GROWING CRYSTALS ON A MICROSCOPE STAGE

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Introduction

Many compounds crystallize rapidly from evaporating solutions, and many can be crystallized from melts. Because of this, it is possible to do simple crystallization experiments and to watch crystals grow over short times. Students can study several different compounds during one lab period. Crystal habit, growth zones, nucleation, deformation textures--students can examine many things quickly and easily. During the past year, we have studied many different compounds, and tried various techniques, as we worked to develop new exercises for our mineralogy students. We have found the results to be fun and exciting, and we summarize some of them here. These are preliminary results only, but we think some great laboratory projects can be developed using the approach we describe. We have spent six months precipitating crystals from various aqueous solutions, but have only just begun growing them from melts.

Equipment

The experiments require only minimal equipment: a hot plate with a calibrated temperature scale (or a thermometer for measuring hot plate temperature), a "dimple" plate (depressive slide plate), and a petrographic microscope. Additionally, vials, pipets, mortar and pestle and other standard lab equipment are needed.

Compounds Studied

We obtained simple and intriguing results by precipitating crystals from saturated solutions of kernite ($Na_2B_4O_7 \bullet 4H_2O$), sylvite (KCl), halite (NaCl), smithsonite ($ZnCO_3$), rhodochrosite ($MnCO_3$), gypsum ($CaSO_4 \bullet H_2O$) and an unnamed organic compound $CaH_4(C_3S_3N_3)_2 \bullet 11H_2O$. Additionally we grew crystals from molten para-dichlorobenzene, octachloropropane, biphenyl, thymol, and camphor. (We are indebted to W. D. Means for suggesting these compounds and providing materials; see Means, 1986).

Procedure

For precipitation experiments, we prepared solutions by finely grinding minerals, putting about 0.5 gm of the resulting powder and some warm water in a one dram vial, and shaking. Kernite, sylvite and halite readily dissolve, but the carbonates do not. To help dissolution, we added HCl to some carbonate solutions. We also prepared one solution by combining equal amounts of saturated kernite and sylvite solutions. Once a presumed saturated solution was prepared, we placed a drop or two in a dimple on the dimple plate, and then heated it on the hotplate. Periodically, we removed the dimple plate from the hotplate and examined it under a petrographic microscope; when crystallization began, we left it on the microscope stage. For the crystallization experiments, we melted crystals between two glass slides and allowed them to recrystallize (Means, 1986).

Selected Results

halides: Sylvite and halite are particularly intriguing because as crystals begin to form they develop pronounced growth zones. We added food coloring to the solutions to make the zones more pronounced. Forms included dodecahedrons and cubes. Growth is from the outer parts of a dimple toward the center, and is quite rapid if the dimple plate is very hot. Microstructures and other imperfections are readily apparent if crystallization is fast. We were not able to obtain euhedral crystals from commercial ionized salt, presumably because it is processed to reduce recrystallization.

kernite: Kernite crystallizes typically as fine needles, sometimes forming radiating splays. Rare monoclinic plates may form. Needles propagate through the solution and striations appear on the larger crystal faces, but growth zones are not obvious. Crystallization is quite rapid; in fact, it is so rapid that if the dimple plate is too hot it occurs practically instantaneously.

sylvite and kernite together: As the solution evaporated, kernite needles grew. When the last crystals of kernite formed the sylvite crystals began to appear. Sylvite soon completely covered the kernite needles, which generally settled to the bottom of the dimple. Getting the two to crystallize simultaneously, or nearly so, might be possible, using a different composition solution.

smithsonite: We had difficulty precipitating $ZnCO_3$ because of its low solubility. Addition of HCl increased solubility and small well-formed crystals with rhombohedral and scalenohedral forms developed on evaporation, but they were crystals of zinc chloride, not zinc carbonate. We tried several different temperatures and solutions but could not grow large crystals of zinc carbonate.

gypsum: Gypsum is relatively easy to dissolve in water, and precipitates as well formed monoclinic crystals. Larger crystals show growth striations and, if crystallization is rapid, show deformation features. Although both gypsum and kernite have distinctly different forms, they seem to precipitate in the same manner. It therefore might be intriguing to try solutions saturated in both to see what happens.

camphor and thymol: After crystallization, camphor has a quartz-like appearance. Crystals are subhedral, equigranular, and have low birefringence. Undulatory extinction is also apparent. The appearance is remarkably similar to a quartzite. In contrast, thymol produces feathery and radiating clusters of crystals with higher birefringence.

Conclusion

The experiments described above, and many other similar ones, provide a simple way for students to see crystallization in action. Many different compounds, forming many different kinds of crystals, can be studied. The equipment is easily obtained, the costs are low, and the experiments can be completed in short time.

References

Means, W.D. (1986) Three microstructural exercises for students. Journal of Geologic Education, 34, 224-230.