Lesson Plan Overview: Mine-a-Pie

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Background

The "Mine-a-Pie" lesson is based on the Alaska Resource Education lesson plans for both "Mine-a-Pie" and "Finding Oil in a Cupcake." The lessons have been simplified to be taught in a shorter time frame (45 to 60 minutes opposed to two to three hours).

Standards — Earth Systems, Earth and Human Activity, Engineering Design

Objectives — Teach the students the basics on the following objectives:

- Alaskan mining resources
- Mining procedures
- Environmental impact
- Budgeting
- Cost analysis
- Reflection

Target Grades — 3rd to 6th grade

Time Requirements

Instruction	45 to 60 minutes
Preparation	60 to 90 minutes (requires baking cakes)

Preparation

<u>Pies</u>

Prepare pies for each small group (about six)

- Bread loaf aluminum pans (9"x5"x2.5")
- Two yellow cake mixes
  - Requires 6 eggs and one cup of vegetable oil
- Cans of corn, black beans, and peas
- Oats
- Chocolate frosting
- Blue and green sprinkles
- Chocolate syrup (insert with a straw)

Mix the vegetables and oats with the cake mix
Bake the cakes
Use a straw to inject chocolate syrup into the cake
Add the frosting
Add green sprinkles to represent vegetation
Add green sprinkles to represent water

	Supplies	Plastic forks, spoons, and knives Toothpicks Plastic translucent straws Paper towels and Clorox wipes Calculators (optional) Pencils
	Handouts	STEM Experiment: Mine-a-Pie student directions Background (Mining) Laws and Permits that Affect Mining
	Groups	Divide the students into small groups (2 to 6). It is recommended the groups are academically and behaviorally balanced. Each group will complete one "pie" and handout.

Format

The students work in small groups, 2 to 6.
The students will discuss multiple options to plan their strategy.
The students will collaboratively mine and count their resources.
The students will complete the Profit Analysis Sheet to document their resources. They need to use addition, subtraction, and multiplication. They may use calculators (teacher discretion).
The students will complete a reflection component.

Procedures

1. The teacher presents a brief overview of mining in Alaska.
2. The students spend a "budget" to buy tools to mine.
   - The students have multiple tool options.
   - The students have the option to purchase insurance.
3. The students work collaboratively to "mine" a pie (cake) for a finite amount of time (ten minutes).
4. The students count the resources mined and the number of environmental "spills."
5. The students calculate their gross profit and subtract their initial investment and environmental penalties to determine their net profit.
6. The students complete two reflection questions.
7. The teacher announces the net profits of each team to recognize their hard work.
8. The class discusses that they learned, what they would do differently, and how the activity has impacted their perspective of mining operations in Alaska.
9. The students will celebrate their success by eating their pies.

STEM Experiment: Mine-a-Pie

Names _____

_____

Synopsis

In this experiment, you and your team, will carefully "mine" a pie for valuable "minerals." You will have an initial budget of $1000 and you must decide how to use your money to receive the highest possible profit. Since the mining season is limited by the weather, you will have a finite amount of time to mine (ten minutes). Your profit is based on how many valuable minerals you can extract from the mine before the time expires. You will receive substantial monetary penalties ($200 per incident) if you damage the environment (e.g. get frosting or crumbs anywhere). You may not touch anything except the tools that you purchase. You will complete the Profit Analysis Sheet to determine your overall success.

EXPENSE CHART

You begin the mining season with a $1000 budget to purchase various mining resources. Complete the following Expense Chart BEFORE you begin mining. The funds that you don't spend are considered profit. You may not make additional purchases after you begin mining.

Resource	Description	Cost	Purchases
Land Lease (10 minutes)	Pie	$300	$300
Excavator	Fork	$150	
Loader	Spoon	$100	
Scraper	Knife	$50	
Crane	Toothpick	$50	
Drill	Straw (cost per drilling)	$50	
Insurance	Only pay $100 per incident (1/2 normal)	$250	
		TOTAL EXPENSES	

PROFIT ANALYSIS SHEET

Carefully identify and count the minerals that you extracted.

Resource	Description	Value	Amount Mined	Income
Gold	Corn	$100		
Coal	Black Beans	$10		
Jade	Peas	$50		
Oil	Chocolate Syrup	$150 per time "oil" was found with a "drill" (straw)		
			TOTAL INCOME	

How many times did your team have a "spill" (frosting or crumbs)?

Penalties	Expense	Incidents	Fines
Environment incidents	Pay $200 per incident, or $100, if you bought insurance		

Total Income _____

Fines _____

Total Expenses _____

Net Profit [ ]

REFLECTION

What did your team learn about mining?

What would you do differently if you had a second opportunity to mine?

Mining
Background

Mining has played a major role in Alaska since the first days of the Klondike Gold Rush in the late 1800's. Before the advancement of large scrapers and bulldozers, mining was mainly done on a small scale using pans, sluice boxes, or small dredges along river beds. With the advent of track bulldozers in the late 1920's to the big bulldozers and drag lines of the 1950's, Alaska's large mineral deposits have become increasingly economical to mine.

There are many mineral commodities mined today in the state, including: copper, gold, jade, lead, platinum, sand and gravel, silver, tin, zinc, coal, oil and natural gas. There are different types of mining techniques used in Alaska including placer, strip or open pit, and underground mining. Generally, Alaska zinc and coal are mined above ground. Alaska silver and gold is mined underground, as seen in Southeast, or in placer mines as seen in the Interior.

Before a company decides to open a mine, the area must be tested and explored to predict if the mine will yield a profit. If the geologic testing proves favorable, the company will decide to go ahead and begin the permitting process through the local, state, and federal government. During this permitting process the company must pay to have an environmental impact statement (EIS) conducted on the proposed area. An EIS is a study which determines the potential hazards to safety, wildlife, habitats, and air/water quality, to name a few, from which the company, public, and agencies can respond on the various development reviews. From this information the permits may or may not be awarded.

After a company purchases or leases a piece of land, they must determine if the area is worthwhile to mine and receive permission to do so from local, state, and federal government agencies. The company will then make the investment to build roads, housing, milling facilities, and prepare the area to mine. This requires an enormous amount of planning and design, and could cost the company hundreds of millions of dollars. Even after all of the studies and exploration, the mining company always takes an economic risk. All of their studies are only educated guesses about the mineral amount and quality and the future economic conditions.

The mined material is called ore; it is the rock which contains the valuable mineral. Sometimes the mineral is found as a vein or chunk. Sometimes it is intermixed with the rock. You could think of an ore like a cookie with big chocolate chips and tiny bits of finely crushed nuts. Both the large chunks of chocolate and the tiny bits of nut would be the mineral and the whole cookie (flour, sugar, eggs. . .) the ore.

After the ore is extracted from the ground, it is taken to the mill. This facility is usually located near the mine. During the milling process, the mineral is extracted from the ore by crushing it with large steel balls or rods, and separated using large magnets, gravity, or chemicals. The wastes, called tailings, are the left over rock from this extraction process. The milled mineral, called concentrate, is then sent on to a smelter or a refinery to be made into its purest form. Some mining companies mill, smelt, refine, and mine. Others only mine and mill, selling their concentrate to someone else who will process it and sell it to the manufacturer.

In Alaska, as in other states, the state and federal government tax mining companies. This money is used to help run state and federal government. A mine in Alaska may be in operation anywhere from 5-50+ years depending on the mineral they are mining, the location, the mining technology being used, the amount of mineral to be extracted, and the market value of the product.

Mining is not a delicate procedure. It involves moving a lot of the Earth's crust to extract the minerals we use in our everyday lives. The Surface Mining Control and Reclamation Act of 1977 and the state reclamation laws address some of the environmental concerns of mining. These laws require a mined area be returned to a natural, safe state and without harm to other resources. This means contours and vegetation are returned to the area to stabilize erosion and provide suitable habitat. Surface and ground water is protected from contamination, and the area is made safe and usable. The permitting process of mining requires that the company wishing to mine an area state, in explicit detail, their plans to reclaim a mine. They must also indicate how they will pay for this reclamation. The cost for reclamation is included in the cost of mining.

Laws and Permits that Affect Mining

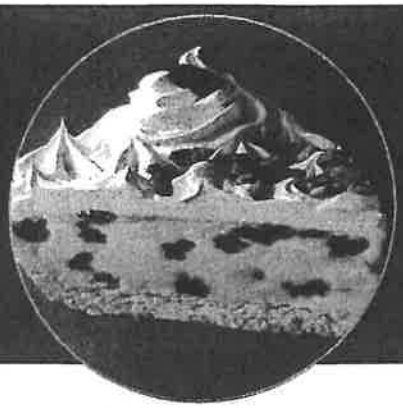
Can you match each law with its name?	
Environmental Protection Act	A law that requires an approved reclamation plan before a miner or mining company engages in a mining operation
Surface Mining Control and Reclamation Act of 1977	A law that requires mining companies and other developers to prepare an Environmental Impact Statement analyzing the long-term effects on the environment that may result from their operations.
Alaska State Statute 27.19.030	A federal law which requires a coal mine area to be returned to a natural, safe state and without harm to other resources.

Can you match each Permit with its name?	
Waste Management Permit	If a project is on Federal lands, then authorizations must be obtained from the appropriate managing agency, such as the U.S. Forest Service or Bureau of Land Management.
Air Quality Control Permit	If tailings or waste rock from a mine project has the potential for impacting state waters, then this permit must be obtained. This permit usually requires pre-operational, operational and post closure monitoring. The permit also requires financial assurance both during and after operations, and to cover short and long-term treatment if necessary, closure costs, monitoring, and maintenance needs.
Appropriate Federal "Landowner".	The construction, modification, and operation of mining facilities that produce air contaminant emissions require this Construct, and a separate Air Quality Control Permit to Operate. The determination to require a permit is based on the source location, total emissions, and changes in emissions for sources specified in 18 AAC 50.300(a). Generally, air quality must be maintained at the lowest practical concentrations of contaminants specified in the Ambient Air Quality Standards of 18 AAC 50.020(a).

Grade: Grade 6-8 | Time: 2 hours

Mine a Pie

Essential Questions:
How are minerals extracted?
How do mines operate?



Overview

Students mine a plot of "land" and determine a profit or loss based on the choices made.

Assessment

Can students

- Analyze a solution to the problem of extracting minerals profitably, and describe the effects on federal and state law on mining?

Vocabulary

- Milling
- Ore
- Profit
- Reclamation
- Tailings

Teacher Information and Procedure

Prior knowledge for students: None

Source: Adapted from Alaska Resources Kit: Minerals and Energy, Module D-Ecology/Economy Rev 1996
(Graphics from Depositphotos.com)

Materials needed

- For Each Pie (recommended 2 for 4 students):
- Gallon Ziplock bags - to use to cover pies if you aren't going to use them right away
- Pie tins or thick paper plates - to put pies in when they are ready to be used
- Materials for pies (substitutions of mud, gravel, sand, etc. may be made for oats and flour):
  - » oats (2 cups/pie)
  - » flour (2 cups/pie)
  - » water (1-2 cups)
  - » 15-bean soup mix (or any combination of beans to use as minerals)
- Blue cake sprinkles (1 bottle/30 pies)
- Green cake sprinkles (1 bottle/30 pies)
- Whipped topping or frosting (1 large bucket/4 pies)

Other Materials

- Paper towels
- Large mixing bowl

Alaska Standards Addressed

Science GLEs
The student demonstrates an understanding
- that solving problems involves different ways of thinking by:
[6] SE2.1 identifying and designing a solution to a problem.
[6][7] SE2.2 comparing the student's work to the work of peers in order to identify multiple paths that can be used to investigate a question or problem. (L)
[7] [8] SE2.1 identifying, designing, testing, and revising solutions to a local problem. (L)
[8] SE2.2 comparing the student's work to the work of peers in order to identify multiple paths that can be used to investigate and evaluate potential solutions to a question or problem. (L)
-of how to integrate scientific knowledge and technology to address problems by:
[6] SE1.1 recognizing that technology cannot always provide successful solutions
[7] SE1.1 describing how public policy affects the student's life.
- the processes of science by:
[3] [4] [5] SA1.1 asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring and communicating.
[4] SA1.2 observing, measuring and collecting data from explorations and using this information to classify, predict, and communicate.

Geography GLEs
E1) understand how resources have been developed and used; F3) analyze resource management practices to assess their impact on future environmental quality; Government and Citizenship F4) understand the role of price in resource allocation;
9) understand those features of the economy of the state that make it unique, including the importance of natural resources, government ownership and management of resources,
G3) identify and compare the costs and benefits when making choices

Reading GLEs
The student follows written directions by
[6] [7] [8] 2.6.1 Completing a task by following written, multi-step directions

Math GLEs
The student demonstrates an ability to classify and organize data by
[7][8] S&P-1 displaying, organizing, or explaining the classification of data in real-world problems using [7]circle graphs, frequency distributions, stem and leaf, with appropriate scale [8]using histograms, scatter plots,
or box and whisker plots with appropriate scale

Alaska English/Language Arts and Mathematics Standards (2012)
- RSL.6-8.1, RSL.6-8.3, RSL.6-8.4, RSL.6-8.9
- WL.6-8.1
- SL.6-8.1, SL.6-8.4

- Measuring cups
- Newspaper or something to cover desks
- Plates, Forks, Spoons
- Toothpicks - one box
- Popsicle sticks - one box
- Calculators (if desired)
- Copies of the following (if you can use different colors of paper it will help students to keep track of all the different sheets:
  - » Dig, Dig, Dig directions sheet
  - » Cost/Income Charts
  - » Mine Reclamation Cost Shee
  - » Cost Tally Sheet
  - » Mineral Income Tally Sheet
  - » Profit/Loss Tally Sheet

What to do in advance

- Read the background information directions for the activity.
- Make copies of attached sheets.
- Make pies (See attached directions) and revise the mineral income chart if necessary.

Teaching the Lesson

Gear-up

Give students the handout "Laws that Affect Mining" and have them complete the quick matching exercise. Discuss the answers, and the purposes and possible effects of the laws.

Explore

Introduction: In this activity students will be mining a portion of a pie containing beans which represent a variety of minerals. It is assumed that all areas of the pie have the same chance of being profitable. The students will have to pick their proposed mining areas based on economic and environmental considerations. They may not mine in preserved areas, or near water resources, and they must design a reclamation plan. They must lease their land, pay for employees, equipment, and transportation, in addition to extracting as little material as possible, yet maintaining a high mineral profit.

After the area is mined and milled, the students reclaim the land. Students then calculate the amount of money made from their extraction compared to the amount of money it cost them to mine it to determine if their company had a profit. After companies determine their losses and gains, they then examine their choices to determine if they could have made more money with a wiser choice.
This lesson can be as complicated or as simple as the teacher wishes to make it. Delete some of the steps or tasks depending on the time available and the abilities of your students.

1. Discuss the minerals mined in Alaska. The following are the minerals found in Alaska: Sub-bituminous Coal, Bituminous Coal, Anthracite Coal, Copper, Zinc, Silver, Jade, Gold, Tin, Platinum.

   Explain to the class that they will be working in teams to represent a company mining a small plot of land, and mining beans that represent the different Alaskan mineral commodities. Show them which bean represents each commodity. On this property they may find some or all of the resources mined in Alaska. Discuss why geologically this would not likely be true. Explain that most mines only mine one or two valuable minerals, that which is most abundant in the area and economically worth recovering.
2. Review the costs of mining. Although money can be made, it costs money to buy/lease land, mine it, prepare it, transport it and reclaim it. Discuss the economic risks of not knowing for certain what you will find under the ground.
3. Discuss that state law, governing metal mines, and the Surface Mining Control and Reclamation Act of 1977, governing coal mines, require that mines must be restored to federal and state guidelines to ensure the area is safe and stabilized. Discuss that some state and federal money comes from mining taxes and revenues.

4. Divide the class into mining teams (companies) and have them come up with a company name. Explain that each team represents one mining company interested in leasing up to 2 square miles of land out of an 8 square mile area. The company has an idea what minerals could be recovered from this plot of land (see Minerals Income Chart), but there is no way of really knowing abundance until the digging begins.
5. Pass out the Dig, Dig, Dig directions, charts, and tally sheets. Read through the following directions aloud with students before passing out the pies. (These directions follow the student sheet Dig, Dig, Dig in more detail.)
   a. Each team receives a pie and chooses a part of it to mine. This pie represents 8 square miles of land and you will be mining a part of it. You may choose a 1/16, 1/8, 3/16 or 1/4 of the pie to mine. You may not mine any area that is preserved (green sparkles). You may choose an area containing a river or lake, but you must leave at least 1 cm of that water (blue frosting) untouched.
   b. After your team chooses the area you will mine, mark the area by drawing a line in the whipped topping with a toothpick and dividing it into 1/16 sections. (Showing whether you chose 1/16, 2/16, 3/16 or 4/16).
   c. Now you need to pay to lease your land. See the Cost/Income Chart sheet. Look under Lease Cost Chart. Choose the price which describes the size plot you choose. Find the Cost Tally Sheet. Put the price to lease your land next to LEASE COST.
   d. Now write how you plan to reclaim your mine on a sheet of paper titled Reclamation Plan. It can be more expensive or take different techniques to reclaim an area which is exposed to the wind or sloped. Wind can blow soil and seeds away, so sometimes one has to plant seedlings. Slopes can have a lot of water erosion and land slides; therefore, one must shape different contours to help secure the soil and top layers.
   e. Next you need to figure out how much it will cost you to reclaim your land after you mine it. Use the Reclamation Cost Sheet to figure out the cost to reclaim your land. The prevailing winds in the flow chart refer to the wind which always blows from the back to the front of the room. Follow the flow chart for each 1/16th you will mine. If you choose 3/16 of the pie, you would go through the flow chart 3 times. Each time you would follow the chart for a different 1/16th. After you have the price for all your sections, add them together to get the total price for reclaiming your mine. Write this on the Cost Tally Sheet next to RECLAMATION COST.
   f. Figure the tax for leasing the land using the formula on the Cost Tally sheet and write it next to TAX.
   g. Use the Employee Cost Chart on the Cost/Income Chart sheet to hire employees to mine your area. Write it next to EMPLOYEE COSTS on the Cost Tally Sheet.
   h. Choose mining tools from the tool list found on the Cost/Income Chart sheet. You may choose more than one tool, and may add tools while mining, but you must pay for every tool used. Write the cost for each tool you choose on the Cost Tally Sheet next to EQUIPMENT COST.
   i. Get your purchased tools. When you are mining you may NOT use your hands. You MUST extract ONLY using the tools provided. At any time during the activity you may buy additional tools. AT NO TIME MAY YOU USE YOUR HANDS, even when the minerals have been extracted and you are trying to "clean them up" (milling.) Mine the plot. All minerals found are extracted and placed on a plate. Remove minerals carefully with as little environmental disturbance as possible. Anyone mining in a preserved area (green sparkle) or too close to the water will be fined (by the teacher).
   j. Mill the minerals, meaning remove the gunk from the mineral, and categorize them into piles.
   k. After mining and milling, tally the amount of money made from each of the minerals found using the Minerals Income Tally Sheet.
   l. Explain that Alaskan bulk items may be more expensive to transport if the mine is far from

a port. Calculate the amount of money it will take to transport your minerals to port using the formula on the Cost Tally Sheet under COAL TRANSPORT COSTS. Record your answer.

m. Add the total amount of money made on the Mineral Income Tally Sheet.

n. Add up the total amount of money spent on Cost Tally Sheet. Write the total money made and the total costs on the Profit/Loss Tally Sheet.

o. Subtract the total costs from total made to determine whether your company had a loss or a profit.

6. Students follow the directions on the Dig, Dig, Dig instruction sheet to complete this activity. You may choose to do steps 3, 5-8 and 11- 15 together as a class, to assist students with the forms.
7. Give the students 5-10 minutes to reclaim their mine after they've finished milling. Check to see that they have followed their reclamation plan and that the area has been sufficiently restored. If it has not, fine them, charge them more employee time, and require they fix their area.

Generalize

Compare the costs, incomes, and profits of the companies.
On their profit/loss sheets, teams analyze why they think they lost or made money and design a plan for increasing profits next time. Share the teams' company analyses.

List and discuss all the "pieces of the puzzle" that must be solved in order to have a profitable mine: Are there minerals present? What will it cost to get (or try to get) the minerals? What will it cost to transport them to buyers? How much of the mineral will we be able to get? What are the laws and regulations that must be followed, and what will that cost?

Discuss these questions

- ◊ How would it affect our lives if no one could afford to extract minerals?
- ◊ Why and how does public policy affect mining? What would happen if there were no laws governing mining?

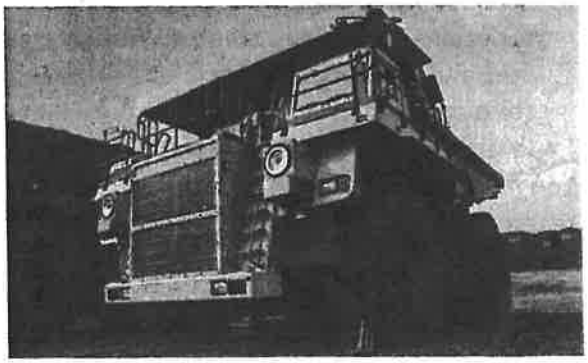
Assess

Ask each student to write a summary of the activity, discussing the factors that must be considered before deciding to mine. They should also discuss the potential public impacts of mining and the purpose of laws to regulate mining.

Extensions, adaptations, and more resources

If you have a limited time, or want to challenge your students with more real life scenarios, then include a time factor. Make each minute worth 1 month. After 12 minutes of mining, charge them another year of wages for their employees. You may choose to mine for 1, 2 or 3 years. Usually 2 years is sufficient. You may also choose someone to purchase the minerals/ metals. Encourage students to save room during their mining time to mill their minerals. When the time is up, have a purchaser (teacher, principal, custodian) buy the minerals which are "clean" enough to make it worth purchasing them. The students should only tally profits from those minerals which were sold.

- Simplify the activity by using only one or two types of minerals.
- Graph the classes' profits and costs.
- Research local mines, including the jobs they support, the tools they use, what they mine, and where they sell it.
- Find out the actual cost per ton of each of the minerals in today's market, and compare with the costs used for this simulation.
- Research the minerals that are mined in Alaska and how money from mining may help the state economy.
- Brainstorm careers in mining.
- Research to find out more about the Surface Mining Control and Reclamation Act of 1977 and other laws that affect mining in Alaska. Find out what kind of permits are required for mining.



Background

Mining has played a major role in Alaska since the first days of the Klondike Gold Rush in the late 1800's. Before the advancement of large scrapers and bulldozers, mining was mainly done on a small scale using pans, sluice boxes, or small dredges along river beds. With the advent of track bulldozers in the late 1920's to the big bulldozers and drag lines of the 1950's, Alaska's large mineral deposits have become increasingly economical to mine.

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Laws and Permits that Affect Mining

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Teacher Directions for Making Mine-A-Pies *(<u>not</u> edible)*

Ingredients for pie:

- 2 cups of oats (per pie)
- 2 cups flour (per pie)
- water (1-2 cups)
- 15-bean soup mix (or any combination of beans to use as minerals)

Note:

See the Minerals Income Chart on the Cost/Income Chart page and make sure you have all of the kinds of beans named. If not, or if you are using other substitutions, you will need to change the chart. The following are the minerals found in Alaska from most to least abundant: Sub-bituminous Coal, Bituminous Coal, Anthracite Coal, Copper, Zinc, Silver, Jade, Gold, Tin, and Platinum. When making your pies, put in more of the coal and less of the Gold, Tin and Platinum since they are less abundant.

- Blue frosting or cake sprinkles (1 tube/6 pies)
- Green frosting or cake sprinkles (1 small tube/30 pies)
- Whipped topping (1 large bucket/4 pies)

Notes

- ◊ The beans represent the minerals to be "mined" in the pie. You can adjust the amount you put in each pie.
- ◊ You may substitute any of these ingredients. You may also use mud, sand, gravel, and soil, beads, buttons, metal nuts, etc. instead of food items.

Directions for making the pie(s)

a. Mix the oats and flour together. Add beans and cereal (see note above about cereal)

b. Add water to make moist but not too moist. You want it firm enough that the students will have to dig the minerals out.

c. Put the mixture into the pie pan. Mold into the form of a mountain.

d. Cover with a thin layer of frosting or cool whip (generic whipped topping works best, but also melts and can be very messy) You may choose to omit the frosting on parts of the pie, as some areas in Alaska do not have sufficient top soil.

e. Use blue frosting or sprinkles to mark rivers, a wetland and/or lake.

f. Sprinkle green cake frosting or sprinkles on top to represent a pre-served area (remember to leave plenty of land accessible for mining).

g. Place in a Ziplock bag, (do not close), to keep moist if not being used right away.

DIG, DIG, DIG

Follow the steps outlined below

1. Choose a plot of land to mine. It can not be bigger than 1/4 of the pie. You may choose 1/16, 1/8, 3/16, or 1/4 of the pie.
2. Draw the area YOU will mine on your pie using the toothpick. Divide it into 1/16 sections.
3. Figure out the amount of money it will cost you to lease the land you chose by using the chart called Lease Cost Chart. Write it next to LEASE COST on the Cost Tally Sheet.
4. Write how you will reclaim your mine once you're finished extracting the minerals. Write your idea on a piece of paper called Reclamation Plan.
5. Figure out how much money it will cost to reclaim each 1/16 section your mined area using the flow chart on the sheet called Mine Reclamation Costs. Write it next to RECLAMATION COST on the Cost Tally Sheet.
6. Figure out the amount of tax you will need to pay on your lease using the formula on the Cost Tally Sheet. Write the amount next to TAX on the Cost Tally Sheet.
7. Use the Employee Cost Chart to figure the cost to hire employees to mine your area. Write this amount next to: EMPLOYEE COSTS on the Cost Tally Sheet.
8. Choose your tools from the Equipment Cost Chart and write their prices next to: EQUIPMENT COSTS on the Cost Tally Sheet.
9. Mine your area. Place all the minerals on a plate. You may NOT USE YOUR HANDS. You may not mine within 1 cm of any water or in a preserved area.
10. Remove all of the extra "goo" stuck to the mineral. You may NOT USE YOUR HANDS. Put all the minerals into similar piles.
11. Use the Minerals Income Sheet to figure out what you took out of the ground. Then use the Minerals Income Tally Sheet to figure out how much money you made from each mineral you mined.
12. If you mined any coal, figure out how much money it cost YOU to transport (move) this bulk resource to a port for shipping. Use the formula on the Cost Tally Sheet under COAL TRANSPORT. Write the price next to: COAL TRANSPORT COSTS.
13. Add up all the money you made on the Minerals Income Tally Sheet. Write the total on the Profit/Loss Tally Sheet.
14. Add up all your mining costs on the Cost Tally Sheet. Write the total on the Profit or Loss Tally Sheet.
15. Subtract all of the money it cost you to mine from the money you made. If you have money left over, this is the money your mine made this year, or your PROFIT. If you do not have any money left over and you have a negative number, this is the money you lost.

Company Name _____

COST / INCOME CHART

SIZE OF MINE	COST
1/16 of the pie	$150,000
1/8 of the pie	$300,000
3/16 of the pie	$450,000
1/4 of the pie	$600,000

EQUIPMENT COST CHART

TOOL	COST
Toothpick	$20,000
Popsicle stick	$50,000
Fork	$100,000
Spoon	$200,000

EMPLOYEE COST CHART

SIZE OF MINE	EMPLOYEE FORMULA	COST
1/16 of the pie	10 people x $50,000/year	$500,000
1/8 of the pie	20 people x $50,000/year	$1,000,000
3/16 of the pie	30 people x $50,000/year	$1,500,000
1/4 of the pie	40 people x $50,000/year	$2,000,000

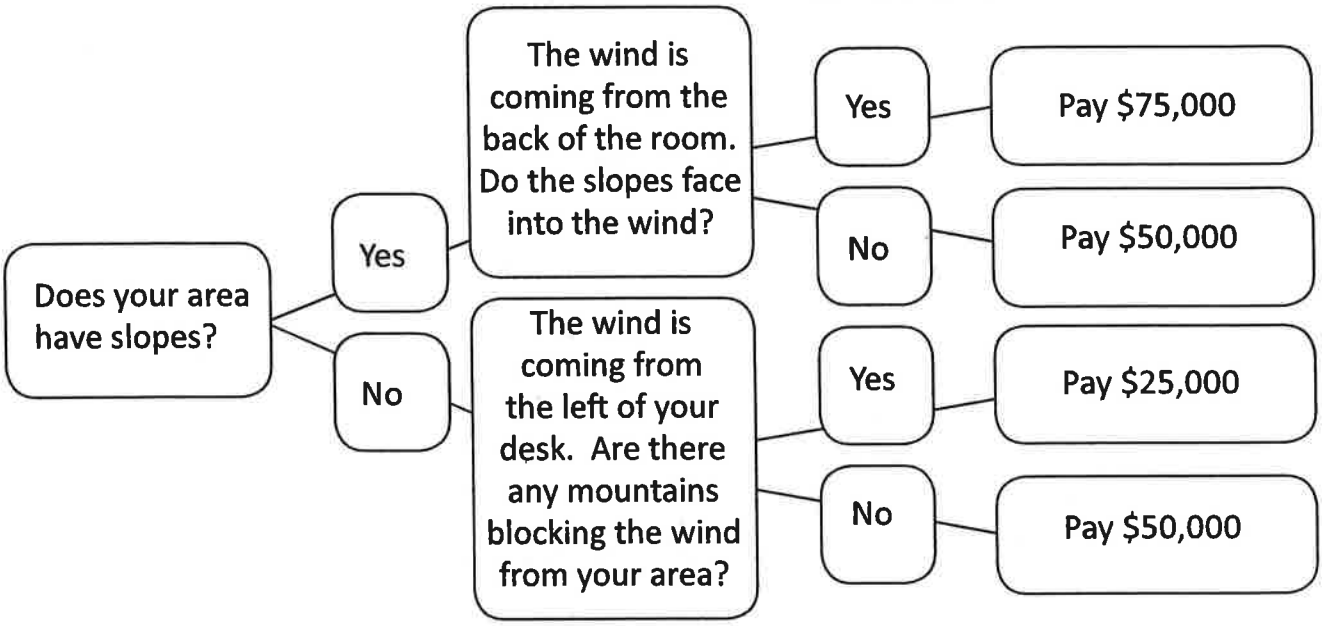
MINERALS INCOME CHART

OBJECT	MINERAL	PRICE
Wheat puff	Sub-Bituminous Coal	$5,000
Lentil	Bituminous Coal	$6,500
Black Bean	Anthracite Coal	$10,000
Pinto Bean	Tin	$10,000
Split Pea	Jade	$25,000
Kidney Bean	Copper	$50,000
Lima Bean	Zinc	$50,000
Black Eyed Pea	Silver	$75,000
Yellow Pea	Gold	$500,000
Chick Peas	Platinum	$750,000

Company Name _____

MINE RECLAMATION COSTS

Directions: Follow the flow chart for each 1/16 you choose to mine. Treat each 1/16 individually. Some of your sections may be more expensive than others due to the terrain of the area.



Write the price for each of your 1/16 sections on the lines below. After you have figured the reclamation price for each section, add them together to get your total RECLAMATION COST.

Section 1: _____ Section 3: _____
Section 2: _____ Section 4: _____

TOTAL: _____

Company Name _____

COST / INCOME CHART

Lease Cost _____

Reclamation Cost _____

Tax=Lease Cost divided by 5

Your Tax _____

Employee Costs _____

Equipment Costs

Tools:

_____ _____

_____ _____

_____ _____

Coal Transport Costs
Chunks of coal x $1500
Your Coal Transport Cost _____

Total costs of your Mining Operation _____

Company Name _____

MINERAL INCOME TALLY SHEET

ITEM	MINERAL REPRESENTED	# OF CHUNKS	VALUE PER CHUNK	INCOME
				(Multiply # of chunks by value per chunk)
	Bituminous Coal		$6,500	
	Anthracite Coal		$10,000	
	Tin		$10,000	
	Sub-Bituminous Coal		$5000	
	Copper		$50,000	
	Zinc		$50,000	
	Bituminous Coal		$6,500	
	Gold		$500,000	
	Anthracite Coal		$10,000	
	Copper		$50,000	
	Silver		$75,000	
	Jade		$25,000	
	Gold		$500,000	
	Tin		$10,000	
	Zinc		$50,000	
	Platinum		$750,000	
			TOTAL INCOME	

Company Name _____

PROFIT/LOSS TALLY SHEET

Enter your **Total Income** from
Mineral Income Tally Sheet _____

Enter your **Total Cost** from Cost Tally Sheet _____

Subtract to get your Company's **Profit** _____

Why do you think your company made or lost money?

Make a plan increase your profit next time you mine and write it here and on the back of the sheet.

Mine-a-Pie Profit Analysis Sheet

Company Name: _____

COSTS

Land Lease			
Land	Lease Cost	How much land you want to lease	Your Cost
1/4 Pie	$500		
1/2 Pie	$1,000		$
Employees			
For 1/4 Land		$300	$
For 1/2 Land		$500	$
Equipment			
Equipment	Cost per each	How many you want	Your Cost
Toothpick	$25		$
Spoon	$50		$
Fork	$75		$
Reclamation			
Insurance that you will restore the land			$500
	Your Total Costs		$

INCOME

Income				
Item	Mineral	Value	Amount you mined	Your Income
	Coal	$50		
	Jade	$100		
	Gold	$200		
		Your Total Income		$

PERMIT

Regulator's Signature **REQUIRED** BEFORE mining

_____

PROFIT ANALYSIS:

TOTAL INCOME $_____

- TOTAL COST - $_____

= PROFIT

(How much you made!) = **$**_____

Grade: 3-5 | Time: 1 hour

FINDING OIL IN A CUPCAKE

Essential Question: How do we get fossil fuels?

Overview

Students learn about how fossil fuels are formed, followed by a fun activity pretending to be geologists, taking core samples trying to find oil... in a cupcake.

Assessment

Can students

- Explain how fossil fuels were formed?
- Describe how geologists take core samples to map what is underground?

Vocabulary

- Fossil fuel
- Petroleum
- Geologist
- Nonrenewable
- Core Sample

Teacher Information and Procedure

Prior knowledge for students:
The "*Fossil Fuel Hunt*" activity would provide a good background

Source: Alaska Resource Education. Cupcake activity adapted from http://www.womeninmining.org/cupcak1.htm.

(Graphics figure on page 5 from www.NEED.org, Others from Depositphotos.com and by volunteers)

Materials needed

- Handout: "*What are Fossil Fuels?*"
- Cupcakes, 1 per student (See Teacher Information on "*Preparing Cupcakes*")
- Clear plastic straws
- Student worksheet "*Finding Oil....In a Cupcake?*"
- Colored Pencils
- Dental floss – to cut the cupcake
- Enough white cupcake mix to make one cupcake each for students
- Foil baking cups
- 2 or 3 colors of food coloring
- Frosting
- Clear straws

What to do in advance

- Make cupcakes – see teacher prep at end of lesson
- Make copies of the handout and worksheet

Teaching the Lesson

Gear-up

Watch a film, read a story, or view a poster about the age of dinosaurs. Introduce the idea that we use some resources today that are as old as dinosaurs.

Ask the students questions about fossil fuels:

- What is a fossil fuel?
- How were they formed?
- How can we find them?
- How do we use fossil fuels?
- Do we have them in Alaska?

Read/discuss the handout "*How Do We Find Oil*". Re-address the questions listed above.

Have the students take turns guessing where oil, gas, and coal resources are found on a map of Alaska.

Explain that they will be pretending to be geologists looking for oil "underground".

Show them a cupcake and explain that there are several colors of cake inside and that there might be "oil" (tell them what color the oil is) inside!

Pass out cupcakes with instructions not to touch/eat them until you give the go ahead.

Alaska Standards Addressed

Science GLEs

The student demonstrates an understanding of:

- the attitudes and approaches to scientific inquiry by [3] SA2.1 answering "how do you know?' questions with reasonable answers [4]SA2.1 supporting the students own ideas with observations and peer review

- the processes of science by [3,4,5]SA1.1 asking questions, predicting, observing, describing, measuring, classifying, inferring, and communicating [3]SA1.2 observing and describing the student's own world to answer simple questions, [4] SA1.2 observing, measuring, and collecting data from explorations and using this information to classify, predict, and communicate [5] SA1.2 using qualitative and quantitative observations to create inferences and predictions

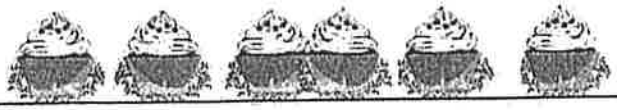
Geography GLEs

A 1) use maps and globes to locate places and regions;

Alaska English/Language Arts and Mathematics Standards (2012)

- RI.K-5.4, RI.K-5.7
- WS.K-5.1, WS.K-5.8

Finding Oil...In a Cupcake?



Divide the batter into several bowls and add food coloring to the bowls. Make them dark. Leave some of the batter white. Choose one color to be "oil" and use it in a smaller amount of batter. Layer the different colors of batter into the baking cups and make sure that the "oil" is hidden near the bottom and does not extend all the way across the cupcake.

Pass out the handouts and have each student draw what they think it might look like inside their cupcake.

Ask them how they might discover what is inside without removing any frosting or cutting it.

Explain that geologists take "core samples" to see what is deep below the Earth's surface with little disturbance to the surface.

Pass out straws and have students "drill" their cupcake three times, making a new drawing each time to illustrate what the "core" looks like and what the inside of the cupcake looks like. As they do it, discuss how their activity is like the work that geologists do to find oil.

Let students cut the cupcakes open and make a final drawing, then eat the cupcakes!

Generalize
Discuss with students the idea that fossil fuels formed under special conditions, and that the amounts available are limited and they are a nonrenewable resource. Talk about how we use fossil fuels and how we might sometimes waste them.

Assess
Have students write in their journals or on paper to describe what they know and what they have learned about fossil fuels.

Extensions, adaptations, and more resources:
Add math by adding parts from "Finding Oil is a Piece of Cake" activity to further explore how we find oil.

For more background information see attend sheet: Energy Sources and Natural Fuels Volume 2 NSTA/API Monograph by Aldridge et al.

Children's Books about Fossil Fuels:

Energy Essentials: Fossil Fuel Saunders, Nigel and Steven Chapman, Raintree, Chicago, Illinois, 2004. ISBN 1-41090-501-2

Future Energy: Fossil Fuels Richards, Julie, Smart Apple Media, North Mankato, Minnesota, 2004. ISBN 1-58340-334-5

Worksheet - Finding Oil...In a Cupcake?

Geologist's Name _____

What do you imagine is inside your cupcake? Draw a picture here:

Draw "Core Sample 1" here:
Try drawing your cupcake after you have seen the first sample.

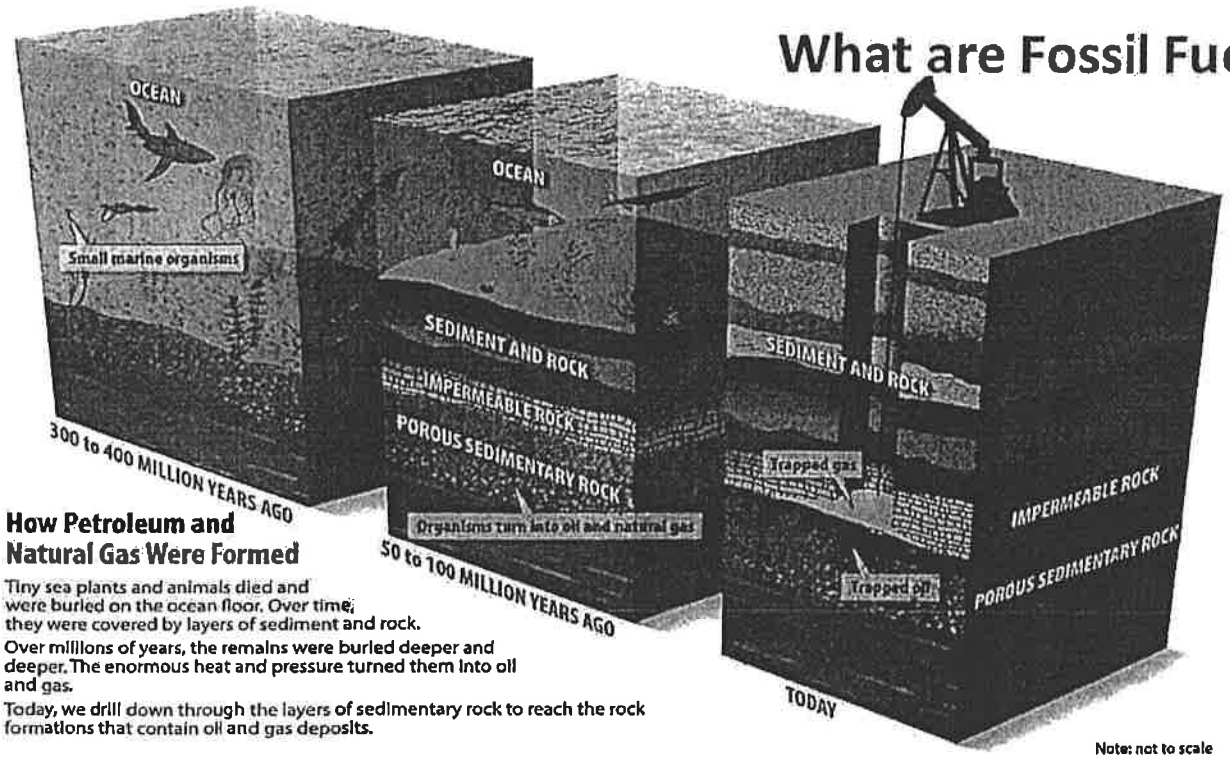
Draw "Core Sample 2" here:
Try drawing your cupcake after you have seen the second sample.

Finding Oil...In a Cupcake? *(continued)*

Draw "Core Sample 3" here:
Try drawing your cupcake after you have seen the third sample.

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

What are Fossil Fuels?



How Petroleum and Natural Gas Were Formed

Tiny sea plants and animals died and were buried on the ocean floor. Over time, they were covered by layers of sediment and rock.

Over millions of years, the remains were buried deeper and deeper. The enormous heat and pressure turned them into oil and gas.

Today, we drill down through the layers of sedimentary rock to reach the rock formations that contain oil and gas deposits.

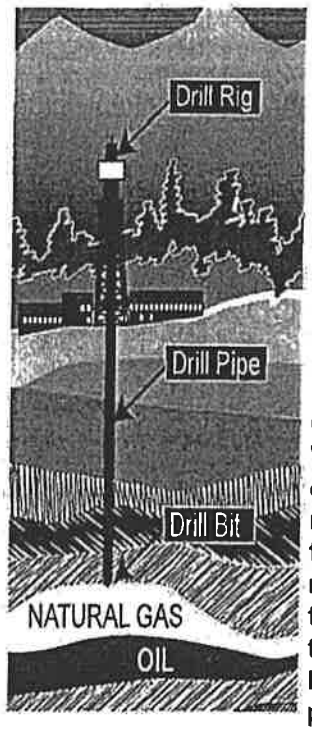
Note: not to scale

How Do We Find Oil?

Trying to "see" what is beneath the surface of the Earth is one of the jobs of a geologist. Rather than digging up vast tracts of land to expose an oil field, drills can collect samples from underground that can be analyzed to determine the composition of the Earth's interior. You will work as a geologist to discover if there is oil beneath the surface of a cupcake representing the earth's crust.

Where is oil found?

Because oil and gas are lighter than water, they float on top of water. Oil and gas that formed in the source rock deep within the earth floated up through tiny open spaces called pores in the rock. Some seeped out at the surface of the earth. Some was trapped by dense, non-porous rock, called shale. These underground traps of oil and gas are called reservoirs. Reservoirs contain porous rocks that allow fluids to flow through the pore spaces, that is, that are permeable. Often discovered in dome-shaped structures called anticlines, oil does not reside in underground lakes as is commonly supposed. Instead, it is trapped in rocks with holes (pores) like sponges. Natural gas is dissolved in the oil or separates and is trapped on top of the oil as a separate layer.



How do you know where to drill?

At first, people drilled wells near spots where oil seeped naturally to the surface. Or they made haphazard guesses about where to drill, often with disappointing results. Even with the modern technology, the search for oil is fraught with uncertainty. The odds are against discovering oil in a new location. And when oil is found, rarely is there enough to make production commercially viable.

Core Samples

When oil wells are drilled, sometimes a coring tool is used to obtain samples of the reservoir rock for study. Geologists study these core samples to learn about the reservoir and help decide how to produce the oil and gas from it. A rotary tool with a tough diamond bit drills through the rock. Drilling proceeds at a rate of 30 to 60 feet per hour. In the United States, the average well is more than a mile deep; the deepest is nearly seven miles.

By studying the core samples and by interpreting other subsurface data, scientists and engineers can reasonably predict how big the reservoir is and how much oil it contains, and how easy or difficult it will be to produce the oil. Economic studies are then done to assess production methods and the equipment needed to develop the oil field.