SCIENCE SPOTLIGHT

POWER FROM THE CORE :

HARVESTING EARTH'S HEAT

This project was undertaken with the financial support of the Government of Canada.

Canada

digital moment

steamlabs

GEN ACTION

Power from the Core: Harvesting Earth's Heat

Origin Story:
GEOTHERMAL ENERGY

What Is It?

Deep inside our planet, about 2,900 kilometres deep, there is a very hot and dense ball made mostly of two metals, iron and nickel. Its temperature ranges from 4,400 °C to 6000 °C and its radius is about the size of our Moon at 3,485 kilometres. We call this ball the Earth's core.

The energy produced by the heat within the core is called geothermal energy. The word 'geothermal' is derived from two Greek root words: γῆ - gê, meaning Earth, and θερμός - thermós, meaning hot. Simply put, geothermal energy is heat produced by our planet Earth.

Why Is the Core So Hot?

The main reasons for the high temperatures in Earth's core are:

1. **Accretion** - Our planet was formed by a process known in planetary science as accretion. This process involves many small stellar objects colliding with each other, forming a bigger one, in this case, planet Earth. This process generates large amounts of heat and our planet's core still holds high temperatures dating back to that time.
2. **Friction** - The friction caused by different materials moving within the core. Try creating friction yourself by rubbing your hands together. Your hands will get warmer the more you rub them.
3. **Radioactive Decay** - This applies to the radioactive decay, or the way some chemical elements change over time, of three main elements: Thorium, Uranium, and Potassium. This is a natural process that happens to all matter in the universe. It happens because atoms lose energy over time, and part of that energy is heat, which contributes to the temperature of the core.

From the Core to Home
IF THE HEAT IS INSIDE THE EARTH, HOW CAN WE USE IT?

Lucky for us, the heat from Earth's core does not just sit there. It flows to the surface of the planet via conduction, which is a process where heat flows from a hotter place to a colder one. The heat from the core flows from a high concentration of heat to a lower concentration of heat, or from the Earth's core to its surface. For example, think of a pot on a stove - the stove gets hot, and that heat starts travelling to the surface of the pot.

WHY IS GEOTHERMAL A GOOD FOSSIL FUEL REPLACEMENT?

Geothermal energy has three characteristics that make it appealing as a fossil fuel replacement:

1. It can produce energy at a constant rate despite the weather conditions or time of the day. This makes it a great complement to solar and wind energy.
2. It is constantly being renewed by the heat in the Earth's core and extracting it produces near-zero carbon dioxide (CO_2) emissions.
3. It is a valuable source of heat in countries with harsh winters, like Canada.

Impact on Our Communities:
PROVINCE OF ALBERTA STUDY

In a study conducted by Dr. Jacek A. Majorowicz and Dr. Stephen E. Grasby, they concluded that "As space heating is the dominant energy demand in Canada, with single households representing around 80 percent of energy usage, the geothermal heating transition in Alberta would be the best option for municipalities."

The high levels of energy usage described by Dr. Majorowicz and Dr. Grasby, combined with the accessibility of geothermal sources in the province of Alberta, resulted in potential savings on CO_2 emissions of sixty metric tonnes (MT = 1000 kilograms) per year. The savings potential makes this another tool to continue increasing electricity production that matches the requirements of our growing population over time.

Does Alberta Meet the Conditions to Use Geothermal Energy?

There are three key aspects to consider when considering implementing large scale geothermal plants anywhere in the world:

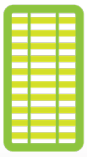
- The temperature of the rock at the desired drilling places and depths.
- The availability of fluid (most of the time water) to carry the heat to the surface.
- The rocks surrounding the fluid are permeable (porous) enough to let the fluid move through.

In their study, Dr. Majorowics and Dr. Grasby conclude that Alberta's Basin, a lower section of the Earth compared to its surroundings, is the more probable place to satisfy these required geothermal conditions either by using geothermal power plants or Heat Pumps.

Geothermal Power Plants

These are large scale energy production sites that involve drilling into the ground, not so deep as to reach the Earth's core, but often to depths more than one kilometre. Most geothermal plants consist of two wells, one used to pump hot fluid out of the ground, and the other one used to pump the cooled fluid back into the ground to be heated again.

Heat Pumps



Think of these as small geothermal plants that can replace traditional heating systems such as furnaces and boilers and cooling systems such air conditioning units in our homes and schools.

Energy requirements are increasing and will keep on doing so as they help better people's lives. To help in the transition from fossil fuels and satisfy future energy needs we should start looking at the untapped power laying at our feet.

TIME FOR GENACTION!

Try This at Home:
HEAT TRANSFER THROUGH CONVECTION

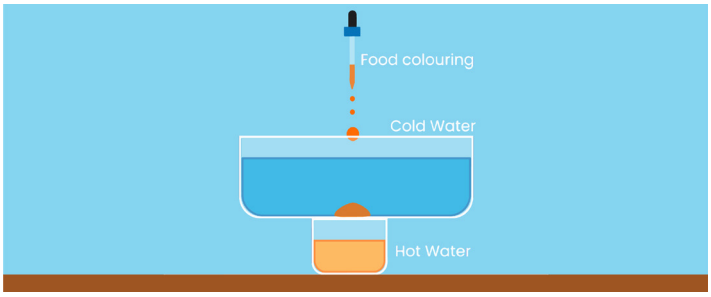
One of the ways that the heat from Earth's core travels to the surface is through convection, which is the transfer of heat (energy) from one fluid to another. In this interesting experiment, you will be able to see convection in action!

You will need:

- One plastic or glass container with cold water
- One cup with hot water (smaller than the cold water container)
- Food colouring
- One eye dropper (optional)

Steps:

1. Put a few drops of food colouring in the container with cold water. Let the dye sink without mixing or disturbing the liquid.
2. Place the cup with hot water below the container with cold water.
3. Give it a few seconds and see convection in action. The food colouring will start bubbling up to the surface and eventually, the heat (colour) will spread through the container.



Climate Action:
SPREAD THE HEAT

The best way to create action around Geothermal energy is to encourage help those around you discover the opportunities and benefits this energy has. As most of us do not have the opportunity to dig in geothermal sites, we can use examples around our house to illustrate the way heat moves through convection to explain the concept to our family and friends.

- A fridge door open is letting cold air into the environment and taking warm air from it.
- Help find air leaks within your house or school. Places where the air from outside is coming in and affecting the temperature of that room. A good place to start is by inspecting the edges of the windows and doors.

Knowledge shared is power to make the world a better place.

This Science Spotlight was written based on Majorowicz, Jacek A., Stephen E. Grasby. (2020).
"Heat transition for major communities supported by geothermal energy development of the Alberta Basin, Canada" Geothermics, vol. 88 iss. 3. 10.1016/j.geothermics.2020.101883

Climate Change Past, Present, and Future

Earth is the only planet in the solar system known to support life. What makes our home so special? Earth has an atmosphere, a layer of gases between our planet and space. Some of these gases, like carbon dioxide, are called **greenhouse gases**. They are crucial parts of our atmosphere; they trap in the heat of the sun, similar to how heat is trapped in a greenhouse, or in a car on a hot day. This process, called the **greenhouse effect**, keeps Earth's temperature warm enough for living things to thrive.

The sun's rays hit our round, tilted planet unevenly. This uneven heating of Earth's surface leads to differences in temperature, which drives weather patterns. We call the patterns in temperature and weather over long periods of time **climate**. Different parts of the world have vastly different climates; it depends on how much heat they receive, as well as what landscape features are nearby. Water, mountains, ocean currents, and forests all impact our climate. In turn, living things around the world have adapted to the climate they live in.

Something, though, is changing. Over the past two hundred years, humans have been burning fossil fuels, such as coal and oil, to make energy to power our daily lives. Fossil fuels are made from decomposed plant matter and microscopic life millions of years old. This matter is full of carbon, and, burning it releases, or emits, billions of tonnes of **carbon dioxide** gas into the atmosphere every year. When too much carbon dioxide is emitted, the delicate balance of greenhouse gases maintaining

Earth's climate is upset. More and more heat is trapped, causing the planet to warm. Weather patterns change, water levels rise, storms get worse.
Climate has changed many times throughout Earth's history, from ice ages to periods much hotter than today. So why is this time any different? Scientists agree on two things. One, temperatures are rising faster than they ever have in documented climate history. Two, this climate change is driven by human activities, due primarily to greenhouse gas emissions.
Climate change is already impacting people's ways of life all over the world. Powerful storms, droughts, forest fires, and floods are threatening people's access to food, water, and safe homes.

The most important step we can take to prevent serious climate change is to reduce greenhouse gas emissions. Incredibly brave and caring people around the world are finding new ways to reduce emissions and make our communities climate resilient every single day. And you can join them! These Science Spotlights are here to help us learn more about climate change and how you can take action.

Our Commitment to the Decolonization of Science

Institutions of GenAction initiative respect and affirm the inherent and Treaty Rights of all Indigenous Peoples across what we now know as Canada. We give thanks to the Indigenous Peoples who care for this land since time immemorial and pay respect to their traditions and ways of knowing. We acknowledge their many contributions to innovations in Science, Technology, Engineering, and Mathematics, past and present, and are committed to deepening engagement and collaborating with Indigenous Peoples as partners in order to advance truth and reconciliation and the decolonization of science.

Climate Change: Past, Present, and Future is based on...Delmotte, Masson, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, et al. 2021. "Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change." Intergovernmental Panel on Climate Change. Cambridge University Press. In Press.