Assimilation and its geochemical modeling in magmatic systems

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Magmas readily react chemically and/or physically with their surroundings. A plethora of concepts and computational models have been used to describe and investigate such processes. In this contribution, we concentrate on two issues: 1) defining assimilation in a fresh conceptual sense and 2) reviewing geochemical (± thermodynamical) models used to computationally replicate it.

We define the end-member modes of magmatic interaction (pure mixing, pure mingling, pure assimilation) by constraining an initial state (t_0) and a later state (t_n) for a system that at t_0 consists of chemically and physically separated active melt (A) and passive melt/homogeneous wallrock (B). The effective variables are the melt fraction (F) of B at t_0 and the intensity of segregation of the system (I) at t_n.

The first geochemical models of assimilation used simple mixing equations (as would also apply to pure mixing of liquids). Thermodynamic considerations have shown, however, that bulk assimilation of large amounts of solid wallrock is considerably limited by the enthalpy available from the crystallizing resident magma. The most recent models that combine geochemical and thermodynamical aspects confirm that the chemical differentiation of magmatic systems – although dominated by crystallization processes – may be considerably influenced by simultaneous assimilation of partial melts of chemically distinct wallrock.