Paste with a Taste

Grade: K-2
Time: 1 class period

Lesson #P6:

How Do We Use Minerals?

Overview
Students produce a useful product from minerals.

Essential Question:
What can be made from minerals?

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- Toothpaste Recipe Sheet

Source: Adapted from “Paste with a Taste” from Women in Mining website

Paste with a Taste

Grades K-2
1 class period

Overview:

Students produce a useful product from minerals.

Essential Questions:
What can be made from minerals?

Assessment
Can students:
Tell, write or draw an explanation of how to make toothpaste and what it is made of?

Vocabulary

- mineral
- calcite
- trona
- measure
- recipe

AAAS Benchmarks for Science Literacy

By the end of 2nd Grade students should know that:
* Objects can be described in terms of the materials they are made of (clay, cloth, paper, etc.) and their physical properties (color, size, shape, weight, texture, flexibility, etc.).
* Several steps are usually involved in making things.

Teacher Information and Procedure

Prior knowledge for students: none

Materials needed:

- Calcium carbonate (finely powdered unflavored TUMS or Dolomite Powder will work)
- Sodium bicarbonate (baking soda)
- Small plastic cups, 1 per student
- Popsicle sticks for stirring, 1 per student
- Eye droppers, 1 per group
- Plastic spoons, 1 per group
- Water
- Assorted food colors and flavoring (Flavor extracts)
- Have some commercial toothpaste samples available.
- Optional: Hydrogen peroxide, fluoride, sugar (artificial sweeteners work best)
- Copies of Toothpaste Recipe Sheet

What to do in advance:

Measure out ½ teaspoon of calcium carbonate and ¼ teaspoon of sodium bicarbonate into each student's cup.
Seat the students in groups of four.
Distribute materials to students, and put a container of water on each table.

What to do during the lesson:

Gear up:

Review something you learned in your health curriculum about brushing teeth, and/or sing a tooth-brushing song. Some good ones can be found at http://www.preschooleducation.com/sdental.shtml

Explore:

As a class, make toothpaste according to the following basic recipe:

1/2 teaspoon calcium carbonate, 1/4 teaspoon sodium bicarbonate in a small plastic cup, add just enough water (with eye dropper) to make a paste.

Measure your own ingredients into your cup in front of the students, and talk about each one.

Have students taste the basic recipe and compare it to the toothpaste they use at home. Discuss ways that they might improve the toothpaste.
Show them what you have available as “toothpaste additives”. Allow each group of 4 students to decide on a way that they will make the basic recipe more appealing to other children, and then to make “improved” toothpaste.

Each group must keep a record of their recipe and submit it with the sample for judging. The panel of judges, which can be another class, parents, etc, will determine the winner. Have a prize for the winning sample.

Generalize:
What are the properties of each ingredient that made it useful for toothpaste? How did the homemade toothpaste compare to the ones you buy? What other ingredient is added to toothpaste to fight cavities?

Assess:
Have students tell, write, or draw and explanation of the steps in making toothpaste and what it was made of.

Extensions, adaptations, and more resources:

Make an advertisement for your toothpaste.

Find out how Alaska Natives took care of their teeth before toothpaste and toothbrushes were available.

ROCKS IN YOUR MOUTH
by John Sznopek, USGS

Did you know that the stuff you brush your teeth with contains minerals? The toothpaste we all use every day to brush our teeth contains many different kinds of materials, including, amazingly, crushed rocks. Nevertheless, that's only part of the story. Let's start at the beginning and introduce you to this common household product. Later, we'll come back to those useful rocks.

After we eat foods containing sugar, armies of bacteria living in our mouths convert sugar to acid. This acid can attack our teeth and cause cavities. Brushing our teeth with toothpaste helps to prevent this through mechanical and chemical processes. The most obvious process in brushing is a mechanical action, which cleans the food debris and plaque from our teeth. One of the chemical processes that takes place when you brush your teeth is the neutralization of acid so that it can no longer attack. Yet another chemical process is the removal of stains by a special whitening agent. Chemicals contained in toothpaste may also kill bacteria. Killing bacteria lessens the formation of plaque. The plaque we are talking about is not an award hanging on the wall. This type of plaque is a thin layer on our teeth, which contains pieces of food, saliva and bacteria. If plaque is not removed from our teeth, tartar, also called calculus, eventually forms. Tartar is plaque that has hardened on our teeth. Formation of tartar can then lead to cavities or gum disease, neither of which we want. Toothpaste helps to reduce tartar buildup, but only professional cleaning removes tartar.

When toothpaste was first developed, its only function was to clean teeth. So, its composition was fairly simple. Your grandparents probably remember brushing their teeth with table salt or baking soda. That's really basic. Today, toothpaste does a lot more. It helps prevent tooth decay and gum disease. It also desensitizes and whitens teeth. These modern dentifrices (another name for toothpaste) remove stains and food particles from our teeth, and also have certain desirable physical properties. For example, you would not want the toothpaste to run off the brush and down your arm, so consistency is important. Toothpaste has evolved into quite complex formulas. It has to fulfill many functions, both therapeutic and cosmetic.

Toothpaste is composed of many different ingredients, each having a very special function. Searching for active ingredients led to the use of stannous

fluoride. It could be combined safely with toothpaste and prevented tooth decay. Fluoride has been added to drinking water for 50 years and has been available in toothpaste since the 1950s. One of the principal natural sources of fluoride is fluorspar. Fluorspar is a mineral composed of calcium and fluorine. Although fluorspar ore is found worldwide, it is not produced in the United States. China is the world's largest producer of fluorspar ore. Other active ingredients incorporated into toothpaste loosen plaque and prevent its buildup. Additional chemical additives are incorporated in some toothpaste to promote healthy gums.

What keeps toothpaste together? What keeps it smooth, creamy, and prevents it from drying out and becoming hard as a rock? The answer is a humectant. Humectants are a major element in all toothpastes. They help to retain moisture and make toothpaste creamy and squeezable. Glycerin and sorbitol are two common humectants. Glycerin, also called glycerol, is a by-product of soap manufacturing. Sorbitol is found in some berries and fruits. Both glycerin and sorbitol are alcohols that may be synthetically produced. They both mix with water, are odorless, and sweet tasting. Most toothpaste contains glycerin, which acts both as a plasticizer and a moistening agent.

Now, let's use our imaginations to understand the purpose of some other important materials in toothpaste. Picture an ocean, with its sandy beach, foaming surf, and some seaweed, which has washed up on this beach. Each of these represents some components of the toothpaste. When you clean your teeth, the action of rubbing toothpaste against your teeth produces foam similar to that produced at the beach. Brushing activates a detergent called sodium lauryl sulfate. The foam that is generated helps the toothpaste to penetrate and loosen deposits on the surface of your teeth.

Chemicals made from seaweed are used as binders. Binders help the toothpaste maintain its shape as it sits on your toothbrush. Various types of gums, but not the chewing variety, are also used to keep all the ingredients together in a nice blob. Some examples of these gums are xanthan gum and cellulose gum.

Yet another example of 'rocks in your mouth' is sand (remember the beach?), which is composed of quartz or silicon dioxide. As sand, it is so hard that it would scratch your teeth. So the mineral is processed into a more useable form, called amorphous silica, which is much softer. Silica also acts as a thickener. This property keeps the liquids and solids in the toothpaste from separating.

[alumn] Other rocks or rock products are used in toothpaste. As much as half the weight of toothpaste comes from polishing agents, also called abrasives. These help scrub our teeth and remove plaque. It is a myth that abrasives in toothpaste wear away our tooth enamel. The little enamel erosion that does occur, however, is probably due to over-zealous brushing. Several minerals are used for polishing teeth. One of these is alumina trihydrate, a principal component of many bauxite ores. Bauxite is also the main ore mineral for aluminum. Alabama is a principal domestic source of alumina trihydrate. Additional polishing agents are calcium carbonate (mineral) and phosphate salts such as dicalcium phosphate, calcium pyrophosphate, and insoluble sodium metaphosphate. Although some of these minerals are mined in the United States, others are imported from around the world.

One of the most common polishing agents used today is sodium bicarbonate (derived from the mineral Trona), the chemical name for baking soda. Important deposits of this mineral are located in California and Wyoming. Baking soda is incorporated in as much as one third of all toothpaste today. Its popularity is due to its safety, its low cost, and its compatibility with fluoride. Compatibility with fluoride is very important because other polishing agents can block the fluoride's effectiveness in preventing tooth decay. The carbonates also neutralize acids that are produced in our mouths, thus helping to prevent cavities. In the United States, we use almost a pound of toothpaste per person per year. Altogether then, we use more than 37,000 pickup truck loads of abrasive minerals in our mouths every year.

These specific minerals have two drawbacks, they don't have a great taste and they don't provide a splash of color, so flavoring, sweeteners, and colorants are added to toothpaste. A wide variety of flavoring oils are used to give products a distinctive and pleasant taste. In most toothpaste, saccharin or cyclamate is added for sweetening. The clean white color of toothpaste is typically due to yet another mineral, rutile or titanium dioxide. It is mined in the United States, Florida and Virginia, and overseas and is used as a pigment in endless applications.

Toothpaste tubes are made from three basic materials: aluminum, plastic, and glue. Typically, toothpaste tubes have outer and inner layers of polyethylene, a plastic, with a layer of aluminum foil glued between them. The inner plastic layer does not react chemically with the active ingredients in toothpaste. The layered tube is the choice of most toothpaste producers. This is because the foil provides the feel people prefer and allows the tube

to be rolled and crimped. As mentioned earlier, aluminum is obtained from bauxite ore. Aluminum metal for foil is produced from imported ore. Plastics are derived from oil and natural gas, which are found throughout the world.

According to the Tube Council of North America, more than 800 million tubes have been manufactured for toothpaste in North America in each of the last several years. Considering the average toothpaste tube to be approximately six inches long, if they were laid end-to-end, one year's production would circle the earth more than three times.

Not very long ago, toothpaste was very simple and composed of only a few major components like table salt or baking soda. Today, formulas have become far more complex due to the incorporation of ingredients that produce therapeutic and cosmetic benefits. Even with the addition of these important additives, toothpaste must maintain its great taste and clean our teeth, as we have come accustomed to over the years. So the next time you brush your teeth, consider the complexity of this common product, and don't forget the important contributions that these 'rocks in your mouth' provide us every day.

Our Toothpaste Recipe

½ Teaspoon of calcite
¼ Teaspoon of trona

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The Mineral Trona