

Encyclopedia Article

Hydrothermal Processes

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Any subsurface encounter between **water** and heat produces a hydrothermal process. The heat is usually supplied by upwellings of **magma** from the mantle, the water by **precipitation** that percolates downward through surface rocks. Some oceanic water enters the mantle at subduction zones and becomes an important ingredient in upper-mantle magmas.

Most hydrothermal processes are driven by convection. Convection occurs because water, like most substances, expands when heated. The result is that hot water rises and cool water sinks. Convection occurs when any water-permeated part of the earth's **crust** is heated from below: heated water fountains upward over the hot spot and cool water descends around its edges. These movements occur through cracks and channels in the **rock**, forcing the water to move slowly and remain in constant contact with various **minerals**. Water convecting through rock is thus an effective means of dissolving, transporting, and depositing minerals. Most deposits of concentrated minerals, including large, shapely **crystals**, are created by hydrothermal processes.

Some manifestations of hydrothermal processes are dramatic, including the geysers and hot **springs** that sometimes occur where shallow magma is present. However, most hydrothermal circulation occurs inconspicuously in the vicinity of large magmatic intrusions. These can cause water to convect through the rocks for miles around.

Along the **mid-ocean ridges**, for example, the heat of the magma that rises continuously from the mantle to form new oceanic crust causes water to convect through the top mile or two (2-3 km) of oceanic crust over many thousands of square miles. Down-convected ocean water encounters hot rocks at depth, is heated, yields up its dissolved magnesium, and leaches out manganese, copper, calcium, and other **metals**. This hot, chemically altered brine then convects upward to the ocean floor, where it is cooled and it releases most of its dissolved minerals as solid precipitates. This process makes the concentrations of vanadium, cobalt, nickel, and copper in recent sea-floor sediments near mid-ocean ridges 10-100 times greater than those elsewhere, and has formed many commercially important ores.

Two of the metals transported in large quantities by sea-floor circulation (i.e., calcium and magnesium) are important controllers of the **carbon dioxide** (CO₂) balance of the ocean and thus of the atmosphere. A volume of water approximately equal to the world's **oceans** passes through the hydrothermal mid-ocean ridge cycle every 20 million years.

See Also

[Fumarole](#); [Geyser](#); [Mid-Ocean Ridges and Rifts](#); [Sea-Floor Spreading](#)