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# Mechanisms and timescales for the assembly of large volumes of silicic magma in the upper crust

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Caldera-forming eruptions with volumes of the order of 1000 $km^3$ provide evidence of accumulation of batholith-scale bodies of silicic magma. The development of these bodies can be viewed in four stages, running in series: generation, segregation, ascent and emplacement. The generation of large volumes of silicic magma in the crust is undeniably linked to intrusion of mantle-derived magma. Numerical analyses show that the extraction of melt generated in this way, by porous flow into veins and fractures developed as a result of large tensile stresses created by fluidabsent partial melting, can be surprising rapid. Melt extraction rates determined experimentally under such conditions are of the order of 0.1-1 m/yr and provide support for dike-ascent models, which yield batholith filling times of only a few hundred years. This timescale is orders of magnitude less than that suggested by slip rates on faults (advocated as a mechanism to provide room for batholith development) and is consistent with piecemeal accumulation of batches of melt that ascend in pulses.

The rate-limiting step in the development of large, silicic magma systems, therefore, appears to be the generation of melt in the source region, triggered by repeated intrusion of mantle-derived magma. Although numerical investigations of periodic influx of basaltic magma are in their infancy, recent progress in this line of research provides insight into the influence of intrusion volume, geometry, orientation, depth, periodicity and composition (water content) on the thermal evolution and the degree and timescale of melt generation in the crust.

Intriguingly, although the relationship between the large volumes of silicic magma erupted to form calderas and the emplacement of plutons remains uncertain, recent field and geochronologic evidence suggest that incremental accumulation of large plutons in the upper crust may occur over millions of years, without a large magma body ever existing. In such cases, caldera-forming events may reflect transient mobilization and eruption of composite batholiths following mafic input into the upper crust.

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