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REVIEW

Dynamics of Crustal Magma Transfer, Storage and Differentiation

Edited by C. Annen and G.F. Zellmer

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This book is a collection of 12 papers that address four important issues in magma evolution: magma transfer from mantle to surface, dynamics of magma transport, magma reservoir dynamics and processes of silicic melt generation. The papers include both case studies and theoretical analyses, and they use a variety of approaches including petrology, geochemistry and geophysics. All the case studies deal with subduction zones, except those of Leeman et al. on the magmatic system of the Snake River Plain, Yellowstone, and Wright and Klein on the Kilauea volcano. In this respect, the book deals in depth only with subduction-related magmatic systems. However, as the editors discuss in the introduction of the book, ocean ridge and intraplate volcanism are much less variable than subduction-related volcanism, which may have very different petrogenetic characteristics, resulting from their complex genesis, crustal storage, and tectonic influences. This book does a very good job on focusing only on the very complex subduction-related magma evolution.

Two papers deal with magma transfer from mantle to surface: Zellmer provides an overview of first-order controls on transfer from the mantle wedge to the surface, and Ciglioni et al. provide a detailed assessment of the transfer of magma in Stromboli volcano. Both papers serve as a very useful overview for the non-specialist, and make the subsequent papers more accessible.

The second theme, dynamics of magma transport, is complex and depends on the particular type of magma involved. Bunger assesses relative importance of the various factors that control sill propagation. The filling of subvolcanic magma chambers is the result of the rate of magma supply and the rate at which room is created by extension. Wright and Klein interpret these processes from geodetic, seismic and eruption data at Kilauea, whereas Martin-Del Pozzo et al. demonstrate the use of magnetic data to track magma ascent and lava dome extrusion at Popacatapetl, Mexico.

Crustal magma reservoirs and plumbing systems are complex and require an integration of petrography, mineral chemistry and geophysics to understand their workings. Jerram and Martin present techniques that quantify key aspects of crystal populations in magmas and relate them to processes such as magma cooling, recharge, decompression and degassing. Such techniques may help to link mineral textures to isotopic heterogeneities and provide fingerprints of different types of crystals. Ban et al. use petrological details of crystal assemblages to reconstruct a short-lived stratified magma chamber beneath Zao volcano in Japan.

The last theme of the book concerns processes of silicic melt generation, a subject on which there has been great progress in the last decade. Silicic melts may be generated in a variety of ways, often involving the interplay of more than one parent or more than one process, and within a variable time-scale. Five papers provide interesting data sets and discussions on these issues. Dosseto et al. show that differentiation from mafic to intermediate and felsic magmas in some arc volcanoes may be an unexpectedly rapid process. The papers by Gray et al. and Burgess and Miller invoke magma mixing in the generation of felsic magmas, whereas the paper by Leeman et al. suggest partial melting of upper crust by massive input of basalts into the mid to upper crust over several million years. Straub demonstrates constancy in the petrogenetic and eruptive processes producing basaltic andesite and rhyolite over 42 Ma in the Izu-Bonin arc.

The 12-page introduction to magma dynamics by Zellmer and Annen is a useful overview of the state of the art. It is written in a manner that is accessible to the general geologist and would bring anyone interested in igneous rocks up to date on this important topic. This is an important book that deserves to be in every good geological library and will appeal to a wide range of geoscientists.