THEME 5:
THE DEEPER EARTH

Session 5.4:
Processes in magma chambers

CONVENED BY:
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The purpose of this session is to bring together researchers working in any discipline on any aspect of processes occurring in magma chambers. Topics might include: dynamics of melt segregation and accumulation; the processes of separation of crystals and residual melt in the chamber; evolution of cumulates; magma fractionation and mixing; the dynamics of replenishment of open-system chambers and the relationship between recharge events and eruptions; passive and active degassing; the composition of evolving gaseous phases; rate and timescales of magmatic processes; and the links between observations and fluid dynamical models of magma chambers.

5.4.11

Thermal reaction fronts in porous rock

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When fluid of one temperature and composition invades a reacting porous rock, saturated with fluid of a different composition and temperature, reactions may arise between the two fluids and also between the invading fluid and the host matrix. If the invading fluid reacts with the matrix, as in a replacement type reaction, then a reaction front will lag behind the fluid-fluid front. Furthermore, as the invading fluid migrates into the rock, a thermal front may also develop, owing to the contrast in termperature of the fluid and the matrix. Such a thermal front may induce a change in solubility and hence a second reaction front develop. Finally, the two fluids may mix dispersively as the flow migrates through the rock, and this can lead to a further class of mixing reaction if the equilibrium concentration of the mixture varies non-linearly with temperature.

The interaction and speed of each of these reaction fronts may be crucial for determining the net change in composition of the rock, and possible formation of compositional layering in the matrix as a result of the invasion or partial invasion of the matrix by a different fluid.

In this presentation, some physical constraints on the propagation speed of these different reaction fronts will be explored, and the results of the analysis applied to magma chamber processes. In particular, the situation in which new basaltic magma invades a cumulate layer and displaces some of the original pore fluid will be addressed, identifying some of the key processes which may determine the formation of compositional layers within the existing matrix.

The presentation will also touch on the important impact of density changes on the migration of such fronts, and their stability. Indeed, in a number of situations the front may become unstable, leading to fingering instabilities. A series of laboratory experiments exploring the dynamics of the reaction fronts, both thermal and compositional and the fingering stabilities will be presented to illusrate the possible morphology of such reaction zones.