Activity 17: Creating a Crystal Forest

Maine Geological Survey

Objectives:

To demonstrate that low temperature chemical activity can result in the formation of silicate structures. To have students recognize the significance of low temperature geologic activity in a variety of surface and near surface environments.

Time:

This activity takes one (1) class period and observations (2-5minutes) over several days.

Background:

While high temperature geologic environments, such as igneous and metamorphic activity, does contribute significantly to both rock and mineral formation, low temperature reactions ALSO occur which are of major geologic significance. Examples of these reaction systems include the formation of cementing agents in conglomerates; the creation of gypsum, salt, and nitrate deposits; and often striking oxide and carbonate deposits in the upper portions of sulfide ore bodies.

This demonstration is a variation on the coal, ammonia water, water glass, and iron nail activities which were prevalent in the 1950's. It was also popular in a number of packaged varieties in novelty stores. Flinn Scientific Inc. offers a number of similar prepackaged kits including AP6157–Growing Crystals in Gel ($45.35), AP8715–Crystal Growing Rock ($22.80), and AP4424-Silicate Garden ($38.30).

You can develop your own approach to this with a little experimentation and practice. Obtain 1 gallon of water glass which is the trade name of sodium silicate. This is available at any well stocked hardware store for about $15.00. Dilute this to a density of about 1.1 with clean tap water (about a 50%-50% mix of the two). Upon the addition of almost any water soluble transition metal salt (see materials list) the following happens. Columns of various colored crystals will start to form and build upwards from the bottom of the container. This will continue, although more slowly than at first for several days. As the salts dissolve they release positively charged metallic ions such as Co++, Ni++, and Mn++. These ions combine with the negatively charged silicate polyatomic ions to form a partially insoluble silicate membrane around the precipitating metal ion. Due to greater pressure on the sides of the membrane than on the top, the membrane bursts upwards, more salt is released and the process repeats itself. Some of the crystals within geodes may form by similar processes. This is fascinating to observe over a period of time. Experimentation will give you the best selection of materials to use; the forest is fragile and will collapse if shaken or bumped.

Materials:

As this is primarily a demonstration one set only is needed; if you wish to have students do this, multiply by the number of groups performing the experiment. See safety precautions and comments section. You will need:

- sodium silicate
- tap water
- measuring cup
- clear GLASS one quart to one gallon container
- sand, coal, or rocks (optional) to provide topography for the forest
- 0.5 grams each of a number of the following chemical compounds - manganese chloride, chromium nitrate, iron sulfate, zinc sulfate, iron II chloride, cobalt nitrate, and so on. These materials are often stocked by chemistry teachers.

Procedure:

Dilute the water glass to the desired density, and mix well. Place stones, coal, or sand in bottom of container and fill with the water glass solution to within two or three inches of the top of the container. Sprinkle the selected chemicals into the container in random, overlapping patterns across the bottom. Observe the results.

Special Safety Precautions:

Care must be exercised in the handling of the transition metal salts. The ones listed above are ALL toxic if ingested. Use only the .5 gram indicated. Students should not do this unless they have been trained in proper chemical handling techniques and have safety gloves available. Teachers should wear gloves (modeling correct behavior) when handling the transition metal salts. When finished with the experiment, the whole mixture (except rocks) can be flushed down the lab sink with plenty of tap water. Under NO circumstances should students attempt to take any of these materials home.

Follow-Up:

Show slides of the "Cave of Swords", a huge natural cave in Naica, Mexico, which is filled with giant selenite (gypsum) crystals up to 7 feet in length. Ask students to describe what they feel is the process that produced this cave.

The white powdery material in sheetrock (wallboard) is the mineral gypsum which has the chemical formula calcium sulfate. Have students find out how gypsum is formed and the locations of major gypsum producing areas. Nova Scotia is the nearest large producer.

Have the chemistry instructor come in to show his/her version of this demonstration.

References:

Activity adapted by Duane Leavitt from *Chemical Magic*, by Leonard A. Ford (T. S. Denison and Company, Inc., Minneapolis, Minnesota, 1959).

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Student Sheet

Purpose:

To observe crystal formation from a solution at constant temperature as an example of a process that is widespread on or near the earth's surface.

Materials:

The class as a whole will need a clear glass container, water, sodium silicate, and 2-3 grams of various metallic salts.

Procedure:

Your teacher has prepared a solution of water and sodium silicate which is called water glass, and has partially filled a clear glass container with this solution. Rocks or clean sand may have been placed on the bottom of this container to provide hills and valleys for the forest to grow around or on. Small amounts of metallic salts (chemical compounds) will be used as the seedlings for the forest. They will be sprinkled into the solution and allowed to fall to the bottom.

In the space below, describe what happens after the salts are added. Be specific in reference to the location, timing, pattern, and extent of crystal growth. If appropriate, explain your observations.

Questions:

1. What caused the forest to grow?

2. Do you think the forest would grow in ordinary tap water? Would it grow in pure sodium silicate? Ask your teacher to try these variations. Describe what happens.

3. Left the way it is, do you think the forest would grow indefinitely? Explain your reasoning. Then test your reasoning, by observing the forest over several days.

4. Was heat energy a major contributing factor to crystal growth? Explain.

5. What was the role of salts in crystal growth?

6. Explain how crystal growth is affected by changes in concentration.

7. What natural rock or mineral formation might form in a similar fashion?

8. (Optional) What types of crystals would you expect to form in:
   a. Death Valley:

   b. A cave:

   c. The pore spaces of a conglomerate:

   d. The weathering zone of a metal sulfide deposit: