How Efficient is Melt Homogenization in the Lower Crust?

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Lower-crustal 'MASH' or 'hot zones' are important regions for melt homogenization and geochemical diversification. Here, we use magmatic fabrics and magmatic amphibole geochemical data from the Early Cretaceous Malaspina Pluton to investigate the geometry and degree of melt homogenization in a lower-crustal MASH zone. The Malaspina Pluton was emplaced at ~40-50 km depth and was assembled by numerous intrusions of dioritic sheets that were fed from a 6-km wide subvertical feeder zone. Magmatic amphiboles are dominantly pargasite, magnesiohastingsite and tschermakite with $Mg^{\#}$s ranging from 40-60. Trace-element data show two amphibole groups, which we define as depleted and enriched based on HFSE and LILE concentrations. Enriched amphiboles have high Zr concentrations (30-150 ppm) and display pronounced enrichment in light rare-earth elements. In contrast, depleted amphiboles show low Zr (<30 ppm) concentrations and have depleted light rare earth element patterns similar to N-MORB. Amphibole crystallization temperatures range from 965-845°C, with no difference between enriched and depleted groups. Whole-rock, Sr- and Nd-isotopes are remarkably homogeneous and show no apparent difference between enriched (εNd_i= 0.1 to -0.1; $^{87}Sr/^{86}Sr_i$ =0.70420-0.70413) and depleted groups (εNd_i=0.3 to -0.4; $^{87}Sr/^{86}Sr_i$=0.70424-0.70411). Zircon O- and Hf- isotopes are also remarkably homogeneous with sample average values ranging from εHf=+2.9 to +4.3 and $\delta^{18}O$ ranging from 5.67 to 5.75 ‰. We suggest that melts originated from a common, isotopically homogeneous source, and underwent contrasting fractional crystallization histories in separate deep-crustal storage reservoirs beneath the Malaspina Pluton. These melts were then emplaced as discrete subhorizontal sheets into a crystal-rich mush zone where they experienced little homogenization during their emplacement and storage in the lower crust.