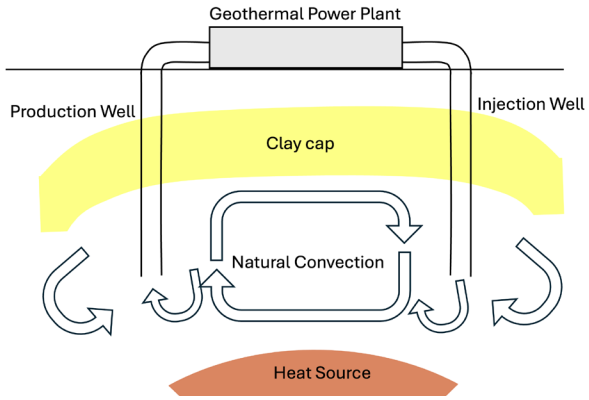
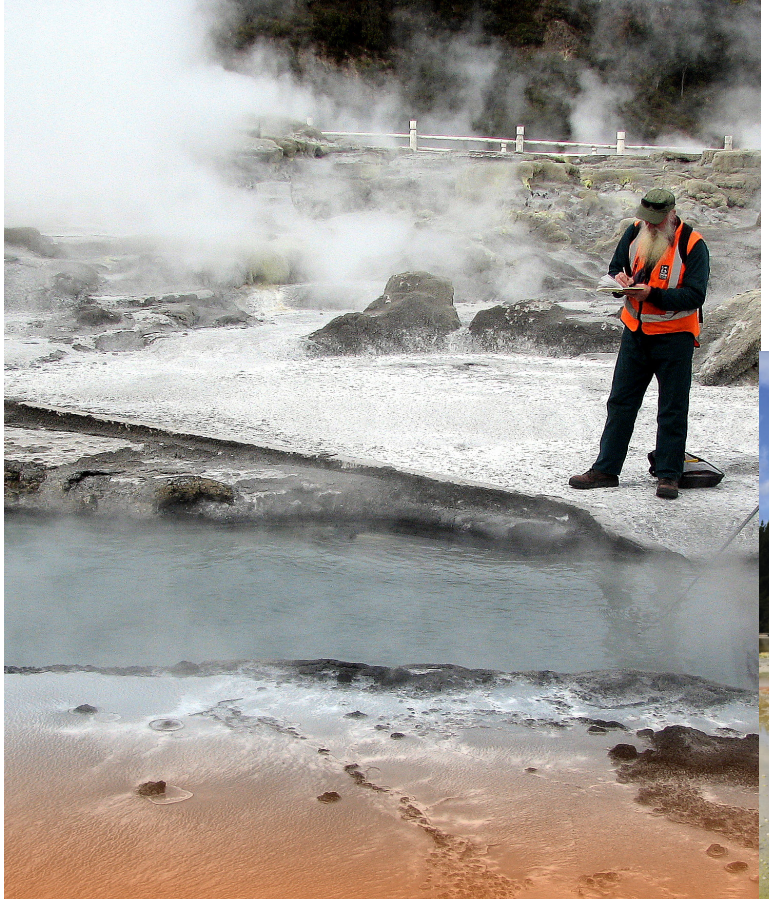


Figure 5 Geothermal Power Plant (revised after Gangly and Mohan Kumar, 2012)

TOP 6 MAIN PURPOSES OF DIRECT USE

1. Geothermal Heat Pumps
2. Bathing/Swimming
3. Space Heating
4. Greenhouse Heating
5. Aquaculture Pond
6. Industrial

(Lund and Toth, 2021)



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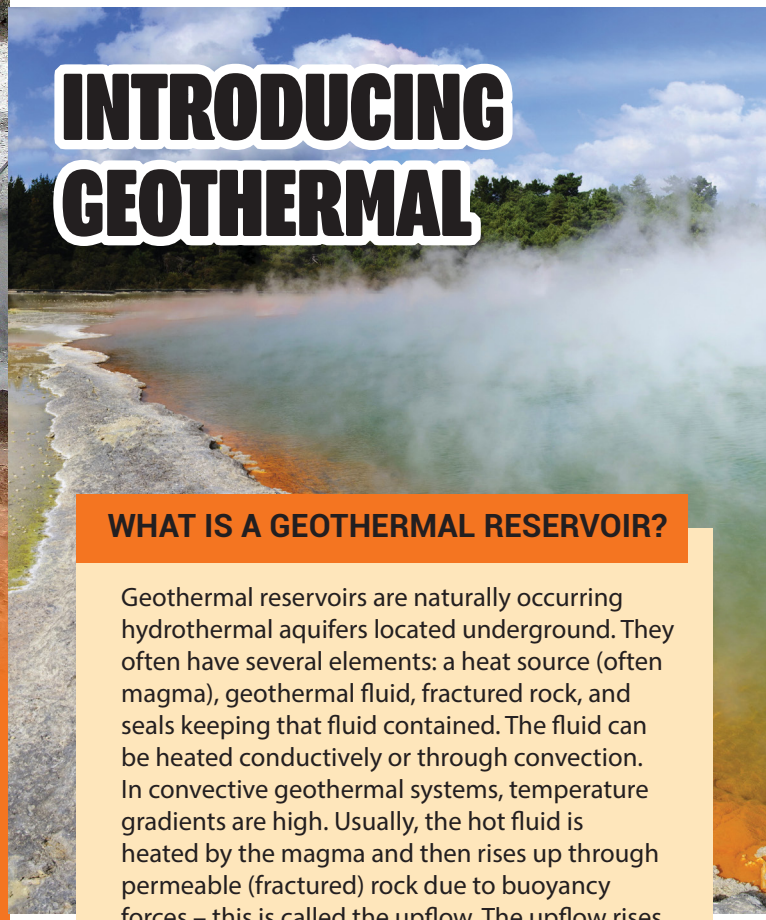

INTRODUCING GEOTHERMAL

WHAT IS A GEOTHERMAL RESERVOIR?

Geothermal reservoirs are naturally occurring hydrothermal aquifers located underground. They often have several elements: a heat source (often magma), geothermal fluid, fractured rock, and seals keeping that fluid contained. The fluid can be heated conductively or through convection. In convective geothermal systems, temperature gradients are high. Usually, the hot fluid is heated by the magma and then rises up through permeable (fractured) rock due to buoyancy forces – this is called the upflow. The upflow rises until it hits an impermeable clay layer that acts as a seal (often called the clay cap), and the fluids then move laterally, producing an outflow.

Hence, the geothermal fluid circulates under the cap, keeping a large volume of reservoir rocks at a high temperature. The hottest part of the reservoir can reach more than 300°C.

GEOTHERMAL RESERVOIR IS MADE OF ....

- Heat Source (magma)
- Fluid (hot water and/or steam)
- Permeable Zone (fractures/permeable rocks)
- Seals (clay/impermeable rocks)

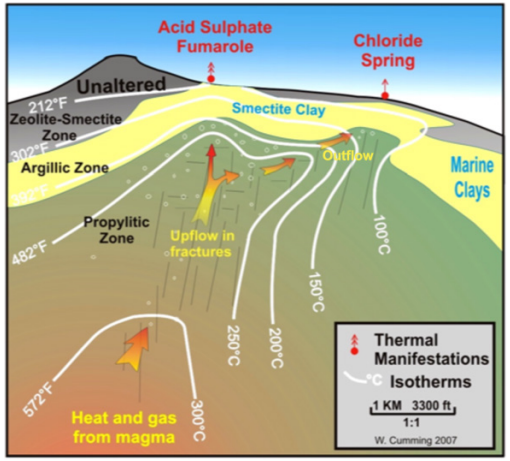

Figure 1 Conceptual Cross-Section of a Geothermal Reservoir (revised after Cumming, 2007)

CULTURAL SIGNIFICANCE

Geothermal surface features such as hot pools, steaming ground, and geothermal craters play an important part to Māori. They occur when hot water or steam escape from the reservoir. A taonga (treasure), different fields and features hold significance including being a place for bathing, cooking, and tourism. The Champagne Pool in Wai o Tapu is one of the examples for tourism locations (Figure 2). See 'Māori and Geothermal' fact sheet for more detail.

Figure 2 Champagne Pool, Wai o Tapu

WHERE THEY ARE LOCATED

Located at the Pacific and Australian plate boundary, Aotearoa-New Zealand has a wealth of world-class geothermal systems (Figure 3). The most famous geothermal resources are found in the Taupō Volcanic Zone (TVZ), which is an extension of the Kermadec Arc. The tectonic movement in TVZ causes the crust to stretch, meaning magma is closer to the surface to more easily generate volcanoes and geothermal activity.

Throughout many other parts of New Zealand, there are a number of cooler geothermal systems. These often present themselves as hot or warm springs. An example is along the Alpine fault in the South Island, where places such as Hamner Springs use the hot water for bathing.

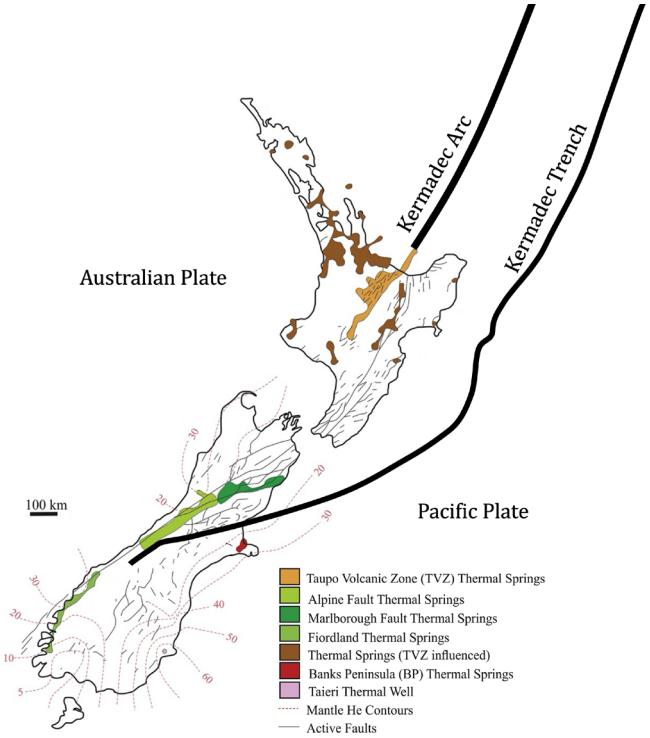

Figure 3 Location of hot springs in NZ (revised after Griffin et al., 2017)

SYSTEM CLASSIFICATION New Zealand

Geothermal fields in New Zealand are classified into four groups by regional councils, which regulate geothermal activities in New Zealand to maintain sustainable usage and protect precious environmental and cultural resources.

SYSTEM CLASSIFICATION

- Development Systems
- Limited Development Systems
- Research Systems
- Protected Systems

INTERNATIONAL GEOTHERMAL FIELDS

New Zealand's geothermal resources are a typical example of a geothermal system formed in the Ring of Fire (Figure 4). The Ring of Fire is a geologically active area, where neighbouring tectonic plates push against or away from each other, known as plate boundaries. Approximately 90% of the earthquakes and 75% of the Earth's volcanic activity occur here (National Geographic, 2024). Geothermal activity is associated with volcanic activity, and is concentrated in this area also.

There is also volcanism and geothermal in other areas, such as in Iceland, which is an extensional plate boundary, and in Hawai'i which is a hot spot of volcanism in the middle of a tectonic plate. Some types of geothermal fields are not associated with volcanism at all, for example hot aquifers in deep sedimentary basins.

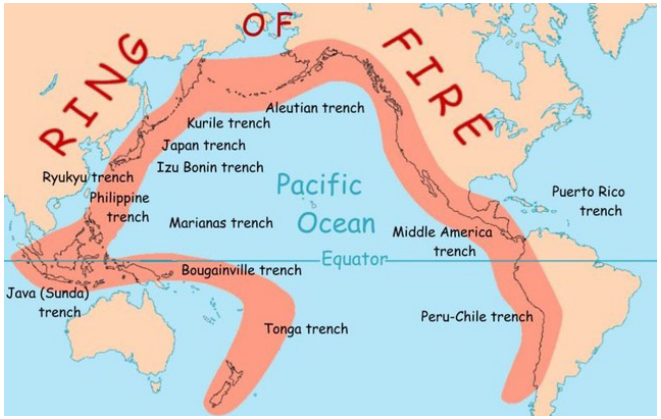

Figure 4 Ring of Fire (National Geographic, 2024)