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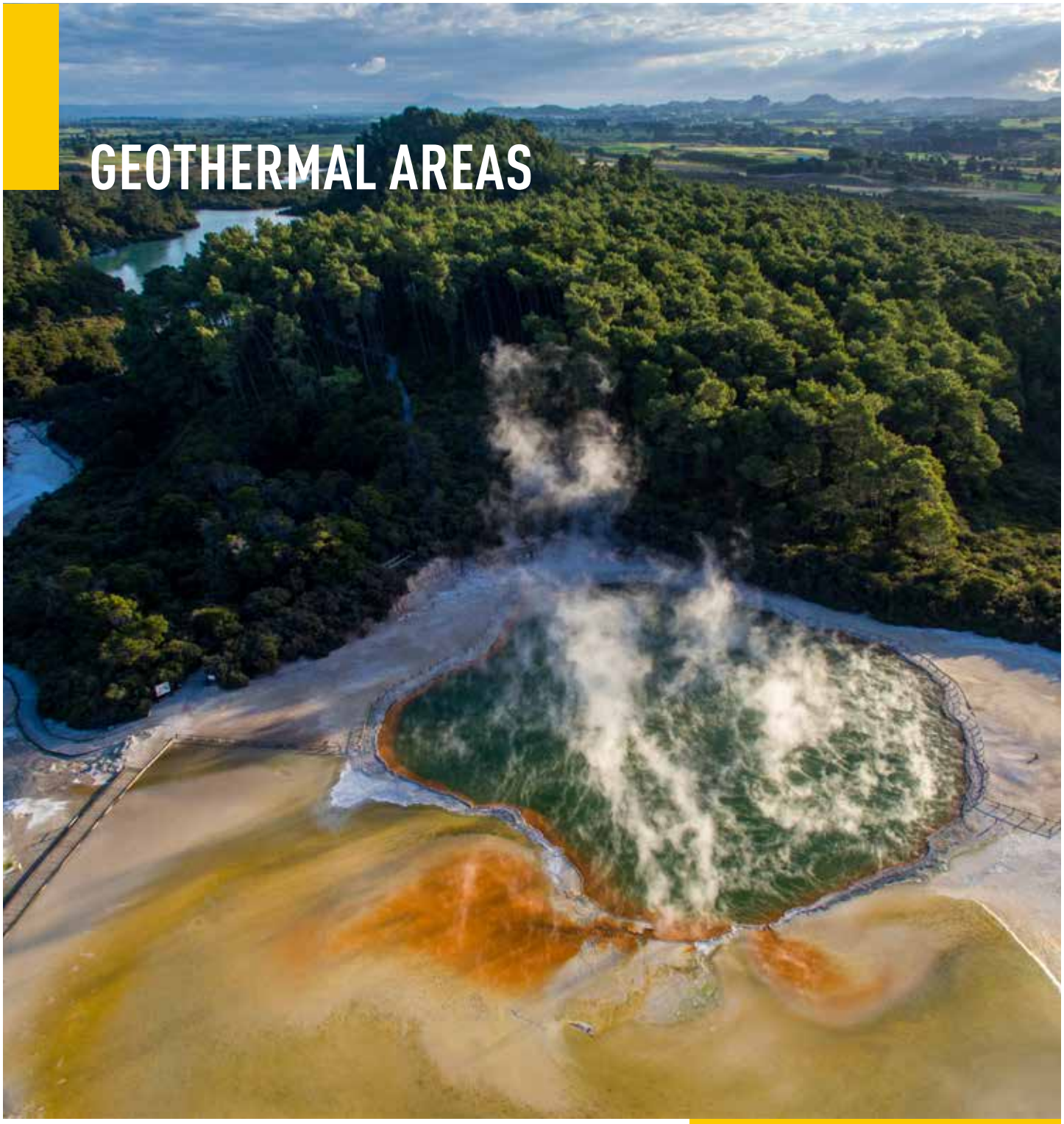
Educational Travel & Experiences

GEOTHERMAL AREAS



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Geothermal Areas

Geothermal areas

Geothermal areas occur when meteoric water (water that has recently fallen as precipitation) from above mixes with the hot groundwater from below, creating amazing results. There are several different hydrothermal features that result from the mixing of these two different forms of water.

At the most basic level of geothermal activity, you see fumaroles or steam vents which occur when there is so little water underground that it boils away before reaching the surface. Water is released as steam along with a few other gases including hydrogen sulfide and carbon dioxide.

Hot springs

Hot springs represent the next level of geothermal activity. These discharges of groundwater are usually rich in minerals from beneath the surface and range in temperature from 30° to 104°C or 86° to 219°F. Hot Springs develop in two settings: where deep groundwater surfaces along faults or fractures, and in geothermal regions where groundwater is heated by shallow magma or hot rock.

As hot spring water flows out of the ground unobstructed, the resulting pool of water has several distinct rings of temperature, the hottest of course being around the centre. High temperature water prohibits most life, but occasionally you will find organisms that feed off of the released hydrogen gas. This lack of life makes the water look clear and blue. However, the outer temperature rings do allow some bacteria to live, so each ring is a slightly different colour depending on which organisms can live there.

When hot springs travel through volcanic ash to reach the surface, a viscous slurry called a mud pot is formed. Mud pots are very acidic and tend to dissolve nearby rock.

Mud pot in Yellowstone National Park, USA

Champagne Pool in Rotorua, New Zealand

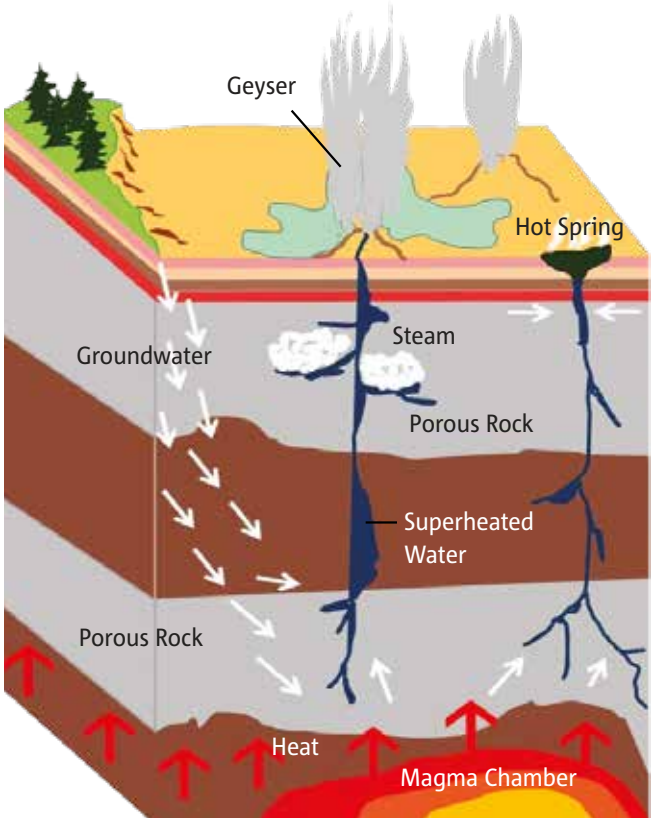
Geothermal Areas

Geysers

Geysers are one of the more explosive forms of geothermal activity, erupting hot water from the surface of the planet. It can be helpful to think of them like underground hot springs at the base of a constricted plumbing tube. The water at the bottom of the "spring," close to the hot underground magma, becomes superheated by its proximity. Gradually, the water begins to boil (the boiling point is much higher underground because of the increased pressure) and produce steam. This steam quickly pushes towards the surface, violently ejecting all the water in the "plumbing tube" above it. This is why geyser eruptions begin with a column of water and end with a release of steam. These eruptions happen periodically depending on how long it takes to heat the water beneath the geyser.

All geysers get their name from one famous example, the great Geysir of Iceland. The name Geysir means "roarer" in Icelandic and refers to the loud roaring noise made by the exiting steam. Outside of Iceland, there are three other main areas where geysers occur: Yellowstone Park in the United States, Rotorua in New Zealand's North Island, and Kamchatka, Russia. There are a few other geyser locations around the world, but because of the rare underground conditions needed to create them, they are not a frequent phenomena.

Geyser



The Uses of Geothermal Waters

Naturally enriched and heated, geothermal waters are a major source of energy and minerals for the areas around them.

Energy

Humans can tap into the energy of high pressure water and steam by drilling in geothermal fields. This reduces the pressure and allows the water to "flash" steam. The steam can then be led into turbines to generate electricity or used for domestic and greenhouse heating.

Minerals

In 1986, scientists discovered that significant quantities of gold and silver were present in depressurised geothermal waters. Mineral deposits (gold, silver, and lesser amounts of base metal sulfides) are now thought to be located near the boiling zones of formerly active geothermal systems.

Environmental implications

Depressurising and extracting geothermal fluids can be risky. The reduction in pressure is harmful to geysers and hot springs. Extracted waters also contain a significant amount of toxic metal compounds, including arsenic and mercury. Additionally, the sulfide minerals deposited around hot springs can be oxidised during the extraction process and release metal cations that make the surrounding water more acidic.

See if you can answer the questions below, without looking back at the previous pages!

What is the difference between a mud pot, a hot spring and a geyser?

Why do you think it's important for scientists to study water chemistry?

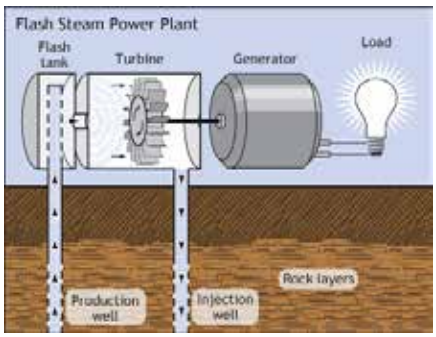
Geothermal Energy

Geothermal energy is heat that comes from beneath the surface, and it is a very versatile energy source. There are several types of geothermal power plants that generate energy from drilling wells into geothermal reservoirs near the surface:

Flash steam plants

Most geothermal power plants are flash steam plants. Hot water from production wells flashes (explosively boils) into steam when it is released from the underground pressure of the reservoir. The force of the steam is used to spin the turbine generator. To conserve water and maintain the pressure in the reservoir, the steam is condensed into water and injected back into the reservoir to be reheated.

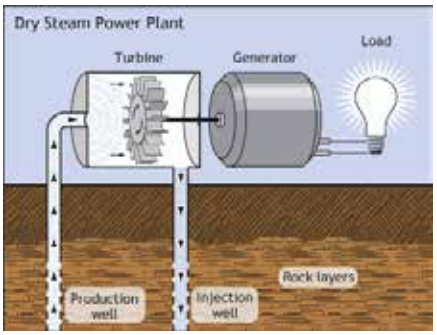
Geothermal plant location: The Geysers in California; Berlin flash power plant (El Salvador)



Dry steam plants

A few geothermal reservoirs produce mostly steam and very little water. In dry steam plants, the steam from the reservoir shoots directly through a rock-catcher into the turbine generator. The rock-catcher protects the turbine from small rocks that may be carried along with the steam from the reservoir.

Geothermal plant location: Larderello dry steam power plant (Italy)

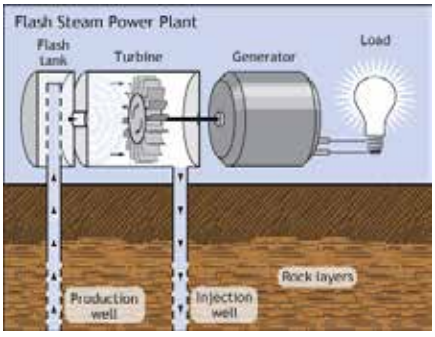


Binary cycle power plants

Binary cycle plants transfer the thermal energy from geothermal hot water to other liquids to produce electricity. The geothermal water is passed through a heat exchanger in a closed pipe system, and then reinjected into the reservoir. The heat exchanger transfers the heat to a working fluid – usually isobutane or isopentane – which boils at a lower temperature than water. The vapour from the working fluid is used to turn the turbines.

Binary systems can, therefore, generate electricity from reservoirs with lower temperatures. Since the system is closed, there is little heat loss, almost no water loss, and virtually no emissions.

Geothermal plant location: Azores islands



Other Common Uses of Geothermal Energy

Hot spring bathing and spas

For centuries, people have used hot springs for cooking and bathing. Early Romans used geothermal water to treat eye and skin diseases. Disputes over lands with hot springs even led to some medieval wars. Today, hot springs are still used for bathing around the world, and millions of people visit health spas to soak in the mineral-rich water.

Heating

After bathing, the most widespread use of geothermal energy is as a means for heating buildings. Geothermal district energy systems pump hot water from a reservoir through a heat exchanger that transfers the heat to buildings through a sequence of separate pipes. The water is then pumped back to the geothermal reservoir to be reheated. There are many other systems in use in the country today. Because it is clean and economical, district heating is becoming increasingly popular.

Agriculture and aquaculture

Geothermal waters are used in many places to warm greenhouses that grow fruits, vegetables, and flowers. Natural warm water can also speed up the growth of organisms like fish, reptiles, and amphibians.

Industry

Heat generated from geothermal waters can also be used for drying cloth, drying fruits and vegetables, washing wool, pasteurising milk, and drying timber products. It is also used to help extract gold and silver from ore.

Geoexchange systems: heating and cooling

Once you reach about twenty feet below Earth's surface, the temperature is remarkably constant year round. For most areas, this means that soil temperatures are usually warmer than the air in winter and cooler than the air in summer. Geothermal exchange systems take advantage of this to heat and cool buildings. A liquid – usually a mixture of water and antifreeze –flows through a long loop of pipe buried in the ground. This liquid absorbs heat from the ground and carries it into the building in cold months and absorbs heat from the building during warmer months, carrying it back out of the building.

A major benefit to these systems is that they don't have to manufacture heat. The heat is free, renewable, and readily available in the ground. The system only needs a small amount of electricity to pump the liquid through the pipes and deliver the conditioned air to the building.

Geothermal Heating

Hot springs in Nozawa Onsen, Japan

What is Energy?

We already talked a little bit about how geothermal waters can generate energy, but what defines energy? Energy is the ability to do work.

All forms of energy fall into two categories: Potential and kinetic.

Potential energy is stored energy or gravitational energy. Examples:

Chemical energy is energy stored in the bonds of atoms and molecules. It is found in substances like petroleum and natural gas.

Mechanical energy is energy stored in objects by applying a force, like the energy stored in compressed springs or stretched rubber bands.

Nuclear energy is energy stored in the nucleus of an atom. The energy is released when the nuclei are combined in the process of fusion or when split during fission.

Gravitational energy is the energy of position. An object's height and weight are usually a good way to determine gravitational energy. A heavy rock positioned at the top of a steep cliff has high gravitational energy because it has the potential to generate so much energy by falling.

Kinetic energy is motion. The following are some examples:

Electrical energy is the movement of electrons. Electricity is electrons moving through a wire.

Radiant energy is electromagnetic energy that travels in transverse waves. Solar energy is an example.

Thermal energy (heat) is the internal energy in substances. It is due to the vibration or movement of atoms and molecules within substances. Geothermal energy is a form of thermal energy.

Motion energy is the movement of objects and substances from point A to point B. Wind is an example of motion energy in action.

Sound energy is the movement of energy through substances in longitudinal waves. Sound is produced when a force causes an object to vibrate.

Energy Classifications

The ten major sources of energy today can also be classified as either renewable or nonrenewable.

Nonrenewable energy sources: Coal, petroleum, natural gas, propane, and uranium. These sources cannot be replenished in a short period of time.

Renewable energy sources: Biomass, geothermal energy, hydropower, solar energy, and wind power. Each of these sources can be quickly renewed and reused indefinitely.

Energy Discussion

As one of Earth's main renewable energy sources, geothermal energy gives humans a lot of room for expansion. With some exceptions, most methods for utilising it produce no emissions and cause little to no damage to the environment.

Discuss the following energy implications with your classmates:

When you dry your clothes outside, what source of energy are you using?

Define a renewable and non-renewable energy source and provide 5 examples of each.

What countries do you think use a lot of energy? Justify your answer.

In times of drought, which energy source would experience a drop in production?

What are the advantages and disadvantages to rising oil prices?

What natural resources does a community need to utilise geothermal energy? If it's not an easily accessible source of energy in your community, what are some other renewable energy sources you could use instead?