Extension ideas
Partial melting - simple process, huge global impact

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Simulating Partial Melting in the Classroom

Abstract

The reason why partial melting occurs in different geological environments is sometimes difficult for students to comprehend. The following is a visual method I use to demonstrate this concept in the classroom.

Whilst students readily accept that partial melting of rock has something to do with changes in temperature (the Earth Learning idea “Partial melting” provides a good analogue for this), the effect of pressure is more difficult to simulate. Using standard phase diagrams, A-level students can be made aware that melting of the mantle will begin when the earth’s temperature (geotherm) exceeds the melting point temperature (solidus) for peridotite *(Figure 1)*.

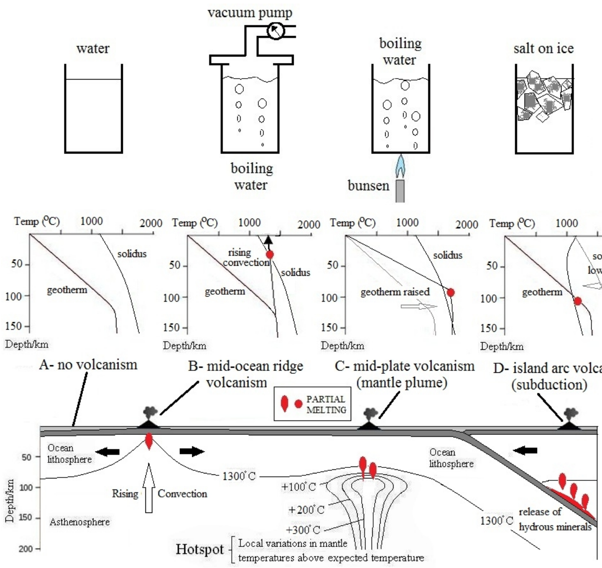

Figure 1: Partial melting simulations of different geological environments.

In a “normal” situation the mantle does not start to melt as the geotherm is below the melting temperature of peridotite *(Figure 1A)*. I simulate this with a beaker of near boiling water to show that, whilst hot, the water has not sufficiently energy to boil under the atmospheric pressure of the classroom. Boiling is synonymous with melting in these simulations.

The hot water can then be made to boil by simply heating the water above its current temperature with a Bunsen burner. *Figure 1C* represents this situation, when the geotherm locally exceeds the melting point of mantle peridotite above a hot spot (mantle plume?), as in the mid-plate example of Hawaii. Here the pressure is not significantly changed and melting is mainly a function of temperature.

At a convergent boundary partial melting is achieved by the release of water from hydrous minerals along a subduction zone which locally lowers the melting temperature of the overlying mantle wedge *(Figure 1D)*. The “wet” solidus is now locally below the geotherm which induces partial melting. This is more difficult to simulate in the classroom but students get the idea if they are directed to the effect of salt on ice to bring about melting.

At a divergent boundary partial melting results from rapid decompression of the mantle as a rising convection cell moves towards the surface. The pathway is shown in *Figure 1B*. To simulate this I use a small, hand-held, vacuum pump 2, normally used for bleeding car brakes (Figure 2).

Figure 2: Water boiling below 100^{0}C under reduced pressure of vacuum pump

By filling the container with the hot water used in simulation A and reducing the pressure (shown on the gauge), the water can be seen to boil below its normal atmospheric pressure boiling temperature (100^{0}C) thereby simulating the effect of rapid pressure reduction on partial melting in the mantle. This simulation works very well although anyone with access to a school physics laboratory may be able to use a larger pump and pressure container to make water satisfactorily boil at only 45^{0}C.

References and further reading - next page . . . .

References and further reading

- Earthlearningidea 'Partial melting - simple process, huge global impact' http://www.earthlearningidea.com/PDF/82_Partial_melting.pdf
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