Generation of intermediate to acidic magmas at convergent plate margins by fractional crystallization in lower crustal magma reservoirs

P. ULMER[1*] AND O.MÜNTENER[2]

[1]Institute of Geochemistry and Petrology, ETH Zurich, 8092 Zurich, Switzerland (peter.ulmer@erdw.ethz.ch)
[2]Institute of Earth Sciences, University of Lausanne, 1015 Lausanne, Switzerland (othmar.muntener@unil.ch)

We present experimental results on the differentiation of (near) primary, hydrous, calc-alkaline magmas by fractional crystallization under conditions of lower crustal magma reservoirs at convergent plate margins (pressures of 0.7 – 1.0 GPa and temperatures from 1300 – 700°C). Experimental simulation of fractional crystallization is particularly suited to understand the major controls on phase relations and compositions of magmas differentiating in the lower crust. We investigate the mutual phase relations of the principal phases olivine, cpx, opx, garnet, amphibole, plagioclase and Fe-Ti-oxides. Crystallization experiments at lower crustal conditions demonstrate that liquids at 0.7 to 1.0 GPa evolve from metaluminous to slightly peraluminous, corundum normative compositions. If high-Mg basalts and basaltic andesite in equilibrium with mantle peridotite are considered as the most common primary arc magmas from which lower crustal rocks fractionate, crystallization produces between 45 to 70% of ultramafic, olivine, clinopyroxene and amphibole dominated cumulates and residual andesite compositions that are typical for more evolved upper crustal magmas and rocks. Andesites at temperatures below 970°C fractionating amphibole, plagioclase, Fe-Ti-oxide and garnet (at 1.0 GPa) will drive the SiO_2-content systematically from 57 to 78 wt% over a temperature interval of >250°C and only requires 50-60% additional crystallization. We use new partitioning data to model the trace element evolution of siliceous magmas, demonstrating that many plutonic and volcanic rocks worldwide are hallmarks of crystallization moderated by lower crustal processes.