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Experimental techniques for separating immiscible silicate liquids: Toward improved phase relations and trace element partition coefficients

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Interest in liquid immiscibility, accompanied by debate over its significance for magmatic systems, is longstanding[1].Recently, silicate-silicate and silicate-salt immiscibility have been proposed in the formation of some critical metal ore fluids; e.g., iron-oxide-apatite deposits[2,3], granite-hosted REE deposits[4] and granite-hosted Mo deposits[5]. Constraints on the compositions of conjugate liquids, and how they change with the prevailing conditions, are therefore essential for scrutinising genetic models for these systems.

High temperature experiments can constrain both the phase relations of immiscible systems and the partitioning of trace elements between co-existing liquids. In many instances, however, it is challenging to achieve complete phase separation[1,6], making analyses a challenge. This problem is compounded in systems displaying extensive quench modification, in which melt exsolution or crystallization upon quench must be distinguished from phases that were intermixed at the run conditions.

To help mitigate these issues, we are investigating methods to enhance phase separation in immiscible systems. Work to-date has focused on F-rich alkaline granite compositions, for their relevance to the Strange Lake REE deposit, QC, Canada, and the ability to compare our results with prior work[6]. We find a range of conditions where immiscibility occurs, however, spatial separation of the conjugate melts is often incomplete and quench exsolution and crystallization is sometimes extensive. To overcome this, we have exploited the preferential wetting of silica glass by F-poor melts to improve phase separation; permitting more straightforward interpretation of run-product textures. We also find that long duration experiments (>100 hrs) improve density-driven melt separation, however, these experiments may be subject to F-loss through the container walls. Work is ongoing to test this approach, and the use of small thermal gradients, for immiscible melt separation in other systems.

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