Cold storage in massive magma chambers

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Silicic magmas erupted in convergent margin volcanic systems experience extended residence in shallow magma storage systems. Conditions within these zones strongly influence eruptive behaviour, and thus considerable effort has been placed on constraining the physical conditions and thermal evolution of stored magmas. The thermal conditions of stored magma is of interest due to the strong dependence between temperature and viscosity, and the potential for using the thermal history for monitoring the interplay between addition of hot magma via recharge versus convective and advective (eruptive) heat loss.

We constrain the thermal history of stored magmas by combining thermally dependent crystal residence estimates based on diffusion and crystal growth and absolute ages estimated by radiometric techniques. Initial application to Mount Hood, OR suggests that only a small proportion of the duration of magma storage is spent at temperatures > 750°C where magma is rheologically mobile. Mount Hood represents the low-volume end of a spectrum of erupted volumes in convergent margins, and we are now exploring silicic eruptions of considerable larger volume, including several of largest known eruptions on Earth. Results to date using multiple approaches suggest that residence times at 750°C remain in the decade to millennia range, and are far shorter than estimates of the total duration of magma storage. Importantly we see no indication that very large eruptions require an extended “incubation” of mobile magma.