

A predictive thermodynamic model for element partitioning between plagioclase and melt

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There are various attempts in the literature to infer from the chemical zoning in plagioclase phenocrysts the magma evolution [1] and to determine magma residence times of plagioclases from diffusion modelling [2]. Both methods rely on accurate knowledge of partitioning coefficients between plagioclase and melt, D_i , and their dependencies on thermodynamic parameters and chemical composition. Based on a regular mixing model and numerical fitting of numerous experimental data [3] derived an equation for Sr and Ba of the form, $RT \ln D_i = A_i X_{An} + B_i$. In a more recent work [4] the same relation was also used for various other elements to fit experimental pl-melt partitioning data. However, there is no a priori justification to use this relation also for other elements than Ba and Sr.

Here we present a new predictive model for the element partitioning between the metal site in plagioclase and melt. We have used the Brice model [5] to fit simultaneously the experimental data of 115 partitioning experiments, including those of [4] and unpublished data (partially published in [5]). The dependency of D_i on X_{An} is dominated by lattice strain effects and is related to the linear dependence of the optimum ionic radius r_0 on the anorthite content. Once the relevant parameters of the Brice model, r_0 and the Young's modulus of the site, are calibrated, the partitioning data can be corrected to isolate their T dependence. The inferred T dependence of the divalent cations and monovalent cations is perfectly consistent with available data for the free energy of fusion for anorthite and albite, respectively. The effect of the melt chemistry cannot be ignored in general but is minor compared to the lattice strain effects in most cases.

The major implication of this new model is that D_i becomes less sensitive to X_{An} and more sensitive to T than predicted by the relations of, e.g., [3] and [4]. This can be explained by the implicit relationship of X_{An} and T in most partitioning experiments.

[1] Blundy and Shimizu (1991) *Earth Planet Sci Lett*, **102**, 178-197; [2] Costa *et al* (2003) *Geochim Cosmochim Acta*, **67**, 2189-2200; [3] Blundy and Wood (1991) *Geochim Cosmochim Acta*, **55**, 193-209; [4] Bindeman *et al* (1998) *Geochim Cosmochim Acta*, **62**, 1175-1193; [5] Blundy and Wood (1994) *Nature*, **372**, 452-454.

Sr-Nd-Hf-Pb isotope systematics of the Oyu Tolgoi Cu-Au deposit (Mongolia)

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New Sr-Nd, Hf and Pb isotope data are presented for a representative suite of 21 samples of plutonic and volcanic rocks (D_3 to C_1) from the giant Oyu Tolgoi porphyry Cu-Au district in the South Gobi, Mongolia.

Sr-Nd isotopes (whole-rock) show a restricted range of initial compositions, with ϵ_{Nd} varying from +2.1 to +7.4 and $(^{87}Sr/^{86}Sr)_t$ predominantly between 0.7035 and 0.7045 reflecting formation from a relatively uniform juvenile lithophile-depleted source.

Hf isotopes (zircon) exhibit a range of -4.5 to +13.6 (**Fig. 1**). Felsic rocks show predominantly (apart from one sample) a juvenile mantle-derived signature whereas volcanic rocks exhibit some mixing with evolved crustal sources.

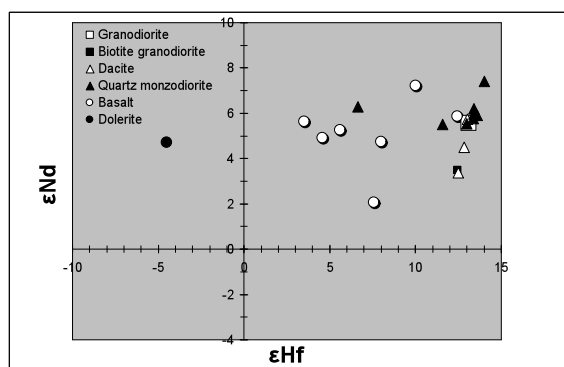


Figure 1: Hf and Nd isotopes for the Oyu Tolgoi deposit.

Pb isotopes (whole-rock) indicate a rather preserved array of isotopic compositions such as $^{206}Pb/^{204}Pb$ 17.773-19.058, $^{207}Pb/^{204}Pb$ 15.445-15.544 and $^{208}Pb/^{204}Pb$ 37.456-38.489. These are in full agreement with Sr-Nd-Hf isotopes indicating presence of a mantle component. Several samples show contributions from a MORB-related source.

All four isotopic systems hint that magmas from which the large Oyu Tolgoi porphyry system was generated, originated predominantly from juvenile material within the subduction-related setting of the Gurvan-Saikhan terrane.