Textural, chemical, and inclusion records of rapid crystallization

MONA-LIZA C. SIRBESCU AND JAMES J. STUDENT

314 Brooks Hall, Central Michigan Univ., Mt. Pleasant, MI, 48859, sirbe1mc@cmich.edu (stude1jj@cmich.edu)

Microthermometry on coeval fluid and melt inclusions combined with conductive-cooling modeling document cases of rapid and highly undercooled crystallization of thin, internally-zoned pegmatite dikes. Rythmic compositional and textural variations in the inward-crystallized pegmatites suggest the existence of diffusion-controlled boundary layers and fluid-magma immiscibility.

The 2 m wide Animikie Red Ace (ARA) dike, NE Wisconsin is a nonmiarolitic pegmatite emplaced in country rocks at an estimated temperature of 220 °C and pressure of 3.5 kbars, that crystallized in ≤10 days. Remelting of crystallized-melt inclusions from the ARA quenched margin yielded liquidus temperatures of ~720 °C which is the temperature at which crystallization would have started in hypothetical, equilibrium conditions. However, cooling rates as high as 370 °C/day in the ARA outer zones exceeded the crystal nucleation rate, resulting in strong degrees of magma undercooling. Based on pressure-corrected trapping temperatures of primary fluid inclusions, which record the actual crystallization conditions, the pegmatite magma crystallized sequentially, starting with the outer zones at an average temperature of ~460°C, equivalent to magma undercooling of ≥240°C. Fluid saturation at the ARA may have occurred early, based on inclusion data.

The Cryo-Genie (CG) dike, southern California is a rapidly-crystallized, miarolitic, gem-bearing pegmatite emplaced in 150°C country rocks at 2 kbars. Fluid inclusions reveal crystallization temperatures of ~400°C (undercooling as high as 300°C) in the marginal zones down to as low as 230°C in the pocket, hydrothermal minerals. Fluid saturation was reached later in the crystallization sequence of the CG pegmatite, as suggested by inclusions and textural transition from fine-grained "line-rock" to coarse pegmatite. Unidirectional, radial, and skeletal textures characterize both ARA and CG dikes, supporting rapid, disequilibrium crystallization. Formation of diffusion-controlled boundary layers may have lead to 2-phase or 3-phase immiscibility in the crystallizing melt as suggested by textural and compositional zoning at outcrop to microscopic scale. Episodic extreme enrichments in borate, phosphate, and/or manganese are suggested by tourmaline ± manganoan fuoroapatite ± garnet-rich layers.

Microbially driven chemical weathering in glaciated systems

M. SKIDMORE[1]*, S. MONTROSS[1], M. TRANTER[2], A.-L. KIVIMÄKI[3] AND R.J. PARKES[4]

[1]Department of Earth Sciences, Montana State University, Bozeman, MT 59717, USA (*correspondence: skidmore@montana.edu)
[2]Bristol Glaciology Centre, School of Geographical Sciences, University of Bristol, Bristol, BS8 1SS, UK (present address: ENVIRON, Ratapihantie 11, FIN-00520 Helsinki, Finland)
[3]Department of Earth Sciences, University of Bristol, Bristol, BS8 1RJ, UK
[4]School of Earth, Ocean and Planetary Sciences, Cardiff University, Main Building, Park Place, Cardiff, CF10 3YE, UK

Interactions between dilute meltwater and fine-grained, freshly comminuted debris at the bed of temperate glaciers liberate significant solute. The proportion of solute produced in the subglacial environment via biotic and abiotic processes remains unknown. This research quantifies the solute produced via biotic vs. abiotic weathering during 100-300 day laboratory incubations at 2°C using glacial sediment and meltwater from the Haut Glacier d'Arolla, Switzerland and Bodalsbreen, Norway demonstrating the biotic contribution is substantial. This indicates that subglacial microbial activity is likely an important driver of chemical weathering in glaciated environments. This contrasts with conventional geochemical models that assume negligible chemical weathering occurs at low (~ 0°C) temperatures. Thus, subglacial biogeochemical weathering and its impact on global geochemical cycles and climate deserves greater consideration, especially during periods of enhanced ice cover, during Earth history.