Construction and storage of crustal-scale magmatic systems

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Crustal-scale magmatic systems can feed hazardous volcanic eruptions while generating and recycling continental crust. Volumes of these eruptions and the rate of crustal growth, in turn, are linked to magma fluxes and time scales of magma emplacement in the crust. In order to improve our understanding of heat and mass budget of magmatic systems, quantification of magma fluxes and timescales of magmatism are of great importance. The main problem that limits our understanding of these systems is the lack of direct observation of different units of a crustal-scale magma plumbing system and not being able to monitor their long-term evolution deep in the crust. To fill this gap, we use a thermal model and test a parameter space to quantify the timescales, magma fluxes, and heat budget required to form lower and upper crustal magma bodies, which allows us to constrain the evolution of crustal-scale magma plumbing systems in an idealized model. To compare our modeling results with observations from real magmatic systems, we present new high-precision CA-ID-TIMS U/Pb zircon geochronology and LA-ICP-MS zircon geochemistry from a well-known magmatic crustal cross section, the Ivrea-Verbano Zone and Serie dei Laghi magmatic system, Italy. This Permian (~280 Ma) rift-related magmatic system is exposed from its volcanic products to its lower crustal roots. We document the lifetime and petrologic links throughout the crustal column and compare the results with our model outputs. We further compare these observations with recently published age information on the Ordovician Famatinian arc, another exposed crustal cross section of a magmatic system in Northern Argentina. These observations tightly confine the total duration of magmatism in extensional and compressional environments, and offer the first high-precision timescale estimates for the construction of large-volume magmatic columns in rift and arc settings.