Parameterized lattice strain models for REE partitioning between amphibole and silicate melt

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The distribution of REE+Y between amphibole and silicate melt is important for understanding a wide variety of igneous and metamorphic processes in the lithosphere. In this study, we used published experimental REE+Y partitioning data between amphibole and silicate melt, the lattice strain model [1], and non-linear least squares regression method to parameterize key partitioning parameters in the lattice strain model (D_0, r_0, and E) as a function of pressure, temperature, and both amphibole and melt compositions. Two models, which give nearly identical results, are obtained in this study. In the first model, D_0 depends on temperature and amphibole composition: it positively correlates with Ti content, and negative correlates with temperature and Mg, Na, and K contents in the amphibole. In the second model, D_0 depends solely on the melt composition: it positively correlates with Si content, and negatively correlates with Mg, and Ca contents in the melt. In both the mineral and melt composition models, r_0 negatively correlates with the ferromagnesian content in the *M4* site of the amphibole and E is a constant. The very similar coefficients in the equations for r_0 and best-fit values for E in the two models allow us to develop a new thermometer for amphibole-melt equilibria. The thermometer predicts the temperatures in phase equilibrium experiments with a precision of 87ºC (1σ), adding confidence to our parameterizations of D_0. Our model and experimental data simulating fractional crystallization of arc magmas [2] suggests that (1) REE partition coefficients between amphibole and melt can vary by an order of magnitude during arc magma crystallization due to variation in the temperature and composition of the amphibole and melt, and that (2) fractional crystallization of amphibole plays an important role in decreasing the Dy/Yb and Dy/Dy* ratios in arc magmas [3].

[1] Blundy & Wood (1994) *Nature* **372**, 452-454. [2] Nandedkar et al. (2014) *CMP* **167**, 1015. [3] Davidson et al. (2013) *J Petrol* **54**, 525-537.