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275-7 Boiling Brines and Syrup to Bring Igneous Processes into the Classroom

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Solutions of water and a salt or sugar make excellent experimental analog magmas for teaching igneous petrology concepts, because of the comparatively low temperatures involved, the simplicity of the apparatus needed, and the responsiveness of familiar chemical systems. Aqueous solutions of KCl, NaCl, $CaCl_2$, $MgCl_2$, or sucrose can be used to determine ice saturation curves (ice liquidus), as described previously (Brady, 1992, 2003). New experiments that include boiling on a hot plate add significantly to the teaching possibilities, as each aqueous solution has a steam saturation curve (boiling point elevation curve) that can be determined by students. Furthermore, boiling increases the concentration of the dissolved salt or sugar (fractionation!) to levels that cannot be achieved at room temperature; this can lead to simultaneous saturation with both steam and crystals (salt or sugar) at a “chaotectic point” (Greek: “gas” + “to melt”). Simultaneous crystallization and boiling of sucrose solutions produce a solid that contains vapor cavities (vesicles). KCl, $CaCl_2$, and $MgCl_2$ solutions concentrated by boiling crystallize, partially or completely, upon cooling to room temperature. The proportions of crystals and liquid in cooled solutions can be measured by students as tests of the lever rule. KCl solutions may be used to simulate magma chambers in which the nucleation and growth of crystals results in crystal settling due to density contrast, but also crystal rising due to convection. Low nucleation rates, allowing superheating and especially supercooling, also may be demonstrated.

Brady, J. B. (1992) Does ice dissolve or does halite melt? -- A low-temperature liquidus experiment for petrology classes: Journal of Geological Education, 40, 116-118.

Brady, J. B. (2003) Phase diagrams from kitchen chemistry. Accessed May 30, 2008. http://serc.carleton.edu/NAGTWorkshops/petrology/teaching_examples/3659.html

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