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Plutons, magma chambers, and magma fluxes

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Intrusive rocks are the dominant product of Earth's magmatism. They are mainly observed in the form of mappable bodies of various shapes and volumes called plutons. Recent works showed that plutons form by localized injections of discrete magma pulses over variable periods of time. Detailed field, structural and petrological observations associated to geochronological data, show that these injections occur in magmatic cycles with various timescales. At the smallest time- and space-scales, plutons record the incremental process of pulse amalgamation. At larger time- and space-scales this rapid incremental process is lost, and plutons record instead larger cycles of magma transfer. The dynamics of pulsed magmatism observed in plutonic systems is then a proxy for deep lithospheric and magmatic processes. Experimental petrology and numerical simulations of magma-reservoir evolution suggest that the chemical diversity of intrusive magmas is largely acquired in deep crustal hot zones whereas the textural diversity of plutonic rocks is related to crystallization at shallower levels. Furthermore, structural, textural and geochronological evidences do not support the concept of plutons as being fossil magma chambers, and chemical evidence indicate that plutons are not the restites or cummulates of effusive magmas either. Thus the link between plutonic and volcanic systems needs to be carefully assessed. Why and how plutons form is primordial and central in our understanding of the global process of Earth magmatism.
Behind the concept of pluton is the observation of focused emplacement of magma in space and time, i.e. the existence of a "close in space - close in time" relationship. Thus the question we need to address is "Why and how magma is accumulated at a given locality during variable periods of time (thousands to millions of years) to form plutons?" The controlling processes could be emplacement-related, transport-related, source-related or a combination of these. We will try to answer this question by examining the respective role of these three successive stages by using a quantitative evaluation of the different magma fluxes involved in magma transfer from deep hot zones to the surface.