ION EXCHANGE AND ZEOLITES

Purpose:

This lesson demonstrates ion exchange so that students will better understand how the chemical process of ion exchange can remove undesired ions from water. This experiment models a natural process that may occur if zeolites are present in the rock surrounding the proposed repository.

Concepts:

Zeolites can help protect the environment and people by removing contaminants from ground water.

Duration of Lesson:

One 50-minute class period

Objectives:

As a result of participation in this lesson, the learner will be able to explain the significance of ion exchange capability when siting the high-level waste repository.

Skills:

Comparing, drawing conclusions, hypothesizing, measuring, observing

Vocabulary:

Cation exchange resin, insoluble, ions, ion exchange, zeolite

Materials:

Reading Lesson
Ion Exchange and Zeolites (advanced reading), p. SR-35

Activity Sheet
Ion Exchange and Zeolites, p. 207

Background Notes
Zeolites, p. 73

Videotape
Science, Society, and America's Nuclear Waste Teleconference Videotapes **(available free of charge from the OCRWM National Information Center, 1-800-225-6972; within Washington, DC, 202-488-6720)**

Other

1 cup cation exchange resin or zeolite	3 bottles that will hold 2 cups of water
caps or stoppers for the bottles	soap (not detergent)
clean, dry 1-liter plastic soda bottle	cheesecloth
strong rubber bands	knife
scissors	measuring cup
1/4 teaspoon measuring spoon	support stand for soda bottle

hard water (or one liter [2 pints] distilled water + 3.3 grams [0.12 ounces] Epsom salts)

Suggested Procedure:

1. Before beginning the experiment, it may be helpful to review the definition of ions as particles with an electrical charge and the concept that particles with opposite electrical charges are attracted to one another.

2. Most municipal water systems in the United States have hard water. However, if your municipal water is naturally soft or if water in the school is softened, you will need to make your own hard water for this activity. You can make a representative hard water by dissolving 3.3 grams (0.1 oz.) of Epsom salts ($MgSO_4 \cdot 7H_20$) in one liter (approximately 1 quart) of distilled water or your softened tap water.

3. Cation exchange resin or zeolites should be available from a water treatment (softening) company. This exercise assumes that the resin supplied is a cation exchange resin in the sodium (Na^+) form; i.e., the resin comes saturated with sodium cations. It is possible that the resin supplier will offer you a cation exchanger in the hydrogen (H^+) form. This will make no difference in the result of the experiment. But point out that Ca^{2+} and Mg^{2+} are replaced in the water by H^+.

4. Before use, the cation exchange resin should be soaked in tap water for at least 24 hours.

5. After students complete the experiment, they should understand that ions of calcium and/or magnesium, which react with the soap molecules to form an insoluble material, have been replaced by ions of sodium, which do not react with the soap molecules, and that the source of the sodium ions is the cation resin. Explain to the students that an ion exchange resin is a manmade product that works the same way as naturally occurring zeolites. The visual result of the ion exchange is the forming of soap bubbles. Students may be familiar with the process of ion exchange as water softening.

6. Upon completion of the activity, you may wish to discuss with students how ion exchange due to the presence of zeolites can contribute to the safety of the environment at the geologic repository.

7. After use, the resin may be recharged by soaking it in salt water and storing it in a sealed container. Before using the resin again, rinse it several times with fresh water.

Teacher Evaluation of Learner Performance:

Student participation in experiment/activity, and participation in class discussion will indicate understanding.