Geophysical Research Abstracts
Vol. 14, EGU2012-3026, 2012
EGU General Assembly 2012


# Some physical aspects of fluid-fluxed melting

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Fluid-fluxed melting is thought to play a crucial role in the origin of many terrestrial magmas. We can visualize the fundamental physics of the process as follows. An infinitesimal amount of fluid infiltrates dry rock at the temperature of its dry solidus. In order to restore equilibrium the temperature must drop, so that enthalpy is released and immediately reabsorbed as enthalpy of melting. The amount of melt produced must be such that the energy balance and thermodynamic equilibrium conditions are simultaneously satisfied. We wish to understand how an initially dry rock melts in response to progressive fluid infiltration, under both batch and fractional melting constraints. The simplest physical model for this process is a binary system in which one of the components makes up a pure solid phase and the other component a pure fluid phase, and in which a binary melt phase exists over certain temperature range. Melting point depression is calculated under the assumption of ideal mixing. The equations of energy balance and thermodynamic equilibrium are solved simultaneously for temperature and melt fraction, using an iterative procedure that allows addition of fluid in infinitesimal increments. Batch melting and fractional melting are simulated by allowing successive melt increments to remain in the system (batch) or not (fractional). Despite their simplified nature, these calculations reveal some important aspects of fluid-fluxed melting.

The model confirms that, if the solubility of the fluid in the melt is sufficiently high, fluid fluxed melting is an efficient mechanism of magma generation. One might expect that the temperature of the infiltrating fluid would have a significant effect on melt productivity, but the results of the calculations show this not to be the case, because a relatively small mass of low molecular weight fluid has a strong effect on the melting point of minerals with much higher molecular weights. The calculations reveal the somewhat surprising result that fluid infiltration produces more melt during fractional melting than during batch melting. This behavior, which is opposite to that of decompression melting of a dry solid, arises because the melting point depression effect of the added fluid is greater during fractional melting than during batch melting, which results in a greater release of enthalpy and, therefore, greater melt production for fractional melting than for batch melting, for the same total amount of fluid added. The difference may be considerable. As an example, suppose that 0.1 mols of $H_2O$ infiltrate 1 mol or silicate rock. Depending on the rock composition this may corresponds to $\sim$ 1 wt% $H_2O$. For a given choice of model parameters (initial temperature, heat capacity and entropy of fusion), about 28% of the rock melts during fractional melting, versus some 23 % during batch melting.

Fluid fluxing is a robust process of melt generation, without which magmatism at Earth's convergent plate margins would be impossible.