Geophysical Research Abstracts
Vol. 12, EGU2010-13450-1, 2010
EGU General Assembly 2010

Rhyolites in caldera complexes: away from granitization but toward numerical models with hydrothermal preconditioning

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We here present results of geochemical investigation and modeling of remelting conditions of rocks that have undergone chemical change in the process of hydrothermal alteration inside of large caldera complexes with high heat flux. Similar conditions exist in rift zones and may characterize early stages of magmatism on the Earth. Oxygen isotope and geochemical investigations of calderas in Yellowstone, Long Valley, and Kamchatka have lead to the model of rapid flash-remelting of hydrothermally-altered rhyolites using the heat of basaltic magmas. These models are based on consideration of zircon geochronology and rapid timescales of magma generation from geologic data. Finite element 2D convective model runs include rhyolitic phase diagram, and we used some effective representation of magma viscosity in the temperature range 500-900°C and with crystal content below 0.50 vol. %. Viscosity description exactly follows experimental data on smooth transition of viscosity at subsolidus temperatures taken at strain rate 10ˆ-13 sˆ-1. Dynamic power-law rheology was used for magmas with low melt fraction at steady state according to recent data of Lavallée et al. (2007). Thermal and chemical evolution of underlying rhyolite-solid silicified roofrock system was considered with varying silica concentration and oxygen isotopic ratios in the hydrothermally-altered layer. The main results of numerical model are:
1. Convection in lower rhyolitic layer system is rather effective even at the thermally insulated bottom due to the gravity instability of the two-phase zone at the melting front. 2. Condition for the onset of convective melting is rather close to the simple conductive estimate of the melting temperature to be the mean of rock and intruded magma. 3. Dependence of the viscosity on the strain rate leads to the wave-like embayments at the rock-magma interface, which accelerates melting process. 4. If the lower layer is represented by the superheated (>50°C) rhyolite, the final rhyolitic product that result from assimilation of the hydrothermally-altered roof yields near-liquidus high-silica rhyolites that become crystal-richer with assimilation of the large fraction of the silicified roof (1/3 by weight). 5. We observe roof-failure (fragmentation) features in numerical runs comparable to the reactive-bulk assimilation models. 6. Short timescales for the assimilation (10ˆ2-10ˆ3 years) are comparable to geochronologic and antecryst-diffusive timescales and magma-generation rates in large caldera complexes.