Modeling differentiation of ferro-basaltic magmas

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To develop models simulating crystallization of Fe-Ti oxides, we have processed experimental data on magnetite-melt and ilmenite-melt equilibria. These data include 62 *Mt*-melt and 75 *Ilm*-melt pairs at temperatures 1040-1150°C, fo_2 from *IW* to *NNO*+2, and bulk compositions ranging from ferrobasalts to dacites. The empirically calibrated *Mt*-melt and *Ilm*-melt equations allowed us to develop two models for calculating crystallization temperatures of the Fe-Ti oxides with an accuracy of 10-15°C, and compositions within 0.5-2 mol%. These models have been integrated into the COMAGMAT-3.5 program, improving our ability to numerically study the effects of temperature and oxygen fugacity on the stability and phase equilibria of Fe-Ti oxides. Application of this approach to the tholeiitic series of Chazma Sill from Eastern Kamchatka (Russia) accurately reproduce the FeO-SiO_2 relations observed in the suite. Another set of calculations has been conducted for 6 cumulative rocks from the Skaergaard intrusion. As a result, initial magma temperature (1165±10°C) and trapped melt composition parental to the intrusion body were determined. Computer simulations of perfect fractionation of this composition as well as another proposed parent produced petrochemical trends opposite to those followed from natural observations. This is interpreted as evidence for an initial Skaergaard magma containing a large amount of olivine and plagioclase crystals (about 40-45%), so that the proposed and calculated parents are related through the melt trapped in the crystal-liquid mixture. This promotes the conclusion that the Skaergaard magma fractionation process was intermediate between equilibrium and fractional crystallization.