Formation of magma chambers and their ability to feed eruptions

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The occurrence and dynamics of volcanic eruptions is linked to the occurrence and dynamics of magma chambers. Since we cannot directly observe magma chambers, our conceptual models are necessarily based on indirect observations that are open to interpretation. These conceptual models include large magma tanks, transient, incrementally emplaced magma bodies, and melt lenses embedded in transcrustal mushes.

The formation of magma chambers requires the concentration of magma in space. In solid rocks, where magma is transported through dykes, an interface in the crust between two layers with different physical properties can act as a magma trap and the magma chamber itself can act as an attractor for further injections. The ability of magma to accumulate is controlled by the thermal state of the crust and by magma flow rates. Within a mush, the formation of melt lenses results from the melt extraction process but the formation of the mush itself also requires favourable thermal conditions and high magma flow rates.

Petrological and geophysical evidence indicate that many eruptions are fed by several magma reservoirs that connect before or during eruption. The size, duration, and style of eruptions depend on the number, size, and composition of the reservoirs. Yet, most magma never reach the Earth's surface; Magma chambers are not able to form or, if they form, the magma is not able to escape. Further transport of magma from a reservoir towards higher levels requires overpressure in the chamber or sufficient buoyancy forces exerted by magma or by volatiles. Eruptive and intrusive flow rates are cyclic and follow power laws. This observation suggests some form of self-organization in the plumbing system. To understand volcanism, we need to understand magmatic systems as interconnected networks of melt and volatiles. To overcome the lack of direct observation we need to combine knowledge from the different disciplines studying magmatism and volcanism.