Crystal Size and Cooling Rate

Objective:
To observe the relationship between cooling rate and crystal size.

Materials:
1. Alum or Copper Sulfate (Alum is a pickling spice and can be purchased in the grocery store)
2. Boiling water
3. Thread and 2-3 pencils
4. Pyrex or kymax container
5. Refrigerator, Freezer or cooler with ice
6. Magnifying glass
7. Paper and pen or pencil to record your data

Procedure:
1. Add Alum (or copper sulfate) into the boiling water into two separate Pyrex containers until no more will dissolve.(Make a hot concentrated or supersaturated solution)
2. Place a piece of string attached to a pencil into each of the warm solutions and record date and the time and the room's temperature.
3. Allow one of the solutions to cool at room temperature.
4. Watch for crystals to form along the sides of the container and on the thread. Record the date and the time. (You will have to wait for the solution to evaporate which is a cooling process for large crystals to form-Humidity and any movement of the solution may effect your results) Set the time for observing at convenient intervals during the first day and then once or twice during the following days.
5. Draw and describe the size of the crystals. (You may save the string of crystals and tape them on appropriately colored construction paper so students may compare the string of crystals side by side- label each string for comparison)
6. Place a new string in the remaining solution.
7. Record the date and time and any observations.
8. Cool the second solution in a refrigerator or in a cooler with ice.
9. Record the time, date and temperature of the cool place
10. Check the cooling solution every 20 minutes
11. Time how long it takes for crystals to form..
12. Draw and describe the crystal size.
13. Compare with the size of the crystals cooled at room temperature.
14. Prepare a new solution or heat the solution again and place in a piece of string into this third solution. Record the date and time and temperature of the freezer.
15. Place the warm solution in a freeze.
16. Check the solution every 10 to 20 minutes.
17. Record the date and time when crystals form.

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18. Compare the size of the crystal size with the refrigerator and room temperature crystals

Observation Questions:

1. Which solution cooled the quickest? The solution in the freezer cooled the quickest it froze in 2 hours.
2. Which solution took the longest to cool? The solution on the counter cooled slowest but it took days for the crystals to form. The water had to evaporate and evaporation is a cooling process. Just think how you feel when you come out of the shower or bathtub and the water evaporates from your skin….cold.
3. Which crystal was the largest? There were fewer but larger crystals in the solution that took the longest to cool.
4. Which crystals were the smallest? The solution that cooled quickly formed many small crystals.

Analysis Questions:

1. How does the cooling rate relate to crystal size? The slower the cooling the larger the crystal.
2. How does this experiment relate to intrusive igneous rocks? Igneous rocks that cool inside the earth cool slowly so the crystals have a longer time to form and can be large. For example the crystals in granite
3. Which part to the experiment would describe extrusive igneous rocks? Igneous rock that cools on the surface of the earth like basalt and scoria has small crystals that require magnification to be seen. The freezer would be the closest model in this experiment.
4. How does this experiment relate to the texture of igneous rocks? Give examples Texture has to do with crystal size in igneous rock. Large crystals have a phaneritic texture like granite or the Alum formed on the counter. The crystal was the size of a grain of rice or larger. Fine or small crystals have an aphantic texture like basalt. Many of the crystals in formed in the freezer were small you could see their shape under a magnifying glass.
5. Where would this process occur in nature? This could happen where igneous rock is cooling along convergent boundaries and subduction zones and divergent boundaries along spreading centers.
6. What other rock types could relate to this lab experiment. Explain why. Chemical sedimentary rocks are formed from minerals dissolved in water. Crystals form when the water evaporates or the minerals precipitate or fall out of the solution. The alum that was put in the freezer precipitated and ended up in the bottom of the glass. While the solution left on the counter evaporated to form alum crystals. Limestone can be formed in this way.

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Follow-up:

Have the students propose other ways to speed up and slow down the cooling rate of the saturated solution. Make hypotheses about crystal size and test your hypothesis.

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