Compositional scatter of magma bodies controlled by simultaneous crystallization and partial settling

Koshi Nishimura[1]

[1] Inst. for Geothermal Sciences, Kyoto Univ.

During the cooling of magma bodies, dense crystals settle out because of gravity, irrespective of the presence or absence of convection. Such crystal separation has been thought to make the magma evolve along a curvilinear path on bivariate trace element diagram, which is often modelled quantitatively using the Rayleigh fractionation equation. Here, however, I show that the magma composition can be widely scattered inside the curvilinear path, by considering the mass balance of simultaneous crystallization and partial settling. Such a scattering pattern of magma (crystals + liquid) composition has often been interpreted to result from periodic magma recharge and mixing, but the liquid trend of the present model differs markedly from that produced by such mixing. The magma and liquid trends expected from the simultaneous crystallization and partial settling are consistent with whole-rock and melt inclusion data from the Bishop Tuff, the product of a great Quaternary eruption. These results suggest that the Bishop magma chamber was not disturbed greatly by magma recharging and mixing; rather, it was static during its long crystallization time (100-500 kyr). The model presented herein might help to illuminate poorly understood magma chamber dynamics using compositional scattering patterns of volcanic and plutonic rocks.