Analogue experiments for understanding a crystal morphology variation of igneous rocks using a no-calorie sweetener

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Crystallization of a magma is progressed during cooling. The number and morphology of crystals are chiefly controlled by degree of undercooling of a magma. Since igneous rocks are generally formed under various cooling profiles, crystal occurrences of natural igneous rocks are varied. As it is generally known, difference of crystal textures between plutonic and volcanic rocks are generated from difference of cooling rate. However, only that knowledge is not enough to understand results of field or microscopic observations. Therefore, students, who major in geology or petrology, should be understand general crystallization process. In this presentation, we propose the easy analog experiments to understand crystallization process of silicate melt.

Erythritol ($C_4H_{10}O_4$), which is no-calorie sweetener, is used for the experiments. The melting temperature is 121 ˚C, and erythritol can be easily melted using a hot plate. Since the melted erythritol is relatively low viscosity, crystallization is easily induced even if low degree of undercooling. This characteristic is different from a sugar.

We melted 25 g of erythritol in a petri dish with 90 mm in diameter. The petri dish including melted erythritol was cooled via various cooling rate. In the result, the crystal morphology was varied from euhedral to dendritic, and spherulitic with increasing degree of undercooling. The crystal size tends to be small with increasing degree of undercooling. The occurrences of crystal textures are consistent with those of natural igneous rocks.

The cooling rate can be easily quantified using an infrared thermometer. The boundary of cooling rate between euhedral and dendritic crystal formations was about 12 ˚C/min. The boundary of cooling rate between dendritic and spherulitic crystal formations was about 40 ˚C/min. Furthermore, latent heat could be also analyzed when crystallization progress. Latent heat is important, because it affect to rheology of advancing lavas or a magma chamber. The in-situ crystallization can be observed under a microscope. We consider that these experiments are strongly effective for geology and petrology education.

Keywords: Erythritol, Crystallization, Igneous rock

