New experimental data and modeling results of coupled alkali feldspar dissolution and secondary mineral precipitation

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In order to evaluate the complex interplay between dissolution and precipitation reaction kinetics, we conducted a series of batch and flow through reactor experiments to assess alkali-feldspar dissolution and secondary mineral formation in initially acidic fluids (pH = 3 -4) at 200°C and 300 bars. Temporal evolution of fluid chemistry was monitored by major and trace element analysis of *in situ* fluid samples. Solid reaction products were analyzed with scanning electron microscopy, X-ray diffraction, transmission electron microscopy, and X-ray photoelectron spectroscopy.

The experimental data allowed us to examine the hypothesis of partial equilibria between secondary mineral products and aqueous solutions in feldspar-water systems. Speciation and solubility geochemical modeling was used to compute the saturation indices (SI) for product minerals and to trace the reaction paths on activity-activity diagrams. The modeling results demonstrated: (1) the experimental aqueous solutions were supersaturated with respect to product minerals for almost the entire duration of the experiments; (2) the aqueous solution chemistry did not evolve along the phase boundaries but crossed the phase boundaries at oblique angles; and (3) the earlier precipitated product minerals did not dissolve but continued to precipitate even after the solution chemistry had evolved into the stability fields of minerals lower in the paragenesis sequence. These three lines of evidence signify that product mineral precipitation is a slow kinetic process and partial equilibria between aqueous solution and product minerals were not held. In contrast, the experimental evidences are consistent with our new hypothesis that slow clay precipitation kientics partly explains the well known field – lab rate discrepancy [1,2].

[1] Zhu *et al.* 2004, In: Wanty, R. B. and Seal, R. R. I. (Eds.) *Water-Rock Interaction*. A.A. Balkema, Saratoga Springs, New York, p. 895-899. [2] Zhu, C. 2005, *In situ* feldspar dissolution rates in an aquifer. *GCA* **69**, .6, 1435-1453.

Origin of basaltic underplating

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The origin of basaltic underplating is mistakenly attributed to that the mantle derived melts is denser than the typical lower crust due to the previous inaccurate arguments. Our density calculation of picrits shows it is not the case. We have developed a quantitative density barrier model and performed thermal simulations to evaluate the evolution of the magma intraplating and underplating process. At the initial stage of magmatism, the mantle-derived basalt is likely to stall at the base of the upper crust due to the density stratification of the continental crust. This is an intraplating process. The underplating is induced by melting of the lowermost crust, which produces a thin melt zone, serving as a physical density barrier for ascending basalts.

The density barrier model predicts that intraplating and underplating cannot simultaneously occur. In addition, the underplating cannot cause the melting of the upper crust, and basaltic intraplating cannot produce significant melts of the lower crust. Hence, intraplating and underplating have a different prospect for related mineralization due to the different element-abundance of the upper and lower crust. The occurrence of S-type granite and associated deposits and HTLP (high-temperature-low-pressure) metamorphism are a tripartite association, which is probably diagnostic of basaltic intraplating.

Several ways can lead to melting of the base of the lower crust. If the intraplated basalt with a high temperature and fast emplacement rate, this will result in a transition from intraplating to underplating. This is the case for mafic LIPs. The short-lived intraplating process can explain why S-type granite and adakite are absent in a mafic LIP.

In addition, coupled with the observations, our numerical results also predict that the intraplating is largely overlooked in many tectonic environments.