

Cookie Coal Mine

Adapted from *Wyoming Energy Curriculum*



— LuRay Parker

Overview

Using a layered cookie, students explore the difficulties, limitations and techniques of open pit mining for coal as they remove the overburden (cookie dough layer) and retrieve the coal (chocolate) beneath it. They replace the overburden and try to restructure the land surface (cookie surface) the way it was prior to mining.

Objectives

Students will:

- develop an appreciation for the structure of the sedimentary rock layers that overlie coal layers.
- develop an understanding of the need for land reclamation during and following the mining of coal in an open pit mine.
- be able to discuss the part coal plays in Wyoming's economy.

- be able to estimate in tons the coal they were able to mine
- appreciate the magnitude of coal extraction in Wyoming.

Goals and Concepts

A 2, 4, 5, 6, 9, 11, 12, 15, 20; **C** 21, 32; **D** 1,7; **E** 4, 7, 14, 16; **F** 3, 5, 11

Grade Level 1-9

Time Needed 45 minutes

Subjects to Integrate Social Studies, Science, Language Arts

Topics strip mining, reclamation, economy, environmental responsibility

Skills observing, kinesthetic concept formation, inferring, motor

Materials

Cookies (two per student) with chocolate cream layer in the middle (the coal) and lighter colored cake layer (the overburden)

Napkins

Toothpicks or straight pins

Tweezers

Cake frosting or Elmer's Glue (the glue for reconstruction)

Two small paper candy cups used for parties for each student (one for the coal truck, and one for holding the frosting or Elmer's glue)

Small washers or bolt nuts to represent the coal cars

Soft aluminum wire to tie coal cars together

Background

Mining coal in Wyoming is the state's largest industry. It employed about 6,000 persons in 2006.

In all extraction of minerals from the crust of the earth, there is disturbance of the land. Some disturbance is accepted by most people as a trade-off for obtaining the ore from which we get metals, energy minerals, and building materials for our modern civilization. Energy production is very important to Wyoming. Coal production is the largest industry in Wyoming. Coal is shipped from Wyoming to all regions of the U.S. and the coal mining industry employs thousands of people.

Some old mining operations have left the land scarred with irreparable damage. Local, state, and federal governments have enacted laws that govern the processes of taking minerals and reclaiming the land. Today, mining companies are generally conscientious about leaving the land with minimal damage. But reclamation (repairing or reclaiming damaged land) is

costly. Sometimes determining the laws and standards of reclamation and the monitoring of the standards by governmental agencies becomes quite contentious.

With this activity students have fun but at the same time learn about the strict standards of reclamation. They observe the protected areas that can not be mined and they estimate the amount of coal mined from the coal layer.

Procedure

Discuss the coal industry in Wyoming. Tell them where coal is mined in Wyoming. Refer to the activity "Coal Mine and/or Power Plant Field Trip" in the Wild Wonderful Wyoming: Choices for the Future program. It is in the Energy Section. Some of your students may have parents employed in the industry. They may be willing to share information with your class before you begin this activity. It might also be beneficial for students to find pictures of coal mining activities (including reclamation) to share before starting this activity. A class collage would add to the discussion.

Discuss the typical standards of reclamation: the top soil (the organically rich top layer of soil) is saved to be spread back over the land with reclamation. Plant surveys, conducted before the land is disturbed, allow for re-planting naturally occurring vegetation. Often native grasses are re-planted in the replaced top soil. Coal mines in Wyoming must also protect the existing animal life. Companies are required to reestablish the kinds of habitats that were disturbed in order to establish the same wildlife species. The drainage structure of the land must be considered. Draws and arroyos must drain into main streams and larger draws without causing lingering erosion problems.

For this activity the teacher or a fellow teacher assumes the role of reclamation inspector. The inspector will make judgments concerning the quality of each student's mining reclamation upon completion of the coal extraction.

Each student receives a pair of tweezers, two or three toothpicks or a straight pin, a large napkin, one cookie, and three small paper candy cups. One cup holds about a level teaspoon of cake frosting which is used to glue the cookie crumbs (rock fragments and soil) together and another cup will serve to hold the coal that is extracted from the mine (chocolate layer). Students strip mine the area that can be mined down to the coal. The stack the overburden in areas not yet mined. Some of the surface area is protected for various reasons or it may be impractical to mine. Each cookie has lands protected that were marked on the cookie by the teacher. A blue area is a sage grouse lek (a strutting area where Sage Grouse mate). A red marking across the cookie is a migration route for deer, antelope or elk. A green marking is an eagle nests. The area one quarter inch from the edge of the cookie represents mountainous areas where the mining for the coal is too difficult.

The teacher may choose to paint a smear of food coloring across each cookie to represent the top soil. If the teacher uses cookies with patterned surfaces, the pattern may represent the draws and the drainage surface. Students can be asked to reconstruct the drainage surface. If the teacher stains the top millimeter or so of the cookie surface with food coloring to represent the top soil, it can be required that the top soil be saved and replaced as the final layer.

Mined coal is placed in one of the small paper candy cups. From the cup the coal is delivered to the train cars – the bolt nuts

that have been tied together with light aluminum wire. Each car holds one hundred tons of coal. Student determines how much coal is extracted from the mine before it is mined out.

Reward the student who best reclaims the land with two or three cookies. Those who meet the inspector's standards receive an additional cookie.

Extending the Activity

1. In 2007 there was 451 million tons of coal mined in Wyoming. This coal was sent on trains to more than half of the U.S. states and some to other nations. It was more coal than was mined in the other three top coal-producing states, Pennsylvania, West Virginia and Kentucky combined. To realize how much 451 million tons is have the students determine how far in rail cars the 451 million tons would stretch. Each car holds 100 tons. A trainload of coal usually has about 100 cars and extends for about one mile. Let students do the math. Answer: 45,100 miles or nearly two times around the earth at the equator.

2. Invite a guest speaker from the Wyoming Department of Environmental Quality to discuss and show pictures of mining and reclamation operations. Call or write Wyoming Department of Environmental Quality, Land Quality Division, 250 Lincoln, Cheyenne, Wyoming 82002 (307)-777-7781

3. Take your students on a field trip to a coal mine and/or a coal fired power plant. Refer to the activity “Coal Mine and/or Power Plant Field Trip” in the Wild Wonderful Wyoming: Choices for the Future program. It is in the Energy Section.

Suggested Assessment

Have students write an essay that describes: (1) the importance of coal to the economy of Wyoming; (2) where coal is found in Wyoming; (3) the importance of reclaiming the land; (4) the processes of mining and reclamation.

Additional Resources

Project Learning Tree - Curriculum:PLT's Energy & Society Program. In addition to hands-on activities, Energy & Society integrates music and dance.
www.plt.org/curriculum/energy.cfm - 25k
Project Learning Tree, American Forest Foundation 1111 19th Street, NW
Washington, DC 20036

Dinosaurs and Power Plants, copyright, August, 1990-08
Office of Fossil Energy
U.S. Department of Energy
1000 Independence Ave., SW
Washington, DC. 20585
(202) 586-6503

<http://smtc.uwyo.edu/coal/> is a website developed by the Science and Math Teaching Center at the University of Wyoming about Wyoming Coal. Students can take a field trip through a mine and learn about Wyoming coal and coal fields, how to transport coal and how coal was formed. This is great resource for Wyoming teachers and students. All of the links really work. The self-guided field trip tour can be used with young students if the teacher acts as the guide to assist with some of the quick time videos.

Good coal sites on the world wide web are:
webwww.virtualsciencefair.org/2006/wong6j2/coal.htm
www.teachcoal.org/aboutcoal/articles/faqs.html

Wyoming Science Standards

1. CONCEPTS AND PROCESSES

In the context of unifying concepts and processes, students develop an understanding of scientific content through inquiry. Science is a dynamic process; concepts and content are best learned through inquiry and investigation.

BENCHMARK Grade 4

EARTH, SPACE, AND PHYSICAL SCIENCE

- 4. Properties of Earth Materials: Students investigate water, air, rocks, and soils to compare basic properties of earth materials.**
- 6. Changes in Earth and Sky: Students describe observable changes in earth and sky, including rapid and gradual changes to the earth's surface, and daily and seasonal changes in the weather.**
- 8. Changes in States of Matter: Students demonstrate that the processes of heating and cooling can change matter from one state to another.**

2. SCIENCE AS INQUIRY

Students demonstrate knowledge, skills, and habits of mind necessary to safely perform scientific inquiry. Inquiry is the foundation for the development of content, teaching students the use of processes of science that enable them to construct and develop their own knowledge. Inquiry requires appropriate field, classroom, and laboratory experiences with suitable facilities and equipment.

BENCHMARK Grade 4

- 2. Students use the inquiry process to conduct simple scientific investigations.**
 - C. Draw conclusions and accurately communicate results, making connections to daily life**
- 3. Students identify and use appropriate scientific equipment.**
- 4. Students properly use safety equipment and hazards and safety symbols while practicing standard safety procedures.**

3. HISTORY AND NATURE OF SCIENCE IN PERSONAL AND SOCIAL DECISIONS

Students recognize the nature of science, its history, and its connections to personal, social, economic, and political decisions. Historically, scientific events have had significant impacts on our cultural heritage.

BENCHMARK Grade 4

- 2. Students recognize how scientific information is used to make decisions.**
 - A. Identify and describe local science issues, such as environmental hazards or resource management.**

Wyoming Math Standards

CONTENT STANDARD

BENCHMARK Grade 4

1. NUMBER OPERATION AND CONCEPTS Students use numbers, number sense, and number relationships in a problem-solving situation.

4. Students demonstrate computational fluency with basic facts (add to 20, subtract from 20, multiply by 0-10).

5. Students add and subtract to thousands and multiply hundreds by a single digit.

6. Students explain their choice of problem-solving strategies and justify their results when performing whole number operations in problem-solving situations.

8. Students use estimation strategies to solve problems.

Social Studies Standards

CONTENT STANDARD

3. PRODUCTION, DISTRIBUTION, AND CONSUMPTION

Students demonstrate an understanding of economic principles and concepts and describe the influence of economic factors on societies.

BENCHMARK Grade 4

1. Students describe the importance of major resources, industries, and economic development of the local community and Wyoming.

2. Students describe different ways that people earn a living in the local community and in Wyoming.