Grade: 6-8 | Time: 1-2 hours

FINDING OIL IS A PIECE OF CAKE

Essential Question:

How do oil producers work together to share in the risks and benefits of exploration and extraction of oil?

Overview

Students simulate oil exploration by buying leases, developing plans, "drilling" a layer cake, and using samples to draw cross sections. They learn about unitization, calculate profits in a math activity.

Assessment

Can students:

- Use information from samples to make inferences about subsurface geologic conditions?
- Describe how unitization relates to efficiency, fairness, and environmental impacts of oil exploration?

Vocabulary

- Anomaly
- Porosity
- Unitization
- Core Sample

Teacher Information and Procedure

Source: Partially adapted from http://www.womeninmining.org/Layercake1.htm. (Graphics by Depositphotos.com)

Materials needed

For gear-up activity:

- Store bought cake/cupcakes:
  - Cupcakes or cake
  - Meat injector
  - Chocolate syrup
- Blue, green, and/or yellow food coloring
- Colored pencils (black, blue, red, green and yellow)
- Clear plastic straws (can be cut in half, each student/group will use between 1-5)
- Single-sided razor blade.
- Paper plates, plastic forks, napkins
- Dental floss (to cut the cake)

What to do in advance

- Inject chocolate into cake/cupcakes (you do not have to inject all). One per group

Alaska Standards Addressed

Science GLEs

The student demonstrates an understanding of:

- the processes of science by [6, 7, 8] SA1.1 asking questions, predicting. Observing, describing, making generalizations, inferring, and communicating.

Geography GLEs

A: 2) make maps, globes, and graphs; A: 5) analyze how conflict and cooperation shape social, economic, and political use of space.

E 1) understand how resources have been developed and used; F: 3) analyze resource management practices to assess their impact on future environmental quality;

Math GLEs

The student demonstrates ability to use measurement techniques by [6] MEA-3 using a scaled ruler to an eighth of an inch or millimeter on a map or drawing [6] MEA-7 measuring length to the nearest 1/8 of an inch or nearest millimeter. The student accurately solves problems (including real-world situations) by [6] E&C-5 developing or interpreting scale models (scale factors such as 1 in. = 1 ft.) (L)[8] E&C-2 adding, subtracting, multiplying or dividing integers or positive rational numbers [8] E&C-3 using percents and percentages (e.g., tax, discount) [8] E&C-4 converting between equivalent fractions, decimals, or percents (M3.3.5) The student demonstrates an ability -to problem solve by [6][7][8] PS-1 selecting, modifying, and applying appropriate problem-solving strategies -apply mathematical skills and processes across the content strands by [6] PS-5 using real-world contexts such as social studies, friends, school and community [8] PS-5 using real-world contexts such as science, humanities, peers, community, and careers.

Alaska English/Language Arts and Mathematics Standards (2012)

- RSL.6-8.4
- SL.6-8.1

Teaching the lesson

Gear up

As a demonstration, fill three beakers to the same (measured) level with gravel, sand, and silt. Pour water into each beaker until it just reaches the top of the soil, using a graduated cylinder or measuring cup to determine exactly how much water it takes. Compare the amount of water held by each type of soil and discuss porosity. The amount of pore space is equal to the volume of water that the soil holds. Which type of soil is the most porous? Show how porosity is calculated. (Divide ml of water (pore space) by ml of soil and convert to a percent).

Ask students if they know how oil occurs underground. What are characteristics of an "oil reservoir"? Discuss the idea that oil is found in porous rocks. Discuss conditions besides porosity that are necessary for oil to occur. Why wouldn't oil be found in gravel (heat and temperature are needed to transform organic matter into oil, and under those conditions soil materials would be cemented and transformed into rocks)?

Show how a rock can be porous, using a piece of pumice that has been weighed, measured for volume (use a graduated cylinder and see how much water it displaces), immersed in water at least overnight. Tell students how much the rock weighed when it was dry, and then weigh it again. Since 1 ml of water weighs 1 gram, you will know how much water the rock absorbed. Calculate the rock's porosity.

Ask students if they know how geologists locate porous, oil-bearing rocks underground. Tell them that they'll be doing an activity that will help them learn about one method, core sampling, which is used to locate oil. They will also learn about how oil companies share in the costs and the profits that come from locating oil. absorbed. Calculate the rock's porosity.

More ideas:

-Use chalk instead of pumice, checking the weight every 5 minutes after immersing it until the weight stops increasing. Chalk will have greater porosity, but it will fall apart if left in water too long.

-Turn the demonstrations into student investigations and spend a day or two letting student groups do the measuring, weighing, observing, and calculating.

Complete lab instructions can be found at: http://www.planetseed.com/node/19768

Explore

1. Present the cake and explain that it represents a part of the North Slope that is suspected to be rich in oil reserves. Explain that the cake contains oil, represented by chocolate syrup, but its location under the frosting is unknown. Explain that some preliminary geologic studies have indicated that the greatest oil potential might be towards the northeast corner of the cake, but that there is also a small, rich deposit suspected somewhere in the southwest quarter. Show a map of the tracts of cake available for leasing. *(if you want the cake to be fresher when it's time to eat it you may wish to just describe it today and bring it to class tomorrow!)
2. Have the students take their core samples and identify if they found oil or not.
3. Have the students try to identify where their oil is in the cake.
4. Slice the cake and examine the location of oil, then eat it!

Generalize

Discuss the simulation: What does an oil company need to know before leasing and exploring for oil?

What are the risks and benefits associated with oil exploration?

Did you find "oil"? How many of your drill holes were useful in helping you to find the oil? Why would you want to have as much information as possible before beginning to drill?

Why is it complicated to find oil? What issues are involved in finding and developing oil fields?

Assess

Ask students to write responses to the following questions:

Why is core sampling useful to geologists exploring for oil, and why is it necessary to combine core sampling with other exploration methods?

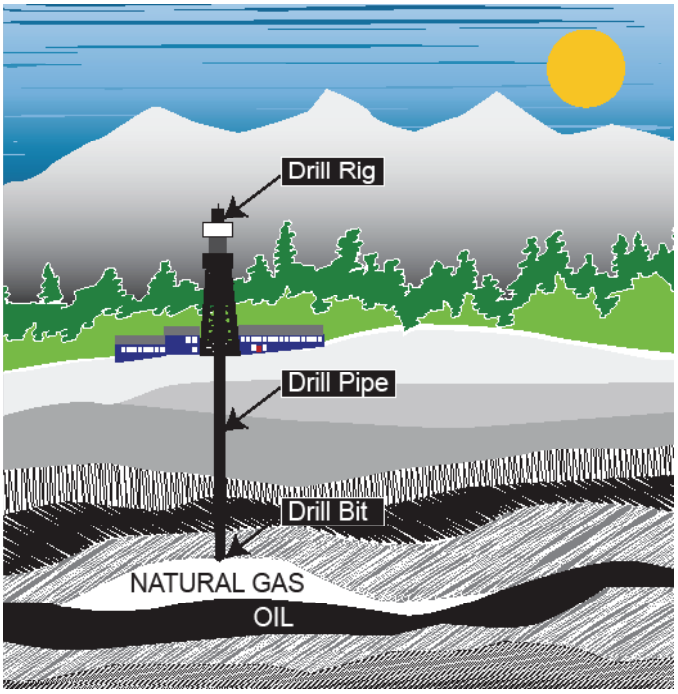
Extensions, adaptations, and more resources

For younger students, use the matching or less complicated math sheets.

Creative cake-bakers can add surface features on top of the frosting, such as pingos, rivers, ice roads, wildlife. Sensitive wildlife areas can be omitted from the lease offerings.

BLM'S Competitive Oil And Gas Leasing & Drilling Process is explained at http://www.wilderness.org/Library/index.cfm

Petroleum Game-An Interdisciplinary Adventure at www.geoblox.com



Teacher Background

OIL LEASING AND UNITIZATION

Each year, oil and gas companies lease tracts of land on the North Slope, the Beaufort Sea, and Cook Inlet from the State of Alaska. The leases come with terms that have been set prior to the sale, including the amount that lessees will pay in royalties and taxes on oil produced and the dates on which the leases begin and end.

If a reservoir of oil extends beneath several tracts of land that are leased by different oil companies, problems can arise:

- The first oil company to develop a well might extract all of the oil out of the reservoir and prevent the other leaseholders from getting their share.
- Too many wells might be drilled if each company drills on their own tract. More wells than are necessary cost more and also have more environmental impacts from disturbance of the surface and construction of facilities. Too many wells can also cause reduced pressure in the reservoir and make it more difficult to recover all of the oil.
- It might not be profitable to extract the oil from a small reservoir unless it is combined with larger reservoirs and facilities are consolidated.
- Accidents and oil spills can occur as companies rush to get the oil first.

In order to prevent those problems, oil leases are unitized, or joined into a single unit that contains an entire oil prospect. The leaseholders in the unit select a single operator to carry out exploration and development. They share in the costs of developing the oil and also get shares of the oil that is produced, in proportion to how much land they own or by how much of the oil they own beneath the surface. Sometimes unitization may be required by the state; otherwise leaseholders can apply to the state to form their own units.

The lessees get together and identify a prospect and apply to form an exploration unit. The unit includes the tracts or parts of tracts that contain an oil reservoir. They select a Unit Operator to explore and develop the leases.

The Unit Operator and the State agree on the terms of a Unit Agreement. They agree on the Unit Boundaries and on a Plan of Exploration. It tells when they will conduct seismic studies and drill exploratory wells, and when they will apply to form a Participating Area.

The Unit Operator explores by drilling a well, and proposes a Participating Area within the unit, based on findings. The Unit Operator and the state agree on a Plan of Development and on how to allocate the production costs and the oil to the various tract holders. The plan describes the wells that will be drilled and the processing facilities that will be built.

Finding Oil is a "Piece of Cake"

Company Name: _____

COSTS

Land Lease			
Land	Lease Cost	How much land you want to lease	Your Cost
1/2 Cake	$500		$
Whole Cake	$1,000		
Employees			
For 1/2 Land		$300	$
For Whole Land		$500	$
Equipment			
Equipment	Cost per each	How many you want	Your Cost
Straw	$25		$
Permit Applicaitons			
Environmental and Health & Safety			$1,000
	Your Total Costs		$

INCOME

Item	Current Value **$/barrel**
Barrel of oil	

PERMIT

Regulator's Signature
REQUIRED BEFORE drilling
_____

COST ANALYSIS:

How many barrels of oil would you need to sell to pay for your costs?

Your **total costs** / priace of a **barrel of oil**
_____/ _____ = _____**barrels**

If you were to extract 100,000 barrels, how much would you make?

Note: Taxes and royalties are 47%

(100,000 x **$ barrel**) = _____ x **0.47**(taxes) =

Taxes to the state = _____

100,000 x $ barrel —taxes to the state - total costs =

_____-_____-_____=

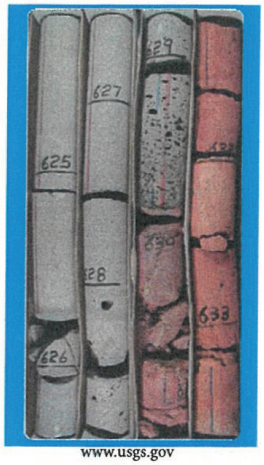
= $_____ profit (how much you made!)

What do we use oil for?

Finding Oil...In a Cake?

Geologist's Name: _____

What do you imagine is inside your piece of cake? Draw a picture here:



www.usgs.gov

DRAW "CORE SAMPLE 1" HERE:
Try drawing your piece of cake after you have seen the first sample.

DRAW "CORE SAMPLE 2" HERE:
Try drawing your piece of cake after you have seen the second sample.

Finding Oil...In a Cake? (continued)

DRAW "CORE SAMPLE 3" HERE:

Try drawing your piece of cake after you have seen the third sample .

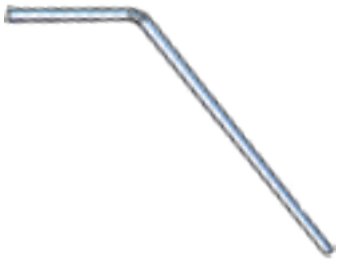
Cut open the cake and draw what it really looks like inside:

Name: _____

Finding Oil Matching

Cupcake

Land



PERMIT: Signature REQUIRED