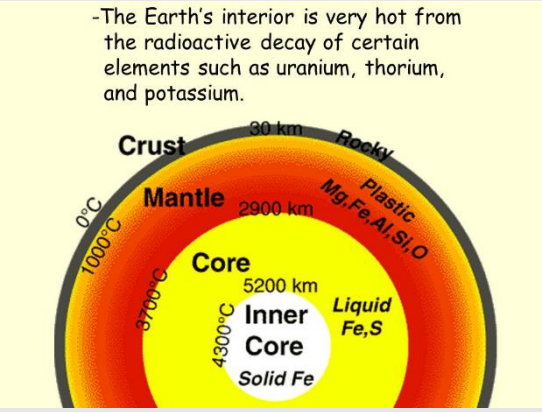
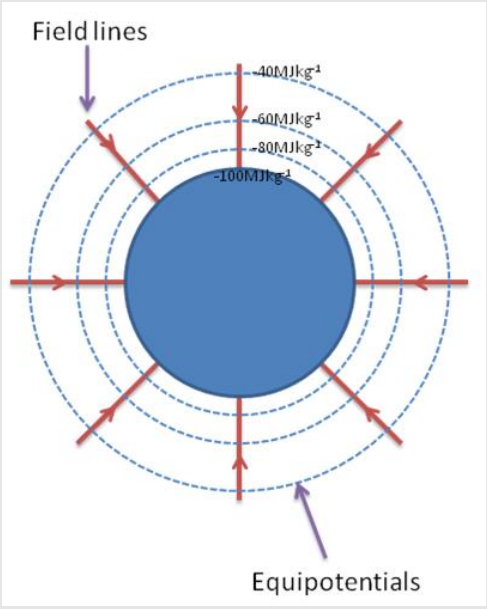
ENERGY FROM GEOTHERMAL SOURCES

WHERE DOES GEOTHERMAL COME FROM?

- Internal heat energy is present in the Earth due to the release of thermal energy from the **conversion of gravitational potential energy** when the **Earth formed.**
- Internal energy is present due to **radioactive decay** reactions that **form Uranium, thorium and potassium** in the mantle and crust.





Geothermal energy is a renewable resource. It can be used to heat buildings, provide hot water and drive turbines to generate electricity. In a human timescale the source will not run out.

- **Geothermal energy**: energy extracted from hot subsurface rocks or water.

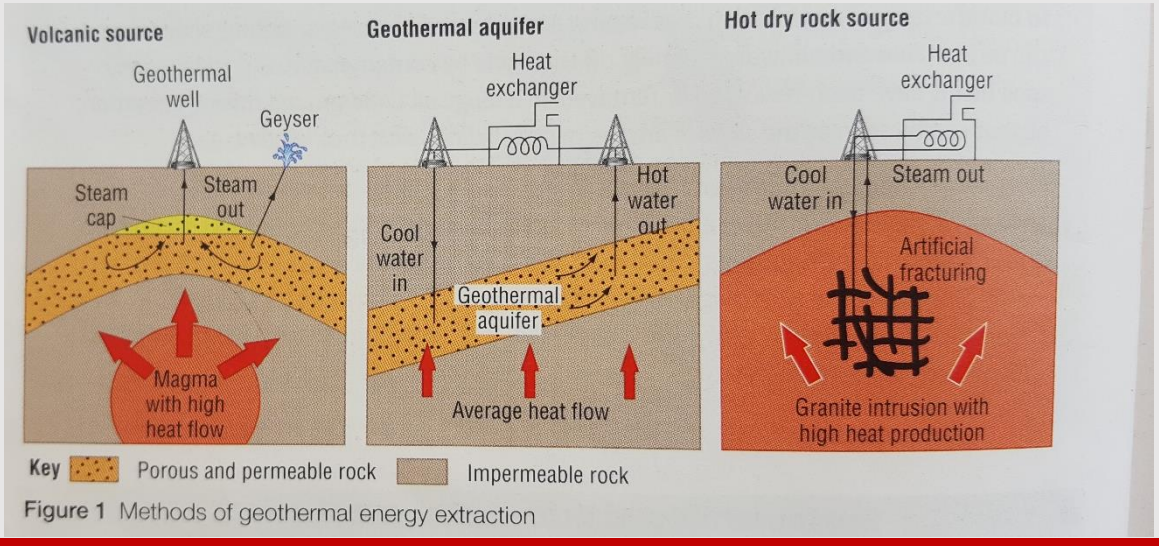


Figure 1 Methods of geothermal energy extraction

METHODS OF EXTRACTION: VOLCANICS

In volcanic areas, magma at **temperatures of 700^{0}C to 1000^{0}C** heats the **gr**oundwater contained within surrounding rocks/ an aquifer.

This requires a trap rock (impermeable aquiclude) to overlay some porous permeable rock that can store groundwater with a geothermal volcanic source nearby. The water at depth is under pressure and so does not boil but instead becomes superheated.

Boiling points are dependent on pressure too!

The superheated water will sometimes rise to the surface if it forces its way up a fracture/fault and the pressure release forms a geyser. However, if a **borehole is dug** down into the rock, the **superheated water rises** the borehole and the **reduction in pressu**re causes it to '**flash' to steam.** The steam can be used to **drive turbine**s directly to turn **generators** that produce electricity, or the steam **can heat water** which is then used to turn turbines. The latter method reduces the **problem of corrosion** to turbine blades and pipes as **volcanic waters**

contain corrosive constituents. Water is then pumped back down into the ground after use to eli**minate waste disposal problems** and **extend the life of the well.**

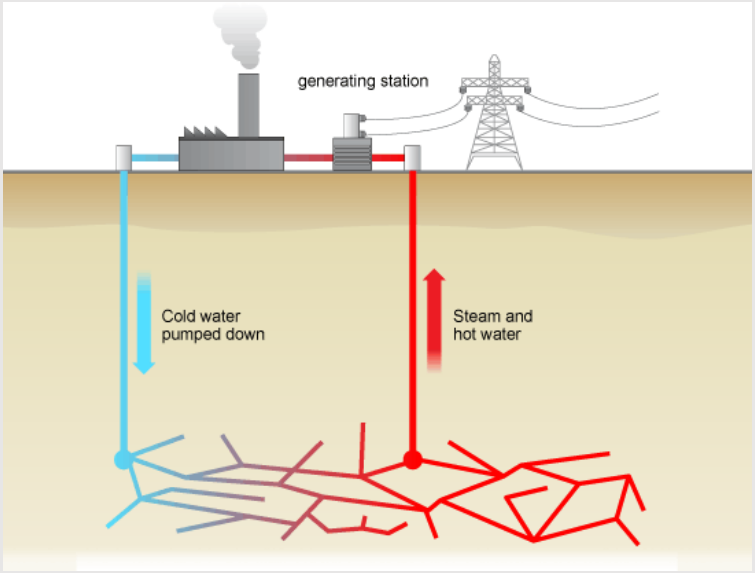
Geothermal energy from volcanic sources is used in **Iceland**, the USA, **Japan, New Zealand**, Italy and the Philippines.

Iceland is the world leader of geothermal energy, using about 6000 GW of geothermal power each year. **87% of all homes in Iceland** are heated/have a hot water supply via **geothermal energy.**

METHODS OF EXTRACTION: GEOTHERMAL AQUIFER

Hot water can be extracted from **geothermal aquifers in deep sedimentary basins** provided the geothermal gradient is **30^{0}C/Km**, the groundwater will be above **60^{0}C 2-3Km** down. Geothermal aquifers are **interbedded with impermeable shales and mudstones**, which have a lower thermal conductivity so **help insulate** the hot water.

Hot water is pumped to the surface, passed through a **heat exchanger** that hea**ts a water supply**. Cooled waters are then **reinjected into** the ground to **maintain the water pressure** in the geothermal aquifer.



Such schemes are currently operating **around Paris** and, until recently in Southampton too.

The British Isles has several potential geothermal aquifers (e.g. **Hampshire**, East Yorkshire and Lincolnshire Basins).

METHODS OF EXTRACTION: HOT DRY ROCK SOURCES

Granite intrusions contain a **higher concentration** of **radioactive heat producing elements**. The geothermal gradient in granites is **~ 40^{0}C/Km**, giving temperatures of **200^{0}C at depths of 5km**. But granites are **dry rocks** with **low groundwater content**.

To exploit the resource, **paired boreholes** are dug into the intrusion. The granite is **artificially fractured** using water or explosives and high-pressure **water is injected**, **heated by the rocks** and **rises back up** to the surface through the **second borehole.**

Suitable dry rocks in the **British Isles** includes **granites in the Southwest England**, northern England and the Scottish Highlands.

Hot dry rocks are likely to become important in the future.

Advantages	Disadvantages
If situated in the right location, geothermal energy can be **very price competitive** and reduces the dependence on fossil fuels.	Production areas are **geographically restricted -** it requires suitable geology.
Does not produce carbon dioxide emissions	There is the danger of **volcanic eruptions** or **earthquakes** in volcanically active areas.
S**ustainable** as the water can be **re-injected** into the ground to **extend the life** of individual wells and **solve the problem of disposing of saline groundwater**.	Extraction of groundwater can result in the **subsidence of surface** strata and **may trigger earthquakes.**

Unlike other **renewable energy resources**, it can work **continually day and night** and is not affected by changing **weather** conditions.	Each geothermal well is only **viable for ~ 20-30 year**s.
	Groundwater is often **saline** and may **contain toxic elements**. The **water is corrosi**ve, and **salts may precipitate out** and **block pipes** in the geothermal plant.