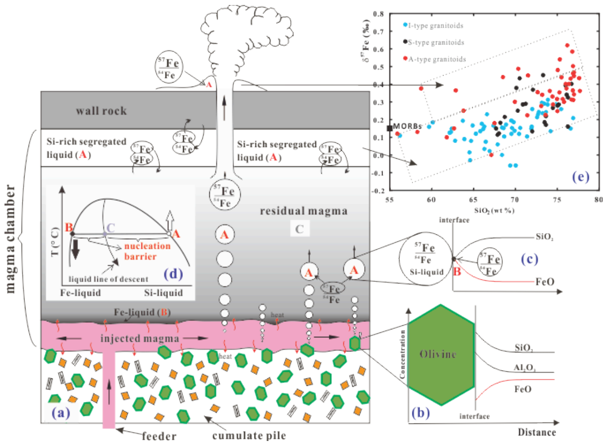
A mineral-interface nucleation and separation (MINS) model for liquid immiscibility in silicate melts

DAN ZHU[1*], HUIMING BAO[1,2], AND YUN LIU[1]

[1] State Key Laboratory of Ore Deposit Geochemistry, Institute of Geochemistry, Chinese Academy of Sciences, Guiyang 550002, China (*correspondence: zhudan@vip.gyig.ac.cn)

[2] Department of Geology and Geophysics, E235 Howe-Russell Complex, Louisiana State University, Baton Rouge, LA 70803, USA

The potential role of liquid immiscibility in late-stage magmatic differentiation has been debated for nearly a century. Here we propose a mineral-interface nucleation and separation (MINS) model in which the injection of a hot primitive magma into a cooler and larger magma body triggers a rapid cooling of the injected magma and consequently rapid crystal growth of plagioclase and olivine. In this model, nucleation of Fe-rich globules starts at the interfaces of plagioclase while growth of Si-rich droplets at interfaces of olivine (Fig.1).



The MINS model highlights dynamic disequilibrium and diffusional processes, and has three main predictions. (1) Si-rich droplets can grow larger and rise to the top of a magma chamber due to their lower density. (2) Si-rich liquids are enriched in heavy Fe and Mg isotopes relative to the bulk magma chamber as a result of diffusional isotope effects during the growth and ascent of Si-rich liquids in a magma chamber. (3) Si-rich liquids are not depleted in incompatible elements relative to those in the bulk magma chamber as a result of slow diffusivities of these elements.

Figure 1:The MINS Model for the origin of A-type granitoids in silicate melts