Lesson Plan 13

Benefits of Volcanoes

What benefits do volcanoes bring to New Zealand?

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Divide the class into 3 groups.

The 3 groups brainstorm the positive effects of volcanoes on one of the following areas;

- The Earth
- New Zealand
- The area close to an active volcano

Each group presents their information to the class so they can build up a record on the worksheet of the local and global benefits of volcanoes.
The completed worksheet example covers some advantages of volcanism but creative students will think of many more.

Discuss

1. **What is a geothermal field, what do you see in them and where are they?**
   An area where hot water and gases are escaping from the ground in various ways, including geysers, hot springs, fumaroles, mud pools, hot water pools and steaming ground. NZ's best known examples are around Rotorua and Taupo.
2. **Where does the hot water or steam come from?**
   It starts as rainwater that has found its way underground through faults, rock fractures and layers of porous rock. This is called groundwater. When it is heated it rises back to the surface.
3. **How is the water heated?**
   When the water comes into contact with magma or hot rock it is heated and can reach temperatures of over 300°C but it does not boil because it is under huge pressure from the overlying rock.
4. **What are the coloured areas around geysers and hot pools?**
   The hot water or steam reacts with the fractured rocks it comes into contact with underground. Minerals are dissolved out of these rocks and mixed into the water. When the water cools or evaporates on the Earth's surface, mineral deposits such as silica are left behind. Pure silica is white but other minerals or micro-organisms such as bacteria that grow in the water can produce a range of beautiful colours.

- Complete the Geothermal Fields and the Water Cycle worksheet.

Learning Intentions

- Identify the long term economic and environmental benefits of volcanism for NZ and the wider world
- Describe
  - the features and locations of NZ's geothermal fields
  - where the water comes from,
  - what it is mixed with
  - how it is heated
  - how it can be used

Success Criteria

Students can

- Give examples of the benefits of volcanism on a local and global scale including uses of geothermal fields
- Explain the connection between geothermal fields and hot rock or magma
- Show understanding of a geothermal water cycle by completing the worksheet

Resources

- Benefits of Volcanoes Worksheet and completed example
- Geothermal Fields and the Water Cycle Worksheet

Vocabulary

benefit, geothermal, geyser, mineral, dissolve, groundwater, micro-organism, geothermal field, geothermal power, steam

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Teacher Notes 13

Benefits of Volcanoes

What benefits do volcanoes bring to New Zealand?

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New Zealand's volcanoes bring advantages as well as risks.

Many of the landscapes that make New Zealand world famous have been, and continue to be, created by volcanism. The topography has a direct effect on the economy. Tourists and locals visit our active volcanoes, and cities such as Auckland and Dunedin have been built around sheltered harbours which are remnants of volcanoes.

Although destructive in the short term volcanic eruptions have long term benefits for the local environment and the planet. The worksheet activity should reinforce this concept.

Cones and calderas are not the only features of New Zealand's volcanic areas. Geothermal fields with their springs, geysers and boiling mud pools can be equally spectacular and unlike a volcanic eruption, their energy can be harnessed and used safely.

Geothermal fields are rare on a world scale and are created in two ways.

Low temperature fields (20-100°C) are due to hot rock below active faults. High temperature fields (above 100°C) are associated with active volcanism. All of New Zealand's high temperature fields are located in the Taupo Volcanic Zone except Ngawha which is in Northland.

As students have seen in previous activities, hot things rise and create convection currents. The upward flow of water heated by hot rock creates a downward counter flow of cold, rain water in the surrounding area. These large scale, slowly circulating, convection systems are very stable and the rising plumes of hot water create geothermal fields which may last hundreds of thousands of years. At Rotorua rainwater takes at least 100 years to emerge as hot spring water.

In a geothermal field nature itself turns a volcanic hazard into a resource. The underground heat exchange between the water and the magma cools the magma and delivers its heat energy to the surface in a more useful and less explosive form.

The hot water or steam can be used directly (cooking, heating, bathing, drying of products such as timber and paper) or converted into electrical energy in geothermal power stations. In 2007 geothermal power supplied 6% of NZ's total power capacity.

Geothermal power is a sustainable and renewable energy resource but extracting water or steam from the ground can lower pressure in the geothermal field and affect nearby areas. When power production began at Wairakei, fumaroles increased and hot springs disappeared at the nearby Craters of the Moon thermal area. After the hot water is used it must then be reinjected into the ground or discharged into a waterway. This is not always detrimental, for example steam used to generate energy at Wairakei produces waste hot water which is used as a heat source for prawn farming.

Some of New Zealand's most unique geothermal areas, such as Ketetahi, Waiotapu and Waimangu are protected and will never be utilised so that their natural thermal activity is preserved.

All students should be familiar with the water cycle and the final drawing activity requires them to add geothermal processes to their existing knowledge. This extension of the water cycle shows how heat within the Earth affects water that falls on the surface and works its way down to warmer regions.

Current research is showing that specialized micro organisms thrive in extreme environments such as geothermal and hydrothermal waters. This connection between living things and active geological processes may help explain the origins of life on Earth.

Curriculum Links

Planet Earth and Beyond

Physical World

Science Concept	NOS
PE-Earth Systems **L 3/4** - explore and describe natural features and resources **Planet Earth Interacting Systems** **L 3/4** - describe how natural features are changed and resources affected by natural events Living World Ecology **L 3/4** - explain how living things are suited to their environment	**Communicating in Science** **Investigating in Science** **Understanding about Science**

Social Science
L 3-Understand how people view and use places differently.
Understand how people make decisions about access to and use of resources.
L 4-Understand that events have causes and effects.

Geothermal power plant

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Would life on Earth be possible without volcanoes?

Without volcanic eruptions life on Earth may have been impossible.

For an explanation see:
http://www.youtube.com/watch?v=E1Uvr8dUDHQ

Where are NZ's geothermal fields?

See: http://www.teara.govt.nz/en/hot-springs-mud-pools-and-geysers/1

Why are there hot springs in the South Island?

Warm springs (less than 70°C) are found in non-volcanic areas of NZ such as the South Island. Faults (deep fractures in the rock) allow water to rise rapidly from deep areas where it has been heated by hot rocks. The best known example would be the 'hot' springs at Hanmer which lies on the Alpine Fault.

What are 'boiling' mud pools?

As steam or gas rises to the surface it may pass through a pool created by rain water, condensed steam and mud. The mud is produced from a breakdown of soft rocks by steam and acidic fumes. This leads to mud pools which spray out mini mud eruptions or appear to boil as bubbles form on the surface.

What is a geyser and why do they stop and start?

Geysers are hot springs that erupt boiling water and steam. They have a narrow neck (opening) on the surface with a large reservoir of hot water underneath. When the reservoir boils, the water is forced from the narrow opening as a mixture of steam and hot water. This continues until the reservoir is empty. The geyser is quiet again until the reservoir has refilled so the time between eruptions depends on the size of the reservoir.

For more information on NZ's unique geothermal features and a gallery of pictures and video see:
http://www.teara.govt.nz/en/hot-springs-mud-pools-and-geysers

How do geothermal power stations work?

See: http://www.sciencelearn.org.nz/contexts/future_fuels/looking_closer/geothermal_power

http://www.teara.govt.nz/en/geothermal-energy

Can anything live in geothermal areas?

The plants and animals that live in geothermal areas are as unique as the geothermal systems they inhabit.

For further information on plants and animals see:
http://www.teara.govt.nz/en/hot-springs-mud-pools-and-geysers/5

http://www.teara.govt.nz/en/life-in-hot-springs

Can anything live in geothermal waters?

This is one of the modern frontiers of scientific exploration because in recent decades it has been shown that geothermal waters are teeming with microscopic life. These micro-organisms are known as extremophiles because of the extreme environments they thrive in. The heat and dissolved minerals in the water would be toxic to other life forms but are used by the extremophiles as an energy source. New Zealand's geothermal regions provide a natural laboratory for the study of these lifeforms.

For more information see:
http://www.teara.govt.nz/en/life-in-hot-springs
http://www.youtube.com/watch?v=VU-A6Sx7k-U&feature=channel

What is sinter?

As geothermal waters cool the minerals they contain leave the solution and are deposited as thin layers of new rock. The most common mineral is silica and it forms a rock called sinter. Sinter is usually white and can be deposited in various shapes such as terraces or mounds. The most famous sinter terraces were the Pink and White Terraces destroyed in the Tarawera eruption. The colour of sinter can be changed by the micro-organisms living on it.

Silica builds up continual layers like very thin glass on any surface it comes across. The extremophiles that live on the silica become layered into the sinter structure. The nature of the relationship between sinter deposits and the extremophiles they contain is not yet completely understood and may help explain how life on Earth began.

For more information on sinter and micro-organisms see:
http://www.teara.govt.nz/en/life-in-hot-springs/4

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Name:

World	New Zealand	Areas close to active volcanoes

Activity sheet 13

Benefits of Volcanoes

What benefits do volcanoes bring to New Zealand?

Name:

World	New Zealand	Areas close to active volcanoes
• Large eruptions can lower the temperature of the planet for months or years. Sunlight is reflected back into space by the ash particles in the air. This can be a negative and a positive. The eruption of Indonesia's Mt Tambora in 1815 sent so much sun reflecting sulphur into the atmosphere that global temperatures fell the following year and 1816 is known as the year without a summer. • On the other hand, in these days of global warming, eruptions could help counter the effects of greenhouse gases by decreasing the amount of sunlight heating the Earth. • Geothermal areas around volcanoes are used for power generation in New Zealand, Iceland and Italy. • Volcanic rocks eventually break down to form fertile, mineral rich soils. • Valuable elements such as sulphur, zinc, silver, copper, gold, mercury and uranium are found in volcanoes	• Volcanic rocks can be quarried and used for roading and building. • Pumice is a natural glass that can be used for grinding and polishing metals, stones and other materials • Porous volcanic rock can create fresh water aquifers. • Volcanic mineral deposits can be mined, in the future it may be possible to retrieve precious metals produced by hydrothermal activity at NZ's submarine volcanoes • Tourism • Industries are based around scientific exploration, hazard monitoring, disaster preparation and education.	• Soils benefit from a small amount of 'volcanic topdressing'. Volcanic ash can act as natural fertilizer by adding sulphur and trace elements such as selenium to soils. Ohakune's famous carrots are the result of volcanic soils. • Hydroelectric power from rivers flowing off large volcanoes-Tongariro Power Scheme • Geothermal power-NZ has several geothermal power stations such as Wairakei, most are located in the Taupo Volcanic Zone • New islands such as Rangitoto can be created

Answer sheet 13

Benefits of Volcanoes

What benefits do volcanoes bring to New Zealand?