A Middle School

Petro Science Curriculum

Presented by

Illinois Petroleum Resource Board

Original curriculum courtesy of

Oklahoma Energy Resources Board

Aligned to Illinois Learning Standards

POWERING EDUCATION

Updated 1/1/2020

What is the IPRB?

The **Illinois Petroleum Resources Board** formed to provide public awareness, education programs and to restore abandoned well sites throughout the state. Funding for IPRB programs comes from voluntary contributions of oil and natural gas producers and royalty owners in Illinois.

IPRB provides funding and expertise in the reclamation and restoration of abandoned oilfield sites in the State of Illinois. These restoration projects fulfill another goal of IPRB which is to restore abandoned sites previously used for oil and gas production into agricultural or commercial use for current land owners.

For more information about IPRB and the free education programs, please visit the website at iprb.org, contact us at office@iprb.org or call the Illinois Petroleum Resources Board at 618-242-2861.

One of our most important missions is Energy Education! Our program serves two primary goals:

1. To develop and design oil and natural gas education activities for K-12 teachers and students in Illinois.

2. To provide teachers with:

- Workshops statewide that provide free training and resources in energy education
- Educational field trips for students and teachers
- Professional development hours
- Other education resources that help interest students in science and math, energy, and their understanding of how Illinois crude oil and natural gas are an important part of the energy picture and the Illinois economy.

Professional development

The IPRB will provide professional development credits for use of this curriculum. To receive information on professional development sessions, please contact the IPRB at email office@iprb.org or 618-242-2861.

FREQUENTLY ASKED QUESTIONS

The activities in this book are designed to teach students through discovery hands-on investigative experiences and open-ended inquiry questions.

WHAT IS ENERGY?

The world is full of movement. Birds fly into the air, trees move in the wind, and ships sail on the sea. People, animals, and machinery move around, but not without a source of energy.

Living things and machines need energy to work. For example, the energy that turns the blade of a windmill comes from the wind.

The sun provides the energy needed to produce the food you eat.

Food provides the energy your muscles need to ride your bike. The energy to make a car, plane or motorboat move comes from the gasoline inside the engine.

FROM WHERE DOES ENERGY COME?

All energy originates from the sun. Without the sun, there would be no life on earth. The energy from the sun is transformed into many other types of energy that we use every day. Important forms of energy are oil, natural gas and coal, also known as fossil fuels.

HOW ARE OIL, NATURAL GAS AND COAL FORMED?

Millions of years ago, the seas were filled with billions of tiny plants and animals. As these plants and animals died, their remains sank to the ocean floor and were buried in layers of sand and sediment. As more and more time passed, heat and pressure worked on the buried remains until they became fossil fuels. These fossil fuels were then trapped in underground rock formations. If rock is porous (containing holes or void spaces), it can accumulate oil, natural gas and coal.

For more than 150 years, man has been exploring and extracting fossil fuels. Today, when we use the products made from fossil fuels, we are releasing the energy that first came to earth from the sun millions of years ago.

HOW DO WE FIND OIL AND NATURAL GAS?

Edwin L. Drake was the first person to drill specifically for oil. In 1859, near Titusville, Pennsylvania, Drake struck oil. Drake's discovery helped make the finding of oil a big business. By 1900, prospectors had found oil fields all over the country, especially in Oklahoma and Texas.

Today, prospecting for oil and natural gas is highly skilled detective work as scientists use computers, satellites, sound waves and high-tech equipment to search both underground and under the ocean floor. Long before drilling can begin, geologists and geophysicists (scientists who explore for oil and gas) gather clues to locate possible sites for drilling. These clues come in many forms . . . from maps to locating fossils to studying sound waves from deep beneath the surface. The scientists make their best predictions, locate the spot and then the exploration begins. However, this process does not proceed without concern for the environment.

For many years, oil and gas companies have devoted considerable time and resources to finding ways of reducing their impact on the environment. In fact, U.S. companies are spending more dollars protecting the environment than drilling new wells. The effects that drilling, as well as any eventual production operations, will have on an offshore environment or a sensitive onshore tract must be anticipated and thoroughly spelled out. Blowout preventers used during the drilling process insure against the potential release of oil or natural gas into the atmosphere making oil "gushers" a relic of the distant past. Steel casing is set and cemented to protect the water table from contamination. Oil companies routinely take all necessary steps to prevent harmful interaction with wildlife and crop production.

In the final analysis, it is a question of balance between the need for energy and the desire to have an undisturbed environment. Oil companies and the government must cooperate to ensure this balance is achieved.

HOW IS OIL AND NATURAL GAS TRANSPORTED AND USED?

Once oil and natural gas are produced and collected, they must be safely transported for their many uses. Oil can be transported by truck, pipeline or ships to factories called refineries. Natural gas can only be transported in large quantities through high pressure pipelines. Consequently, natural gas produced in the U.S. can only be used on this continent. Crude oil can be shipped all over the world where it is made into thousands of products that we use every day. You don't need to leave home to find oil in some of its many forms.

By processing fossil fuels at power stations, stored energy can be converted to electricity. The carpet on your floor and the paint on your walls probably have oil in them. You brush your teeth with a plastic tooth brush which is made from petroleum (oil is the key ingredient of plastic). It is estimated that we have found more than 500,000 uses for oil.

Learning Cycle

Petro Science activities follow the learning cycle format:

1. **Wonder Why**

The Wonder Why question focuses on the topic of the activity and engages student interest.

2. **Discovery Procedure**

This stage of the learning cycle provides information and procedures for inquiry-based, hands-on investigations.

3. **Concept Formation**

Based on the discovery activity, this stage of the learning cycle develops the main idea through questioning and additional resources.

4. **Expansion**

This stage of the learning cycle allows for further development of the concept through the use of subject integration, resources, community outreach, creativity and decision-making.

Table of Contents

NOTICE: Remember to always wear safety goggles, and other safety protection when doing science experiments.

Cooking Up Crude

Illinois Academic Standards-English/Language Arts

Grades 6-8

Science and Technical Subjects-Reading

Key Ideas and Details

6-8.1 Cite specific textual evidence to support analysis of science and technical texts.

Integration of Knowledge and Ideas

6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

Science and Technical Subject-Writing

Text Types and Purposes

6-8.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

Research to Build and Present Knowledge

6-8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation

Speaking and Listening

Presentation of Knowledge and Ideas

6.5 Include multimedia components (e.g., graphics, images, music, sound) and visual displays in presentations to clarify information

7.5 Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points.

8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.

Next Generation Science Standards

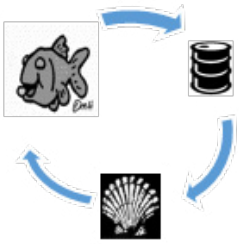
Grades 6-8

Earth's Place in the Universe

MS-ESS1-4 Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.

Earth's Systems

MS-ESS2-2 Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.



Cooking Up Crude

Time: 2-3 class periods

Wonder Why . . .

Have you ever wondered how crude oil and natural gas form?

Concept

The oil and natural gas taken from the earth's crust today originated as microscopic plants and animals that lived in the ocean millions of years ago.

Teacher Information

The fossil activity will lead the students to the discovery that millions of years ago Illinois wasn't anything like it is today. It was under an ocean! Geologists believe this because many rock layers containing fossil remains of marine life have been found throughout the state. Millions of microscopic marine plants and animals which lived in the waters eventually died and settled on the ocean floor. The dead plants and animals were often buried by sand and other sediment. Heat from beneath the earth's crust "cooked" the plant and animal remains forming oil and natural gas deposits within the rock layers. This is why oil and natural gas, or petroleum, are called fossil fuels.

Vocabulary

Fossil: The remains or traces of animals or plants, which have been preserved almost exclusively in sedimentary rocks by natural causes in the earth's crust prior to recorded history.

Sedimentary Rock: A rock formed from the decomposition and cementation of sediments.

Igneous Rock: A rock formed from the cooling of molten rock (magma, lava).

Metamorphic Rock: A rock formed from an existing rock by the addition of heat and/or pressure not to exceed the melting point of rock (at which time it becomes an igneous rock)

Plankton: Microscopic plants and animals that float freely with ocean currents and in other bodies of water.

Phytoplankton: Microscopic plants that make up plankton. These tiny plants are at the base of the ocean food web.

Zooplakton: Microscopic animals that make up and eat other plankton.

Safety

Remind students to wash hands at the end of laboratory investigation.

Student Activity 1: Fossil Survey

Students will explore and identify four fossils that lived in a marine environment. Then students, using a map of Illinois, will place each of the fossils on one of the counties in Illinois where that fossil was found. Students should make inference regarding why these marine fossils are found in Illinois, since Illinois was covered by a shallow sea in the geologic past.

Materials (per group of 4 students)

- Fossil Set (includes one brachiopod, horn coral, trilobite, & crinoid fossils)(included in lab/kit)
- Fossil Guide
- Map of Illinois
- Illinois Fossils by County
- 2 hand lenses

Procedure

1. Distribute one fossil set and one Map of Illinois to each group of students.
2. Give each student a copy of the fossil guide.
3. Have students examine and identify each fossil.
4. Discuss the environment in which each of these animals may have lived. **Answers may include: shallow marine environment, saltwater environment, ocean, shallow sea, watery environment, aquatic environment.**
5. Using the Map of Illinois and the Illinois Fossils by County handouts, have students locate and place the fossils on the map in the counties in which they could be found. Place one fossil per county.
6. Have students complete the Fossils Location Chart.
7. Ask students to make an inference regarding why these fossils are found in Illinois. **Possible Answer: A shallow sea has covered Illinois several times in the geologic past.**

Fossil	Counties
Brachiopod	**Possible Answers: Bureau, Cook, Fulton, Hancock, Hardin, Henderson, Henry, and others....**
Crinoid	**Possible Answers: Hancock, Hardin, Henderson, Jo Daviess, Johnson, Livingston, and others....**
Horn Coral	**Possible Answers: McDonough**
Trilobite	**Possible Answers: Alexander, Henry, Jersey, Kendall, Lee, Madison, Rock Island, and others...**

Map of Illinois

Petro Active Fossil Guide

Trilobite

A trilobite was hard-shelled, segmented creatures that lived millions of years ago. A trilobite was a strange looking little creature. Small grooves divided its body and hard segmented shell into three vertical parts. Its head was covered by a semicircular shield.

Coral

Horn coral, which still exists today, comes in many different sizes, shapes and colors. The coral polyps were simple animals that were able to take calcium out of saltwater and covert it into a rocklike shelter in which they lived.

Crinoids

Crinoids anchored themselves to rocks on the sea floor with a root-like structure that was supported by a stalk or column topped by a cup-like cavity which formed a protective case for a flower-like animal.

Brachiopods

Brachiopods were clam-like marine animals. Their two-piece dorsal and ventral shells enclosed and protected their soft body parts. They usually make their homes in very cold water.

Illinois Fossils by County

County	Fossils
Adams	corals, archimedes, bryozoa, bivalves, fish teeth, crinoids
Alexander	coral, trilobite, bivalves
Boone	spiral shelled gastropods, mollusk, nautiloid cephalopod
Brown	plants
Bureau	brachiopods
Carroll	trilobites
Clinton	bivalves, bryozoa
Cook	shells, trilobite fragments, corals, crinoids, brachiopods
DeKalb	mammal bones and teeth, petrified wood, fish bones, fish teeth, mollusks, mastodon, trilobite fragments
Du Page	mammal bones and teeth, mastodon, castoroides (giant beaver)
Edgar	marine fossils
Effingham	gastropods
Franklin	Well preserved tree ferns
Fulton	plant fossils, fish fragments, brachiopods, sponges
Gallatin	bivalve mollusks
Grundy	fish, gastropods, shark teeth, plants, rarely vertebrates
Hancock	mollusks, corals, crinoids, trilobites, fish spines, teeth, brachiopods, bryozoa
Hardin	echinoderm, crinoids, brachiopods, coral, mollusks
Henderson	crinoids, brachiopods, ammonites
Henry	cephalopods, gastropods, brachiopods, trilobite
Jackson	plant fossils (horsetails, seeds…), mollusks, crustacean
Jersey	trilobites, brachiopods, ammonites
Jo Daviess	corals, Archimedes, bryozoa, bivalves, fish teeth, crinoids, gastropods
Johnson	bryozoa, brachiopods, mollusks, crinoids, corals, blastoids
Kane	mammal bones and teeth
Kankakee	brachiopods
Kendall	nautiloid cephalopod, trilobite fragments, coral, brachiopod
Knox	vertebrates (Symmorium-shark)
La Salle	Sharks teeth, brachiopods, Corals, bryozoa, plants, bivalves.
Lake	brachiopod
Lee	brachiopods, coral - (favosites- honeycomb coral), crinoids, trilobites
Livingston	well preserved plants, crinoids (very well preserved), plants

Illinois Fossils by County

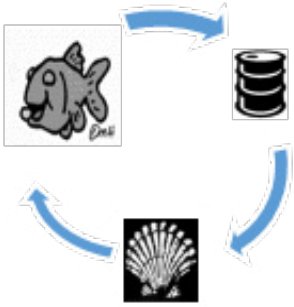
County	Fossils
Macon	vertebrates - teeth
Macoupin	vertebrate (fish teeth)
Madison	fish teeth/spines, trilobites, echinoderm, brachiopod,
Marion	bivalve mollusks
McDonough	well preserved horn coral, brachiopods, crinoids, Archimedes, fish teeth, fossil plants
Menard	bivalve mollusks
Mercer	plant fossils
Monroe	corals, bryozoa, brachiopods, crinoids, nautilus,
Ogle	very large nauteloid cephalopods
Peoria	large coral, brachiopods, crinoids
Perry	Well preserved tree ferns, brachiopods, crinoids
Pike	brachiopods
Pope	well preserved tree ferns, archimedes, brachiopods
Pulaski	vertebrate teeth
Randolph	blastoids, nautilus cephalopods, plants, crinoids, coral, bryozoa, brachiopods
Rock Island	corals, brachiopods, cephalopods, trilobites, corals, vertebrates,
Sangamon	corals, brachiopods, mollusks, gastropods
Schuyler	bivalve mollusks, cephalopods, brachiopods
Scott	abundant brachiopods
St Clair	vertebrates, mollusks, brachiopods, archimedes, nautilus, gastropods
Stephenson	algae, brachiopod, corals, bivalve
Union	crinoids, shark spines, coral, brachiopod
Vermilion	fish scales, brachiopods, plants, bryozoa,
Warren	crinoids, blastoids
Washington	crinoids, vertebrate fossils: conodonts (eel like)
Washington	vertebrates-Caseodus
White	well preserved tree ferns
Whiteside	algae, coral
Will	trilobites, brachiopods, ammonites, large complete straight and loosely coiled cephalopods, fish
Winnebago	echinoderms, crinoids, brachiopods, bryozoa, trilobites, echinoderms



Name _____ Date _____

Cooking Up Crude

Student Sheet



Wonder Why . . .

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Safety

Wash hands at the end of laboratory investigation.

Student Activity 1: Fossil Survey

Materials (per group of 4 students)

- Fossil Set (includes one brachiopod, horn coral, trilobite, & crinoid fossils)included in lab/kit
- Fossil Guide
- Map of Illinois
- Illinois Fossils by County
- 2 hand lenses

Name _____ Date _____

Procedure

1. After receiving the fossil set, Map of Illinois and fossils guide from your teacher, begin by reading through the fossil guide.
2. Using the hand lenses, examine the fossil set and identify each fossil.
3. Discuss the environment in which each of these animals may have lived. Record your thoughts.

_____

_____

_____

4. Using the map of Illinois and the Illinois Fossils by County handout, locate and place the fossils on the map in the counties in which they could be found. Place one fossil per county.
5. Complete the chart.
6. On the following lines explain why these fossils are found in Illinois.

Fossil	Counties
Brachiopod	
Crinoid	
Horn Coral	
Trilobite	

_____

_____

_____

_____

_____

_____

Cooking Up Crude

Student Activity 2: Formation of Oil and Natural Gas

Wonder Why . . .

Have you ever wondered how crude oil and natural gas form?

Concept

The oil and natural gas taken from the earth's crust today originated as microscopic plants and animals that lived in the ocean millions of years ago.

Activity – How do <u>you</u> see it?

Students illustrate the sequence of oil formation.

Materials

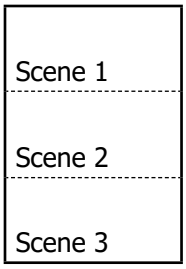
- "Cooking Up Crude"

  https://iprb.org/education/classroom-curriculum/references/

- Paper (8½" x 14")
- Map pencils
- Fossils (if available)

Cooking Up Crude Activity Outline (Power Point Presentation Preferred)

1. Have students discuss their ideas of the formation of oil and natural gas. Allow 10-15 minutes for sharing ideas.
2. Instruct students to remove everything from their desks as they will be listening to a story about the formation of oil and natural gas. During the story each student will make a drawing which will represent the formation of oil and natural gas.
3. Give each student an 8½-inch x 14-inch sheet of paper. Instruct the students to divide the paper into three equal sections by drawing two lines across the width of the paper. Label the sections: Chapter 1, Chapter 2 and Chapter 3.
4. Begin listening to "Cooking Up Crude."
5. Once the students have listened to the narrative and completed their drawings, hand out the narrative for each student to read silently.
6. Let students make changes to their drawings, if necessary.
7. Discuss their drawing with the class.



Extension

- Have students compare their prior ideas on the formation of oil and natural gas with the information from the passage in five well-developed sentences.

Name _____ Date _____

Cooking Up Crude

Student Sheet

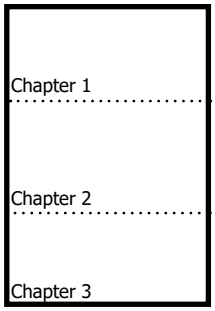
Student Activity 2: Formation of Oil and Natural Gas

Materials

- "Cooking Up Crude" audio file **(https://iprb.org/education/classroom-curriculum/references/)**
- Paper (8½" x 14")
- Map pencils

Procedure

1. Discuss your ideas of the formation of oil and natural gas with your group.
2. Remove everything from your desks except an 8½-inch x 14-inch sheet of paper. Divide the paper into three equal sections by drawing two lines across the width of the paper. Label the sections: Chapter 1, Chapter 2 and Chapter 3.



3. Begin listening to "Cooking Up Crude."
   https://iprb.org/education/classroom-curriculum/references/
4. Read the narrative silently.
5. Make any necessary changes to your drawings representing the formation of crude oil and natural gas
6. Discuss your drawings with the class.

Narrator:

I am going to tell you a story about the history of the formation of oil and natural gas in the state of Illinois. This story will be told in three short chapters. When I finish each chapter, I would like for you to draw a picture representing what you have just heard. Please begin drawing when I say, "Can you picture this scene?" Let's begin.Chapter One

Chapter One

544 million years ago — a geologic period known as the "Paleozoic Era" began—a large sea covered much of the United States, including what is now Illinois. In this sea lived a vast number of microscopic plants and animals called plankton. This microscopic plankton drifted on or near the surface of the water and became so numerous that it could actually be seen with the naked eye.

Throughout the "Paleozoic Era" the sea was also alive with trilobites, corals, crinoids, brachiopods and a host of other marine plants and animals that were evolving over many millions of years. A trilobite was a strange-looking little creature. Small grooves divided its body and hard segmented shell into three vertical parts. Its head was covered by a semicircular shield. Many kinds of trilobites lived in the seas that covered Illinois.

Coral, which still exists today, came in many different sizes, shapes and colors. The coral polyps were simple animals that were able to take calcium out of saltwater and convert it into a rocklike shelter, in which they lived.

Crinoids anchored themselves to the sea floor with a root-like structure that supported a long stalk or column. On top of this stalk was a cup-like cavity, which formed a protective case for a flower-like structure that was used to catch tiny particles of food as they drifted by.

Brachiopods were clam-like animals that lived on the sea floor. Their two-piece dorsal and ventral shells enclosed and protected their soft body parts just like clams and oysters today.

Although during this time Illinois was covered by the sea, other parts of the world were exposed as land. As rivers, wind, rain, avalanches, and ice movements eroded the surrounding landscape, tiny particles—called clastic sediments—were carried into the sea where the billions of tiny sea creatures lived.

All organisms on Earth contain carbon. Billions of tiny plankton can contain quite a large amount of carbon. As these numerous lifeforms in the sea of the Paleozoic era died, their remains settled to the deep sea floor and became covered with the mud, sand and sediment from the eroding mountains and surrounding areas.

If these dead plankton and other sea creatures were buried quickly on the deep sea floor, the sediment would protect them from being exposed to oxygen, which is necessary for decay (or decomposition). If the dead organisms don't decay, the carbon in their remains can be preserved. If a layer has a particularly large amount of carbon, we tend to call it "organic rich".

In Illinois several thin organic-rich layers were deposited, but the thickest, and by far the most important one, was deposited in the middle of the Paleozoic Era, about 360 – 350 million years ago.

Can you picture this scene?

Chapter Two

For perhaps another 100 million years, sediments continued to bury our organic-rich layer. By now it was the last of the Paleozoic Era and the layers of sediments on the sea floor have become thousands upon thousands of feet thick.

The weight and depth of all this rock created immense pressure and heat that began to affect the buried organic rich layers.

About this time the seas were leaving Illinois and no more sediments were being deposited. Even so, the heat and pressure continued to work on these buried sediments and were responsible for slowly changing the inorganic layers into sedimentary rock.

The rare, organic-rich layers were changed into what geologists call source rock – and it is only in these source rocks where the dead organic material can slowly change into hydrocarbons – which are compounds containing only hydrogen and carbon.

Can you picture this scene?

Chapter Three

A few million years later, or around 248 million years ago, the Mesozoic Era began. It was the "Age of Reptiles". Illinois was now dry land and would never again be covered by the sea. From that time through the entire Mesozoic Era - - and through the entire Cenozoic Era - - all the way until today, the animals that plodded, walked, and flew across Illinois had no idea that pressure and heat were continuing to act on the layers of sedimentary rock deep beneath their feet.

The effects of the heat and pressure over all this time formed many layers of sedimentary rock under the Illinois area, including the organic-rich source rock. Much of the water that was in the ancient sea is now in the pore spaces of the sedimentary rocks. The remaining water evaporated or was pushed into areas where seas or oceans now exist.

For over 250 million years, temperatures ranging from 150-300 degrees Fahrenheit have "cooked" the organic materials in the buried sediments causing a complex chemical change creating oil and natural gas.

Molecule by molecule the oil and gas was pushed out of the source rock and migrated into porous reservoir rocks in other layers. It's in these reservoir rocks that we find oil today.

Can you picture this scene?

As you finish drawing the last scene, keep in mind that there are several theories concerning the formation of oil and natural gas. What you have just heard is the most widely accepted scientific theory.

Concept Formation

1. Using the picture you have drawn, tell how oil and natural gas are formed. (Possible answer(s): See teacher information.)

2. Why does Illinois have so much petroleum? (Possible answer(s): Because millions of years ago Illinois was covered by an ocean.)

Teacher Information

Much of what is Illinois today was under an ancient ocean millions of years ago. Geologists believe this because many rock layers containing fossil remains of marine life have been found throughout the state. Millions of microscopic marine plants and animals which lived in the waters eventually died and settled on the ocean floor. The dead plants and animals were often buried by sand and other sediment. Heat from beneath the earth's crust "cooked" the plant and animal remains forming oil and natural gas deposits within the rock layers. This is why oil and natural gas, or petroleum, are called fossil fuels.

Petro Pockets

Illinois Academic Standards-English/Language Arts

Grades 6-8

Science and Technical Subjects-Reading

Key Ideas and Details

6-8.1 Cite specific textual evidence to support analysis of science and technical texts.

6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

Integration of Knowledge and Ideas

6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

Illinois Academic Standards-Mathematics

Grade 6

Reason about and solve one-variable equations and inequalities

6.EE.6 Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set.

MP.2 Reason abstractly and quantitatively

Grade 7

Solve real-life and mathematical problems using numerical and algebraic expressions and equations.

7.EE.4 Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities

MP.2 Reason abstractly and quantitatively

Next Generation Science Standards

Grades 6-8

Earth and Human Activity

MS-ESS3-1 Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.

Petro Pockets

Time: 2 class periods

Wonder Why . . .

Have you ever wondered how oil is able to move through rocks?

Concept

Porosity and permeability are words used to describe the characteristics of rocks. If an oil well is to be successfully produced, the reservoir must have porosity, permeability, and enough pressure to move the oil and natural gas to the wellbore.

Teacher Information

Even though rocks seem to be solid, there are a tremendous number of tiny pores inside them. Some types of rocks contain more pores than other rocks. They are said to have greater porosity. This allows oil or water to collect more easily in them. Some rocks, such as shale, do not have many pores. Since shale was formed in layers, air will generally escape from between the layers. Oil can migrate through permeable rock layers, but it is trapped by impermeable rock layers.

Porosity and permeability are two of the primary factors that control the movement and storage of fluids in rocks and sediments. The primary porosity of a rock consists of the spaces between the grains that make up the rock. The more tightly packed the grains are, the lower the porosity.

Permeability is a measure of the ease with which fluids can flow through a porous rock. A rock may be very porous but if the empty spaces are not interconneced the fluids within the closed pores will not be able to move. Porosity is influenced by the degree to which the pores within the material are interconnected. Shale rock can have high porosity but can be almost impermable due to the poorly interconnected empty spaces.

Vocabulary

Permeability: The ability of a fluid to flow within the interconnected pore network of a porous medium.

Porosity: The ratio of the volume of empty space to the volume of solid rock in a formation indicating how much fluid a rock can hold.

Wellbore: The hole drilled by the drill bit, also known as a borehole.

Safety

Water can be disposed of by pouring it down the drain after use and wipe up any spills.

Emphasize to students that they are not to throw any of the rocks at any time.

Student Activity 1

This is a two-day activity. This activity should begin with about 15 minutes left in the class period and continued the next day. Prior to beginning this activity, review the student's knowledge of porosity.

Materials

- Rock samples (limestone, shale, and sandstone)(included in lab/kit)
- Digital balance(included in lab/kit)
- Plastic cups
- Hand lenses
- Paper Towels
- Water

Procedure

1. Show class members the three rock samples and emphasize that these rocks are typically found in Illinois and they may or may not contain oil.
2. Discuss, "Do these rocks contain holes?" (You may want to pass the rocks around the classroom to allow students to use a hand lens for closer examination.)
3. As a class, find the mass of each of the three rocks and have students record the mass of each rock.
4. Place each rock into a clear 9 ounce cup and fill ¾ full with tap water so that the rock is completely covered.
5. Observe rocks for about 5 minutes and record observations in Table 1.

Table 1

Rock Type	Observations

6. **Let set overnight.**

7. At the beginning of class the next day, remove each rock individually from the water, pat dry, and find the mass.

8. After recording the mass, calculate the change in mass and the percentage of change. Record on Data Table 2.

$$\frac{\text{change in mass (g)}}{\text{day 1 mass (g)}} \times 100 = \text{\% of change in rock mass}$$

9. Challenge students to answer the question "How does the pore size in rocks affect the degree of permeability?" **Possible Answer: Porosity does not directly affect permeability. Permeability is dependent upon the interconnectedness of the pores.**

Sample Data Table 2

Rock Sample	Day 1 Mass (g)	Day 2 Mass (g)	Mass Change (g)	% of Change in Rock Mass
A	10.2	10.6	0.4	3.9%
B	15.2	20.2	5.0	32.9%
C	13.8	15.6	1.8	13.0%

Note: Porosity is more accurately defined by volume rather than mass. However, 1 gram of pure water has a volume of 1 mL, so if a rock gained 5 grams then 5 mL of water has entered the pores of the rock.

Name _____ Date _____

Petro Pockets

Student Sheet

Wonder Why . . .

Have you ever wondered how oil is able to move through rocks?

Vocabulary

Permeability: The ability of a fluid to flow within the interconnected pore network of a porous medium.

Porosity: The ratio of the volume of empty space to the volume of solid rock in a formation indicating how much fluid a rock can hold.

Wellbore: The hole drilled by the drill bit, also known as a borehole.

Safety

Water can be disposed of by pouring it down the drain after use and wipe up any spills

Do not throw away any of the rocks.

Student Activity 1

Materials

- Rock samples (limestone, shale, and sandstone)(included in lab/kit)
- Digital balance(included in lab/kit)
- Plastic cups
- Hand lenses
- Paper Towels
- Water

Procedure

1. Look closely at the three rock samples provided by your teacher. These rocks are typically found in Illinois and which may or may not contain oil.
2. Discuss in class, "Do these rocks contain holes in them?"
3. Find the mass of each of the three rocks and record the mass of each rock.

Name _____ Date _____

4. Place each rock into clear 9 ounce cups and fill ¾ full with tap water so that the rocks are completely covered.

5. Observe rocks for about 5 minutes and record observations in Table 1.

Table 1

Rock Type	Observations

6. Let set overnight.

7. At the beginning of class the next day, remove each rock individually from the water, pat dry, and find the mass.

8. After recording the mass, calculate the change in mass and the percentage of change.

$$\frac{\text{change in mass (g)}}{\text{day 1 mass (g)}} \times 100 = \text{\% of change in rock mass}$$

Data Table 2

Rock Sample	Day 1 Mass (g)	Day 2 Mass (g)	Mass Change (g)	% of Change in Rock Mass
A				
B				
C				

Note: Porosity is more accurately defined by volume rather than mass. However, 1 gram of pure water has a volume of 1 mL, so if a rock gained 5 grams then 5 mL of water has entered the pores of the rock.

Petro Pockets

Student Activity 2

Materials (per group)

- Water (300 mL)
- 3 Styrofoam cups (16 oz)
- 3 Plastic cups (9 oz)
- 3 Stir sticks
- Stopwatch
- Sand
- Small pebbles
- Large pebbles
- 100 mL graduated cylinder(included in lab/kit)
- Sandwich bags (3)
- Black Marker
- Ruler
- Plastic spoon

Procedure

Teacher Note: Explain to the students that the cups filled with sand, small pebbles, and large pebbles represent the internal structure of a whole rock layer.

1. In Table 4, predict what will happen when water is poured through each of the 3 substances.
2. Prepare cups by using coffee stirrers to poke three holes in the bottom of all three styroform cups.
3. Using a permanent marker, draw a horizontal line on the side of each styroform cup. The line should be 5 cm from the bottom of the cup.
4. Draw a horizontal line on the side of the plastic cups. The line should be 3 cm from the bottom of the cup.
5. Determine how many milliliters of water are required to fill the plastic cup to the mark on the side.
6. Pre-wet the sand and pebbles by placing them in separate sandwich bags and adding water. Pour off any excess water.

7. Fill one styrofoam cup to the line with the wet sand. Repeat for small and large pebbles.
8. Place the styrofoam cups filled with sand and pebbles into each of the three clear plastic cups.
9. To prevent an "airlock," slide the coffee stir stick between the two cups. (see diagram)
10. To begin the first trial of the sand permeability test, pour 100 mL of tap water at once into the sand cup.
11. START TIMING the flow as soon as the water begins to drip into the plastic cup.
12. STOP TIMING when the water level reaches the mark on the plastic cup.
13. Record the time (in seconds) on the Data Table 3.
14. Repeat steps 5-8 for the second sand trial.
15. Repeat this entire procedure using the small pebbles and then the larger pebbles.


Cup Setup

Note: Sand and pebbles may be dried and reused year after year.

Conclusion

1. Complete Data Table 3 with the data collected during the procedure.
2. Calculate the mean for the two trials of each substance.
3. Calculate the flow rate by dividing the mL of water by the Flow Time Means.
4. After examining the data and discussing the results, ask students to complete Table 4.
5. Compare and contrast the sand, small pebbles, and large pebbles. Be sure to include a discussion of the size of the porosity and permeability the samples. **Possible Answers: These substances are solids, made of rock (non-living) and are inorganic. They seem to be made of different types of rock and the size of the particles varies greatly. For sand the pore spaces and connections would be much smaller than the pore spaces and connections of the pebbles.**

Sample Data Table 3
(assuming 70 mL of water is required to meet the mark of the cup)

Substances	Volume	Flow Time (s) Trial 1	Flow Time (s) Trial 2	Flow Time (s) Mean	Flow Rate (mL/s)
Sand	70 mL	168.6 s	173.5 s	171.05 s	0.41 mL/s
Small Pebbles	70 mL	28.4 s	24.8 s	26.6 s	2.63 mL/s
Large Pebbles	70 mL	5.4 s	4.8 s	5.1 s	13.7 mL/s

Table 4

What I Think Will Happen	What Happened	Why It Happened
Rocks that contain very small pores will have less permeability than rocks with very large pore spaces.	It took a much longer time for the water to flow through the sand than it did to flow through the pebbles or the larger rocks.	Some rocks such as pumice and shale can have high porosity, yet be nearly impermeable due to the poorly interconnected rock.

Extension

- Clay is a substance with extremely fine solid particles. What can be inferred about the porosity and permeability of clay? **Possible Answer: Clay is made of fine particles which fit tightly together. Due to this, clay is considered to have very low porosity and have almost no permeability.**

Name _____ Date _____

Petro Pockets

Student Sheet

Student Activity 2

Materials (per group)

- Water (300 mL)
- 3 Styrofoam cups (16 oz)
- 3 Plastic cups (9 oz)
- 3 Stir sticks
- Stopwatch
- Sand
- Small pebbles
- Large pebbles
- 100 mL graduated cylinder(included in lab kit)
- Sandwich bags (3)
- Black Marker
- Ruler
- Plastic spoon

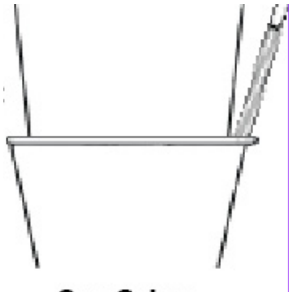
Procedure

1. In Table 4, predict what will happen when water is poured through each of the 3 substances.
2. Prepare cups by using coffee stirrers to poke three holes in the bottom of all three styroform cups.
3. Using a permanent marker, draw a horizontal line on the side of each styroform cup. The line should be 5 cm from the bottom of the cup.
4. Draw a horizontal line on the side of the plastic cups. The line should be 3 cm from the bottom of the cup.
5. Determine how many milliliters of water are required to fill the plastic cup to the mark on the side.
6. Pre-wet the sand and pebbles by placing them in separate sandwich bags and adding water. Pour off any excess water.
7. Fill one styrofoam cup to the line with the wet sand. Repeat for small and large pebbles.

Name _____ Date _____

8. Place the styrofoam cups filled with sand and pebbles into each of the three clear plastic cups.
9. To prevent an "airlock," slide the coffee stir stick between the two cups. (see diagram)
10. To begin the first trial of the sand permeability test, pour 100 mL of tap water at once into the sand cup.
11. START TIMING the flow as soon as the water begins to drip into the plastic cup.
12. STOP TIMING when the water level reaches the mark on the plastic cup.
13. Record the time (in seconds) on the Data Table 3.
14. Repeat steps 5-8 for the second sand trial.
15. Repeat this entire procedure using the small pebbles and then the larger pebbles.

    Note: Sand and pebbles may be dried and reused year after year.



Cup Setup

Conclusion

1. Complete Data Table 3 with the data collected during the procedure.
2. Calculate the mean for the two trials of each substance.
3. Calculate the flow rate by dividing the mL of water by the Flow Time Means.

Table 3

Substances	Volume	Flow Time (s) Trial 1	Flow Time (s) Trial 2	Flow Time (s) Mean	Flow Rate (mL/s)
Sand					
Small Pebbles					
Large Pebbles					

Name _____ Date _____

4. After examining the data and discussing the results, complete Table 4.

Table 4

What I Think Will Happen	What Happened	Why It Happened

5. Compare and contrast the sand, small pebbles, and large pebbles. Be sure to include a discussion of the size of the porosity and permeability the samples.

_____

_____

_____

_____

Traveling Sound

Illinois Academic Standards-English/Language Arts

Grades 6-8

Science and Technical Subjects-Reading

Integration of Knowledge and Ideas

6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic

Speaking and Listening

Presentation of Knowledge and Ideas

6.5 Include multimedia components (e.g., graphics, images, music, sound) and visual displays in presentations to clarify information.

7.5 Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points.

8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.

Illinois Academic Standards-Mathematics

MP.2 Reason abstractly and quantitatively

MP.4 Model with mathematics

Next Generation Science Standards

Grades 6-8

Waves and their Applications in Technologies for Information Transfer

MS-PS4-2 Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

Traveling Sound

Time: 2-3 class periods

Wonder Why . . .

Have you ever wondered if sound waves can travel through matter?

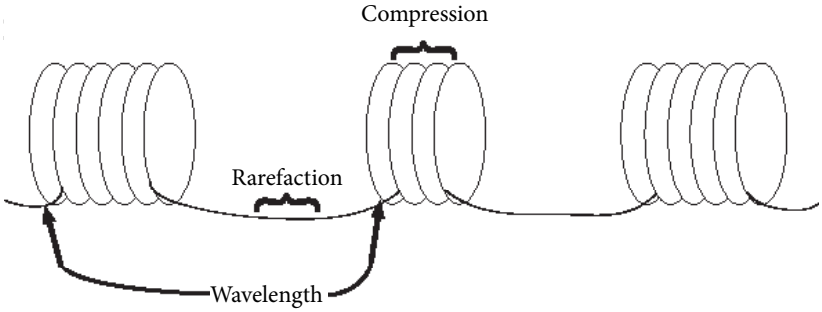
Concept

Sound waves travel through liquids, solids, and gases at different speeds.

Teacher Information

Sound is transmitted through gases, liquids, and solids as longitudinal waves. Before sound can be produced, it requires a vibrating object, a medium in which the sound can travel, and a receiver of that sound.

Figure



Sound waves were described by Albert Einstein as "energy propagated through matter." The energy carried by longitudinal waves converts back and forth between potential energy of the compression and the kinetic energy of the oscillations within the medium.

Sound waves can be used to locate rock formations that have the potential of containing oil and natural gas. Sound travels through different types of rocks at different speeds. For example, sound travels through shale at approximately 1,980 meters per second; sandstone at approximately 2290 meters per second; and limestone at approximately 2,740 meters per second. Through interpretation of the reflections of sound waves, exploration geologists determine the shape and extent of the subsurface formation and the possible location of hydrocarbons.

Safety

Do not throw materials. Handle tuning forks, mallet, slinky and heavy coil with care to prevent personal injury or damage to the equipment.

Vocabulary

Amplitude: The maximum amount of displacement of a particle on the medium from its rest position. The louder the sound the greater the amplitude and the amount of energy in the wave.

Compression: A point on a medium through which a longitudinal wave is traveling that has a maximum density. (Shown in Figure 1)

Kinetic Energy: Energy due to motion.

Longitudinal Wave: The displacement of the medium is in the same direction as the motion of the wave. (Shown in Figure 1)

Medium: Material through which a wave travels

Oscillation: Single back and forth motion.

Potential Energy: Energy due to position. Elastic potential energy allows the wave particle to return to its original position.

Pulse: A single vibration or short burst of sound, electric current, light, or other wave.

Rarefaction: A point on a medium through which a longitudinal wave is traveling that has the minimum density. (Shown in Figure 1)

Reflect: The return of all or part of a sound beam when it encounters the boundary between two media.

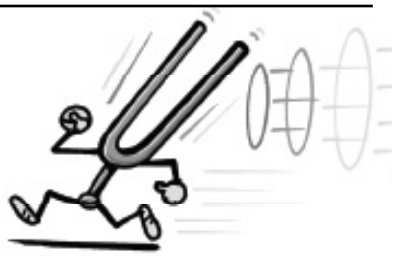
Wavelength: The distance between any two identical points on a wave, such as, the distance between two successive compressions. (Shown in Figure 1)

Student Activity 1

Procedure

1. Ask for approximately ten student volunteers to form a straight line facing the class positioning themselves shoulder to shoulder. Ensure that the students are just touching shoulders and not bracing or supporting themselves against other students.
2. Stand at one end of the line and gently push the student's shoulder toward the opposite end of the line.
3. Instruct the class to make observations.
4. Repeat, this time pushing the student's shoulder with more force.
5. Compare the amplitude and energy of the student waves.
6. The students represented a medium. Waves are energy moving through a medium. Describe and identify the changes in energy that occur as the wave passes through the medium. The energy passes through each student, moving from one end to the other. The first push has less energy than the second. The wave moves in the same direction as the force.

Name _____ Date _____



Traveling Sound

Student Sheet

Wonder Why . . .

Have you ever wondered if sound waves can travel through matter?

Vocabulary

Amplitude: The maximum amount of displacement of a particle on the medium from its rest position. The louder the sound the greater the amplitude and the amount of energy in the wave.

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Reflect: The return of all or part of a sound beam when it encounters the boundary between two media.

Wavelength: The distance between any two identical points on a wave, such as, the distance between two successive compressions.

Safety

Do not throw materials. Handle tuning forks, slinky and heavy coil with care to prevent personal injury or damage to the equipment.

Student Activity 1

Observe the chain of ten students and what happens during the demonstration. Describe and identify the changes in energy that occur as the wave passes through the students.

Speed of a Wave

Student Activity 2

The speed of a wave refers to how fast the compression of the wave (also called the pulse) is moving and is usually expressed as the distance traveled per time of travel. In equation form, speed= distance/time.

$$s = d/t$$

If the pulse on the slinky moves a distance of 20 meters in 10 seconds, then the speed of the wave is 2 m/s.

Materials

- Slinky(included in lab/kit)
- Heavy coil(included in lab/kit)
- Meter stick
- Stopwatch
- Calculator

Procedure

1. Ask students to predict if the speed of a wave will differ in the slinky and the heavy coil.
2. Stretch the slinky out on the floor a distance of 4 meters. Hold tightly to the slinky and do not over stretch the slinky.
3. With the slinky still stretched, create a pulse sharply by quickly moving your hand forward and back. Observe what happens when the pulse reaches the opposite end of the slinky.
4. Find the speed of the wave pulse on the slinky by using the stopwatch to time how long it takes for the pulse to travel down and back a distance of 8 meters. Record data in Table 2: Speed of a Wave.
5. Repeat steps 1-3 for three trials.
6. Repeat steps 1-4 using the heavy coil.
7. Calculate the average time for trials 1-3 for the pulse on the slinky. Record your answer in Table 2.
8. Calculate the average time for trials 1-3 for the pulse on the heavy coil. Record you answer in Table 2.
9. Calculate the average speed of the pulse on the slinky and the heavy coil. Record your answers in Table 2.

Table 2: Speed of a Wave (Sample Data)

	Slinky	Heavy Coil
Distance (m)	8.0 meters	8.0 meters
Time for Trial 1 (s)	1.03 s	1.22 s
Time for Trial 2 (s)	0.95 s	1.31 s
Time for Trial 3 (s)	0.91 s	1.34 s
Average Time (s)	0.95 s	1.29 s
Average Speed of Pulse (m/s)	8.42 m/s	6.2 m/s

Conclusion

1. Compare and contrast how the speed of the wave differs in the slinky and the heavy coil.
2. What variable (independent) did you change? **The type of spring.**
3. What conclusions can you draw from this data?

Name _____ Date _____

Speed of a Wave

Student Sheet

Student Activity 2

The speed of a wave refers to how fast the compression of the wave (also called the pulse) is moving and is usually expressed as the distance traveled per time of travel. In equation form, speed= distance/time.

$$s = d/t$$

If the pulse on the slinky moves a distance of 20 meters in 10 seconds, then the speed of the wave is 2 m/s.

Materials

- Slinky(included in lab/kit)
- Heavy coil(included in lab/kit)
- Meter stick
- Stopwatch
- Calculator

Procedure

1. Predict if the speed of a wave will differ in the slinky and the heavy coil.
2. Stretch the slinky out on the floor a distance of 4 meters. Hold tightly to the slinky and do not over stretch the slinky.
3. With the slinky still stretched, create a pulse sharply by quickly moving your hand forward and back. Observe what happens when the pulse reaches the opposite end of the slinky.
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Name _____ Date _____

Table 2: Speed of a Wave

	Slinky	Heavy Coil
Distance (m)		
Time for Trial 1 (s)		
Time for Trial 2 (s)		
Time for Trial 3 (s)		
Average Time (s)		
Average Speed of Pulse (m/s)		

Conclusion

1. Compare and contrast how the speed of the wave differs in the slinky and the heavy coil

_____

_____

2. What variable (independent) did you change?

_____

_____

3. What conclusions can you draw from this data?

_____

_____

_____

Traveling Sound

Student Activity 3

Materials (per group of 4 students)

- Rock samples (sandstone, shale, limestone) (included in lab/kit)
- Tuning fork (included in lab/kit)

Procedure

1. Ask students to **predict** if the type of rock will affect the sound produced and transmitted through the rock.
2. Working in pairs, have one student position a rock close to one ear (do not touch ear with rock) while covering the other ear with his/her hand. Have the partner strike the tuning fork and touch the base of the tuning fork to the rock.

Conclusion

1. Describe the process we used to test each rock. **Answer: We placed the rock close to our ear, struck the tuning fork and placed it on the rock.**
2. How did this activity relate to the sound and rocks you just investigated? **Answer: Sound travels through different rocks at different speeds. This is just like a wave that travels through different types of springs at different speeds.**
3. Diagram how sound traveled from the tuning fork to your ear. **Answer should include the tine of the tuning fork, base of the tuning fork, a rock and ear.**

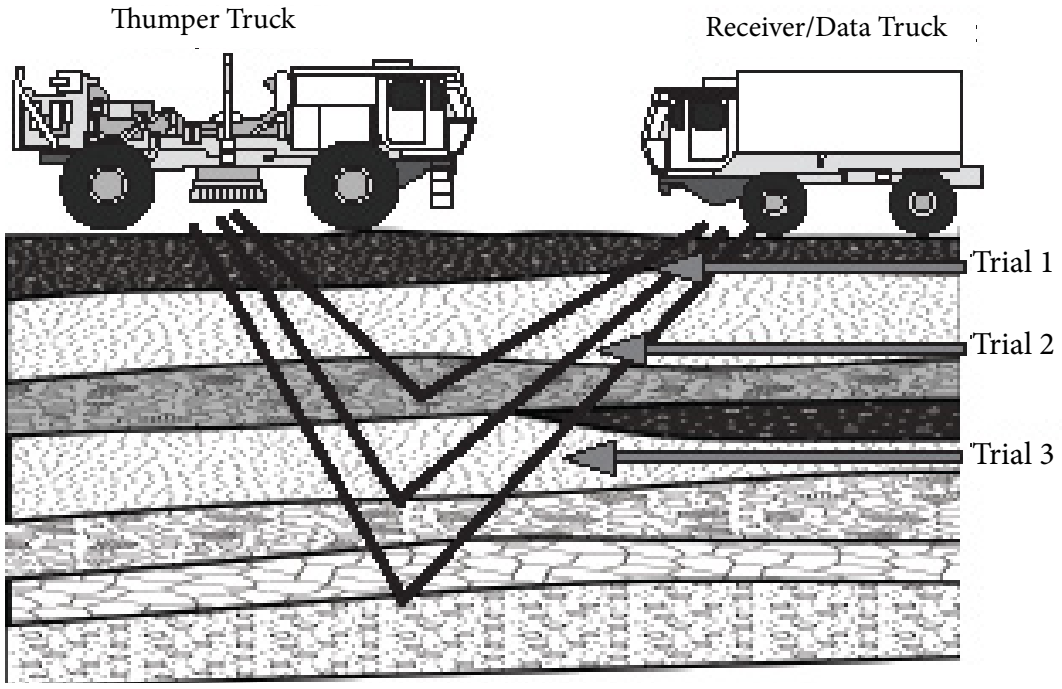
4. What was kept the same (controlled) as you investigated how sound travels in this investigation? **Answer: Tuning fork and air, distance from ear, striking force**
5. What was changed (independent variable) in this investigation? **Answer: The type of rock.**
6. What can you infer caused the differences in the sounds? **Answer: Sound travels through rock. Different types of rocks produce different sounds.**

Extension

- Sound waves travel through different types of rocks at different speeds. For example, sound travels through shale at approximately 1,980 meters per second; sandstone at approximately 2,290 meters per second; and limestone at approximately 2,740 meters per second. Through interpretation of the reflections of sound waves, exploration geologists determine the shape and extent of the subsurface formation and the possible location of hydrocarbons.

  You are now a geologist and a specialist in seismic technology. In seismic technology, sound waves created by thumper trucks on the earth's surface are recorded and analyzed. The reflected sound waves are received by geophones which transmit the sound waves to a seismograph located in a truck. The particular speed at which the sound waves are reflected back create a picture of the underground geology and possible location of petroleum deposits.

  Research a thumper truck and how the sound waves could determine the location of different rock formations.



Name _____ Date _____

Traveling Sound

Student Sheet

Student Activity 3

Materials (per group of 4 students)

- Rock samples (sandstone, shale, limestone) (included in lab/kit)
- Tuning fork (included in lab/kit)

Procedure

1. Predict if the type of rock will affect the sound produced and transmitted through the rock.
2. Working in pairs, have one student position a rock close to one ear (do not touch ear with rock) while covering the other ear with his/her hand. Have the partner strike the tuning fork and touch the base of the tuning fork to the rock.

Conclusion

1. Describe the process we used to test each rock.

   _____

   _____

2. How did this activity relate to the sound and rocks you just investigated?

   _____

   _____

3. Diagram how sound traveled from the tuning fork to your ear.

Name _____ Date _____

4. What was kept the same (controlled) as you investigated how sound travels in this investigation?

_____

_____

5. What was changed (independent variable) in this investigation?

_____

6. What can you infer caused the differences in the sounds?

_____

_____

_____

Seismic Clatter

Illinois Academic Standards-English/Language Arts

Grades 6-8

Science and Technical Subjects-Reading

Integration of Knowledge and Ideas

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7.5 Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points.

8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.

Next Generation Science Standards

Grades 6-8

Earth and Human Activity

MS-ESS3-1 Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.

Seismic Clatter

Locating Petroleum

Pre Activity

Wonder Why . . .

Have you ever wondered about the technology that scientists use to locate crude oil and natural gas? How can you map something you cannot see?

Concept

Scientists use seismic technology to map patterns of rock formations below the surface of the earth. In much the some way, the patterns of a person's finger print can be mapped to identify the individual.

- Patterns

Introduction to map patterns

Materials

- Pencil
- Paper
- Index card
- Transparent tape
- Fingerprint Patterns Visual
- Geological Features Map

Discovery Procedure

1. Make a carbon pad by scratching on a sheet of paper with a pencil.
2. Have students rub their right thumbs across the carbon pad.
3. Tell students to lift two prints of their right thumbs using transparent tape.
4. Have students place lifted thumb prints on opposite ends of an index card and write their names under one of the prints.

5. Collect the thumb prints, and number code the prints void of students' names.
6. Tape identified thumb prints to the corner of lab tables and randomly distribute number-coded thumbs prints to students.
7. Have students identify the matching thumb prints.
8. Review Fingerprint Patterns Visual.
9. Discuss the similarities and differences in the students' prints. Then discuss the similarities and differences in the students' prints and the fingerprint patterns transparency.
10. Review the geological features map as you discuss the following:
    a. Think about the patterns you saw in the thumb prints. The sound waves that scientists use to "see" inside the earth produce maps that also have patterns.
    b. There are several types of geologic features of particular interest to petroleum geologists. The most common are "faults," "anticlines" and "stratigraphic traps."

Fault - A fault is a fracture in the rock formation created when one section of the formation moves in relation to another.

When permeable rocks containing oil and natural gas are moved adjacent to impermeable rocks, the petroleum becomes trapped.

Anticlinal trap – An anticline is formed when layers of rock are folded upward by earth movement.

Oil and natural gas within the reservoir will tend to migrate to the highest point within the structure. Where a cap rock (an overlying layer of impermeable rock – commonly shale) exists above a reservoir rock in an anticline, a trap may form and prevent the upward escape of oil and natural gas.

Stratigraphic trap – These geologic features are formed by a change in the character or extent of the reservoir rock.

For example, sand can become cemented into impermeable rock at one point in the formation, preventing the upward migration of petroleum from the reservoir rock. Underground water may leach out pockets where oil and natural gas can accumulate, or a permeable, petroleum-bearing layer may be **"pinched out"** (tapered to a disappearing edge) and sandwiched between layers of impermeable rock.

Concept Formation

How might thumb prints be compared to these geologic features? (Possible answer(s):

Every person's thumb print is unique just as every rock formation is unique.)

Fingerprint Patterns

Every person in the world has a unique set of fingerprints, unlike those of any other person who ever lived.

Even though everyone's fingerprints are different, there are basic patterns that are always found.

These basic patterns are shown below:

Whorl

Arch

Loop

Whorl This pattern has lots of circles that do not leave either side of the print.

Arch This pattern has lines that start on one side of the print, rise toward the center, and leave on the other side.

Loop This pattern has lines that start on one side of the print, rise toward the center, then turn back and leave on the same side from which they started.

Seismic Clatter

Time: 2-3 class periods

Wonder Why . . .

Have you ever wondered about technology that scientists use to locate crude oil and natural gas? How can you map something you cannot see?

Concept

Scientists use seismic technology to map patterns of rock formations below the surface of the earth.

Teacher Information

Seismic mapping (seismic survey) is used to locate subsurface structures and possible sites for petroleum location. The theory behind the seismic survey is that subsurface structures can be perceived by measuring the transit times of sound waves generated by an explosion or the pounding of a thumper truck.

Sound waves travel through different types of rock at different speeds. For example, sound travels through shale at approximately 1980 meters per second; sandstone at approximately 2290 meters per second; and limestone at approximately 2740 meters per second.

As the sound waves from the explosion or the thumper truck travel downward, they are reflected from the various layers below to geophones on the surface. Seismographs are similar to instruments used to measure earthquakes. The reflected sound waves are received by geophones, which transmit the sound waves to a seismograph located in a truck. The particular rates at which the sound waves are reflected back create a picture of the underground.

Through interpretation of the readings, exploration geologists determine the shape and extend of the subsurface formation and the possible location of hydrocarbons. Even after the seismic picture is assimilated and analyzed by geophysicists, there is no guarantee of discovering oil or natural gas. At best, the seismic picture can provide only a possibility of what lies beneath. Drilling for oil and natural gas is a risky business.

The sound waves that scientists use to "see" inside the earth produce maps that have patterns. These patterns are used to find geologic features associated with oil and natural gas reserves. Hydrocarbon trap identification is one of the first steps that must be done in exploration of crude oil and natural gas. A trap can be defined as any geometric arrangement of rock that permits significant accumulation of hydrocarbons in the subsurface. A trap must include a reservoir rock in which to store hydrocarbons, and a seal that slows or stops migration out of the reservoir. Traps generally exist in predictable places: next to faults, at the tops of anticlines, and in the pinchouts of beds of sandstone or under unconformities.

Petroleum reservoirs contain pores that are interconnected and are filled with water and crude oil and natural gas (hydrocarbons). Since most oils are lighter than water they move upward through the pores or along faults or fractures.

Teacher Note

The Virtual Field Trip "Seismic Exploration" found at
https://iprb.org/education/classroom-curriculum/references/
can be used as an introduction to this activity.

Vocabulary

Angular unconformity: An unconformity in which the older strata dip at a different angle (generally steeper) than the younger strata.

Anticline: Formed when layers of rock are folded upward by earth movement.

Cap rock: A comparatively impervious stratum (p. strata) immediately overlying an oil- or gas-bearing rock.

Dip: The angle at which strata or any planar feature is inclined from the horizontal.

Fault: A fracture in a rock formation created when one section of the formation moves in relation to another.

Migration: The movement of oil, natural gas, and water through permeable rock.

Pinch out: Strata that thins or tapers to a disappearing edge.

Reservoir: A natural underground container of liquids, such as oil or water, and gases. In general such reservoirs were formed by local deformation of strata, by changes of porosity, and by intrusions.

Salt dome: The structure resulting from the upward movement of a salt mass, and with which oil and natural gas fields are frequently associated.

Seismic: Pertaining to, characteristic of, or produced by earthquakes or earth vibration, as, seismic disturbances.

Seismograph: Instrument which records seismic waves.

Shot Point: Position of sound generator

Strata: Sections of a formation that consist throughout of approximately the same kind of rock material. A single sedimentary bed or layer, regardless of thickness.

Stratigraphic trap: Geologic features formed by a change in the character or extent of the reservoir rock.

Syncline: Formed when layers of rock are folded downward by earth movement.

Unconformity: A surface or erosion or nondeposition, usually the former, which separates younger strata from older strata.

Student Activity 1

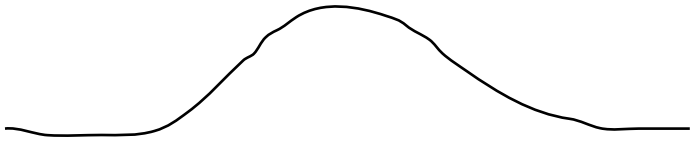
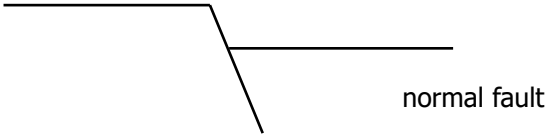
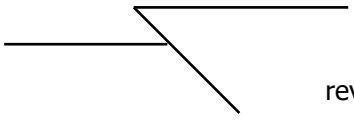
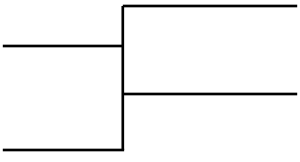
Materials

- Geological Faults and Folds Model (2 per group)(included in lab/kit)
- Hydrocarbon Traps Handout

Procedure

1. Distribute the Hydrocarbon Traps handout to student groups. (Ideally student groups should consist of no more than four students.) Using the vocabulary list, have students discuss the various hydrocarbon traps identified on the handout.
2. Distribute one Geological Faults and Folds Model to each group of students.
3. Have students use the model pieces to create folds and different types of faults.
4. Allow students ample time to explore the different features that may be created with the model pieces.
5. In Table 1: Folds and Faults, have students illustrate each fold or fault that was created.

Table 1: Folds and Faults

Structure	Illustration
Anticline	
Syncline	
Fault 1	 normal fault
Fault 2	 reverse fault
Fault 3	 strike-slip fault (view from above)

Name _____ Date _____

Seismic Clatter

Student Sheet

Wonder Why . . .

Have you ever wondered about technology that scientists use to locate crude oil and natural gas? How can you map something you cannot see?

Vocabulary

Angular unconformity: An unconformity in which the older strata dip at a different angle (generally steeper) than the younger strata.

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Migration: The movement of oil, natural gas, and water through permeable rock.

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Salt dome: The structure resulting from the upward movement of a salt mass, and with which oil and natural gas gas fields are frequently associated.

Seismic: Pertaining to, characteristic of, or produced by earthquakes or earth vibration, as, seismic disturbances.

Seismograph: Instrument which records seismic waves.

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Syncline: Formed when layers of rock are folded downward by earth movement.

Unconformity: A surface or erosion or nondeposition, usually the former, which separates younger strata from older strata.

Name _____ Date _____

Student Activity 1

Materials

- Geological Faults and Folds Model (2 per group)(included in lab/kit)
- Hydrocarbon Traps Handout

Procedure

1. Discuss the various hydrocarbon traps identified on the handout with your group.
2. Model pieces to create folds and different types of faults.
3. In Table 1: Folds and Faults, illustrate each fold or fault that was created.

Table 1: Folds and Faults

Structure	Illustration
Anticline	
Syncline	
Fault 1	
Fault 2	
Fault 3	

Seismic Clatter

Student Activity 2

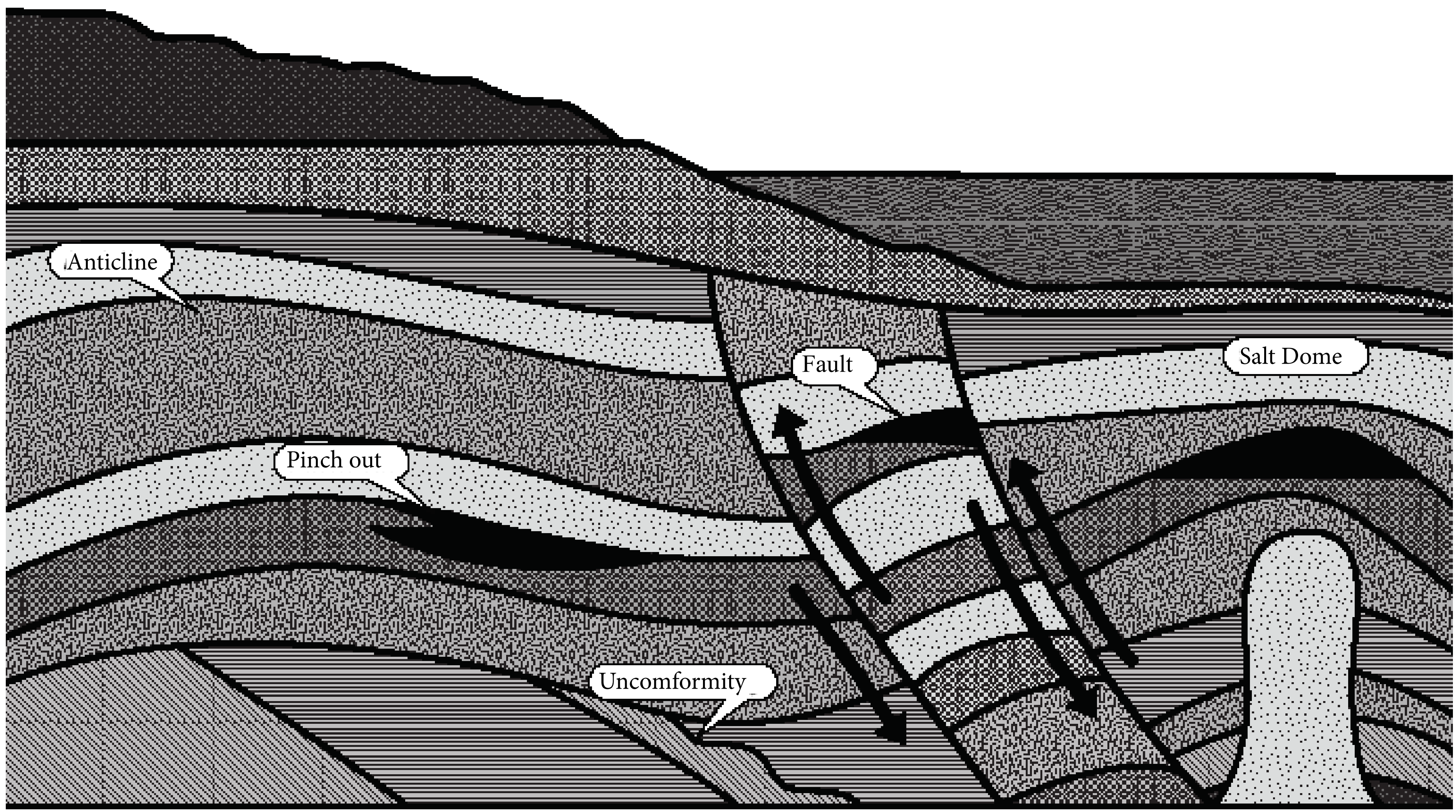
Materials

- Seismic Animations (https://iprb.org/education/classroom-curriculum/references/)
- Hydrocarbon Traps Handout
- Seismic Maps
- Colored Pencils
- Ruler

Procedure

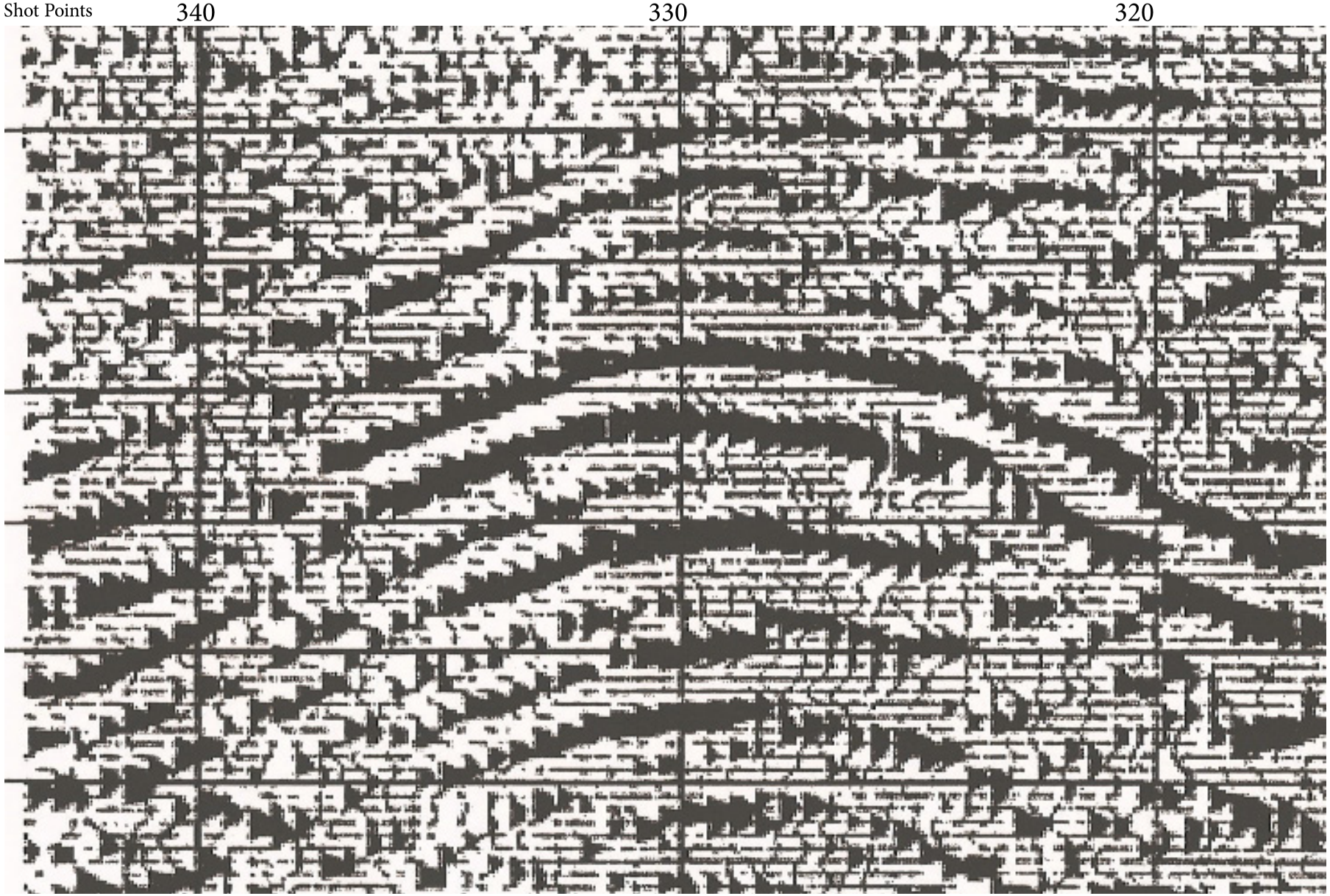
1. Have students watch the two seismic animations. Have them pay close attention to the animations as the information will help them in completing this exercise.
2. Each group of four students will work together to study a series of seismic maps. Students should observe each seismic map and using the Hydrocarbon Traps handout, find geologic features that are associated with oil and natural gas reservoirs.
3. After studying Seismic Map 1 and the Hydrocarbon Traps handout, students will color and describe the general patterns shown by the map. (Teacher guidance is necessary for this step.)
4. Students will continue to do the same procedure for each remaining seismic map.
5. Each group of students will compare their findings with other student groups.

Hydrocarbon Traps Handout



Name_____ Date_____

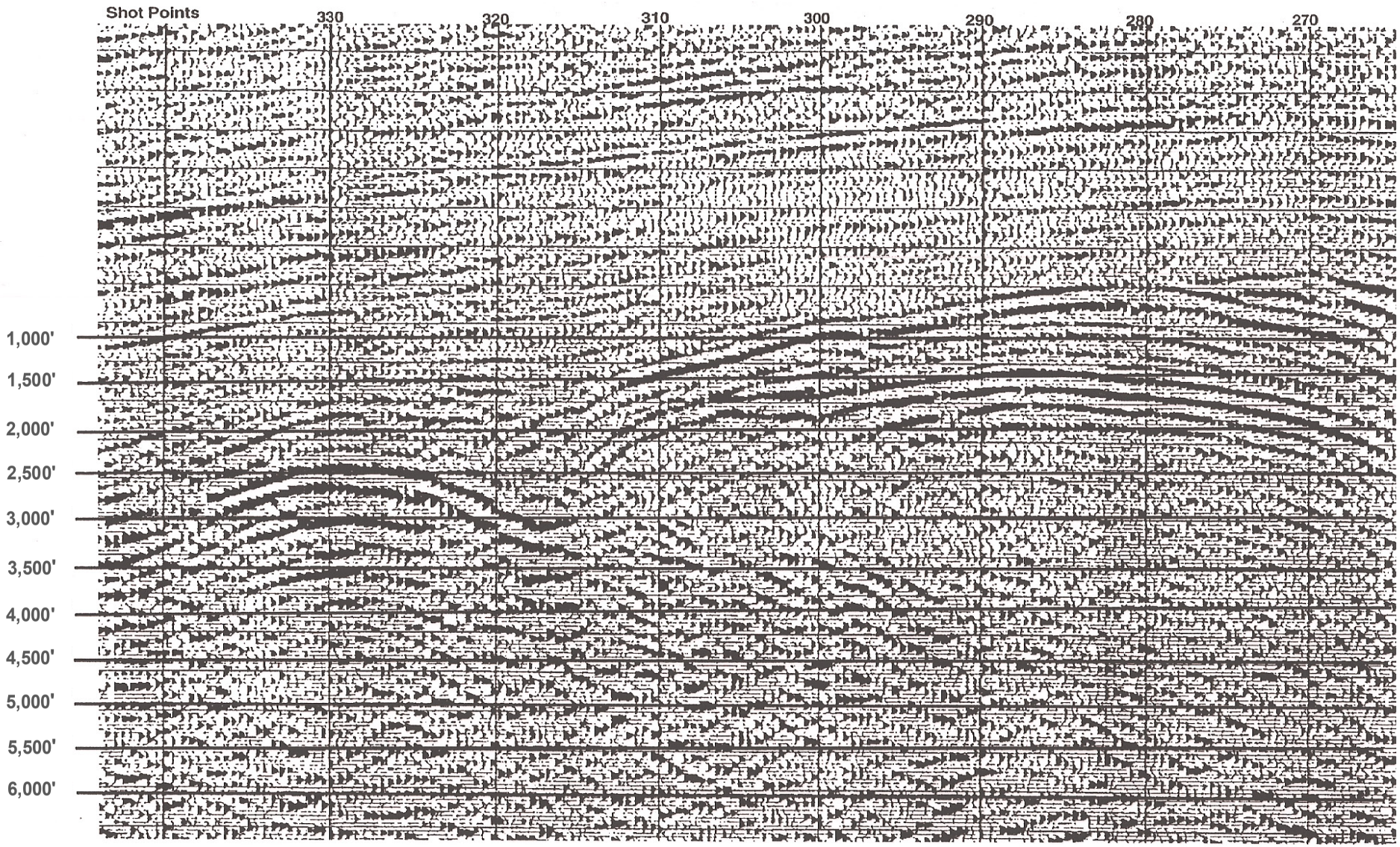
Seismic Map #1



There is a potentially productive zone represented on this seismic plat. It is indicated by a reflection that you find at 3,300 feet at a shot point 330. Color and track the zone as it moves to the left and right of this point.

Name_____ Date_____

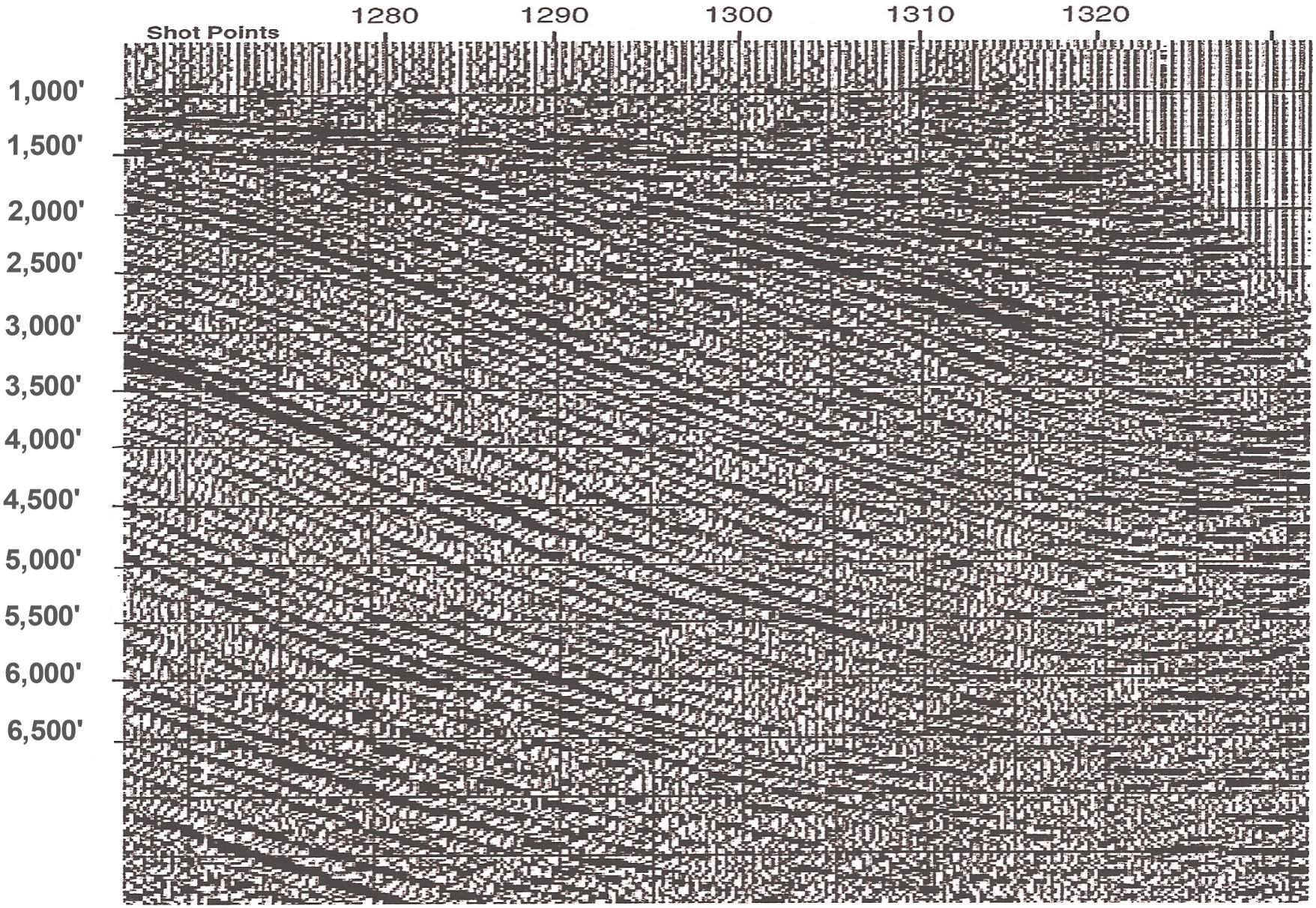
Seismic Map #2



A vertical fault is located between shot point 310 and 320 and begins at a depth of 1,500' and ends at 5,000'. Draw the fault line. The formation on the left side of the fault line is at 3,100' and the formation on the right side of the fault line is at 2,500'. Shade in the formation on either side of the fault.

Name_____ Date_____

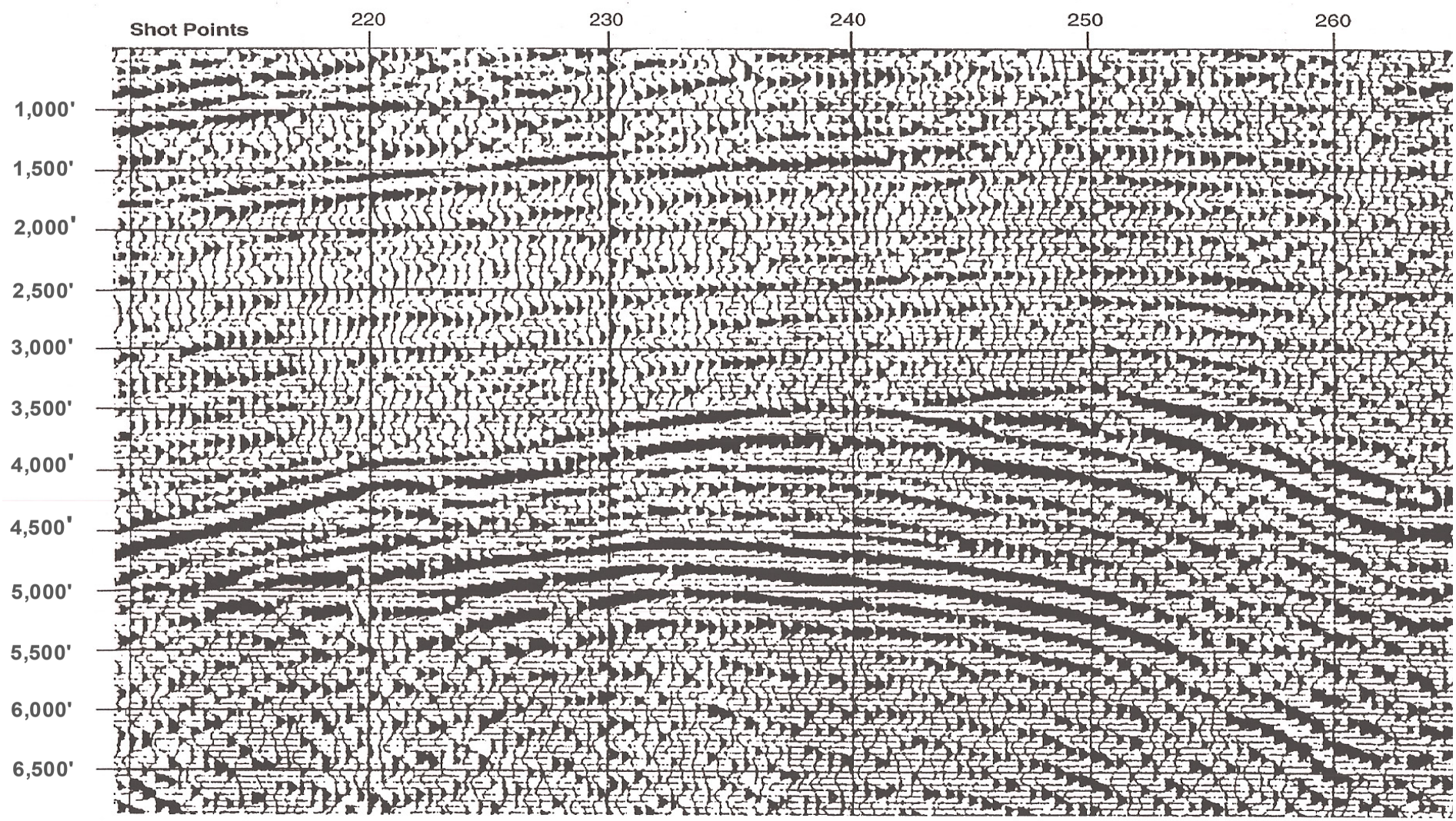
Seismic Map #3



There is a pinchout beginning at a depth of 1,600' between shot points 1285 and 1290 and dipping to the right to a depth of 3,250' as it goes off the plat. Shade this zone one color. Then, using another color, shade the zone the pinchout intersects.

Name_____ Date_____

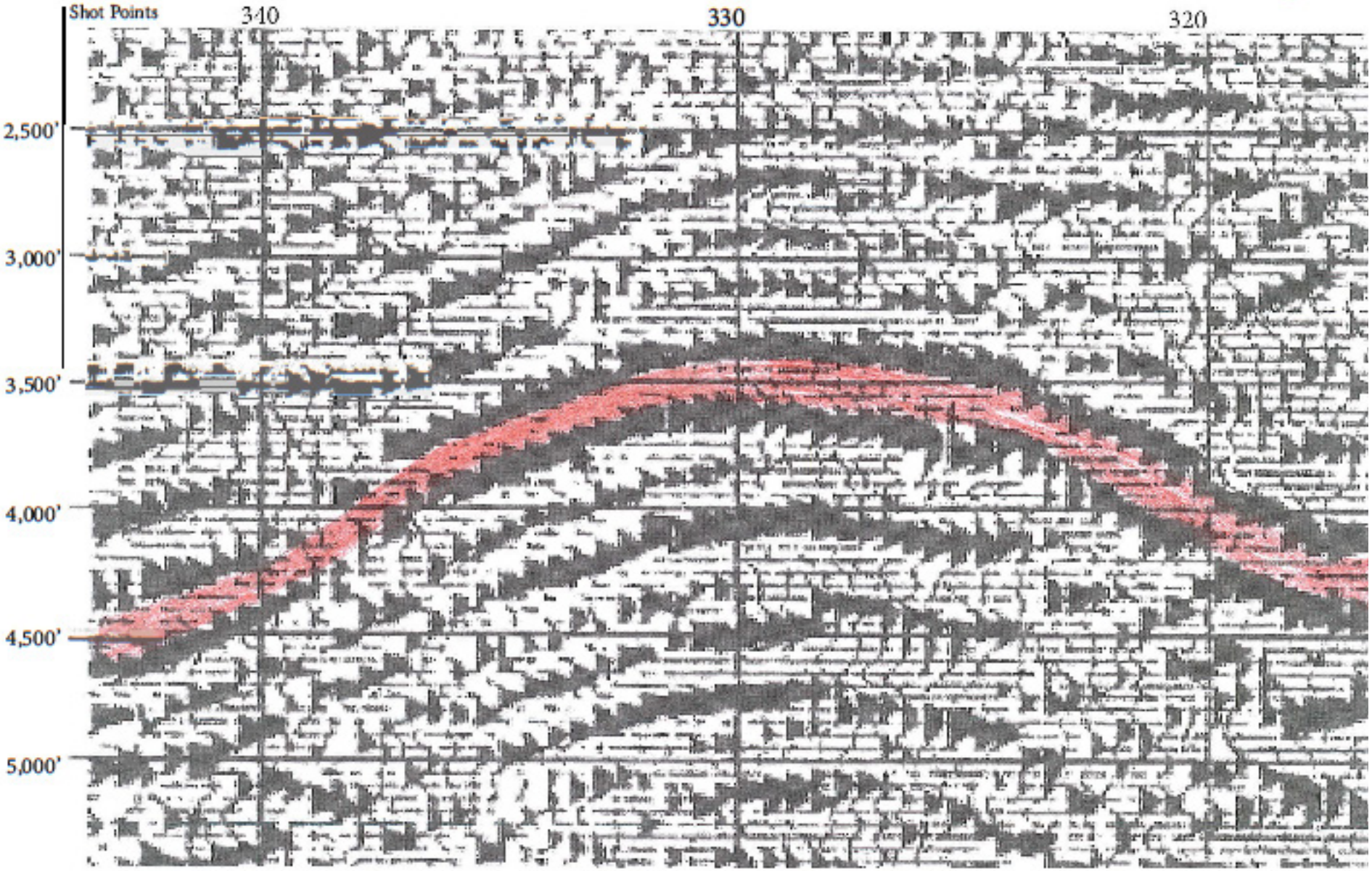
Seismic Map #4



There is a potentially productive anticline structure that peaks just left of shot point 240 at approximately 3,500'. Identify and shade this structure as it continues to either side of the plat. There is a second potentially productive anticline 1,200' below the peak of this structure that peaks just right of shot point 230. Shade this anticline another color.

(answer)

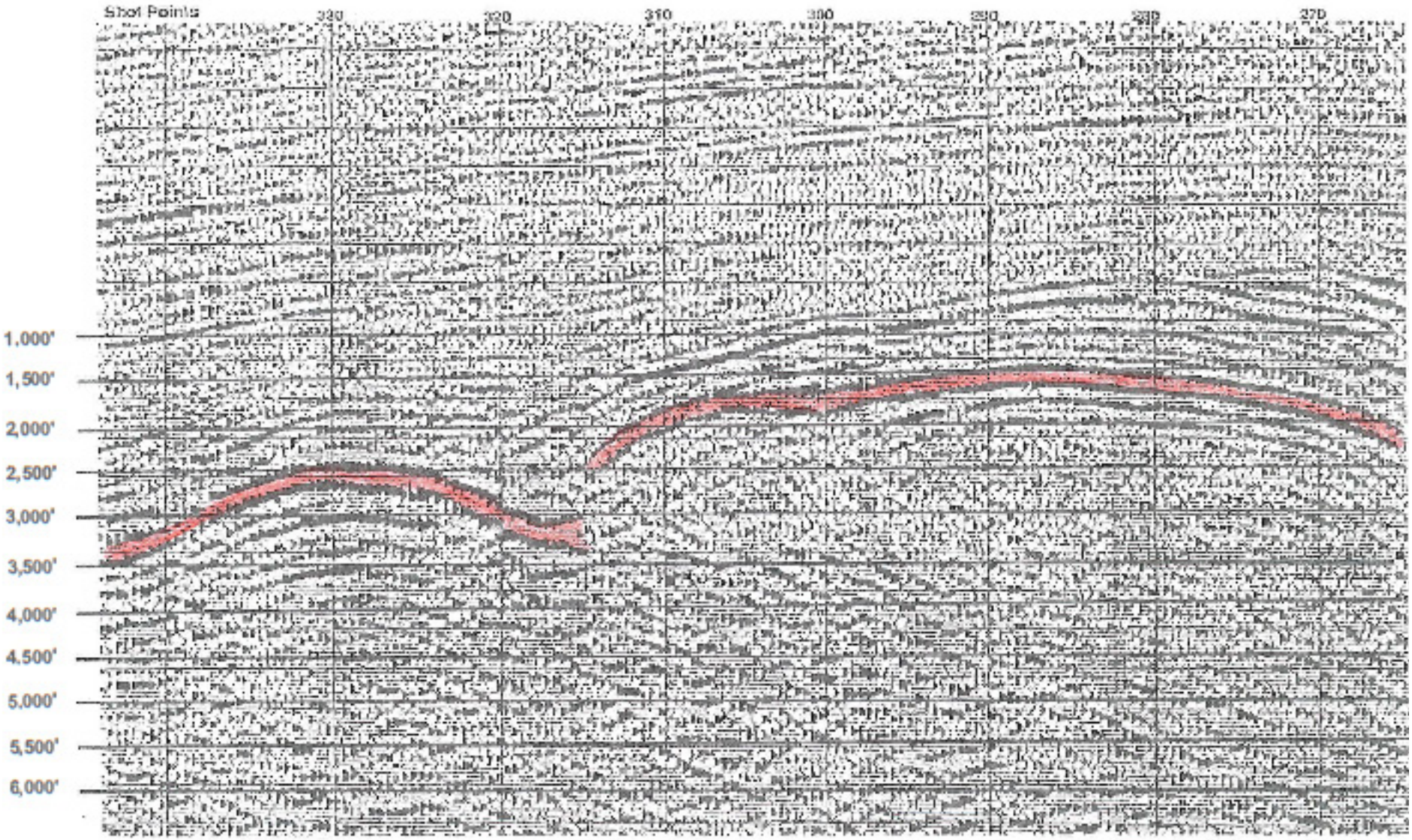
Seismic Map #1



There is a potentially productive zone represented on this seismic plat. It is indicated by a reflection that you find at 3,300 feet at a shot point 330. Color and track the zone as it moves to the left and right of this point.

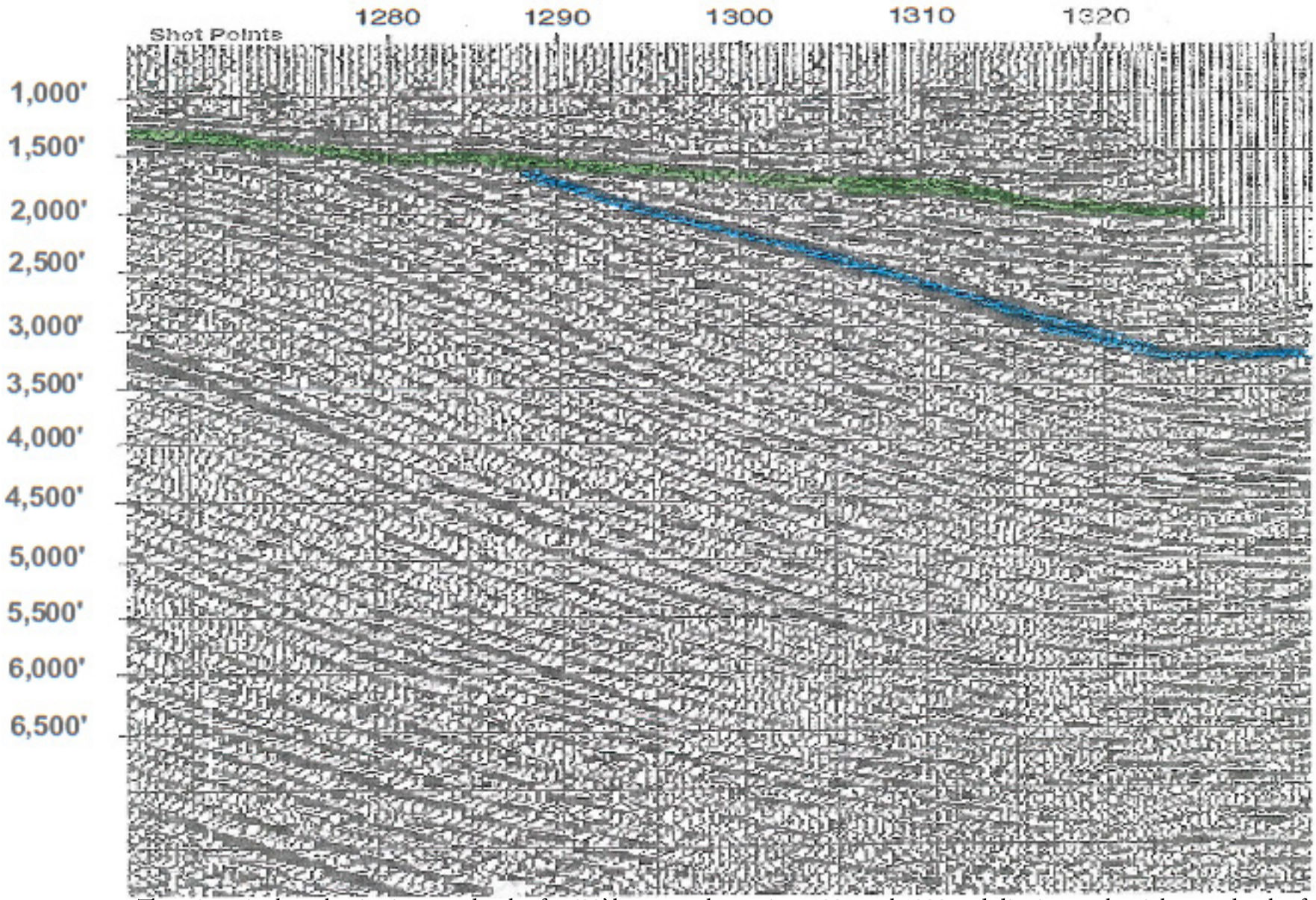
(answer)

Seismic Map #2



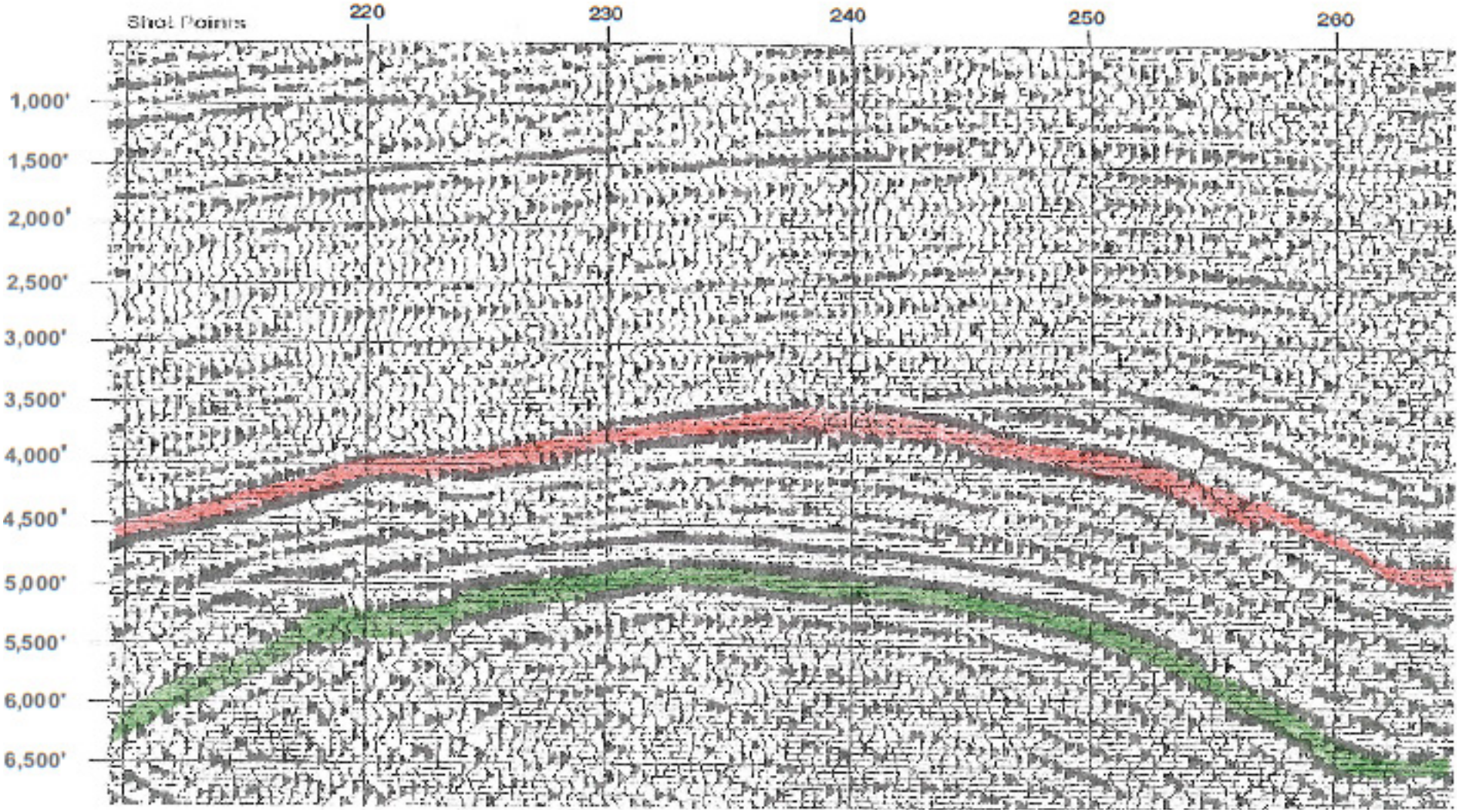
A vertical fault is located between shot point 310 and 320 and begins at a depth of 1,500' and ends at 5,000'. Draw the fault line. The formation on the left side of the fault line is at 3,100' and the formation on the right side of the fault line is at 2,500'. Shade in the formation on either side of the fault.

Seismic Map #3



There is a pinchout beginning at a depth of 1,600' between shot points 1285 and 1290 and dipping to the right to a depth of 3,250' as it goes off the plat. Shade this zone one color. Then, using another color, shade the zone the pinchout intersects.

Seismic Map #4



There is a potentially productive anticline structure that peaks just left of shot point 240 at approximately 3,500'. Identify and shade this structure as it continues to either side of the plat. There is a second potentially productive anticline 1,200' below the peak of this structure that peaks just right of shot point 230. Shade this anticline another color.

Name _____ Date _____

Seismic Clatter

Student Sheet

Student Activity 2

Materials

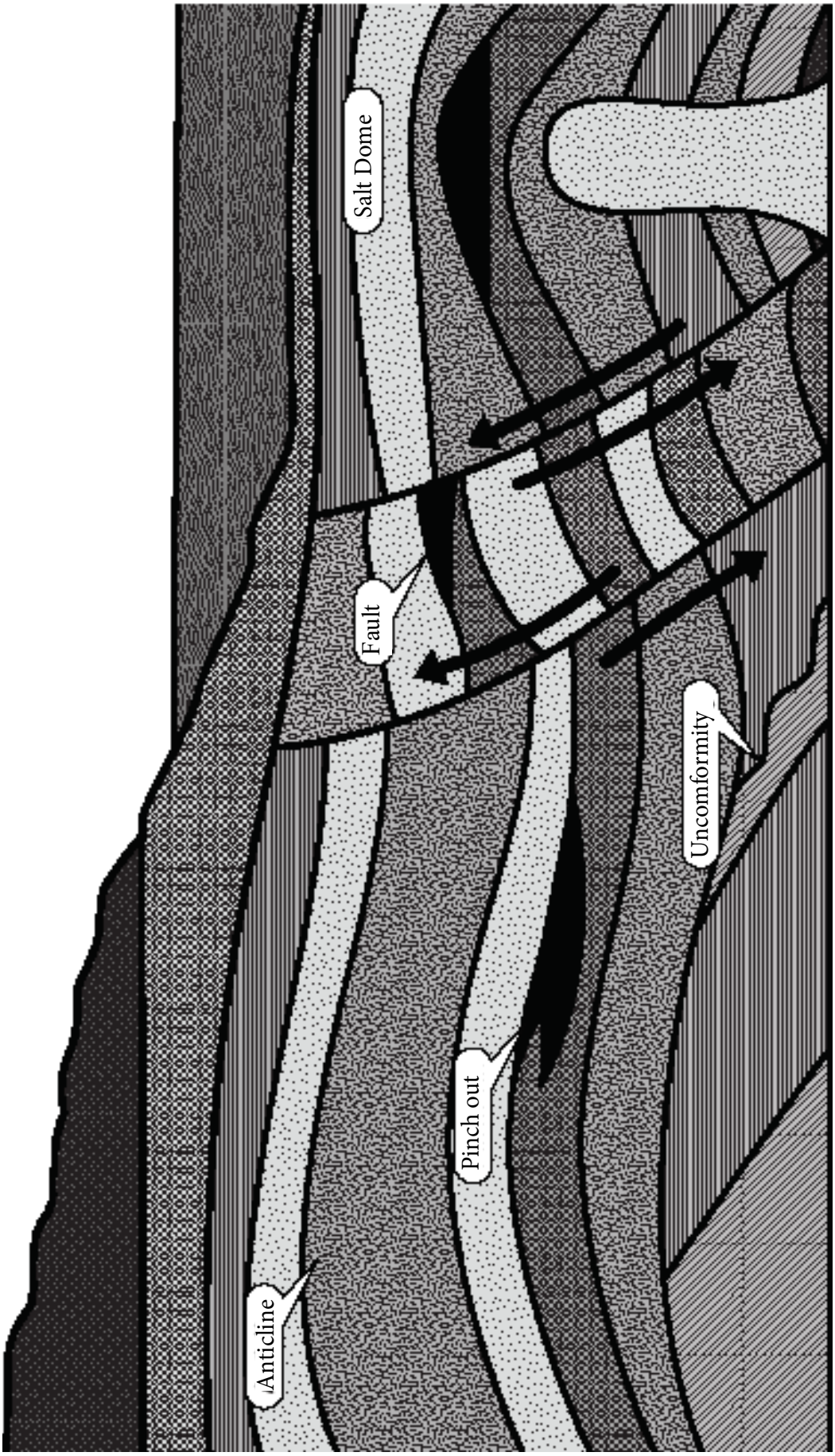
- Seismic Animations (https://iprb.org/education/classroom-curriculum/references/)
- Hydrocarbon Traps Handout
- Seismic Maps
- Colored Pencils
- Ruler

Procedure

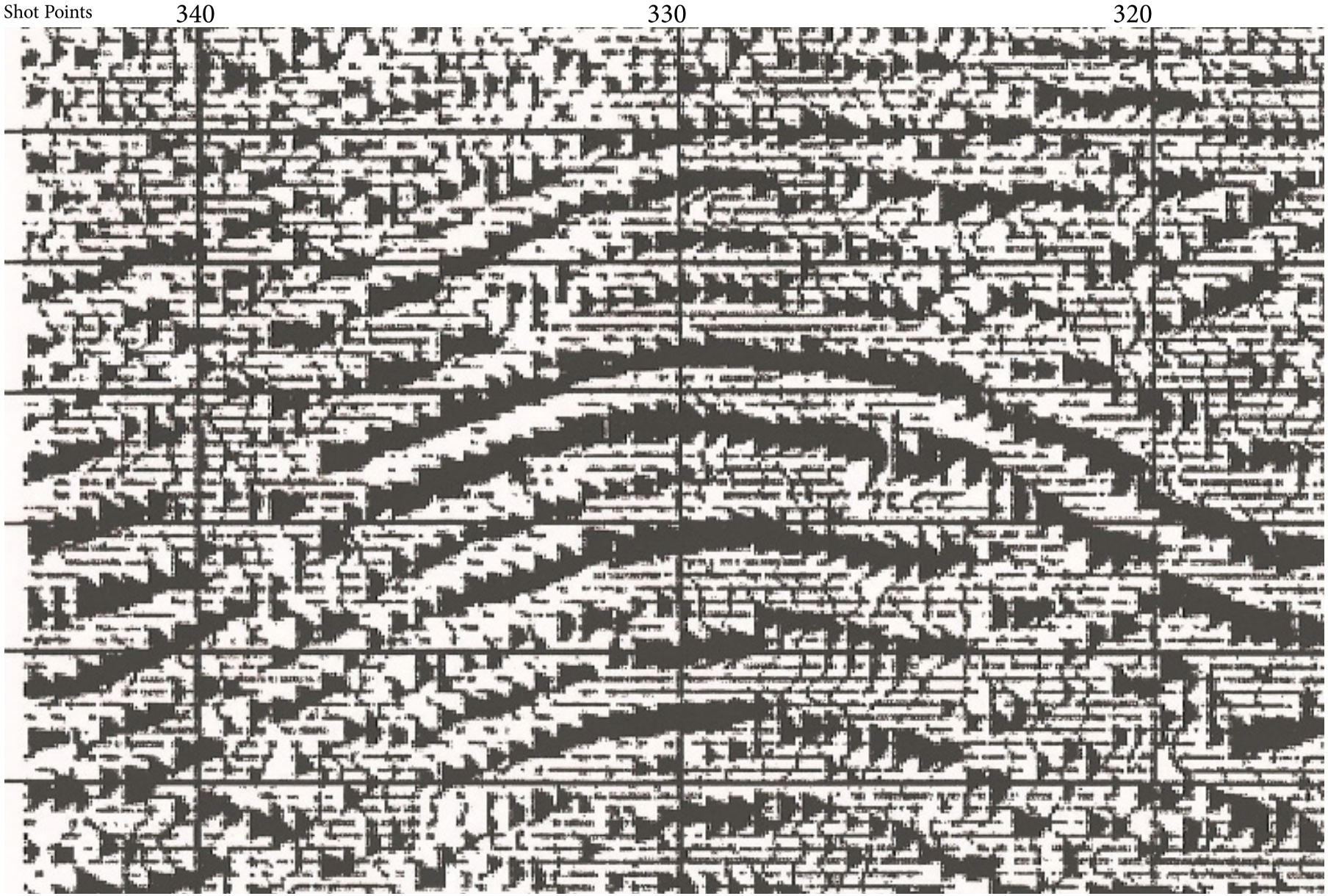
1. Have students watch the two seismic animations. Have them pay close attention to the animations as the information will help them in completing this exercise.
2. Each group of four students will work together to study a series of seismic maps. Students should observe each seismic map and using the Hydrocarbon Traps handout, find geologic features that are associated with oil and natural gas reservoirs.
3. After studying Seismic Map 1 and the Hydrocarbon Traps handout, students will color and describe the general patterns shown by the map.
4. Students will continue to do the same procedure for each remaining seismic map.
5. Each group of students will compare their findings with other student groups.

Name _____ Date _____

Hydrocarbon Traps Handout

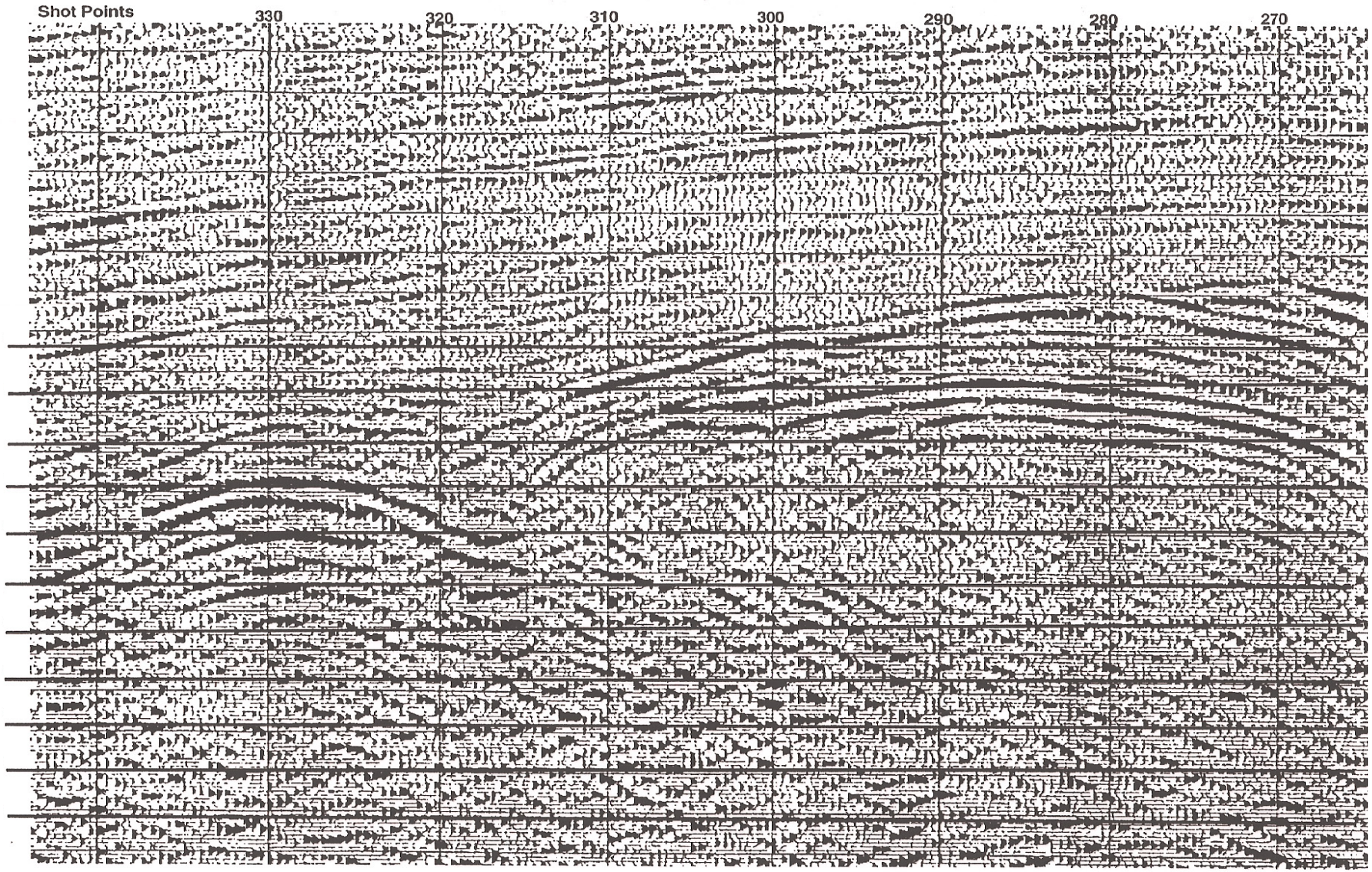


Seismic Map #1



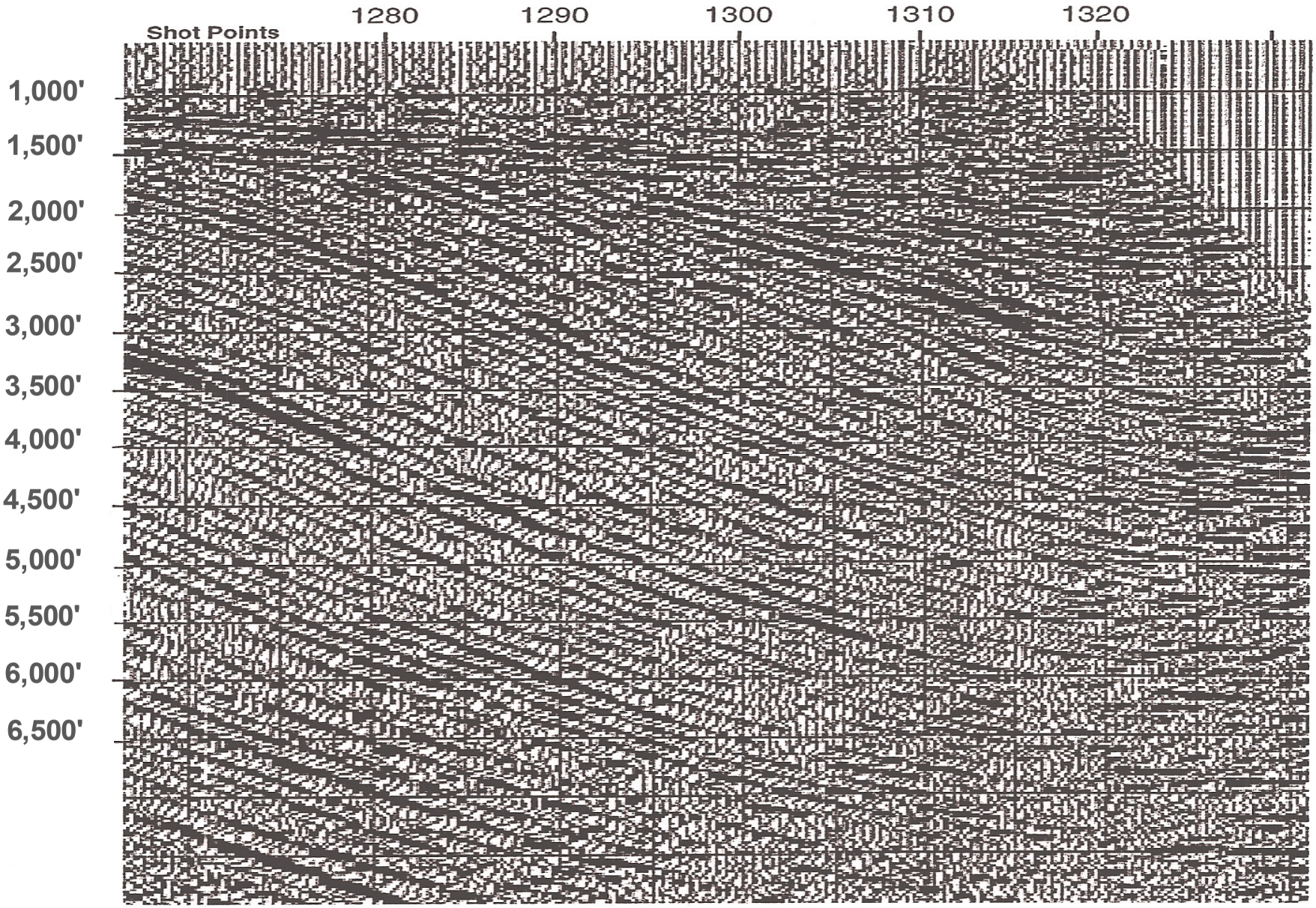
There is a potentially productive zone represented on this seismic plat. It is indicated by a reflection that you find at 3,300 feet at a shot point 330. Color and track the zone as it moves to the left and right of this point.

Seismic Map #2



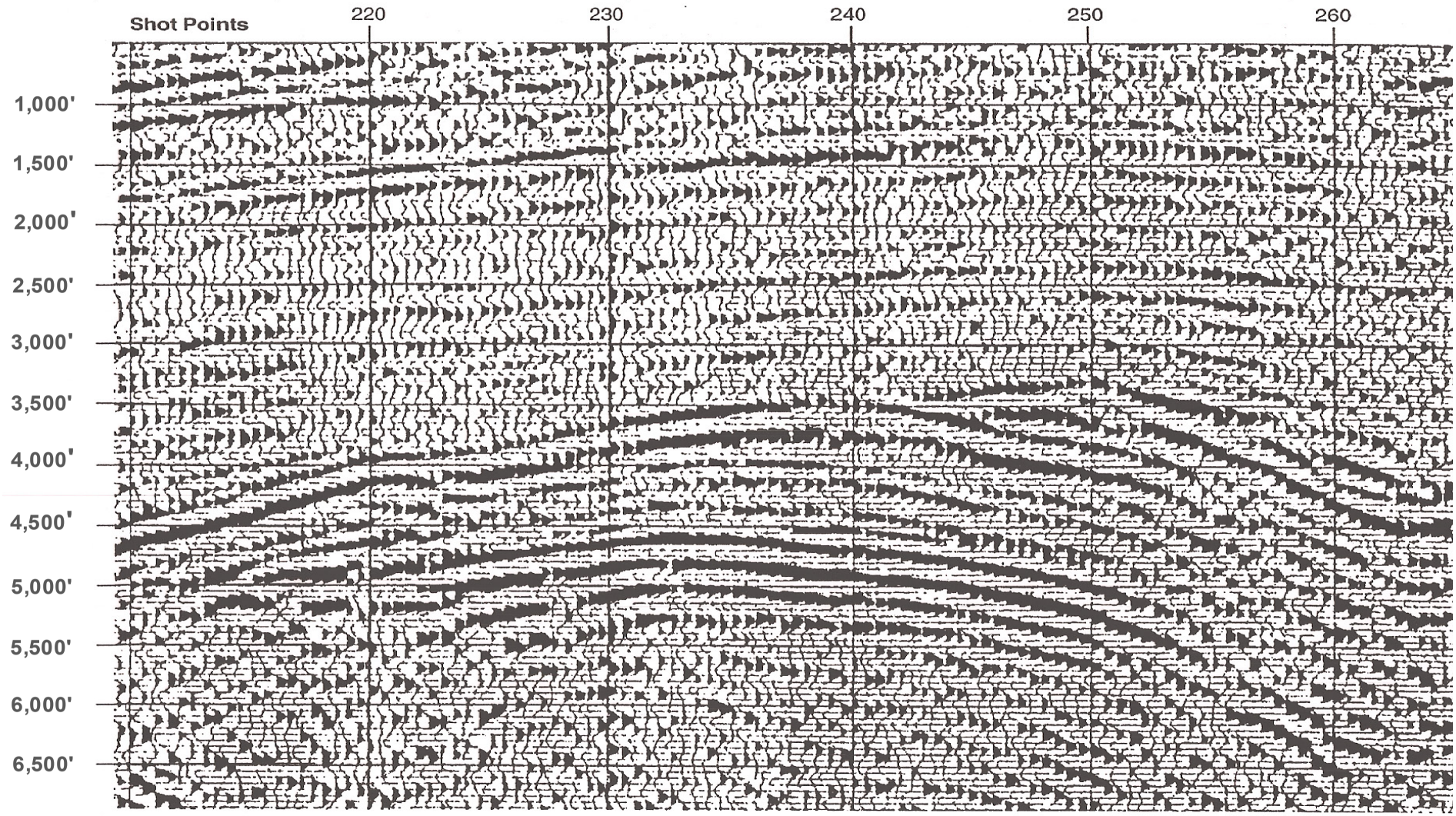
A vertical fault is located between shot point 310 and 320 and begins at a depth of 1,500' and ends at 5,000'. Draw the fault line. The formation on the left side of the fault line is at 3,100' and the formation on the right side of the fault line is at 2,500'. Shade in the formation on either side of the fault.

Seismic Map #3



There is a pinchout beginning at a depth of 1,600' between shot points 1285 and 1290 and dipping to the right to a depth of 3,250' as it goes off the plat. Shade this zone one color. Then, using another color, shade the zone the pinchout intersects.

Seismic Map #4



There is a potentially productive anticline structure that peaks just left of shot point 240 at approximately 3,500'. Identify and shade this structure as it continues to either side of the plat. There is a second potentially productive anticline 1,200' below the peak of this structure that peaks just right of shot point 230. Shade this anticline another color.

Seismic Clatter

Student Activity 3

Materials

- Seismic Maps (completed from activity 2)

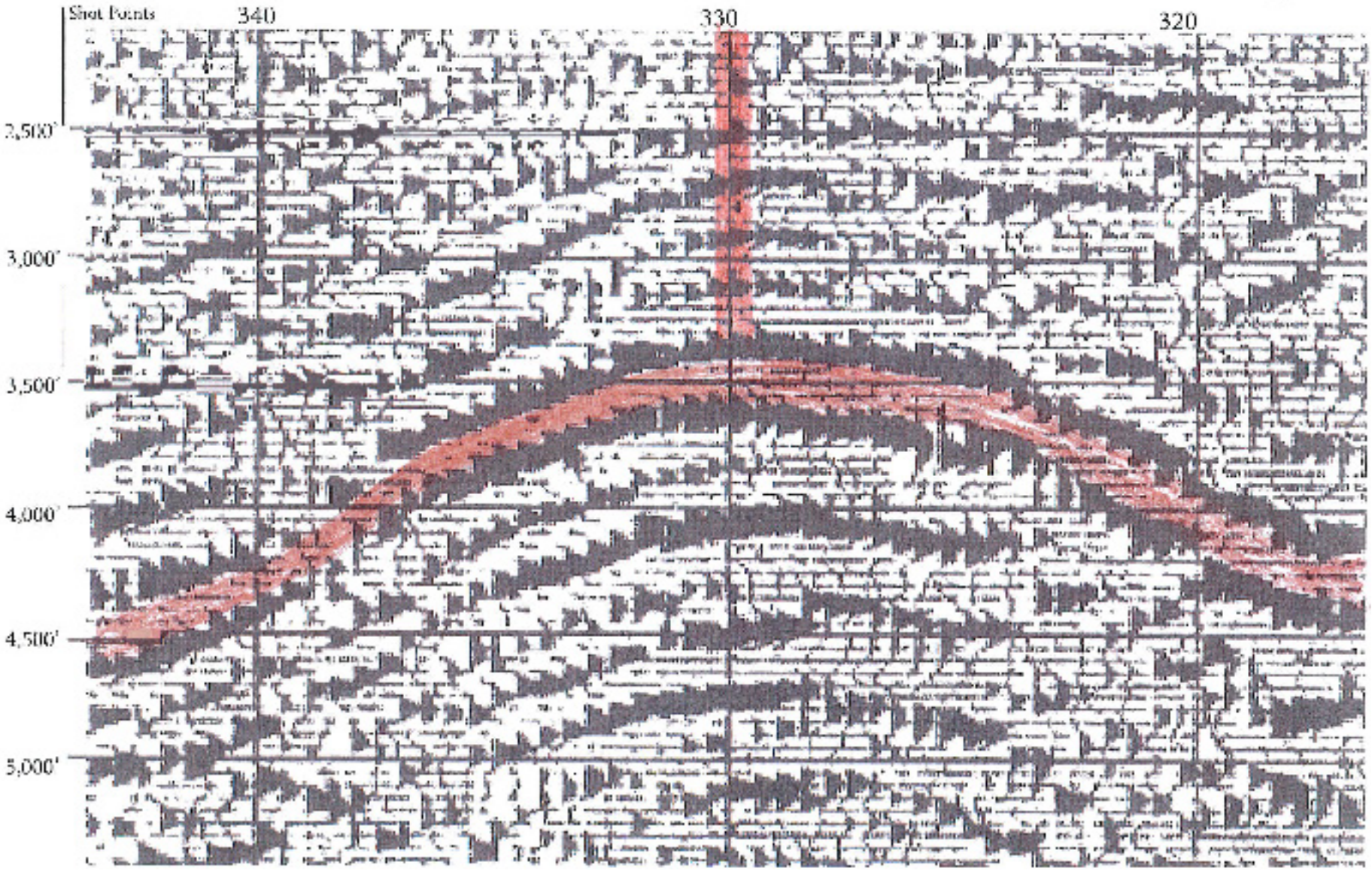
Procedure

1. Each group of students will study their completed seismic maps. On each map, students will determine locations that are potential hydrocarbon traps. Students should draw red lines from the surface down to the point where they would drill a well.
2. In Table 2: Proposed Well Sites, justify your choices of locations. Provide at least three reasons per site.

Table 2: Proposed Well Sites

Seismic Map	Justification
Seismic Map 1	**Possible Answer: The structure is an anticline. Hydrocarbons (oil and natural gas) will migrate into the top of the structure. If a cap rock is present, the hydrocarbons will be trapped there.**
Seismic Map 2	**Possible Answer: There are two anticlines, one on either side of the fault. The scenario from Seismic Map #1 would apply here. The hydrocarbons will migrate away from the fault zone into the anticlines.**
Seismic Map 3	**Possible Answer: If the overlying stratum is a cap rock, hydrocarbons will migrate up through the older strata and be stopped by the caprock.**
Seismic Map 4	**Possible Answer: There are two anticlines, one at a lower depth than the other. Hydrocarbons will migrate into the tops of these anticlines and be trapped there if a cap rock is present.**

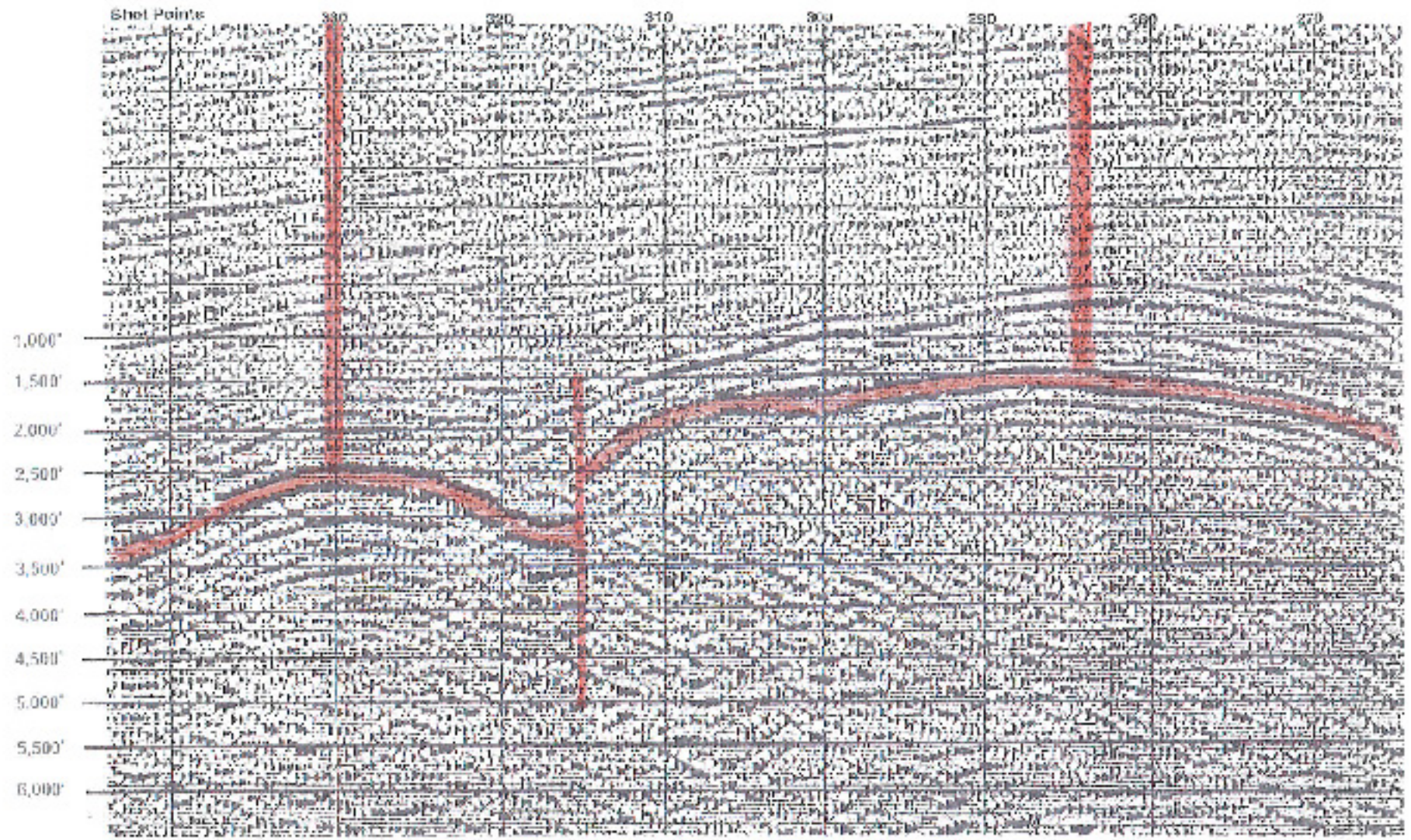
(answer)
Seismic Map #1



There is a potentially productive zone represented on this seismic plat. It is indicated by a reflection that you find at 3,300 feet at a shot point 330. Color and track the zone as it moves to the left and right of this point.

(answer)

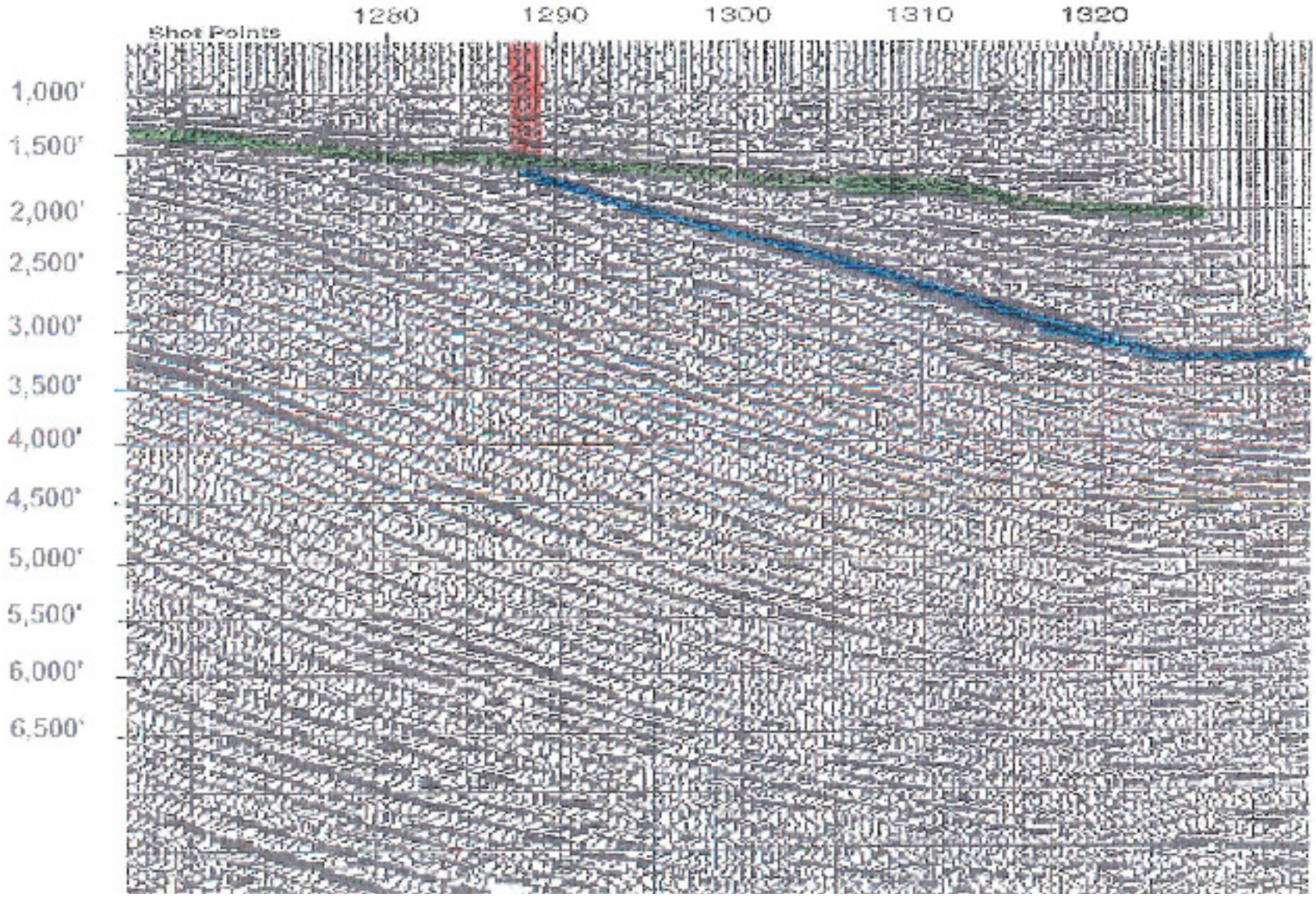
Seismic Map #2



A vertical fault is located between shot point 310 and 320 and begins at a depth of 1,500' and ends at 5,000'. Draw the fault line. The formation on the left side of the fault line is at 3,100' and the formation on the right side of the fault line is at 2,500'. Shade in the formation on either side of the fault.

(answer)

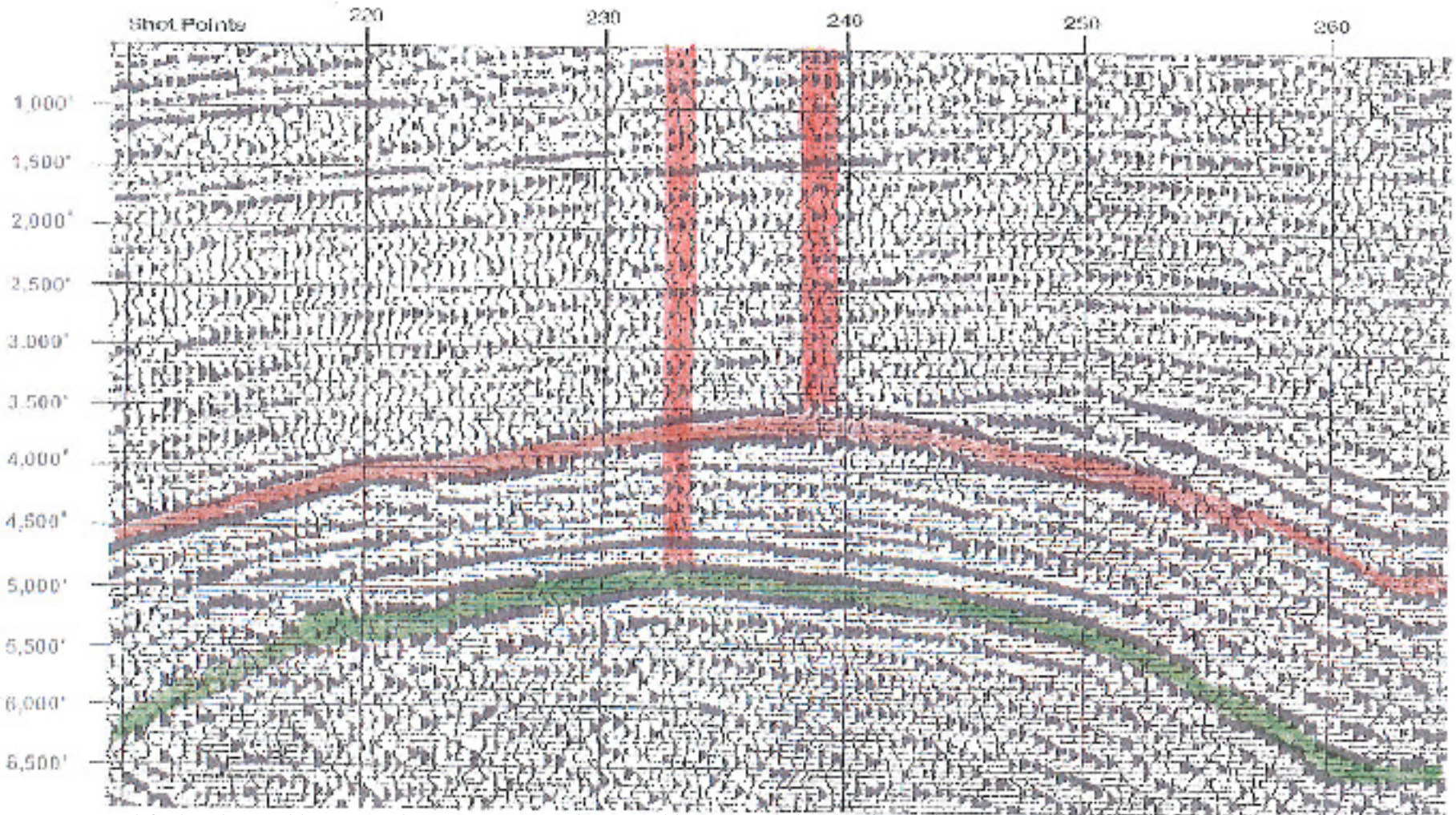
Seismic Map #3



There is a potentially productive zone represented on this seismic plat. It is indicated by a reflection that you find at 3,300 feet at a shot point 330. Color and track the zone as it moves to the left and right of this point.

(answer)

Seismic Map #4



A vertical fault is located between shot point 310 and 320 and begins at a depth of 1,500' and ends at 5,000'. Draw the fault line. The formation on the left side of the fault line is at 3,100' and the formation on the right side of the fault line is at 2,500'. Shade in the formation on either side of the fault.

Extension

- Using the seismic maps and the well drilling animation (**https://iprb.org/education/classroom-curriculum/references/**), students will model how to calculate the costs of drilling for oil. Every centimeter of depth that is drilled costs $150,000. In addition, if no oil is found at a well location, the drilling platform must be moved to a new spot to drill, which costs $75,000. Have each group of students measure the depth in centimeters of each of their proposed well sites. Have students record their results in a table.

Sample Table:

	Drill Site #1	Drill Site #2	Drill Site #3	Drill Site #4	Drill Site #5	Drill Site #6
Centimeters drilled down	Seismic Map #1 ≈ 5 cm	Seismic Map #2 (Site 1) ≈ 7.6 cm	Seismic Map #2 (Site 2) ≈ 6.4 cm	Seismic Map #3 ≈ 2.0 cm	Seismic Map #4 (Site 1) ≈ 6.4 cm	Seismic Map #4 (Site 2) ≈ 8.9 cm
Cost to drill each new site	≈$750,000	≈$1,140,000	≈$960,000	≈$300,000	≈$960,000	≈$1,335,000
Cost to move drilling platform to new site			≈$75,000			
Total cost per well site	≈$750,000	≈$1,140,000	≈$1,035,000	≈$300,000	≈$960,000	≈$1,335,000

Student groups are to assume that their drill site #3 is a dry hole. It does not matter the order in which groups choose to drill their wells. This will provide some variability in the results. Each group must move your drilling platform to a new site.

1. What was the total cost of your exploration? **Possible Answer: ≈$5,520,000**
2. If you were to start over, how would you change your exploration procedure to save money? **Answers will vary.**
3. Compare your results with the other groups. Look at their seismic maps. Were your oil deposits located in the same general areas? **Answers will vary.**
4. Did any of the other groups spend more money than you? Why? **Answers will vary.**

Name _____ Date _____

Seismic Clatter

Student Sheet

Student Activity 3

Materials

- Seismic Maps (completed from activity 2)

Procedure

1. Each group of students will study their completed seismic maps. On each map, students will determine locations that are potential hydrocarbon traps. Students should draw red lines from the surface down to the point where they would drill a well.
2. In Table 2: Proposed Well Sites, justify your choices of locations. Provide at least three reasons per site.

Table 2: Proposed Well Sites

Seismic Map	Justification
Seismic Map 1	
Seismic Map 2	
Seismic Map 3	
Seismic Map 4	

From the Ground Up

Illinois Academic Standards-English/Language Arts

Grades 6-8

Science and Technical Subjects-Reading

Key Ideas and Details

6-8.1 Cite specific textual evidence to support analysis of science and technical texts.

6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

Integration of Knowledge and Ideas

6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic

Next Generation Science Standards

Grades 6-8

Matter and Its Interactions

MS-PS1-2 Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

MS-PS1-3 Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

Motion and Stability: Forces and Interactions

MS-PS2-2 Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

Engineering Design

MS-ETS1-3 Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

From the Ground Up!

Time: 4-5 class periods

Wonder Why . . .

Have you ever wondered how oil and natural gas get from the ground to you?

Concept

Once oil has been located, it must be extracted from the earth and refined before it can be made into usable products.

Teacher Information

Once crude oil and natural gas have been located, different methods are used for extraction. When crude oil and natural gas are extracted from the earth, they are not ready to be used, so several separation practices must be employed. Different liquids have different densities and different hydrocarbons have different boiling points. These properties allow oilfield engineers to prepare crude oil and natural gas for purchase, transport, and refining.

"The Story of Petroleum" found at http://iprb.org/Media.html can be used as an introduction to this activity.

Vocabulary

Contaminant: A substance that contaminates; impurities.

Crude Oil: Unprocessed petroleum; oil as it comes from the ground.

Density: Amount of mass that is in a certain volume of matter; mass per volume; a sound wave travels more quickly through less dense rocks than those with a high density.

Extract: Remove or take out.

Fractional Distillation: Process that separates a hydrocarbon mixture into a number of different parts, or fractions, based on boiling points.

Hydrocarbon: Organic compounds of hydrogen and carbon whose densities, boiling points, and freezing points increase as their molecular weights increase.

Monomer: A molecule that can be bonded to other identical molecules to form a polymer.

Natural Gas: Flammable gas, consisting largely of methane and other hydrocarbons, occurring naturally underground and used as fuel.

Oil Fractions: Different hydrocarbons that are separated from a mixture by fractional distillation.

Petroleum: A liquid mixture of hydrocarbons that is present in suitable rock layers and can be extracted and refined to produce fuels.

Polymer: A substance that has a molecular structure built up mainly from a large number of similar units bonded together (monomers).

Recover: Return to a normal state.

Refining: To make usable; make or become polished; improve.

Safety

Do not put any materials (including liquids) in your mouth.

Alert teacher of any spill, immediately.

Wash hands upon completion of this activity.

Properly dispose of materials after completing Activity 2.

Student Activity 1

Prior to beginning the activity 1, add contents of red dye to the bottle of vegetable oil. Mix well.

Materials (per group of 4 students)

- One 500 mL Erlenmeyer flask (included in lab/kit)
- One two-hole rubber stopper(included in lab/kit)
- 350 mL water
- 150 mL vegetable oil
- Colored oil-soluble dye
- Paper Towels

Procedure

1. Pour 350 mL water into the Erlenmeyer flask.
2. Measure 150 mL vegetable oil and pour into water.
3. Insert stopper. With fingers covering holes, shake vigorously.
4. Record your observations. **Possible Answers: The oil and water create a bubbly solution. They mix together.**
5. Allow the liquids to settle.
6. Record your observations. **Possible Answers: The oil separates from the water. There are 2 layers.**
7. Formulate an explanation of your observations. Include the vocabulary word "density" in your explanation. **Possible Answer: The oil has a density that is less than the water, so it floats on the top of the water.**

From the Ground Up!

Student Activity 2

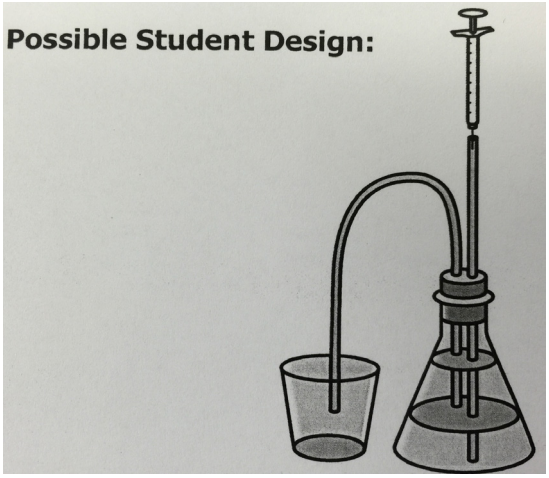
Activity 2 is a student inquiry activity. The challenge is to design and develop a device which will allow for the removal of oil from the water and oil mixture. This represents the retrieval of oil from the ground. Students should be given little direction toward a solution to the problem and use as many materials as possible. Model shown below is one possible mechanism. Student designs will vary.

Materials

- "Pump It Up" Rubric
- 1 plastic test tube(included in lab/kit)
- Two 30 cm sections of vinyl tubing to fit rubber stopper(included in lab/kit)
- 6 clear, plastic straws
- 2 cotton balls
- Small funnel
- One 30 cm section of ¼ inch vinyl tubing(included in lab/kit)
- One 60cc plastic syringe(ncluded in lab/kit)
- Petroleum jelly
- 1 clear, plastic pipette(included in lab/kit)
- One 500 mL Erlenmeyer flask(included in lab kit)
- One two-hole rubber stopper(included in lab/kit)
- One 250 mL clear beaker(included in lab/kit)
- 350 mL water
- 150 mL vegetable oil
- Colored oil-soluble dye
- Paper Towels

Procedure

1. Students will continue working with the oil and water in the Erlenmeyer flask during this activity.
2. Using any provided materials, groups of students will design a device to extract only the oil.
3. On the student sheet, students will diagram their plan and predict its success.



4. Students will construct their device from the materials provided.
5. Students will test their device and record measurements.

Oil (initial amount)	Oil (extracted amount)	Percentage of oil extracted
150 mL	**Answers will vary.**	**Answers will vary.**

6. Students will conclude whether or not their device for oil extraction was successful and analyze any flaws in their design or ways in which it could be improved. Discuss with groups.
7. Score using "Pump It Up" Rubric.
8. Clean-up procedures: Direct students to pour water and oil down the sink. All containers and tubing should be washed with warm, soapy water. Rinse thoroughly and dry. (This may be completed after all students/classes have completed the activity.)

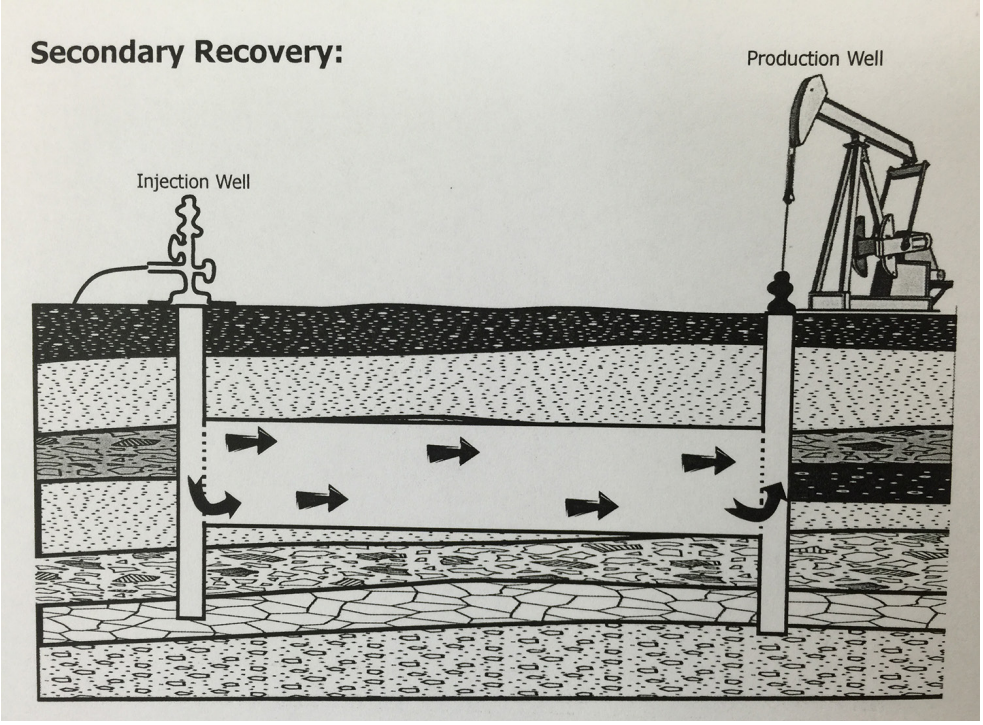
Conclusion

Each group will read the following passage and answer the questions.

Part 1 - Pump It Up:

Since oil, natural gas, and water are under pressure below Earth's surface, these fluids may flow up a well without assistance (similar to a soft drink that has been shaken and then opened). This is called **primary recovery** – using natural pressure inside Earth to extract oil and natural gas. When this pressure is depleted, only a portion of the oil and natural gas has been removed from the site. This does not mean it's the end of the well's life!

Artificial lifting systems, or pumping units, are used to help pull the oil of the reservoir rock and pump it up the well. **Secondary recovery** can also take place. These activities are designed to create increased pressure to cause the oil to flow upward. These activities include waterflood, secondary gas drive, and other methods. During a waterflood, water is injected into other wells in the productive zone to push the oil and natural gas up the producing well. During a secondary gas drive, natural gas is re-injected into the producing formation to push the oil to the other wells that have been drilled in the oil zone.



1. What is the main idea of "Pump It Up"? **Possible Answer: Sometimes oil and natural gas must be extracted using secondary recovery methods, such as waterflood or secondary gas drive.**

2. Relate activity 2 to the actual methods that are used to extract oil and natural gas from the Earth. **Possible Answer: In activity 2, air pressure was used to extract the oil from the container. Water or natural gas can be pushed into a well to help extract oil from the ground.**

3. Compare and contrast primary and secondary recovery. **Possible Answer:**

Primary Recovery	Secondary Recovery
• **Pressure is used to extract oil and natural gas.** • **Pressure comes from natural forces within the earth.** • **May not extract much of the oil and natural gas.**	• **Pressure is used to extract oil and natural gas.** • **Water or natural gas are used to create pressure.** • **Extracts more oil and natural gas.**

4. What is the main idea of "Heat It Up"? **Possible Answer: Crude oil, water and natural gas must be separated and refined before they can be used.**

5. Explain what happens to crude oil and natural gas following extraction. **Possible Answer: First, crude oil and natural gas must be separated. Crude oil must then have the water separated out of the mixture. Finally crude oil is refined using a fracional distillation.**

6. Examine the "Tower of Power: Oil Refining Tower". Arrange the following fractions in order from highest boiling point to lowest boiling point: fuel oil, gasoline, kerosene, bitumen, lubricants. **Answer: Bitumen, fuel oil, lubricants, kerosene, gasoline.**

Name _____ Date _____

Part 2 - Heat It Up:

During extraction, crude oil and natural gas may become contaminated with water, sediment, and other contaminants. Once the oil and natural gas flow out of the wellhead, they must be separated before they are sold. The petroleum enters a closed vessel called a separator. In the separator, the force of gravity separates the natural gas, oil, and water, due to their different densities. The natural gas is pumped through pipelines for use. Oil and water flow into an apparatus called a heater treater. Water and oil separate while in the heater treater. Once these liquids have been separated, the crude oil is ready to be sold.

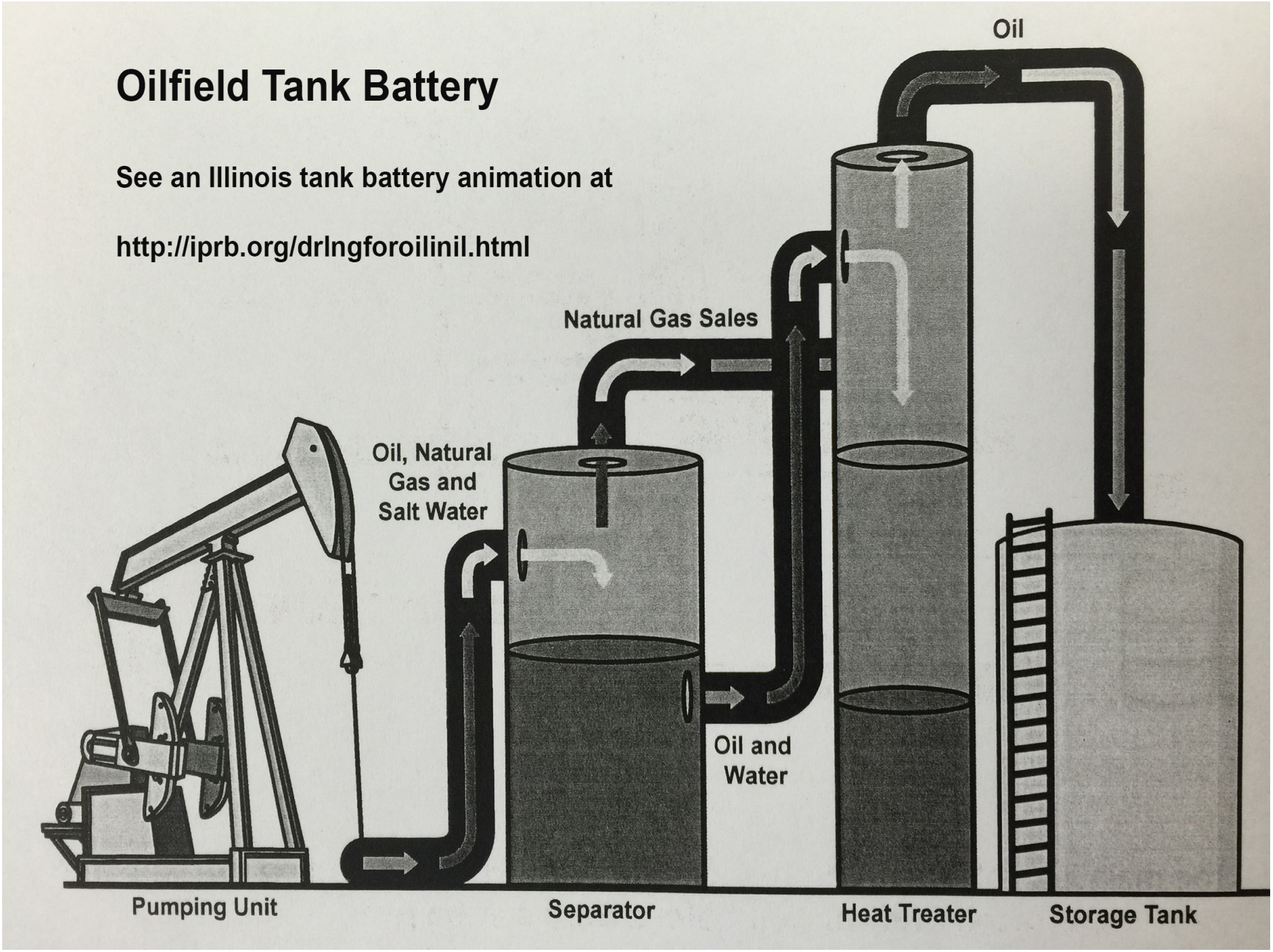
Once crude oil is purchased, it is transported to a refinery. There the crude oil is refined, or processed to remove impurities and separate it into different parts, or fractions. Crude oil is heated, and due to the different boiling points of the hydrocarbons in the crude oil, the fluids separate into different fractions. This process is called fractional distillation. Fractional distillation produces the different fractions of oil that can be transformed into products we use every day! After different fractions are separated, they are pumped into storage tanks.

Tower of Power
Oil Refining Tower
Process
Product
By-Products
Crude Oil
Furnace
Fractionating Tower
oil vapor
Less than 40° C (104° F)
Gases
• gas for gas stoves
• propane
• butane
40° C – 200° C (104° F – 392° F)
Gasoline
• gasoline
• plastics
• chemicals
200° C – 300° C (392° F – 572° F)
Kerosene
• fuel for planes
• fuel for camping lanterns
250° C – 350° C (482° F – 662° F)
Gas Oil
• diesel fuel
• heating oil
300° C – 370° C (572° F – 698° F)
Lubricants
• wax
• motor oil
• lubricating oil
Greater than 370° C (698° F)
Fuel Oil
• fuel for factories
• fuel for utilities
• ship fuel
Greater than 660° C (1220° F)
Bitumen
• surfacing for roads
• surfacing for roofs

Oilfield Tank Battery

See an Illinois tank battery animation at

http://iprb.org/drlngforoilinil.html

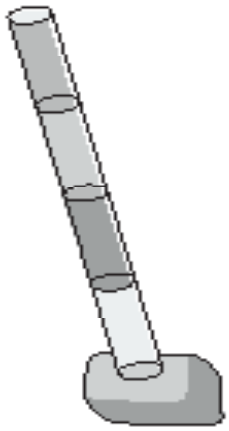


Part Two continued – Density Column

Liquids of different densities will separate and form layers.

Materials

- One clear plastic drinking straw per group
- Liquids of different densities
  - Vegetable Oil
  - Water or Salt Water
  - *Dish Soap
  - *Corn Syrup
  - *Rubbing Alcohol (70% Isopropyl)
  - *Glycerine
- Clay or potato slice
- Plastic pipettes or eye droppers
- Paper towels
- Map pencils



*Not included in kit.

Discovery Procedure

1. To create a density column, use a clear straw and clay (or potato) as a stopper.
2. Predict what will happen when the liquids are poured into the density column. Using colored pencils, create a colored-coded legend and draw a "prediction column."
3. Using plastic pipettes, carefully layer the following liquids (or similar liquids), placing ten drops of each in the straw:
   - Cooking oil
   - Water or salt water (supersaturated)
   - Rubbing alcohol (70% Isopropyl)
   - Glycerine
4. Observe what occurs as the liquids are added, and compare your results with other groups.
5. Using the same color-coded legend, record the order of the liquids in the column and discuss similarities and differences. (Students may need to conduct several trials of this experiment.)

Concept Formation

Why did the liquids form layers in the straw? (Possible answer(s): The liquids are different densities.)

Part 3 - What's Up:

Oil and natural gas are naturally occurring hydrocarbons. Only two elements, hydrogen and carbon, make up a hydrocarbon. Hydrogen and carbon have a strong attraction to each other. As a result, they form many compounds. Hydrocarbons are named by the number of carbon atoms they contain. These compounds are named by using a prefix and the root "-ane".

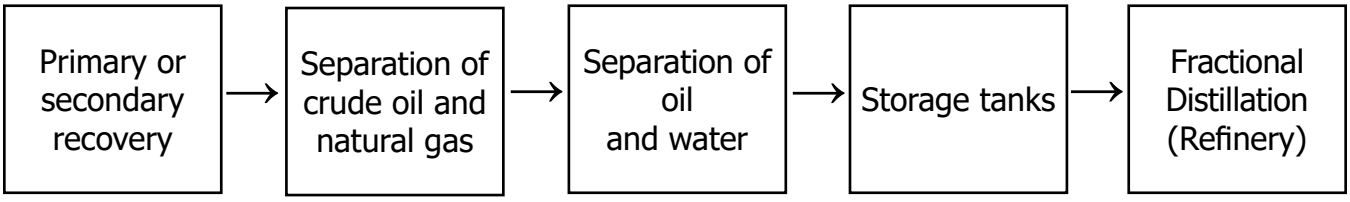
Prefix	# of Carbon Atoms	Uses
Methane	1	Natural gas, bottled fuel gas
Ethane	2	
Propane	3	
Butane	4	
Pentane	5	Solvent, paint thinner, cleaner
Hexane	6	
Heptane	7	Motor fuel, solvent
Octane	8	
Nonane	9	Illuminating oil, diesel fuel, jet fuel, cracking stock
Decane	10	

The simplest hydrocarbon is methane (gas) – one atom of carbon and four atoms of hydrogen. Methane is the main component in natural gas, as shown below. Gasoline is a mixture of several hydrocarbons that are liquid. Crude oil is also a mixture that usually occurs as a liquid. Tars and asphalts are solid hydrocarbons, under normal conditions. Raising the temperature of any of these causes a change in state. For example, when a roofer heats tar, it liquefies and binds gravel or other materials into a spreadable mixture. Then, when it cools, it solidifies to form a waterproof surface.

Furthermore, thousands of commonly used products are produced from petroleum, such as sports equipment, classroom items, and even cosmetics! Plastics contain polymers, huge chain-like molecules composed of small molecules called monomers. Due to some of the varying properties of polymers, plastics may be flexible or rigid, transparent or opaque, hard or soft, and elastic or not. Man-made polymers are made possible by the complex processes involved in formation, extraction, and processing of crude oil and natural gas.

7. What is the main idea of "What's Up?" **Possible Answer: Petroleum contains hydrocarbons, can have different properties, and is used in the production of thousands of commonly used items.**

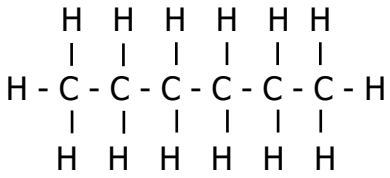
8. Create a flow-chart with the major processes, identified in the passage, involved in extraction through practical use of crude oil and natural gas. Include at least five processes.

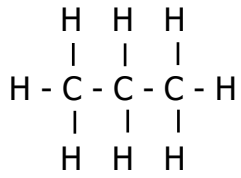


Naming Hydrocarbons

Hydrocarbons are compounds made up of carbon and hydrogen. Hydrocarbons called alkanes are the simplest hydrocarbons. These compounds are named by using a prefix that tells the number of carbon atoms they contain and the root-ane. Using the chart below, name each of the alkanes that are shown.

Prefix	# of Carbon Atoms	Uses
meth-	1	Natural Gas, bottled fuel gas
eth-	2	
prop-	3	
but-	4	
pent-	5	Solvent, paint thinner, cleaner
hex-	6	
hept-	7	Motor fuel, solvent
oct-	8	
non-	9	Illuminating oil, diesel fuel
dec-	10	jet fuel, cracking stock





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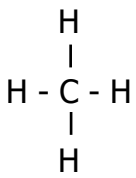

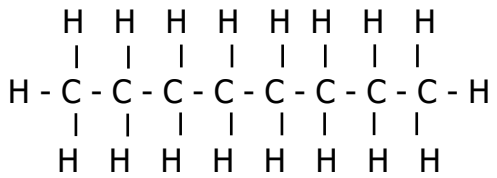

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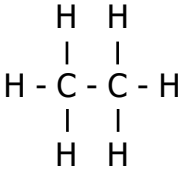
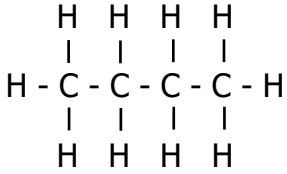




_____ _____

Extension

- Students research types of hydrocarbons and their uses.
- Students research products produced from petroleum and communicate findings to the class.

Name _____ Date _____

From the Ground Up!

Student Sheet

Wonder Why . . .

Have you ever wondered how oil and natural gas get from the ground to you?

Vocabulary

Contaminant: A substance that contaminates; impurities.

Crude Oil: Unprocessed petroleum; oil as it comes from the ground.

Density: Amount of mass that is in a certain volume of matter; mass per volume; a sound wave travels more quickly through less dense rocks than those with a high density.

Extract: Remove or take out.

Fractional Distillation: Process that separates a hydrocarbon mixture into a number of different parts, or fractions, based on boiling points.

Hydrocarbon: Organic compounds of hydrogen and carbon whose densities, boiling points, and freezing points increase as their molecular weights increase.

Monomer: A molecule that can be bonded to other identical molecules to form a polymer.

Natural Gas: Flammable gas, consisting largely of methane and other hydrocarbons, occurring naturally underground and used as fuel.

Oil Fractions: Different hydrocarbons that are separated from a mixture by fractional distillation.

Petroleum: A liquid mixture of hydrocarbons that is present in suitable rock layers and can be extracted and refined to produce fuels.

Polymer: A substance that has a molecular structure built up mainly from a large number of similar units bonded together (monomers).

Recover: Return to a normal state.

Refining: To make usable; make or become polished; improve.

Safety

Do not put any materials (including liquids) in your mouth.

Alert teacher of any spill, immediately.

Wash hands upon completion of this activity.

Properly dispose of materials.

Name _____ Date _____

Student Activity 1

Materials

- One 500 mL Erlenmeyer flask(included in lab/kit)(ncluded in lab/kit)
- One two-hole rubber stopper(included in lab/kit)
- 350 mL water
- 150 mL vegetable oil
- Colored oil-soluble dye
- Paper Towels

Procedure

1. Pour 350 mL water into the Erlenmeyer flask.
2. Measure 150 mL vegetable oil and pour into water.
3. Insert stopper. With fingers covering holes, shake vigorously.
4. Record your observations.

_____

_____

5. Allow the liquids to settle.
6. Record your observations.

_____

_____

7. Formulate an explanation of your observations. Include the vocabulary word "density" in your explanation.

_____

_____

Name _____ Date _____

From the Ground Up!

Student Sheet

Student Activity 2

Activity 2 is an inquiry activity. The challenge is to design and develop a device which will allow for the removal of oil from the water and oil mixture. This represents the retrieval of oil from the ground. You should try to use as many materials as possible.

Materials

- "Pump It Up" Rubric(see below)
- 1 plastic test tube(included in lab/kit)
- Two 30 cm sections of vinyl tubing to fit rubber stopper(included in lab/kit)
- 6 clear, plastic straws
- 2 cotton balls
- Small funnel
- One 30 cm section of ¼ inch vinyl tubing(included in lab/kit)
- One 60cc plastic syringe(included in lab/kit)
- Petroleum jelly
- 1 clear, plastic pipette(included in lab/kit)
- One 500 mL Erlenmeyer flask(inclued in lab/kit)
- One two-hole rubber stopper(included in lab/kit)
- One 250 mL clear beaker(included in lab/kit)
- 350 mL water
- 150 mL vegetable oil
- Colored oil-soluble dye
- Paper Towels

Procedure

1. Continue working with the oil and water in the Erlenmeyer flask during this activity.
2. Using any provided materials, design a device to extract only the oil.
3. Diagram your plan and predict its success.

Name _____ Date _____

4. Construct your device from the materials provided.
5. Test your device and record measurements.

Oil (initial amount)	Oil (extracted amount)	Percentage of oil extracted

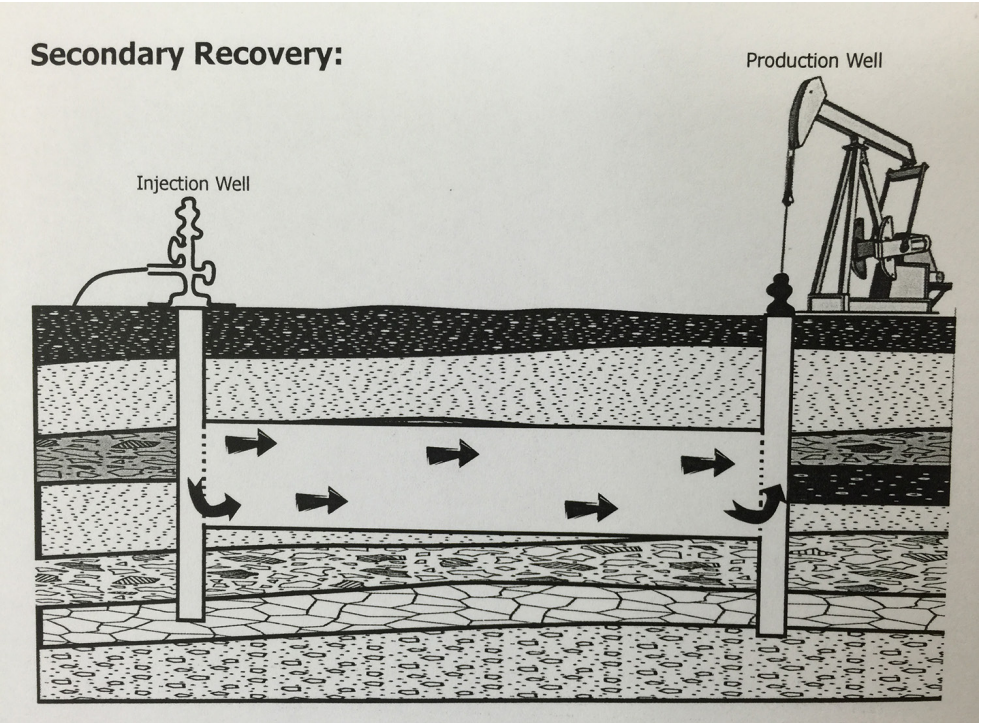
Conclusion

Read the following passage and answer the questions.

Part 1 - Pump It Up:

Since oil, natural gas, and water are under pressure below Earth's surface, these fluids may flow up a well without assistance (similar to a soft drink that has been shaken and then opened). This is called **primary recovery** – using natural pressure inside Earth to extract oil and natural gas. When this pressure is depleted, only a portion of the oil and natural gas has been removed from the site. This does not mean it's the end of the well's life!

Artificial lifting systems, or pumping units, are used to help pull the oil of the reservoir rock and pump it up the well. **Secondary recovery** can also take place. These activities are designed to create increased pressure to cause the oil to flow upward. These activities include waterflood, secondary gas drive, and other methods. During a waterflood, water is injected into other wells in the productive zone to push the oil and natural gas up the producing well. During a secondary gas drive, natural gas is re-injected into the producing formation to push the oil to the other wells that have been drilled in the oil zone.



Name _____ Date _____

1. What is the main idea of "Pump It Up"?

_____

_____

2. Relate the activity 2 to the actual methods that are used to extract oil and natural gas from the Earth.

_____

_____

3. Compare and contrast primary and secondary recovery.

Primary Recovery	Secondary Recovery

4. What is the main idea of "Heat It Up"?

_____

_____

5. Explain what happens to crude oil and natural gas following extraction.

_____

_____

_____

6. Examine the "Tower of Power: Oil Refining Tower". Arrange the following fractions in order from highest boiling point to lowest boiling point: fuel oil, gasoline, kerosene, bitumen, lubricants.

_____

_____

Pump It Up Rubric

	Expert	Proficient	Emergent	Novice
Summarize the problem	Problem has been restated to accurately represent original problem	Problem has been restated to somewhat represent the original problem	Problem has been restated to barely represent the original problem	Problem has not been restated to barely represent the original problem
Generate possible solutions	Diagram of model is developed, reviewed, and revised before construction	Diagram of model is developed, reviewed or revised before construction	Diagram of model is partially developed, but not reviewed, or revised before construction	Diagram of model is not developed before construction
Hypothesis	Hypothesis is directly related to the problem; written in an "if, then, because" format	Hypothesis is somewhat related to the problem; may be written in an "if, then, because" format	Hypothesis is not related to the problem; but written in an "if, then, because" format	Hypothesis is not related to the problem and not written in an "if, then, because" format
Create and Test	Creative use of materials and equipment; physical model represents the original plan	Appropriate use of materials and equipment; physical model represents the original plan	Use of materials and equipment is basic; physical model somewhat represents the original plan	Use of materials and equipment is basic; physical model does not represents the original plan
Collect Data	Data is recorded neatly and accurately; measurements are labeled with appropriate unit; calculations are accurate	Data is recorded accurately; measurements are labeled; calculations are accurate	Data is recorded; measurements are labeled; calculations may be accurate	Data is not recorded or measurements are not labeled or calculations are inaccurate
Conclusion	Conclusions are drawn using the data and refer back to the hypothesis; a thorough summary is written explaining what was discovered	Conclusions are drawn and somewhat refer back to the hypothesis; summary is written explaining some discovery	Conclusions are drawn but do not refer back to the hypothesis; summary is written but lacks discovery	Conclusions are drawn but do not refer back to the hypothesis; no summary is written

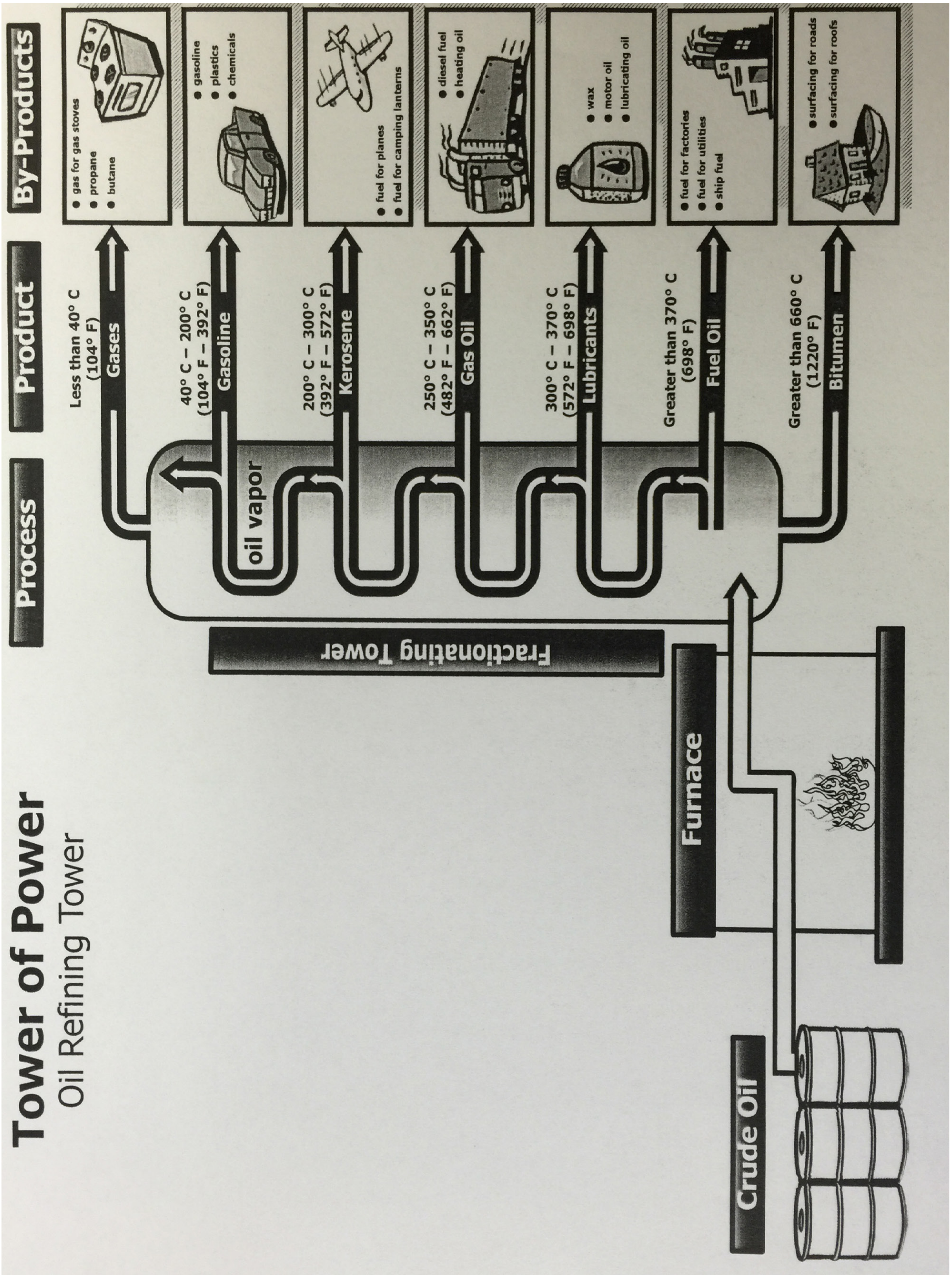
Name _____ Date _____

Part 2 - Heat It Up:

During extraction, crude oil and natural gas may become contaminated with water, sediment, and other contaminants. Once the oil and natural gas flow out of the wellhead, they must be separated before they are sold. The petroleum enters a closed vessel called a separator. In the separator, the force of gravity separates the natural gas, oil, and water, due to their different densities. The natural gas is pumped through pipelines for use. Oil and water flow into an apparatus called a heater treater. Water and oil separate while in the heater treater. Once these liquids have been separated, the crude oil is ready to be sold.

Once crude oil is purchased, it is transported to a refinery. There the crude oil is refined, or processed to remove impurities and separate it into different parts, or fractions. Crude oil is heated, and due to the different boiling points of the hydrocarbons in the crude oil, the fluids separate into different fractions. This process is called fractional distillation. Fractional distillation produces the different fractions of oil that can be transformed into products we use every day! After different fractions are separated, they are pumped into storage tanks.

Name ______________________________ Date ________________

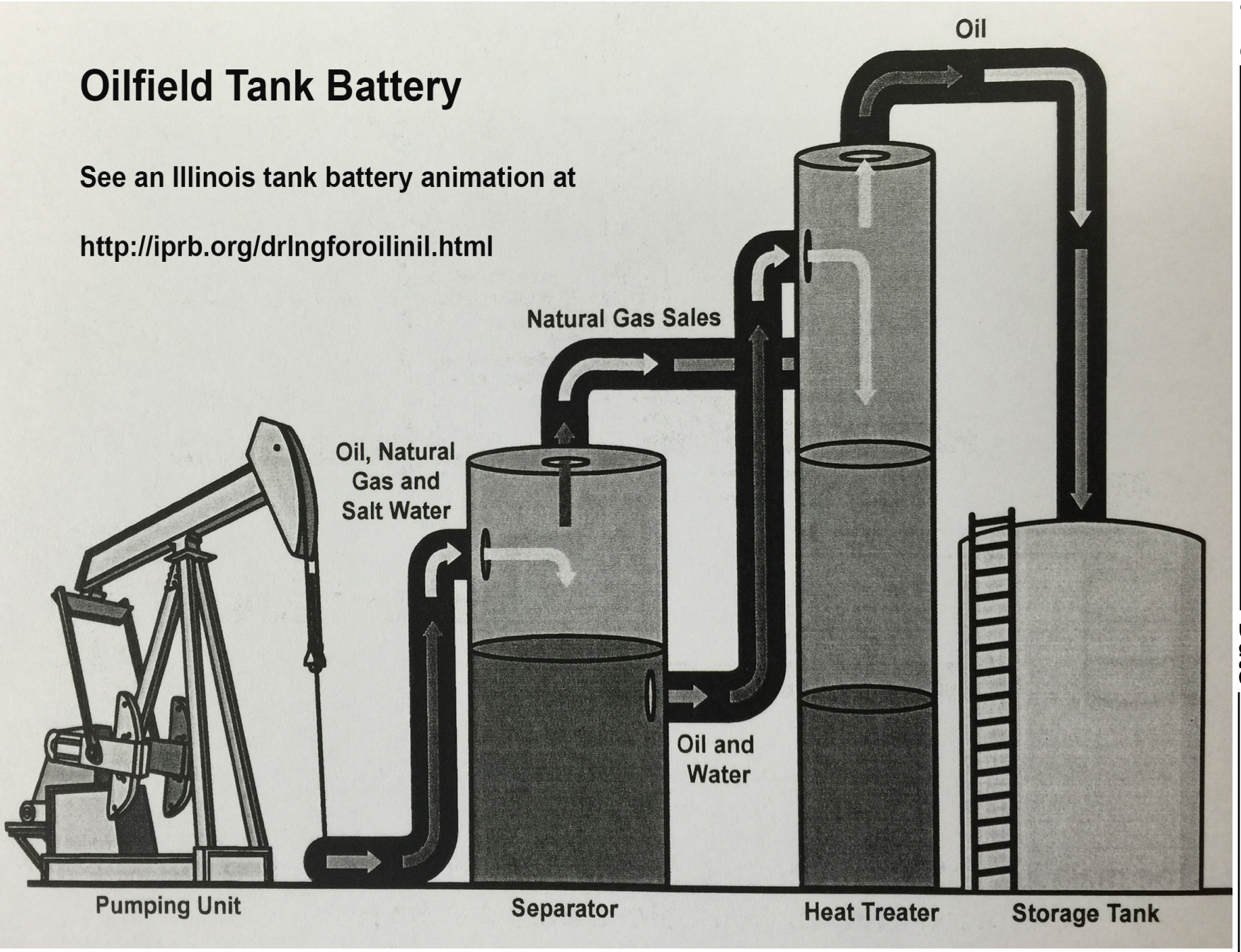

Tower of Power
Oil Refining Tower
Process
Product
By-Products
Crude Oil
Furnace
Fractionating Tower
oil vapor
Less than 40° C
(104° F)
Gases
gas for gas stoves
propane
butane
40° C – 200° C
(104° F – 392° F)
Gasoline
gasoline
plastics
chemicals
200° C – 300° C
(392° F – 572° F)
Kerosene
fuel for planes
fuel for camping lanterns
250° C – 350° C
(482° F – 662° F)
Gas Oil
diesel fuel
heating oil
300° C – 370° C
(572° F – 698° F)
Lubricants
wax
motor oil
lubricating oil
Greater than 370° C
(698° F)
Fuel Oil
fuel for factories
fuel for utilities
ship fuel
Greater than 660° C
(1220° F)
Bitumen
surfacing for roads
surfacing for roofs

Name _____ Date _____

Oilfield Tank Battery

See an Illinois tank battery animation at

http://iprb.org/drlngforoilinil.html



Name _____ Date _____

Lucky

Illinois Academic Standards-English/Language Arts

Grades 6-8

Science and Technical Subjects-Reading

Integration of Knowledge and Ideas

6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic

Science and Technical Subject-Writing

Text Types and Purposes

6-8.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

Research to Build and Present Knowledge

6-8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation

Speaking and Listening

Presentation of Knowledge and Ideas

6.5 Include multimedia components (e.g., graphics, images, music, sound) and visual displays in presentations to clarify information.

7.5 Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points.

8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.

Lucky

Time: 1 class period

Wonder Why . . .

Have you ever wondered what dangers are present around oil field equipment?

Concept

Oil field equipment and the area surrounding them can be extremely dangerous. People who are not trained professionals, should not play or hang out around the equipment.

Teacher Information

Unfortunately, several incidents across the U.S. have resulted in the unnecessary deaths of young people. Oil field safety is an important and vital issue that needs to be addressed.

Vocabulary

Hazard: Any source of potential danger.

Hydrogen Sulfide: An extraordinarily poisonous gas produced by sulfur consuming bacteria at oil wells. It has a molecular formula of H_2S. At low concentrations, H_2S has the odor of rotten eggs, but at higher, lethal concentrations, it is odorless. H_2S is hazardous to workers and a few seconds of exposure at relatively low concentrations can be lethal, but exposure to lower concentrations can also be harmful.

Pumping Unit: The moving lever-like device above an oil well which is used to mechanically lift liquid out of the well.

Storage tanks: A group of connected cylindrical tanks that receive crude oil production from an oil well. In the storage tank, the oil volume is measured and tested before before being transported to a refinery.

Student Activity 1

Materials

- Newspaper Article: *Teen Loses Arm in Oil Pump Jack Accident*
- Video "Lucky" (https://iprb.org/education/classroom-curriculum/references/

Procedure

1. View video "Lucky." **https://iprb.org/education/classroom-curriculum/references/**
2. Read article *Teen Loses Arm in Pump Jack Accident*. (Teacher can read aloud, or students can read silently)
3. Individually, or as a group, ask students to respond to the following questions. Have students share their responses with the class.
    - Summarize the actions the individual was doing which caused the accident.
    - Formulate a reason why was this person chose to engage in this activity?
    - Analyze and describe how this individual's life has been changed and will be different as a result of this accident. Provide at least three changes.
4. Ask students to identify and compile a list of all of the possible hazards depicted within the video. List all of the hazards on a flip chart or white board.

Student Activity 2

Materials

• Oil Field Safety Fast Facts (see below)

Procedure

1. Cut the Oil Field Safety Fast Facts into strips and place into a box or basket.
2. Put students in groups of 2 or 3 and have them draw out one of the facts.
3. Ask each group to creat a product, such as a short rap, poem, song or slogan to convey the meaning of their fact and share with members of the class.

Example Rap:
The weights, they are heavy—They travel up and down
They move round in a circle—While they travel all around
Now if you get caught—You'll get smashed like a bug
And even if you're fast—It will flatten out your mug!
So stay away from well sites—Go somewhere else to play
And you can stay real healthy—And live another day.

Extension

- Write a letter to the editor of a local newspaper to inform the public about the hazards present near well sites and the importance of staying away from them, if you are a untrained professional.

Teen Loses Arm in Oil Pump Jack Accident

Newson6.com
Posted: Feb 08, 2009 4:47 PM CST
Updated: Feb 19, 2010 9:37 AM CST

OKLAHOMA CITY -- A 17-year-old lost his arm Sunday after trying to ride an oil pump jack.

The incident happened at N.W. 104th Street and Hudson Avenue. The victim, a 17-year-old, and his friend climbed the fence, turned on the equipment and tried to ride the pump jack, firefighters said.

Oklahoma City Fire Deputy Chief Clay said when they arrived on scene they realized a "field amputation" was necessary because the 17-year-old's arm had been pinned and crushed.

"Try to remember that what appears to be fun may end up deadly or maiming. I would caution when they hear stories about riding oil or pump jacks, or messing with them, to just write that off. It's not fun when something bad happens," Deputy Fire Chief Clay said.

The friend flagged down a taxi driver to call an ambulance and help turn off the equipment.

The victim's arm had to be amputated at the scene. The teen was airlifted to OU Medical Center.

The victim's name and condition have not been released.

The company that owns the pump jack, Toland and Johnson Inc., said they are upset by the incident, and wish the teen the best in his recovery.

Steve Slawson, Education Chariman of the Oklahoma Energy Resources Board, said their group sends out crucial messages on the dangers of oil well sites, but it can't be repeated enough.

"An oil well is like an outdoor factory, it's got moving machine rigs, electrical connections and combustibles and it's dangerous," Slawson said. "My hope is through his bad experience that other kids will get this message to stay away from oil well sites."

Many pump jacks turn on and off by an automatic timer. In Oklahoma City, well owners are required to fence their machinery, but there is no requirement to hide or key the manual on-off switch, said Mindy Stitt, executive director of the Oklahoma Energy Resources Board, which cleans up abandoned oil wells and educates the public about the industry.

She said representatives from her organization frequently visit schools and tell children to stay away from the thousands of pump jacks that dot the landscape in oil country.

Other accidents involving young people and oil field equipment have occurred over the years, including the deaths of three children who sparked an explosion by lighting a match near an oil tank in Duncan in 1996.

Oilfield Safety Fast Facts

Oilfield equipment can be extremely dangerous, and people should not "hang around" tank batteries and pumping units. Some of the dangers are:

Storage Tanks

- The smallest spark, especially a cigarette or lighter, can cause an explosion from fumes or flammable liquids.

- Anyone opening a hatch might be overcome with fumes and pass out.

- The stairs and rails, which can be as high as two stories, can be covered with oil and be slippery, causing someone to fall down the stairways or over the side.

Pumping Units

- The counterweights weigh up to 20,000 pounds and will crush a human body without stopping. Anyone who falls off the beam or tries to ride the weights can be seriously injured or accidentally killed.

- Anyone who tries to grab the cable on the front of the unit can have their hands cut off as the cable travels up and down.

- The numerous moving parts of a pumping unit can catch, then injure or even kill a person.

- Electrical boxes, wires and components operate at high voltage. Anyone who touches them could receive serious electrical shock.

- Even if a pumping unit is stopped, it is NOT safe. Many units are on timers that start without warning, causing harm if a person is on the unit.

Other Equipment

- Some heater treaters (long, tall tanks) operate at extreme temperatures that could cause burns.

- Many fences are topped with barbed or razor wire, which could cause serious injury.

- Pipelines could leak or explode if tampered with by untrained personnel.

- Chemicals are sometimes used at oilfield sites and could cause burns if touched.

Precious Pretzels

Illinois Academic Standards-English/Language Arts

Grades 6-8

Science and Technical Subjects-Reading

Key Ideas and Details

6-8.1 Cite specific textual evidence to support analysis of science and technical texts.

Integration of Knowledge and Ideas

6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

Illinois Academic Standards-Mathematics

Grade 6

Reason about and solve one-variable equations and inequalities

6.EE.6 Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set.

Understand ratio concepts and use ratio reasoning to solve problems.

6.RP.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.

Grade 7

Solve real-life and mathematical problems using numerical and algebraic expressions and equations.

7.EE.4 Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities

Analyze proportional relationships and use them to solve real-world and mathematical problems.

7. RP. 2 Recognize and represent proportional relationships between quantities.

Next Generation Science Standards

Grades 6-8

Earth and Human Activity

MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment

Precious Pretzels

Time: 2-3 class periods

Wonder Why . . .

Have you ever wondered what you can do to conserve petroleum resources?

Concept

Petroleum is considered a non-renewable energy resource. Conserving petroleum is important; however conservation does require a conscience effort and wise decision making.

Teacher Information

The international oil-supply crisis of the 1970's brought new concerns about our reliance on non-renewable petroleum resources. Governments, consumers and industry focused attention on energy conservation. One result was an improvement in the fuel efficiency of motor vehicles.

Consumers make many of the key decisions about the future of oil and natural gas. What consumers purchase, where they live and work and how they play are major factors in determining the demand for energy and chemicals. In addition, consumers elect politicians who set policies which play a critical role in the operations of the oil and natural gas industry.

Science and technology also affect decision-making concerning oil and natural gas. As ways are found to use these fuels more cleanly and efficiently, the petroleum era is extended through the twenty-first century and beyond.

Student Activity 1

Materials

- Calculator

Procedure

1. Assign each group of three students a Toyota Prius (50 miles per gallon, 12 gallon tank), a Chevrolet Camaro (22 miles per gallon, 19 gallon tank), or Ford F-150 (15 miles per gallon, 31 gallon tank).
2. Tell the students that they live 25 miles from their place of employment. Assuming that the vehicle was completely full of gasoline every Monday morning, how many times during the month will you need to fill up if you only drive back and forth to work? What will the cost of fuel just to drive to work be for one month? (Use the price per gallon for one gallon of 87-octane gasoline at the nearest fuel station and remember to include the initial fueling)

   Answer: The Prius will need to fill up 1 time, the F-150 and Camaro will need to fill up 2 times.

   Example: The cost of the Prius will be ($3.50 * 12 gallons) x 2 fuelings (1 initial fueling and 1 fueling during the month) = $84.00;

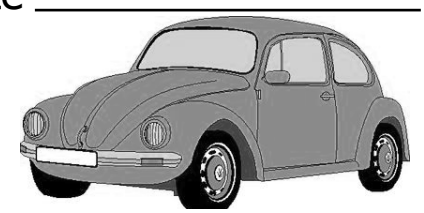
   The cost of the Camaro will be ($3.50 * 19 gallons) x 3 fuelings (1 initial fueling and 2 fuelings during the month) = $199.50

   The cost of the F-150 will be ($3.50 * 31 gallons) x 3 fuelings (1 initial fueling and 2 fuelings during the month) = $325.50

Name _____ Date _____

Precious Pretzels

Student Sheet



Wonder Why . . .

Have you ever wondered what you can do to conserve petroleum resources?

Student Activity 1

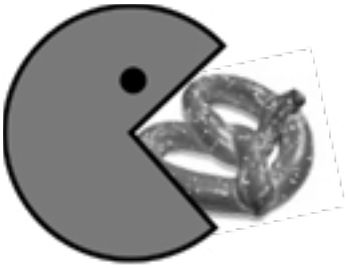
Materials

- Calculator

Procedure

1. Each group of three students has a Toyota Prius (50 miles per gallon, 12 gallon tank), a Chevrolet Camaro (22 miles per gallon, 19 gallon tank), or Ford F-150 (15 miles per gallon, 31 gallon tank).
2. Students live 25 miles from their place of employment. Assuming that the vehicle was completely full of gasoline every Monday morning, how many times during the month will you need to fill up if you only drive back and forth to work? What will the cost of fuel just to drive to work be for one month? (Use the price per gallon for one gallon of 87-octane gasoline at the nearest fuel station and remember to include the initial fueling)

Precious Pretzels



Student Activity 2

Materials

- Five small pretzels per participant
- One NEARVILLE sign
- Car tags

Teacher Preparation

This activity is a game that will simulate conservation of non-renewable resources. Students will travel from HOME to NEARVILLE and back to HOME. There should be 50 steps between HOME and NEARVILLE. Students should not know how many steps are between locations. Mark the spaces and tape the sign to the floor or wall before the students arrive.

General Game Rules:

- The object of the game is to find the most efficient means of transportation.
- Each pretzel represents one gallon of fuel.
- Each step represents one mile.
- A step is heel-to-toe.

Procedure

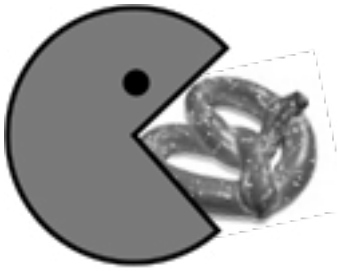
1. Give each student five pretzels.
2. Hand out a car tag to each player.
3. Have each player read their car name tag to find out what kind of car they have, how many passengers they can carry, and how many MPG they can go. (Remember, MPG is equal to steps per pretzel)
4. Travel
    - Instruct students to drive his/her car from HOME to NEARVILLE and back to HOME.
    - Line up at HOME, eat one pretzel and take the appropriate number of steps.
    - Continue this until you run out of pretzels.
    - Stop at the point you ran out of pretzels. (Ran out of gasoline)
5. Discuss which cars got to NEARVILLE and back HOME. Discuss alternatives to everyone driving his/her own car.

Name _____ Date _____

Precious Pretzels

Student Sheet

Student Activity 2



Materials

- Five small pretzels per participant
- One NEARVILLE sign(see below)
- Car tags(see below)

General Game Rules:

- The object of the game is to find the most efficient means of transportation.
- Each pretzel represents one gallon of fuel.
- Each step represents one mile.
- A step is heel-to-toe.

Procedure

1. Each student gets five pretzels.
2. Each student gets a car tag.
3. Read your car name tag to find out what kind of car you have, how many passengers you can carry, and how many MPG you can go. (Remember, MPG is equal to steps per pretzel)
4. Travel
    - Drive your car from HOME to NEARVILLE and back to HOME.
    - Line up at HOME, eat one pretzel and take the appropriate number of steps.
    - Continue this until you run out of pretzels.
    - Stop at the point you ran out of pretzels. (Ran out of gasoline)
5. Discuss which cars got to NEARVILLE and back HOME. Discuss alternatives to everyone driving his/her own car.

Precious Pretzels

Student Activity 3

Materials

- Five small pretzels per participant
- One FARVILLE sign(see below)
- Car tags(see below)

Teacher Preparation

The object of this activity is to find the most efficient means of transportation. Students will travel from HOME to FARVILLE and back to HOME. This activity can involve the entire class or can be done as a class demonstration by using six students. There should be 300 steps between HOME and FARVILLE. To play the game in a smaller area such as a classroom, shorten the distance between HOME, NEARVILLE and FARVILLE to 30 steps between each and give only two pretzels.

General Game Rules:

- The object of the game is to find the most efficient means of transportation.
- Each pretzel represents one gallon of fuel.
- Each step represents one mile.
- A step is heel-to-toe.
- Fuel pretzels may be shared by car pool members, or they can take turns driving.
- A bus can carry everyone.
- Passengers can take turns driving the bus.

Procedure

1. Give each student five pretzels.
2. Keep the same car chosen in Round One.
3. Have each player read their car name tag to find out what kind of car they have, how many passengers they can carry, and how many MPG they can go. (Remember, MPG is equal to steps per pretzel)

4. Travel
    - Instruct students to negotiate with the other members of the class and use some of the alternatives discussed in Activity One. The goal is to go from HOME to FARVILLE and back HOME.
    - After negotiating travel plans, line up at HOME.
    - The driver of the vehicle should eat the pretzel and everyone in the vehicle should take the steps. The driver may eat the passengers' pretzels for fuel, or the students may take turns driving.
    - Stop at the point you ran out of pretzels. (Ran out of gasoline)
5. Discuss who made it to FARVILLE and back HOME? How did they accomplish this? Who did not complete the trip to FARVILLE and back HOME? Why?

Conclusion

1. Which vehicle is the most fuel efficient? Which vehicle is the least fuel efficient? **Answers will vary.**
2. Considering the amount of energy used per passenger, which vehicle is the most efficient? Least efficient? **Answers will vary.**
3. What are the advantages of using mass transportation over individual vehicles? What are the disadvantages? **Answers will vary.**
4. How does having twice as many people in a vehicle affect the amount of fuel needed per passenger? **Possible answer: Less fuel is needed.**
5. If your car travels 330 miles on a tank of gasoline and your gas tank holds 15 gallons of gasoline, what is the MPG of your car? **Answer: 22 MPG**
6. Why do some people choose not to car pool or use mass transportation? **Answers will vary.**
7. How would you go about convincing these people of the need for sharing rides? **Answers will vary.**

Extensions

Assign students to groups of no more than three and hand out the Illinois Road Map to each group. You and your friends are on a road trip to see Ronald Regain's boyhood home in Dixon, IL. You are traveling in the vehicle assigned by your teacher previously (Camaro, F-150, or Prius). Your group stops and fuels the vehicle completely full in Metropolis, IL. As you near Peoria, IL you notice signs that say that this is the last place to fill you gasoline tank before reaching your destination. Using the information about fuel economy on your assigned vehicle, discuss if you can make it to Dixon, IL and back to Peoria, IL without stopping for fuel? **Answer: Prius will make it to Dixon and back to Peoria. The F-150 and Camaro need to fill up or they will run out of gas.**

You and 11 other coworkers need to make a round trip from Springfield, IL to Little Rock, AR (443 miles) for a conference. In order to save the company money, you will need to rent vehicles from the IPRB Rental Agency list. (Supply students will a list of possible cars from the Summary of Car Tags). The cost of rental is the same for each vehicle ($50 per day). Your task is to rent a combination of vehicles to transport your work groups to Little Rock, AR in the most efficient (i.e. cheapest) manner. Note: Only one of each vehicle on the list is available for rental. Students should put together a document with vehicles requested and the cost of travel for the vehicles chosen. Remember to include the cost for each vehicle.

Example Answer:

Vehicle 1: Suburban

Vehicle 2: Dodge Caravan

$100 rental fees

$121 gas for Suburban with gas @ @2.74/gallon

$126 gas for Dodge Caravan with gas @ $2.74/gallon

Summary of Car Tags

Vehicle: Toyota Prius MPG: 46 (46 steps/pretzel) Passengers: 4 Fuel Tank Capacity: 11.9 gal	Vehicle: Ford Focus MPG: 30 (30 steps/pretzel) Passengers: 4 Fuel Tank Capacity: 12.4 gal	Vehicle: Cadillac CTS MPG: 27 (27 steps/pretzel) Passengers: 5 Fuel Tank Capacity: 18.0 gal
Vehicle: Dodge Caravan MPG: 20 (20 steps/pretzel) Passengers: 7 Fuel Tank Capacity: 20 gal	Vehicle: Mercedes Benz C250 MPG: 26 (26 steps/pretzel) Passengers: 4 Fuel Tank Capacity: 17.4 gal	Vehicle: Dodge Ram MPG: 25 (25 steps/pretzel) Passengers: 2 Fuel Tank Capacity: 32.0 gal
Vehicle: Porsche 911 MPG: 17 (17 steps/pretzel) Passengers: 2 Fuel Tank Capacity: 23.8 gal	Vehicle: Volkswagen Jetta MPG: 24 (24 steps/pretzel) Passengers: 4 Fuel Tank Capacity: 18.0 gal	Vehicle: BMW 328i MPG: 28 (28 steps/pretzel) Passengers: 4 Fuel Tank Capacity: 15.8 gal
Vehicle: Lamborghini Aventador MPG: 9 (9 steps/pretzel) Passengers: 2 Fuel Tank Capacity: 23.8 gal	Vehicle: Chevrolet Corvette MPG: 26 (26 steps/pretzel) Passengers: 4 Fuel Tank Capacity: 14.5 gal	Vehicle: Hummer H1 MPG: 8 (8 steps/pretzel) Passengers: 5 Fuel Tank Capacity: 32.0 gal
Vehicle: Chevrolet Impala MPG: 31 (31 steps/pretzel) Passengers: 5 Fuel Tank Capacity: 17.0 gal	Vehicle: Honda Civic MPG: 32 (32 steps/pretzel) Passengers: 4 Fuel Tank Capacity: 13.2 gal	Vehicle: Honda Accord MPG: 29 (29 steps/pretzel) Passengers: 5 Fuel Tank Capacity: 17.2 gal
Vehicle: Chevrolet Equinox MPG: 32 (32 steps/pretzel) Passengers: 5 Fuel Tank Capacity: 18.8 gal	Vehicle: Nissan Versa MPG: 36 (36 steps/pretzel) Passengers: 4 Fuel Tank Capacity: 10.8 gal	Vehicle: Toyota FJ MPG: 20 (20 steps/pretzel) Passengers: 5 Fuel Tank Capacity: 19.0 gal
Vehicle: Toyota RAV-4 MPG: 34 (34 steps/pretzel) Passengers: 5 Fuel Tank Capacity: 15.9 gal	Vehicle: Nissan Maxima MPG: 22 (22 steps/pretzel) Passengers: 4 Fuel Tank Capacity: 10.8 gal	Vehicle: Toyota Tundra MPG: 17 (17 steps/pretzel) Passengers: 5 Fuel Tank Capacity: 26.4 gal
Vehicle: Kia Soul MPG: 31 (31 steps/pretzel) Passengers: 4 Fuel Tank Capacity: 12.0 gal	Vehicle: Subaru Forester MPG: 28 (28 steps/pretzel) Passengers: 5 Fuel Tank Capacity: 15.9 gal	Vehicle: Ford Mustang MPG: 20 (20 steps/pretzel) Passengers: 4 Fuel Tank Capacity: 16.0 gal
Vehicle: Jaguar Convertible MPG: 14 (14 steps/pretzel) Passengers: 2 Fuel Tank Capacity: 18.4 gal	Vehicle: Chevrolet Suburban MPG: 21 (21 steps/pretzel) Passengers: 9 Fuel Tank Capacity: 31.0 gal	Vehicle: Bus MPG: 4 (4 steps/pretzel) Passengers: 47 Fuel Tank Capacity: 60.0 gal

NEARVILLE
Population 15,414

FARVILLE
Population
367,183

Name _____ Date _____

Precious Pretzels

Student Sheet

Student Activity 3

Materials

- Five small pretzels per participant
- One FARVILLE sign
- Car tags

General Game Rules:

- The object of the game is to find the most efficient means of transportation.
- Each pretzel represents one gallon of fuel.
- Each step represents one mile.
- A step is heel-to-toe.
- Fuel pretzels may be shared by car pool members, or they can take turns driving.
- A bus can carry everyone.
- Passengers can take turns driving the bus.

Procedure

1. Each student gets five pretzels.
2. Keep the same car chosen in Round One.
3. Read your car name tag to find out what kind of car you have, how many passengers you can carry, and how many MPG you can go. (Remember, MPG is equal to steps per pretzel)
4. Travel
    - Negotiate with the other members of the class and use some of the alternatives discussed in Activity One. The goal is to go HOME to FARVILLE and back HOME.
    - After negotiating travel plans, line up at HOME.
    - The driver of the vehicle should eat the pretzel and everyone in the vehicle should take the steps. The driver may eat the passengers' pretzels for fuel, or the students may take turns driving.
    - Stop at the point you ran out of pretzels. (Ran out of gasoline)
5. Discuss who made it to FARVILLE and back HOME? How did they accomplish this? Who did not complete the trip to FARVILLE and back HOME? Why?

Name _____ Date _____

Conclusion

1. Which vehicle is the most fuel efficient? Which vehicle is the least fuel efficient?

2. Considering the amount of energy used per passenger, which vehicle is the most efficient? Least efficient?

3. What are the advantages of using mass transportation over individual vehicles? What are the disadvantages?

4. How does having twice as many people in a vehicle affect the amount of fuel needed per passenger?

5. If your car travels 330 miles on a tank of gasoline and your gasoline tank holds 15 gallons of gasoline, what is the MPG of your car?

6. Why do some people choose not to car pool or use mass transportation?

7. How would you go about convincing these people of the need for sharing rides?

Petroleum Power

Petroleum-based products

Wonder Why . . .

Have you ever wondered how many of the products you use today come from petroleum?

Concept

Petroleum is a part of our daily lives. Many products such as nylon, plastics and rubber come from petroleum-based polymers. Scientists have been able to develop polymers with many different properties.

Activity Four – Petroleum Products

Recognizing products made from petroleum.

Materials

- Handout entitled "Petroleum Power" (blackline master)

Discovery Procedure

1. Look around the classroom and list everything you see that is made from petroleum.
2. Review the "Petroleum Power" handout.

Concept Formation

1. How many items did you list?
2. How many more can you think of?
3. What do they all have in common? (Possible answer(s): They all contain hydrogen and carbon.)

Petroleum Power

A partial list of products made from Petroleum (144 of 6000 items)
One 42-gallon barrel of oil creates 19.4 gallons of gasoline.
The rest (over half) is used to make things like the following.

Ammonia	Dice	Ice Cube Trays	Shag Rugs
Anesthetics	Diesel fuel	Ink	Shampoo
Antifreeze	Dishes	Insect Repellent	Shaving Cream
Antihistamines	Dishwasher parts	Insecticides	Shoe Polish
Antiseptics	Dresses	Life Jackets	Shoes
Artificial limbs	Drinking Cups	Linings	Shower Curtains
Artificial Turf	Dyes	Linoleum	Skis
Aspirin	Electric Blankets	Lipstick	Slacks
Awnings	Electrician's Tape	Luggage	Soap
Balloons	Enamel	Model Cars	Soft Contact lenses
Ballpoint Pens	Epoxy	Mops	Solvents
Bandages	Eyeglasses	Motor Oil	Speakers
Basketballs	Fan Belts	Motorcycle Helmet	Sports Car Bodies
Bearing Grease	Faucet Washers	Movie film	Sun Glasses
Bicycle Tires	Fertilizers	Nail Polish	Surf Boards
Boats	Fishing Boots	Nylon Rope	Sweaters
Cameras	Fishing lures	Oil Filters	Synthetic Rubber
Candles	Fishing Rods	Paint	Telephones
Car Battery Cases	Floor Wax	Paint Brushes	Tennis Rackets
Car Enamel	Folding Doors	Paint Rollers	Tents
Cassettes	Food Preservatives	Panty Hose	Tires
Caulking	Football Cleats	Parachutes	Toilet Seats
CD Player	Football Helmets	Percolators	Tool Boxes
CD's & DVD's	Footballs	Perfumes	Tool Racks
Clothes	Footballs	Petroleum Jelly	Toothbrushes
Clothesline	Gasoline	Pillows	Toothpaste
Cold cream	Glycerin	Plastic Wood	Transparent Tape
Combs	Golf Bags	Purses	Trash Bags
Cortisone	Golf Balls	Putty	TV Cabinets
Crayons	Guitar Strings	Refrigerant	Umbrellas
Curtains	Hair Coloring	Refrigerators	Upholstery
Dashboards	Hair Curlers	Roller Skates	Vaporizers
Denture Adhesive	Hand Lotion	Roofing	Vitamin Capsules
Dentures	Heart Valves	Rubber Cement	Water Pipes
Deodorant	House Paint	Rubbing Alcohol	Wheels
Detergents	Ice Chests	Safety Glasses	Yarn

Americans consume petroleum products at a rate of three-and-a-half gallons of oil and more than 250 cubic feet of natural gas per day each! But, as shown here petroleum is not just used for fuel.

Petro-Geopardy!

Review

This activity is a review of the concepts and information presented in the Petro Active curriculum.

Procedure

1. Play Jeopardy (or spelling bee)-style game as a class or in groups. Suggestion: use a transparency of the Petro-Goepardy game board with the colored chips to cover points/ questions as they are selected.
2. Select a team to begin the game. The team should select a category from the board.
3. Read a question from the selected category. Student teams will then have five (5) seconds to ring in (or raise hand) and give the correct response. A correct response gains points and control of the board. If the question is not answered in five seconds, the other team(s) may ring in (raise hand) to answer the question. If the question is not answered, the team with control of the board last may ask another question from the board.

Categories and Points

Cooking Up Crude	Seismic Clatter	Petro Pockets	Oil Field Fractions	Polymer Power	Safety and Conservation
100	100	100	100	100	100
200	200	200	200	200	200
300	300	300	300	300	300
400	400	400	400	400	400
500	500	500	500	500	500

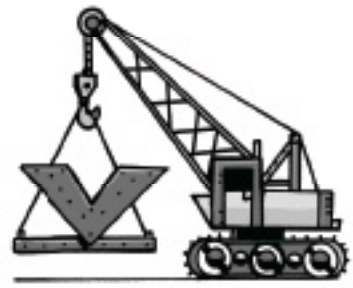
Categories and Answers

Cooking Up Crude	Seismic Clatter	Petro Pockets	Oil Field Fractions	Polymer Power	Safety and Conservation
Tiny Plants and Animals **100**	Seismic Waves **100**	Porosity **100**	Refining **100**	Hydrogen and Carbon **100**	Flammable **100**
Petroleum **200**	Density **200**	Permeability **200**	Natural gas, oil and water **200**	Monomer **200**	Petroleum **200**
Heat, Time and Pressure **300**	Reflection **300**	Displacement **300**	Hydrometer **300**	Cross-link **300**	Divide the no, of miles traveled by no. of gallons used **300**
Oxygen **400**	Seismic Mapping **400**	Impermeable **400**	Vaporization **400**	Polymer **400**	Mass Transportation **400**
Organic **500**	Anticline or Anticlinal Trap **500**	Waterflood & Gas Drive **500**	Distillation **500**	Cross-Linking **500**	Lighting matches around oilfield equipment, riding pumping units, tampering with electrical boxes, tank hatches, or chemicals **500**

Categories and Questions

Cooking Up Crude	Seismic Clatter	Petro Pockets	Oil Field Fractions	Polymer Power	Safety and Conservation
From what was petroleum made?	What low frequency sound waves locate distinctive rock formations and possible petroleum reservoirs?	What term refers to the percentage of holes in rocks?	What is the process of making crude oil usable?	What two elements do petroleum-based products contain?	What do you call liquids that can easily catch fire?
100	**100**	**100**	**100**	**100**	**100**
What is the name of a naturally occurring complex hydrocarbon?	What influences the speed of sound waves?	What is the term used to descibe the passing of a fluid through porous rock?	What are the three components of petroleum that require separation?	What term is given to one unit of a polymer?	What substance is considered a nonrenewable energy source?
200	**200**	**200**	**200**	**200**	**200**
What three things are needed to change sediment into rock?	What term is used to describe the bouncing of sound off objects?	What term is used to describe one medium moving in to replace another?	What instrument measures the density, or specific gravity, of liquids?	What is the term given to a unit that connects two chains of molecules?	How is MPG (miles per gallon) calculated?
300	**300**	**300**	**300**	**300**	**300**
What element is essential for the decaying of organisms?	What type of survey is used to plot the location of possible oil reservoirs?	What term describes a rock that does not allow liquid to travel through?	What term describes the process of a liquid rapidly changing to a gas or vapor?	What term describes substances containing large molecules formed from many small repeating units?	What is the mode of transportation which accommodates a large number of people, such as buses or trains?
400	**400**	**400**	**400**	**400**	**400**
What is the name used to describe substances containing carbon?	What type of geological formation occurs when layers of rock are folded upward by movements of the earth	What are two methods used to force oil from rock formations?	What term describes the process of separating crude oil into its components?	What describes the lateral bonding of long chain molecules into a web-like network?	What are three major causes of oilfield-related accidents?
500	**500**	**500**	**500**	**500**	**500**

Vocabulary Building



Algae – non-flowering stemless water plant

Autotrophic – independent of other organisms in respect of organic nutrition

Bacteria – one-celled microorganism lacking an organized nucleus

Carbonate – a major component of egg shells; the shells of marine organisms and limestone.

Conserve – to safeguard against harm, damage or waste

Cross-link – a unit that connects two chains of molecules

Decay – rot or decompose

Density – amount of mass that is in a certain volume of matter; Mass per volume; a sound wave travels more quickly through less dense rocks than those with a high density.

Displacement – taking the place of; replace another

Distillation – the process of separating the components of crude oil

Efficient – productive with minimum waste or effort

Emulsions – fine dispersions of one liquid in another

Evaporation – to turn from a solid or liquid into vapor

Fissures– a crack, split or narrow passage

Fossil fuels – natural fuel formed over millions of years from plant and animal remains

Flammable – able to burn; the ability to easily catch fire

Fractionating tower – a tall metal column used in processing liquid petroleum into its various components.

Gas drive – the use of natural gas to push oil out of a reservoir and into a well

Hydrocarbon – organic compounds of hydrogen and carbon whose densities, boiling points and freezing points increase as their molecular weights increase.

Hydrogen – tasteless, odorless gas, the lightest element, occurring in water and organic compounds

Hydrometer – an instrument used to measure the density of liquids

Impermeable – impossible to move through

Inorganic – of mineral origin; not containing the element carbon

Mass transportation – a mode of transportation which accommodates a large number of people such as buses or trains

Microorganisms – microscopic organisms; also referred to as microbes

Migration – moving from one place to another

Molecule – the fundamental unit of an element or compound

Molten – melted, made liquid by heat

Monomer – one unit of a polymer

Non-renewable – unable to replace or resupply

Organic – relating to or derived from living organisms containing the element carbon

Overlaying – to lay over or to cover

Oxygen – tasteless, odorless, gaseous element essential to plant and animal life

Permeability – ability of a fluid to flow within the interconnected pore network of a porous medium

Petroleum – a complex hydrocarbon occurring naturally in the earth in solid, liquid, or gaseous state; a naturally occurring complex hydrocarbon

Polymer – a compound of large molecules formed from repeated units of smaller molecules

Porosity – the ratio of the volume of empty space to the volume of solid rock in a formation, indicating how much fluid a rock can hold

Product – the end result of an experiment or process

Production – the phase of the petroleum industry that deals with bringing the well fluids to the surface

Refining – make or become polished; improve; to make usable

Reflection – to bounce from one surface to another (heat, light, sound)

Reservoir – a subsurface, porous, permeable rock body in which oil and/or natural gas has accumulated

Sedimentary rock – a rock composed of materials that were transported to their present position by wind or water

Seismic mapping – an exploration method in which strong low-frequency sound waves are generated on the surface or in the water to find subsurface rock structures

Seismic waves – sound waves of or relating to earth vibration, including those artificially induced

Separator – a closed vessel that aids in the separation of natural gas from oil and water and oil from water

Sound waves – vibration of air or other medium causing a sensation in the ear

Sulfate – salt or ester of sulfuric acid

Tank battery – a group of storage tanks and equipment located on a well site

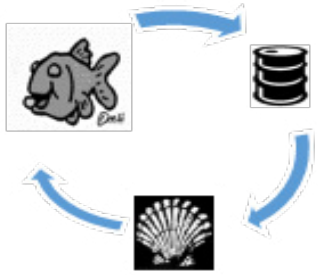
Vaporization – the process of a liquid changing into a vapor

Water flood – the injection of water into the water zone of some wells to push the oil and natural gas up the other wells

Name _____ Date _____

Cooking Up Crude

Student Sheet



Wonder Why . . .

Have you ever wondered how crude oil and natural gas form?

Vocabulary

Fossil: The remains or traces of animals or plants, which have been preserved almost exclusively in sedimentary rocks by natural causes in the earth's crust prior to recorded history.

Sedimentary Rock: A rock formed from the decomposition and cementation of sediments.

Igneous Rock: A rock formed from the cooling of molten rock (magma, lava).

Metamorphic Rock: A rock formed from an existing rock by the addition of heat and/or pressure not to exceed the melting point of rock (at which time it becomes an igneous rock)

Plankton: Microscopic plants and animals that float freely with ocean currents and in other bodies of water.

Phytoplankton: Microscopic plants that make up plankton. These tiny plants are at the base of the ocean food web.

Zooplakton: Microscopic animals that make up and eat other plankton.

Safety

Wash hands at the end of laboratory investigation.

Student Activity 1: Fossil Survey

Materials (per group of 4 students)

- Fossil Set (includes one brachiopod, horn coral, trilobite, and crinoid fossils)
- Fossil Guide
- Map of Illinois
- Illinois Fossils by County
- 2 hand lenses

Name _____ Date_____

Procedure

1. After receiving the fossil set, Map of Illinois and fossils guide from your teacher, begin by reading through the fossil guide.
2. Using the hand lenses, examine the fossil set and identify each fossil.
3. Discuss the environment in which each of these animals may have lived. Record your thoughts.

_____

_____

_____

4. Using the map of Illinois and the Illinois Fossils by County handout, locate and place the fossils on the map in the counties in which they could be found. Place one fossil per county.
5. Complete the chart.
6. On the following lines explain why these fossils are found in Illinois.

Fossil	Counties
Brachiopod	
Crinoid	
Horn Coral	
Trilobite	

_____

_____

_____

_____

_____

_____

Name _____ Date _____

Cooking Up Crude

Student Sheet

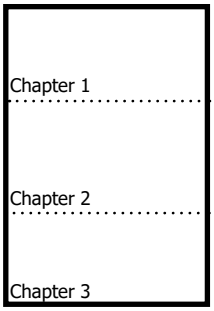
Student Activity 2: Formation of Oil and Natural Gas

Materials

- "Cooking Up Crude"
- Paper (8½" x 14")
- Map pencils

Procedure

1. Discuss your ideas of the formation of oil and natural gas with your group.
2. Remove everything from your desks except an 8½-inch x 14-inch sheet of paper. Divide the paper into three equal sections by drawing two lines across the width of the paper. Label the sections: Chapter 1, Chapter 2 and Chapter 3.



3. Begin listening to "Cooking Up Crude."
4. Read the narrative silently.
5. Make any necessary changes to your drawings representing the formation of crude oil and natural gas
6. Discuss your drawings with the class.

Cooking Up Crude Narrative

Narrator:

I am going to tell you a story about the history of the formation of oil and natural gas in the state of Illinois. This story will be told in three short chapters. When I finish each chapter, I would like for you to draw a picture representing what you have just heard. Please begin drawing when I say, "Can you picture this scene?" Let's begin.Chapter One

Chapter One

544 million years ago — a geologic period known as the "Paleozoic Era" began—a large sea covered much of the United States, including what is now Illinois. In this sea lived a vast number of microscopic plants and animals called plankton. This microscopic plankton drifted on or near the surface of the water and became so numerous that it could actually be seen with the naked eye.

Throughout the "Paleozoic Era" the sea was also alive with trilobites, corals, crinoids, brachiopods and a host of other marine plants and animals that were evolving over many millions of years. A trilobite was a strange-looking little creature. Small grooves divided its body and hard segmented shell into three vertical parts. Its head was covered by a semicircular shield. Many kinds of trilobites lived in the seas that covered Illinois.

Coral, which still exists today, came in many different sizes, shapes and colors. The coral polyps were simple animals that were able to take calcium out of saltwater and convert it into a rocklike shelter, in which they lived.

Crinoids anchored themselves to the sea floor with a root-like structure that supported a long stalk or column. On top of this stalk was a cup-like cavity, which formed a protective case for a flower-like structure that was used to catch tiny particles of food as they drifted by.

Brachiopods were clam-like animals that lived on the sea floor. Their two-piece dorsal and ventral shells enclosed and protected their soft body parts just like clams and oysters today.

Although during this time Illinois was covered by the sea, other parts of the world were exposed as land. As rivers, wind, rain, avalanches, and ice movements eroded the surrounding landscape, tiny particles—called clastic sediments—were carried into the sea where the billions of tiny sea creatures lived.

All organisms on Earth contain carbon. Billions of tiny plankton can contain quite a large amount of carbon. As these numerous lifeforms in the sea of the Paleozoic era died, their remains settled to the deep sea floor and became covered with the mud, sand and sediment from the eroding mountains and surrounding areas.

If these dead plankton and other sea creatures were buried quickly on the deep sea floor, the sediment would protect them from being exposed to oxygen, which is necessary for decay (or decomposition). If the dead organisms don't decay, the carbon in their remains can be preserved. If a layer has a particularly large amount of carbon, we tend to call it "organic rich".

In Illinois several thin organic-rich layers were deposited, but the thickest, and by far the most important one, was deposited in the middle of the Paleozoic Era, about 360 – 350 million years ago.

Can you picture this scene?

Chapter Two

For perhaps another 100 million years, sediments continued to bury our organic-rich layer. By now it was the last of the Paleozoic Era and the layers of sediments on the sea floor have become thousands upon thousands of feet thick.

The weight and depth of all this rock created immense pressure and heat that began to affect the buried organic rich layers.

About this time the seas were leaving Illinois and no more sediments were being deposited. Even so, the heat and pressure continued to work on these buried sediments and were responsible for slowly changing the inorganic layers into sedimentary rock.

The rare, organic-rich layers were changed into what geologists call source rock – and it is only in these source rocks where the dead organic material can slowly change into hydrocarbons – which are compounds containing only hydrogen and carbon.

Can you picture this scene?

Chapter Three

A few million years later, or around 248 million years ago, the Mesozoic Era began. It was the "Age of Reptiles". Illinois was now dry land and would never again be covered by the sea. From that time through the entire Mesozoic Era - - and through the entire Cenozoic Era - - all the way until today, the animals that plodded, walked, and flew across Illinois had no idea that pressure and heat were continuing to act on the layers of sedimentary rock deep beneath their feet.

The effects of the heat and pressure over all this time formed many layers of sedimentary rock under the Illinois area, including the organic-rich source rock. Much of the water that was in the ancient sea is now in the pore spaces of the sedimentary rocks. The remaining water evaporated or was pushed into areas where seas or oceans now exist.

For over 250 million years, temperatures ranging from 150-300 degrees Fahrenheit have "cooked" the organic materials in the buried sediments causing a complex chemical change creating oil and natural gas.

Molecule by molecule the oil and gas was pushed out of the source rock and migrated into porous reservoir rocks in other layers. It's in these reservoir rocks that we find oil today.

Can you picture this scene?

As you finish drawing the last scene, keep in mind that there are several theories concerning the formation of oil and natural gas. What you have just heard is the most widely accepted scientific theory.

Name _____ Date _____

Petro Pockets

Student Sheet

Wonder Why . . .

Have you ever wondered how oil is able to move through rocks?

Vocabulary

Permeability: The ability of a fluid to flow within the interconnected pore network of a porous medium.

Porosity: The ratio of the volume of empty space to the volume of solid rock in a formation indicating how much fluid a rock can hold.

Wellbore: The hole drilled by the drill bit, also known as a borehole.

Safety

Water can be disposed of by pouring it down the drain after use and wipe up any spills

Do not throw any of the rocks.

Student Activity 1

Materials

- Rock samples (limestone, shale, and sandstone)
- Digital balance
- Plastic cups
- Hand lenses
- Paper Towels
- Water

Procedure

1. Look closely at the three rock samples provided by your teacher. These rocks are typically found in Illinois and which may or may not contain oil.
2. Discuss in class, "Do these rocks contain holes in them?"
3. Find the mass of each of the three rocks and record the mass of each rock.

Name _____ Date _____

4. Place each rock into clear 9 ounce cups and fill ¾ full with tap water so that the rocks are completely covered.

5. Observe rocks for about 5 minutes and record observations in Table 1.

Table 1

Rock Type	Observations

6. Let set overnight.

7. At the beginning of class the next day, remove each rock individually from the water, pat dry, and find the mass.

8. After recording the mass, calculate the change in mass and the percentage of change (change in mass/Day 1 mass x 100).

$$\frac{\text{change in mass (g)}}{\text{day 1 mass (g)}} \times 100 = \text{\% of change in rock mass}$$

Data Table 2

Rock Sample	Day 1 Mass (g)	Day 2 Mass (g)	Mass Change (g)	% of Change in Rock Mass
A				
B				
C				

Note: Porosity is more accurately defined by volume rather than mass. However, 1 gram of pure water has a volume of 1 mL, so if a rock gained 5 grams then 5 mL of water has entered the pores of the rock.

Name _____ Date _____

Petro Pockets

Student Sheet

Student Activity 2

Materials (per group)

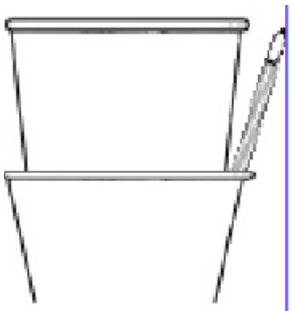
- Water (300 mL)
- 3 Styrofoam cups (16 oz)
- 3 Plastic cups (9 oz)
- 3 Stir sticks
- Stopwatch
- Sand
- Small pebbles
- Large pebbles
- 100 mL graduated cylinder
- Sandwich bags (3)
- Black Marker
- Ruler
- Plastic spoon

Procedure

1. In Table 4, predict what will happen when water is poured through each of the 3 substances.
2. Prepare cups by using coffee stirrers to poke three holes in the bottom of all three styroform cups.
3. Using a permanent marker, draw a horizontal line on the side of each styroform cup. The line should be 5 cm from the bottom of the cup.
4. Draw a horizontal line on the side of the plastic cups. The line should be 3 cm from the bottom of the cup.
5. Determine how many milliliters of water are required to fill the plastic cup to the mark on the side.
6. Pre-wet the sand and pebbles by placing them in separate sandwich bags and adding water. Pour off any excess water.
7. Fill one styrofoam cup to the line with the wet sand. Repeat for small and large pebbles.

Name _____ Date _____

8. Place the styrofoam cups filled with sand and pebbles into each of the three clear plastic cups.
9. To prevent an "airlock," slide the coffee stir stick between the two cups. (see diagram)
10. To begin the first trial of the sand permeability test, pour 100 mL of tap water at once into the sand cup.
11. START TIMING the flow as soon as the water begins to drip into the plastic cup.
12. STOP TIMING when the water level reaches the mark on the plastic cup.
13. Record the time (in seconds) on the Data Table 3.
14. Repeat steps 5-8 for the second sand trial.
15. Repeat this entire procedure using the small pebbles and then the larger pebbles.



Cup Setup

Cup Setup

Note: Sand and pebbles may be dried and reused year after year.

Conclusion

1. Complete Data Table 3 with the data collected during the procedure.
2. Calculate the mean for the two trials of each substance.
3. Calculate the flow rate by dividing the mL of water by the Flow Time Means.

Table 3

Substances	Volume	Flow Time (s) Trial 1	Flow Time (s) Trial 2	Flow Time (s) Mean	Flow Rate (mL/s)
Sand					
Small Pebbles					
Large Pebbles					

Name _____ Date _____

4. After examining the data and discussing the results, complete Table 4.

Table 4

What I Think Will Happen	What Happened	Why It Happened

5. Compare and contrast the sand, small pebbles, and large pebbles. Be sure to include a discussion of the size of the porosity and permeability the samples.

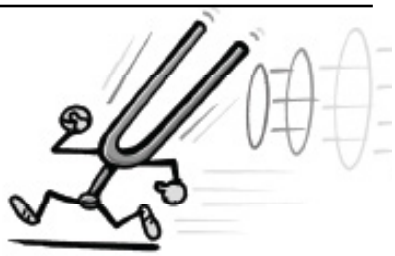
_____

_____

_____

_____

Name _____ Date _____



Traveling Sound

Student Sheet

Wonder Why . . .

Have you ever wondered if sound waves can travel through matter?

Vocabulary

Amplitude: The maximum amount of displacement of a particle on the medium from its rest position. The louder the sound the greater the amplitude and the amount of energy in the wave.

Compression: A point on a medium through which a longitudinal wave is traveling that has a maximum density.

Kinetic Energy: Energy due to motion.

Longitudinal Wave: The displacement of the medium is in the same direction as the motion of the wave.

Medium: Material through which a wave travels

Oscillation: Single back and forth motion.

Potential Energy: Energy due to position. Elastic potential energy allows the wave particle to return to its original position.

Pulse: A single vibration or short burst of sound, electric current, light, or other wave.

Rarefaction: A point on a medium through which a longitudinal wave is traveling that has the minimum density.

Reflect: The return of all or part of a sound beam when it encounters the boundary between two media.

Wavelength: The distance between any two identical points on a wave, such as, the distance between two successive compressions.

Safety

Do not throw materials. Handle tuning forks, slinky and heavy coil with care to prevent personal injury or damage to the equipment.

Student Activity 1

Observe the chain of ten students and what happens during the demonstration. Describe and identify the changes in energy that occur as the wave passes through the students.

Name _____ Date _____

Speed of a Wave

Student Sheet

Student Activity 2

The speed of a wave refers to how fast the compression of the wave (also called the pulse) is moving and is usually expressed as the distance traveled per time of travel. In equation form, speed= distance/time.

$$s = d/t$$

If the pulse on the slinky moves a distance of 20 meters in 10 seconds, then the speed of the wave is 2 m/s.

Materials

- Slinky
- Heavy coil
- Meter stick
- Stopwatch
- Calculator

Procedure

1. Predict if the speed of a wave will differ in the slinky and the heavy coil.
2. Stretch the slinky out on the floor a distance of 4 meters. Hold tightly to the slinky and do not over stretch the slinky.
3. With the slinky still stretched, create a pulse sharply by quickly moving your hand forward and back. Observe what happens when the pulse reaches the opposite end of the slinky.
4. Find the speed of the wave pulse on the slinky by using the stopwatch to time how long it takes for the pulse to travel down and back a distance of 8 meters. Record data in Table 2: Speed of a Wave.
5. Repeat steps 1-3 for three trials.
6. Repeat steps 1-4 using the heavy coil.
7. Calculate the average time for trials 1-3 for the pulse on the slinky. Record your answer in Table 2.
8. Calculate the average time for trials 1-3 for the pulse on the heavy coil. Record you answer in Table 2.
9. Calculate the average speed of the pulse on the slinky and the heavy coil. Record your answers in Table 2.

Name _____ Date _____

Table 2: Speed of a Wave

	Slinky	Heavy Coil
Distance (m)		
Time for Trial 1 (s)		
Time for Trial 2 (s)		
Time for Trial 3 (s)		
Average Time (s)		
Average Speed of Pulse (m/s)		

Conclusion

1. Compare and contrast how the speed of the wave differs in the slinky and the heavy coil

_____

_____

2. What variable (independent) did you change?

_____

_____

3. What conclusions can you draw from this data?

_____

_____

_____

Name _____ Date _____

Traveling Sound

Student Sheet

Student Activity 3

Materials (per group of 4 students)

- Rock samples (sandstone, shale, limestone)
- Tuning fork

Procedure

1. Predict if the type of rock will affect the sound produced and transmitted through the rock.
2. Working in pairs, have one student position a rock close to one ear (do not touch ear with rock) while covering the other ear with his/her hand. Have the partner strike the tuning fork and touch the base of the tuning fork to the rock.

Conclusion

1. Describe the process we used to test each rock.

   _____

   _____

2. How did this activity relate to the sound and rocks you just investigated?

   _____

   _____

3. Diagram how sound traveled from the tuning fork to your ear.

Name _____ Date _____

4. What was kept the same (controlled) as you investigated how sound travels in this investigation?

_____

_____

5. What was changed (independent variable) in this investigation?

_____

6. What can you infer caused the differences in the sounds?

_____

_____

_____

Name _____ Date _____

Seismic Clatter

Student Sheet

Wonder Why . . .

Have you ever wondered about technology that scientists use to locate crude oil and natural gas? How can you map something you cannot see?

Vocabulary

Angular unconformity: An unconformity in which the older strata dip at a different angle (generally steeper) than the younger strata.

Anticline: Formed when layers of rock are folded upward by earth movement.

Cap rock: A comparatively impervious stratum (p. strata) immediately overlying an oil- or gas-bearing rock.

Dip: The angle at which strata or any planar feature is inclined from the horizontal.

Fault: A fracture in a rock formation created when one section of the formation moves in relation to another.

Migration: The movement of oil, natural gas, and water through permeable rock.

Pinch out: Strata that thins or tapers to a disappearing edge.

Reservoir: A natural underground container of liquids, such as oil or water, and gases. In general such reservoirs were formed by local deformation of strata, by changes of porosity, and by intrusions.

Salt dome: The structure resulting from the upward movement of a salt mass, and with which oil and natural gas gas fields are frequently associated.

Seismic: Pertaining to, characteristic of, or produced by earthquakes or earth vibration, as, seismic disturbances.

Seismograph: Instrument which records seismic waves.

Shot Point: Position of sound generator

Strata: Sections of a formation that consist throughout of approximately the same kind of rock material. A single sedimentary bed or layer, regardless of thickness.

Stratigraphic trap: Geologic features formed by a change in the character or extent of the reservoir rock.

Syncline: Formed when layers of rock are folded downward by earth movement.

Unconformity: A surface or erosion or nondeposition, usually the former, which separates younger strata from older strata.

Name _____ Date _____

Student Activity 1

Materials

- Geological Faults and Folds Model (2 per group)
- Hydrocarbon Traps Handout

Procedure

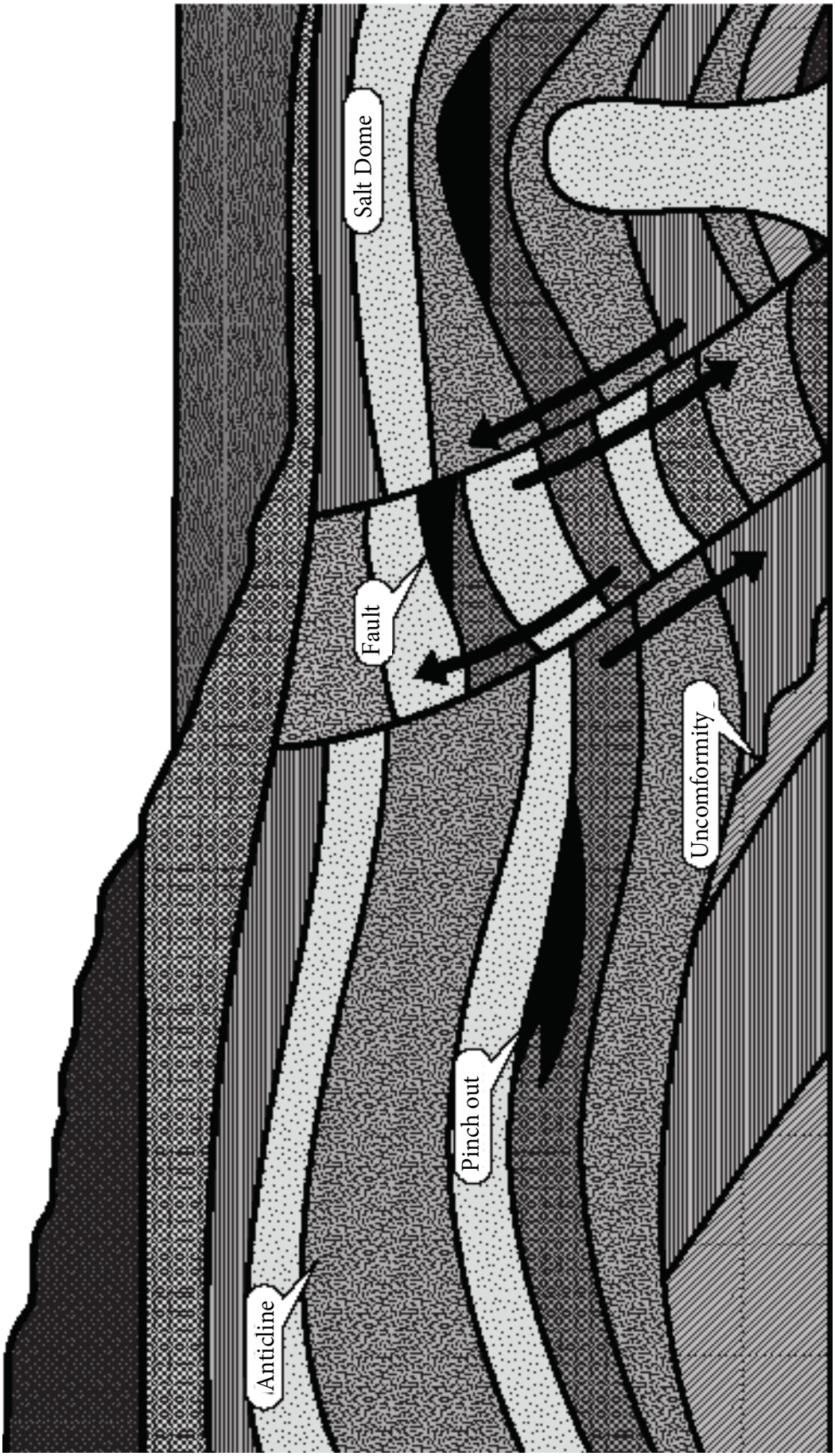
1. Discuss the various hydrocarbon traps identified on the handout with your group.
2. Model pieces to create folds and different types of faults.
3. In Table 1: Folds and Faults, illustrate each fold or fault that was created.

Table 1: Folds and Faults

Structure	Illustration
Anticline	
Syncline	
Fault 1	
Fault 2	
Fault 3	

Name _____ Date _____

Hydrocarbon Traps Handout



Name _____ Date _____

Seismic Clatter

Student Sheet

Student Activity 2

Materials

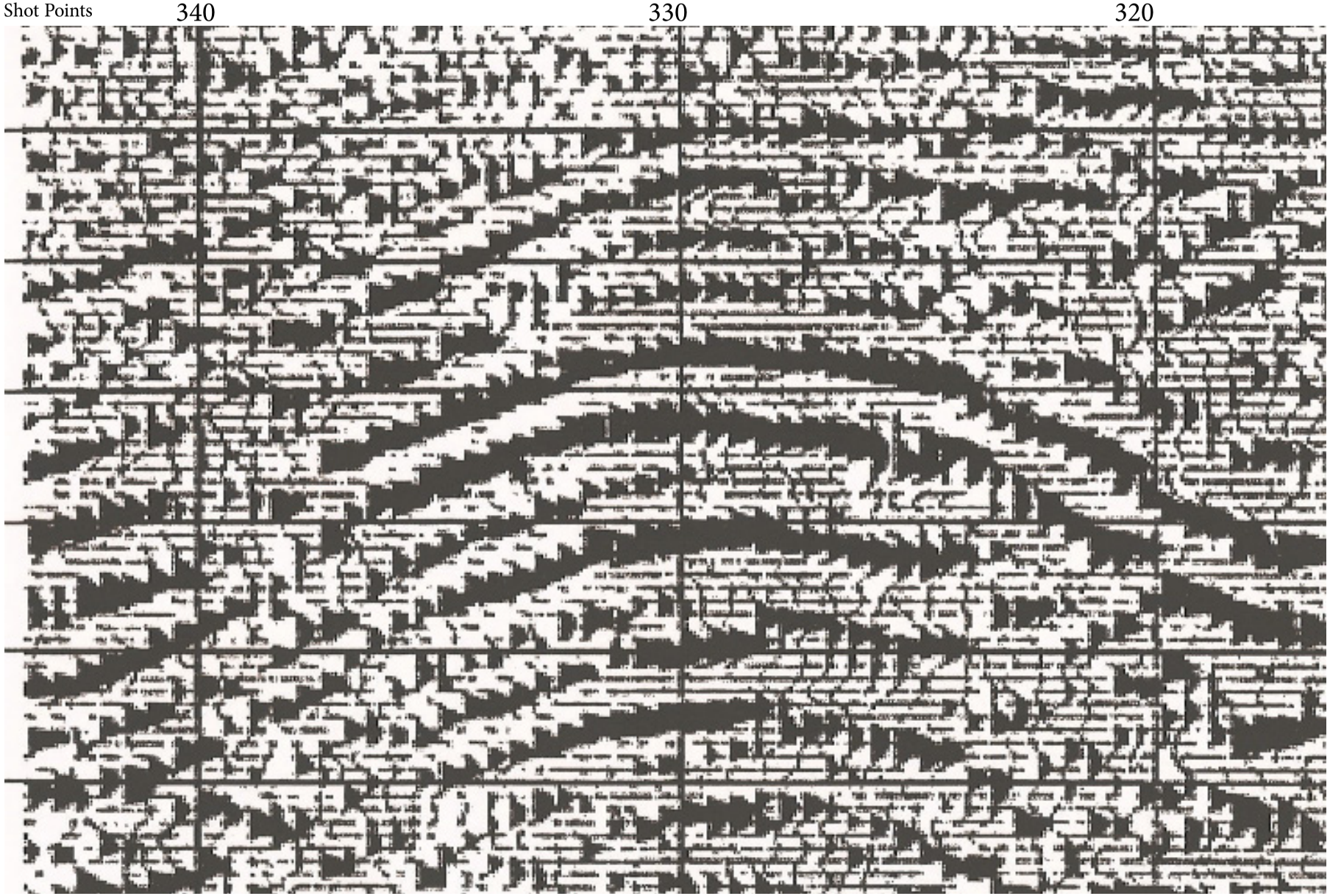
- Seismic Animations
- Hydrocarbon Traps Handout
- Seismic Maps
- Colored Pencils
- Ruler

Procedure

1. Have students watch the two seismic animations. Have them pay close attention to the animations as the information will help them in completing this exercise.
2. Each group of four students will work together to study a series of seismic maps. Students should observe each seismic map and using the Hydrocarbon Traps handout, find geologic features that are associated with oil and natural gas reservoirs.
3. After studying Seismic Map 1 and the Hydrocarbon Traps handout, students will color and describe the general patterns shown by the map.
4. Students will continue to do the same procedure for each remaining seismic map.
5. Each group of students will compare their findings with other student groups.

Name_____ Date_____

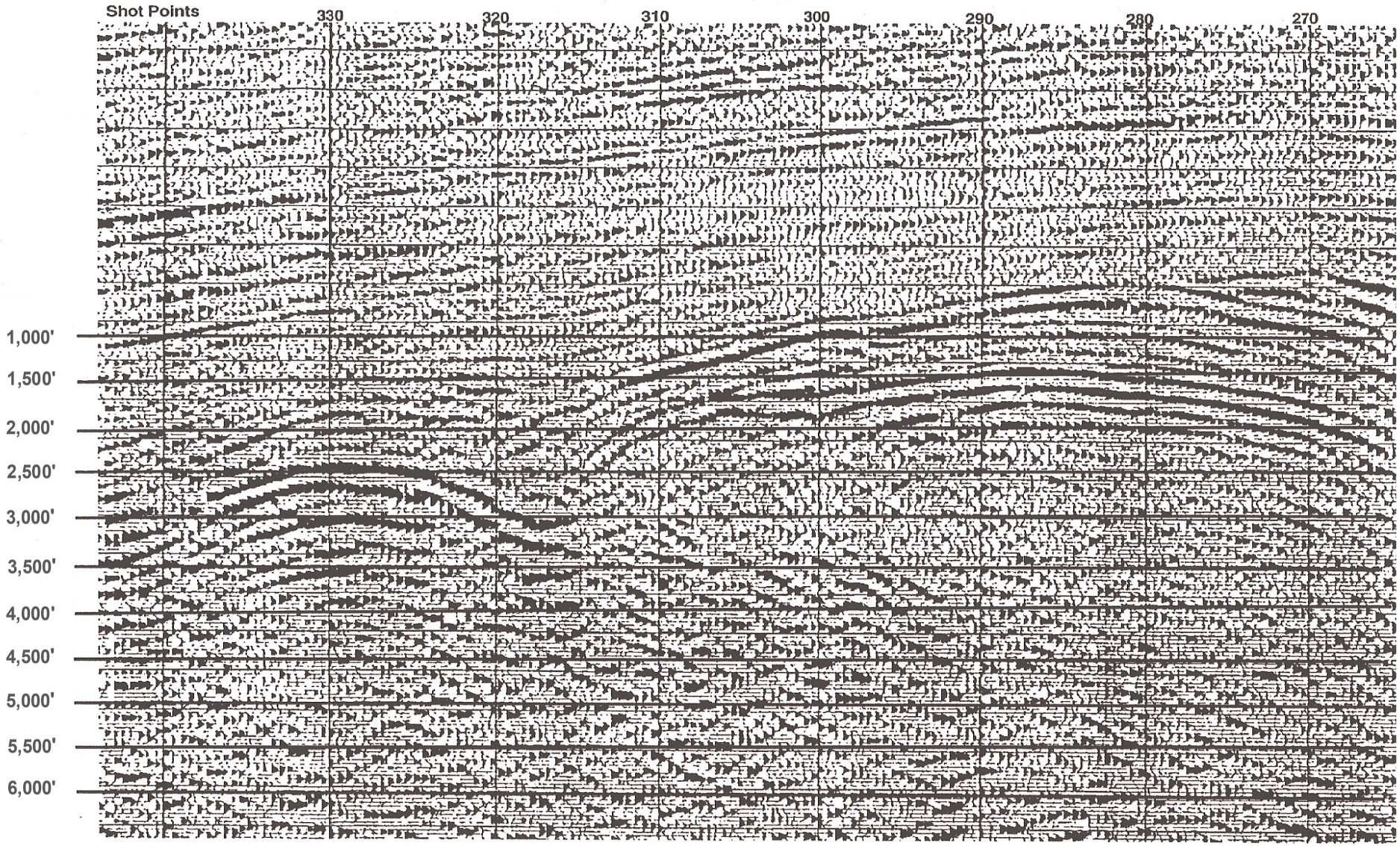
Seismic Map #1



There is a potentially productive zone represented on this seismic plat. It is indicated by a reflection that you find at 3,300 feet at a shot point 330. Color and track the zone as it moves to the left and right of this point.

Name_____ Date_____

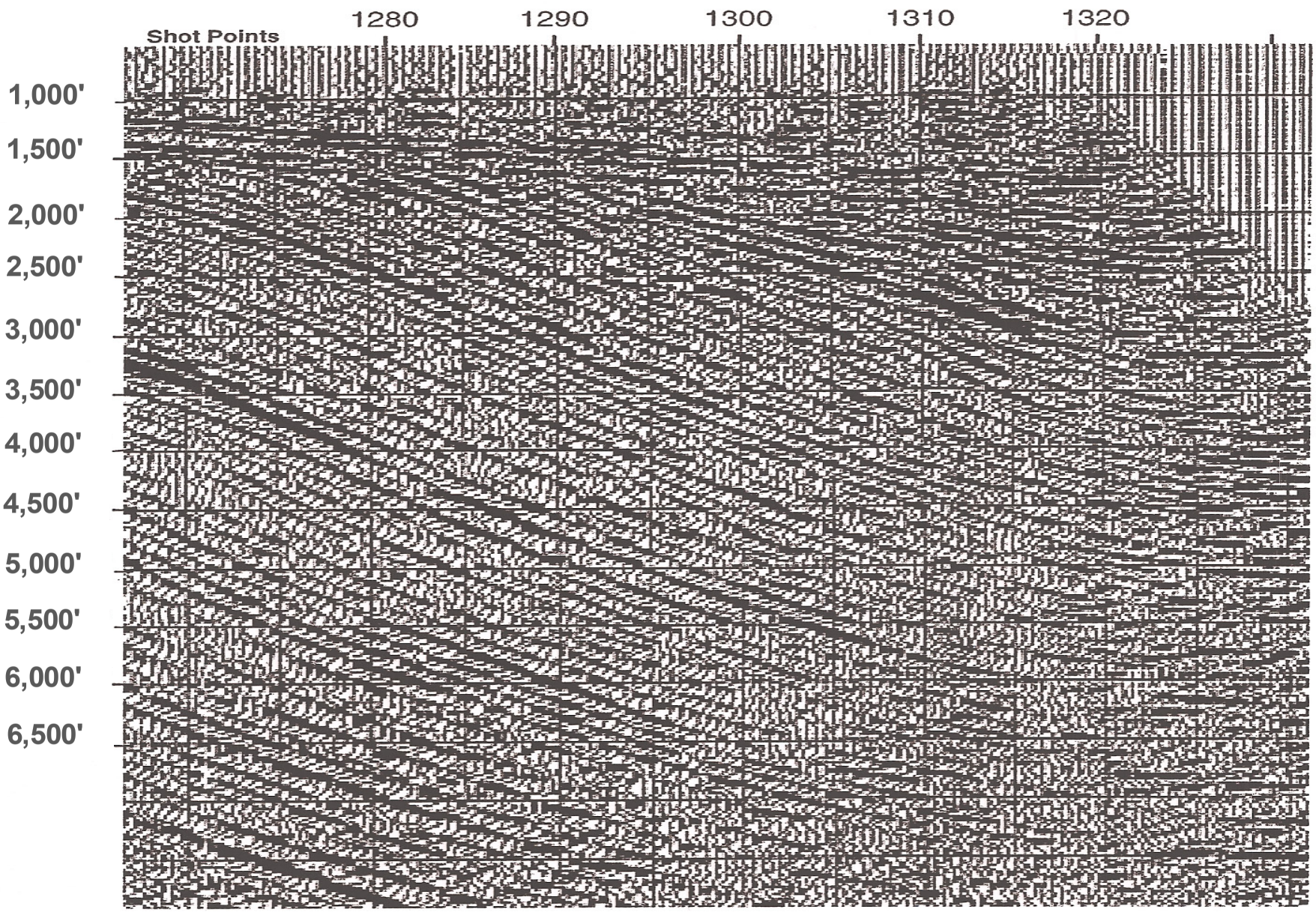
Seismic Map #2



A vertical fault is located between shot point 310 and 320 and begins at a depth of 1,500' and ends at 5,000'. Draw the fault line. The formation on the left side of the fault line is at 3,100' and the formation on the right side of the fault line is at 2,500'. Shade in the formation on either side of the fault.

Name_____ Date_____

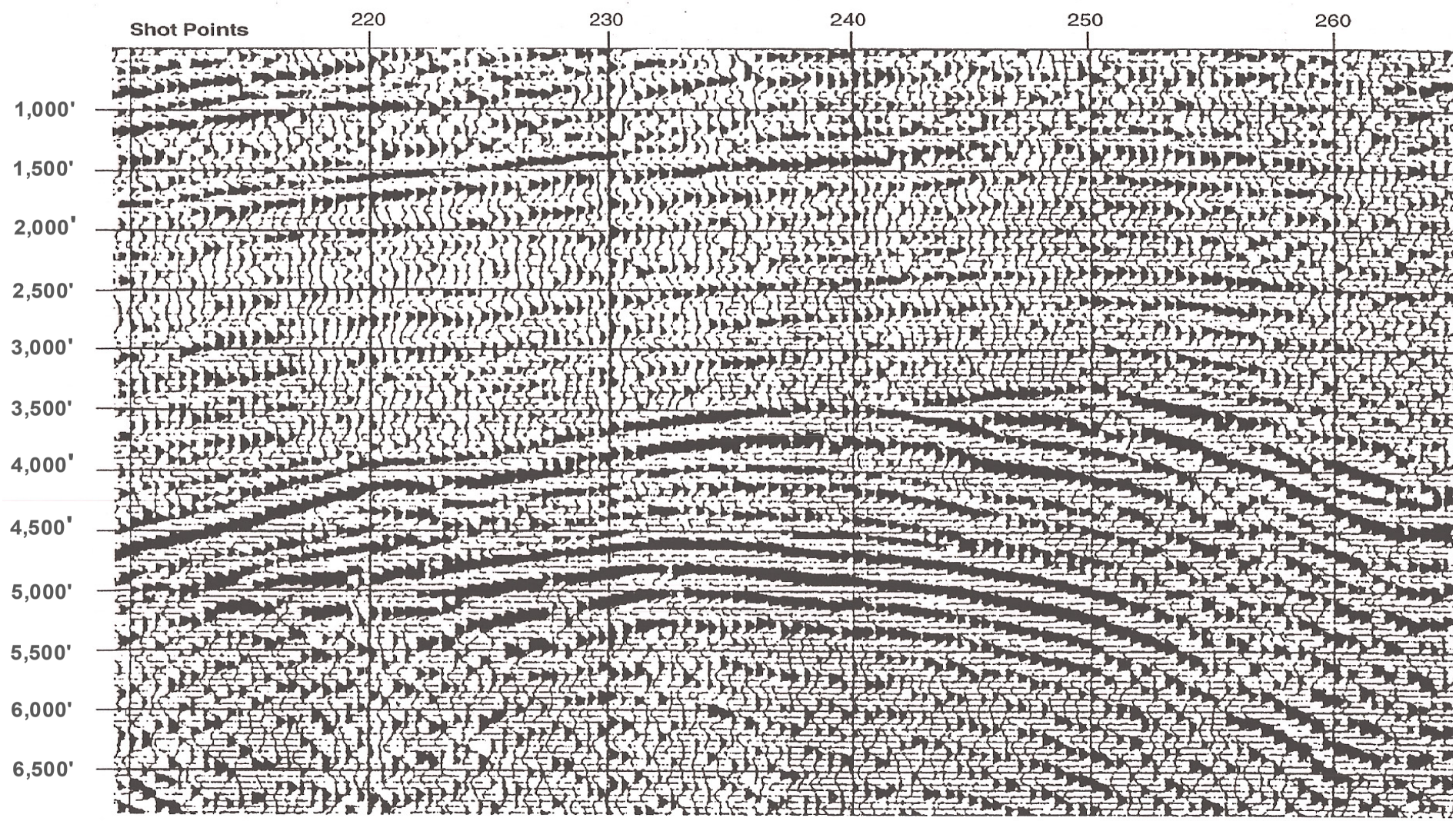
Seismic Map #3



There is a pinchout beginning at a depth of 1,600' between shot points 1285 and 1290 and dipping to the right to a depth of 3,250' as it goes off the plat. Shade this zone one color. Then, using another color, shade the zone the pinchout intersects.

Name_____ Date_____

Seismic Map #4



There is a potentially productive anticline structure that peaks just left of shot point 240 at approximately 3,500'. Identify and shade this structure as it continues to either side of the plat. There is a second potentially productive anticline 1,200' below the peak of this structure that peaks just right of shot point 230. Shade this anticline another color.

Name _____ Date _____

Seismic Clatter

Student Sheet

Student Activity 3

Materials

- Seismic Maps (completed from activity 2)

Procedure

1. Each group of students will study their completed seismic maps. On each map, students will determine locations that are potential hydrocarbon traps. Students should draw red lines from the surface down to the point where they would drill a well.
2. In Table 2: Proposed Well Sites, justify your choices of locations. Provide at least three reasons per site.

Table 2: Proposed Well Sites

Seismic Map	Justification
Seismic Map 1	
Seismic Map 2	
Seismic Map 3	
Seismic Map 4	

Name _____ Date _____

From the Ground Up!

Student Sheet

Wonder Why . . .

Have you ever wondered how oil and natural gas get from the ground to you?

Vocabulary

Contaminant: A substance that contaminates; impurities.

Crude Oil: Unprocessed petroleum; oil as it comes from the ground.

Density: Amount of mass that is in a certain volume of matter; mass per volume; a sound wave travels more quickly through less dense rocks than those with a high density.

Extract: Remove or take out.

Fractional Distillation: Process that separates a hydrocarbon mixture into a number of different parts, or fractions, based on boiling points.

Hydrocarbon: Organic compounds of hydrogen and carbon whose densities, boiling points, and freezing points increase as their molecular weights increase.

Monomer: A molecule that can be bonded to other identical molecules to form a polymer.

Natural Gas: Flammable gas, consisting largely of methane and other hydrocarbons, occurring naturally underground and used as fuel.

Oil Fractions: Different hydrocarbons that are separated from a mixture by fractional distillation.

Petroleum: A liquid mixture of hydrocarbons that is present in suitable rock layers and can be extracted and refined to produce fuels.

Polymer: A substance that has a molecular structure built up mainly from a large number of similar units bonded together (monomers).

Recover: Return to a normal state.

Refining: To make usable; make or become polished; improve.

Safety

Do not put any materials (including liquids) in your mouth.

Alert teacher of any spill, immediately.

Wash hands upon completion of this activity.

Properly dispose of materials.

Name _____ Date _____

Student Activity 1

Materials

- One 500 mL Erlenmeyer flask
- One two-hole rubber stopper
- 350 mL water
- 150 mL vegetable oil
- Colored oil-soluble dye
- Paper Towels

Procedure

1. Pour 350 mL water into the Erlenmeyer flask.
2. Measure 150 mL vegetable oil and pour into water.
3. Insert stopper. With fingers covering holes, shake vigorously.
4. Record your observations.

_____

_____

5. Allow the liquids to settle.
6. Record your observations.

_____

_____

7. Formulate an explanation of your observations. Include the vocabulary word "density" in your explanation.

_____

_____

Name _____ Date _____

From the Ground Up!

Student Sheet

Student Activity 2

Activity 2 is an inquiry activity. The challenge is to design and develop a device which will allow for the removal of oil from the water and oil mixture. This represents the retrieval of oil from the ground. You should try to use as many materials as possible.

Materials

- "Pump It Up" Rubric
- 1 plastic test tube
- Two 30 cm sections of vinyl tubing to fit rubber stopper
- 6 clear, plastic straws
- 2 cotton balls
- Small funnel
- One 30 cm section of ¼ inch vinyl tubing
- One 60cc plastic syringe
- Petroleum jelly
- 1 clear, plastic pipette
- One 500 mL Erlenmeyer flask
- One two-hole rubber stopper
- One 250 mL clear beaker
- 350 mL water
- 150 mL vegetable oil
- Colored oil-soluble dye
- Paper Towels

Procedure

1. Continue working with the oil and water in the Erlenmeyer flask during this activity.
2. Using any provided materials, design a device to extract only the oil.
3. Diagram your plan and predict its success.

Name _____ Date _____

4. Construct your device from the materials provided.
5. Test your device and record measurements.

Oil (initial amount)	Oil (extracted amount)	Percentage of oil extracted

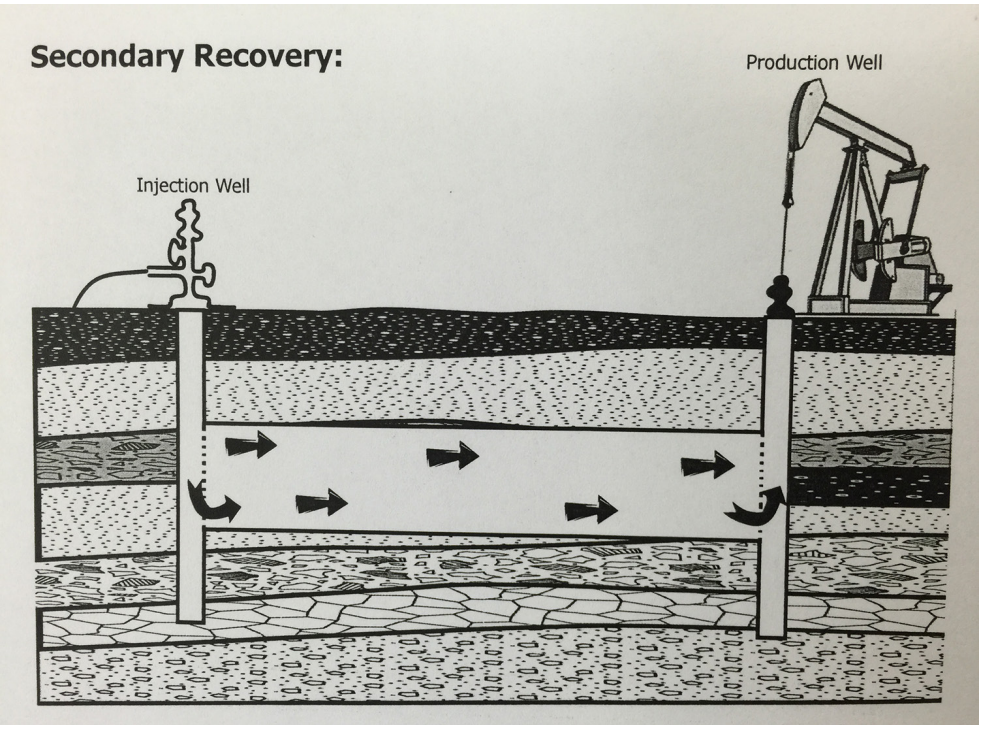
Conclusion

Read the following passage and answer the questions.

Part 1 - Pump It Up:

Since oil, natural gas, and water are under pressure below Earth's surface, these fluids may flow up a well without assistance (similar to a soft drink that has been shaken and then opened). This is called **primary recovery** – using natural pressure inside Earth to extract oil and natural gas. When this pressure is depleted, only a portion of the oil and natural gas has been removed from the site. This does not mean it's the end of the well's life!

Artificial lifting systems, or pumping units, are used to help pull the oil of the reservoir rock and pump it up the well. **Secondary recovery** can also take place. These activities are designed to create increased pressure to cause the oil to flow upward. These activities include waterflood, secondary gas drive, and other methods. During a waterflood, water is injected into other wells in the productive zone to push the oil and natural gas up the producing well. During a secondary gas drive, natural gas is re-injected into the producing formation to push the oil to the other wells that have been drilled in the oil zone.



Name _____ Date _____

1. What is the main idea of "Pump It Up"?

_____

_____

2. Relate the activity 2 to the actual methods that are used to extract oil and natural gas from the Earth.

_____

_____

3. Compare and contrast primary and secondary recovery.

Primary Recovery	Secondary Recovery

4. What is the main idea of "Heat It Up"?

_____

_____

5. Explain what happens to crude oil and natural gas following extraction.

_____

_____

_____

6. Examine the "Tower of Power: Oil Refining Tower". Arrange the following fractions in order from highest boiling point to lowest boiling point: fuel oil, gasoline, kerosene, bitumen, lubricants.

_____

_____

Pump It Up Rubric

	Expert	Proficient	Emergent	Novice
Summarize the problem	Problem has been restated to accurately represent original problem	Problem has been restated to somewhat represent the original problem	Problem has been restated to barely represent the original problem	Problem has not been restated to barely represent the original problem
Generate possible solutions	Diagram of model is developed, reviewed, and revised before construction	Diagram of model is developed, reviewed or revised before construction	Diagram of model is partially developed, but not reviewed, or revised before construction	Diagram of model is not developed before construction
Hypothesis	Hypothesis is directly related to the problem; written in an "if, then, because" format	Hypothesis is somewhat related to the problem; may be written in an "if, then, because" format	Hypothesis is not related to the problem; but written in an "if, then, because" format	Hypothesis is not related to the problem and not written in an "if, then, because" format
Create and Test	Creative use of materials and equipment; physical model represents the original plan	Appropriate use of materials and equipment; physical model represents the original plan	Use of materials and equipment is basic; physical model somewhat represents the original plan	Use of materials and equipment is basic; physical model does not represents the original plan
Collect Data	Data is recorded neatly and accurately; measurements are labeled with appropriate unit; calculations are accurate	Data is recorded accurately; measurements are labeled; calculations are accurate	Data is recorded; measurements are labeled; calculations may be accurate	Data is not recorded or measurements are not labeled or calculations are inaccurate
Conclusion	Conclusions are drawn using the data and refer back to the hypothesis; a thorough summary is written explaining what was discovered	Conclusions are drawn and somewhat refer back to the hypothesis; summary is written explaining some discovery	Conclusions are drawn but do not refer back to the hypothesis; summary is written but lacks discovery	Conclusions are drawn but do not refer back to the hypothesis; no summary is written

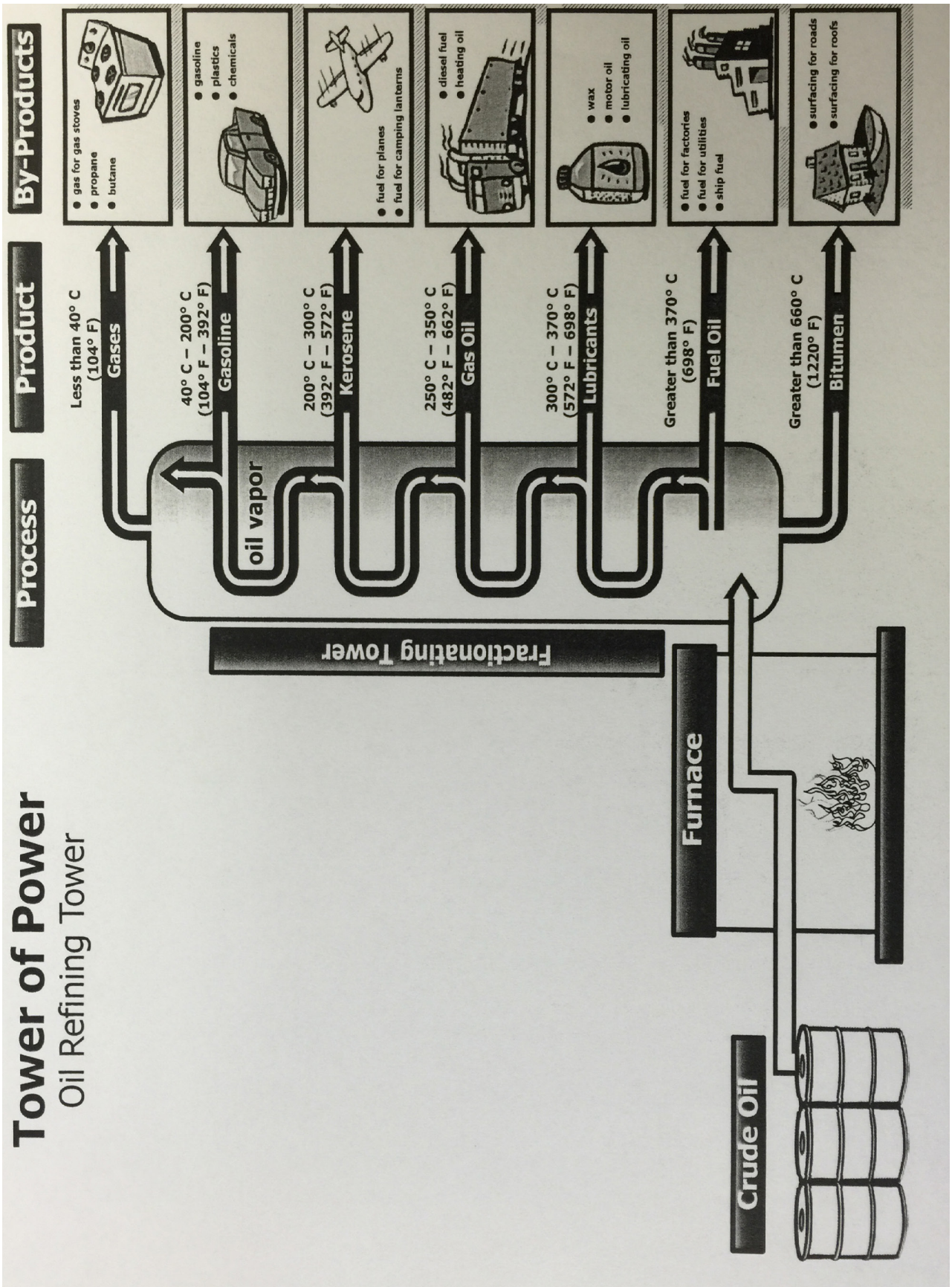
Name _____ Date _____

Part 2 - Heat It Up:

During extraction, crude oil and natural gas may become contaminated with water, sediment, and other contaminants. Once the oil and natural gas flow out of the wellhead, they must be separated before they are sold. The petroleum enters a closed vessel called a separator. In the separator, the force of gravity separates the natural gas, oil, and water, due to their different densities. The natural gas is pumped through pipelines for use. Oil and water flow into an apparatus called a heater treater. Water and oil separate while in the heater treater. Once these liquids have been separated, the crude oil is ready to be sold.

Once crude oil is purchased, it is transported to a refinery. There the crude oil is refined, or processed to remove impurities and separate it into different parts, or fractions. Crude oil is heated, and due to the different boiling points of the hydrocarbons in the crude oil, the fluids separate into different fractions. This process is called fractional distillation. Fractional distillation produces the different fractions of oil that can be transformed into products we use every day! After different fractions are separated, they are pumped into storage tanks.

Name _____ Date _____

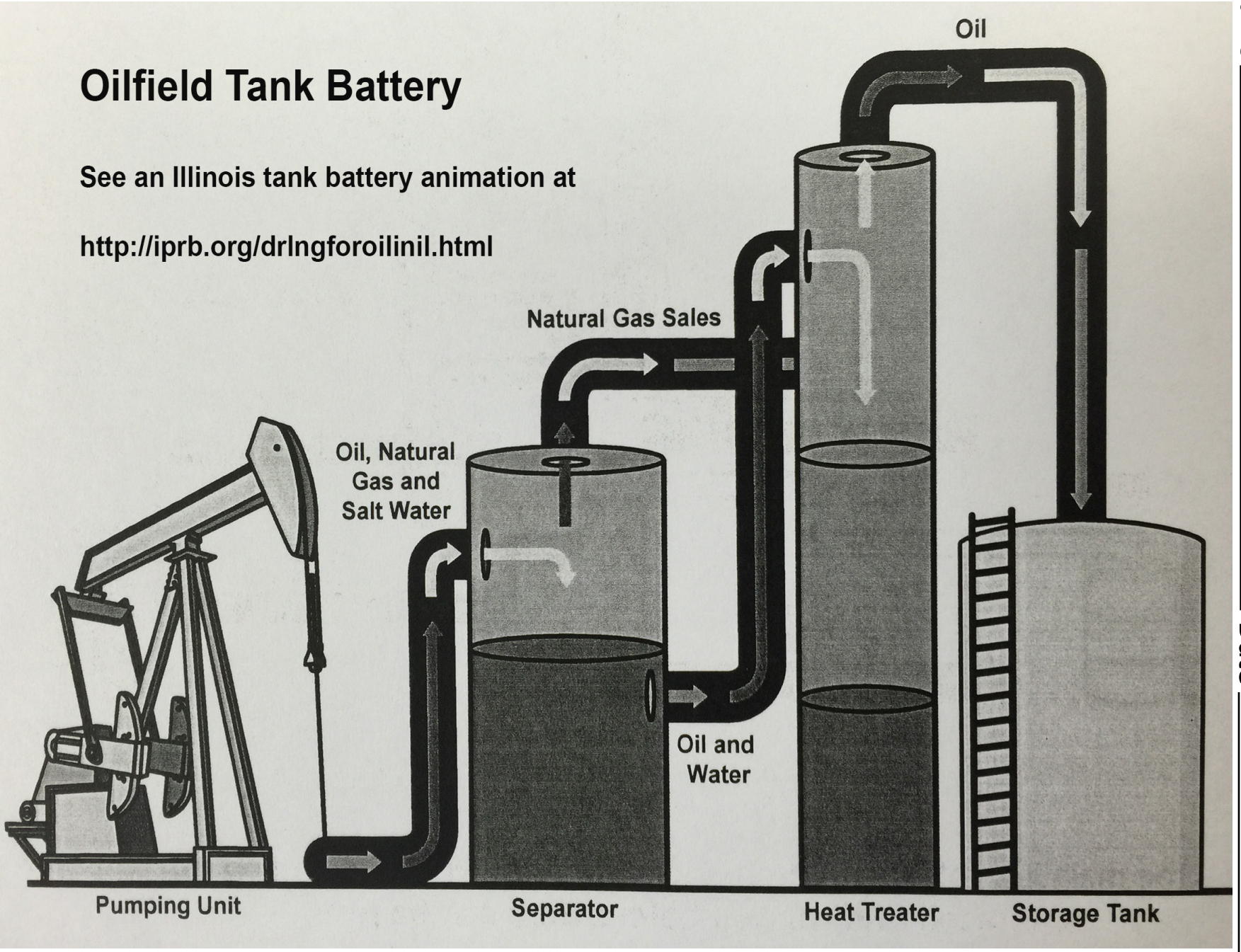

Tower of Power
Oil Refining Tower
Process
Product
By-Products
Crude Oil
Furnace
Fractionating Tower
oil vapor
Less than 40° C (104° F)
Gases
40° C – 200° C (104° F – 392° F)
Gasoline
200° C – 300° C (392° F – 572° F)
Kerosene
250° C – 350° C (482° F – 662° F)
Gas Oil
300° C – 370° C (572° F – 698° F)
Lubricants
Greater than 370° C (698° F)
Fuel Oil
Greater than 660° C (1220° F)
Bitumen
• gas for gas stoves
• propane
• butane
• gasoline
• plastics
• chemicals
• fuel for planes
• fuel for camping lanterns
• diesel fuel
• heating oil
• wax
• motor oil
• lubricating oil
• fuel for factories
• fuel for utilities
• ship fuel
• surfacing for roads
• surfacing for roofs

Name _____ Date _____

Oilfield Tank Battery

See an Illinois tank battery animation at

http://iprb.org/drlngforoilinil.html



Name _____ Date _____

Name _____ Date _____

Part 3 - What's Up:

Oil and natural gas are naturally occurring hydrocarbons. Only two elements, hydrogen and carbon, make up a hydrocarbon. Hydrogen and carbon have a strong attraction to each other. As a result, they form many compounds. Hydrocarbons are named by the number of carbon atoms they contain. These compounds are named by using a prefix and the root "-ane".

Prefix	# of Carbon Atoms	Uses
Methane	1	Natural gas, bottled fuel gas
Ethane	2	
Propane	3	
Butane	4	
Pentane	5	Solvent, paint thinner, cleaner
Hexane	6	
Heptane	7	Motor fuel, solvent
Octane	8	
Nonane	9	Illuminating oil, diesel fuel, jet fuel, cracking stock
Decane	10	

The simplest hydrocarbon is methane (gas) – one atom of carbon and four atoms of hydrogen. Methane is the main component in natural gas, as shown below. Gasoline is a mixture of several hydrocarbons that are liquid. Crude oil is also a mixture that usually occurs as a liquid. Tars and asphalts are solid hydrocarbons, under normal conditions. Raising the temperature of any of these causes a change in state. For example, when a roofer heats tar, it liquefies and binds gravel or other materials into a spreadable mixture. Then, when it cools, it solidifies to form a waterproof surface.

Furthermore, thousands of commonly used products are produced from petroleum, such as sports equipment, classroom items, and even cosmetics! Plastics contain polymers, huge chain-like molecules composed of small molecules called monomers. Due to some of the varying properties of polymers, plastics may be flexible or rigid, transparent or opaque, hard or soft, and elastic or not. Man-made polymers are made possible by the complex processes involved in formation, extraction, and processing of crude oil and natural gas.

7. What is the main idea of "What's Up?"

_____

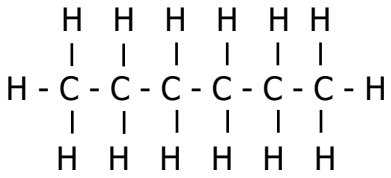
_____

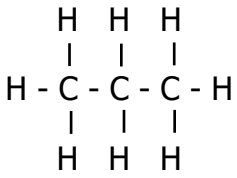
8. Create a flow-chart with the major processes, identified in the passage, involved in extraction through practical use of crude oil and natural gas. Include at least 5 processes.

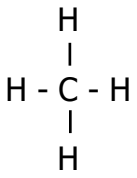
Naming Hydrocarbons

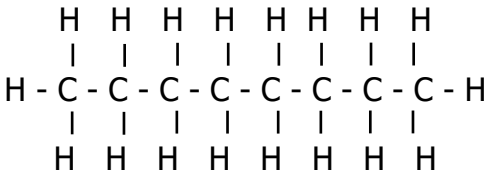
Hydrocarbons are compounds made up of carbon and hydrogen. Hydrocarbons called alkanes are the simplest hydrocarbons. These compounds are named by using a prefix that tells the number of carbon atoms they contain and the root-ane. Using the chart below, name each of the alkanes that are shown.

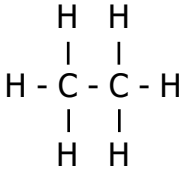
Prefix	# of Carbon Atoms	Uses
meth-	1	Natural Gas, bottled fuel gas
eth-	2	
prop-	3	
but-	4	
pent-	5	Solvent, paint thinner, cleaner
hex-	6	
hept-	7	Motor fuel, solvent
oct-	8	
non-	9	Illuminating oil, diesel fuel
dec-	10	jet fuel, cracking stock

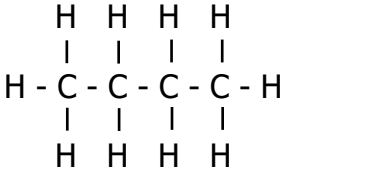








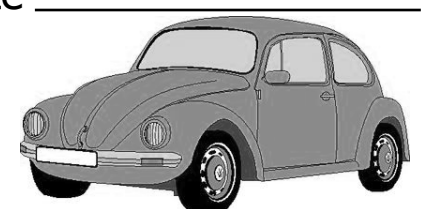




Name _____ Date _____

Precious Pretzels

Student Sheet



Wonder Why . . .

Have you ever wondered what you can do to conserve petroleum resources?

Student Activity 1

Materials

- Calculator

Procedure

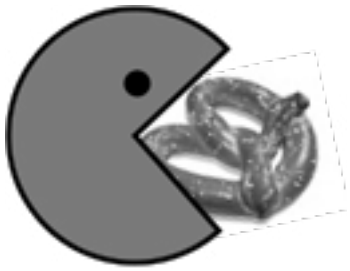
1. Each group of three students has a Toyota Prius (50 miles per gallon, 12 gallon tank), a Chevrolet Camaro (22 miles per gallon, 19 gallon tank), or Ford F-150 (15 miles per gallon, 31 gallon tank).
2. Students live 25 miles from their place of employment. Assuming that the vehicle was completely full of gasoline every Monday morning, how many times during the month will you need to fill up if you only drive back and forth to work? What will the cost of fuel just to drive to work be for one month? (Use the price per gallon for one gallon of 87-octane gasoline at the nearest fuel station and remember to include the initial fueling)

Name _____ Date _____

Precious Pretzels

Student Sheet

Student Activity 2



Materials

- Five small pretzels per participant
- One NEARVILLE sign
- Car tags

General Game Rules:

- The object of the game is to find the most efficient means of transportation.
- Each pretzel represents one gallon of fuel.
- Each step represents one mile.
- A step is heel-to-toe.

Procedure

1. Each student gets five pretzels.
2. Each student gets a car tag.
3. Read your car name tag to find out what kind of car you have, how many passengers you can carry, and how many MPG you can go. (Remember, MPG is equal to steps per pretzel)
4. Travel
    - Drive your car from HOME to NEARVILLE and back to HOME.
    - Line up at HOME, eat one pretzel and take the appropriate number of steps.
    - Continue this until you run out of pretzels.
    - Stop at the point you ran out of pretzels. (Ran out of gasoline)
5. Discuss which cars got to NEARVILLE and back HOME. Discuss alternatives to everyone driving his/her own car.

Name _____ Date _____

Precious Pretzels

Student Sheet

Student Activity 3

Materials

- Five small pretzels per participant
- One FARVILLE sign
- Car tags

General Game Rules:

- The object of the game is to find the most efficient means of transportation.
- Each pretzel represents one gallon of fuel.
- Each step represents one mile.
- A step is heel-to-toe.
- Fuel pretzels may be shared by car pool members, or they can take turns driving.
- A bus can carry everyone.
- Passengers can take turns driving the bus.

Procedure

1. Each student gets five pretzels.
2. Keep the same car chosen in Round One.
3. Read your car name tag to find out what kind of car you have, how many passengers you can carry, and how many MPG you can go. (Remember, MPG is equal to steps per pretzel)
4. Travel
    - Negotiate with the other members of the class and use some of the alternatives discussed in Activity One. The goal is to go HOME to FARVILLE and back HOME.
    - After negotiating travel plans, line up at HOME.
    - The driver of the vehicle should eat the pretzel and everyone in the vehicle should take the steps. The driver may eat the passengers' pretzels for fuel, or the students may take turns driving.
    - Stop at the point you ran out of pretzels. (Ran out of gasoline)
5. Discuss who made it to FARVILLE and back HOME? How did they accomplish this? Who did not complete the trip to FARVILLE and back HOME? Why?

Name _____ Date _____

Conclusion

1. Which vehicle is the most fuel efficient? Which vehicle is the least fuel efficient?

   _____

2. Considering the amount of energy used per passenger, which vehicle is the most efficient? Least efficient?

   _____

3. What are the advantages of using mass transportation over individual vehicles? What are the disadvantages?

   _____

4. How does having twice as many people in a vehicle affect the amount of fuel needed per passenger?

   _____

5. If your car travels 330 miles on a tank of gasoline and your gasoline tank holds 15 gallons of gasoline, what is the MPG of your car?

   _____

6. Why do some people choose not to car pool or use mass transportation?

   _____

7. How would you go about convincing these people of the need for sharing rides?

   _____

Extensions

Assign students to groups of no more than three and hand out the Illinois Road Map to each group. You and your friends are on a road trip to see Ronald Regain's boyhood home in Dixon, IL. You are traveling in the vehicle assigned by your teacher previously (Camaro, F-150, or Prius). Your group stops and fuels the vehicle completely full in Metropolis, IL. As you near Peoria, IL you notice signs that say that this is the last place to fill you gasoline tank before reaching your destination. Using the information about fuel economy on your assigned vehicle, discuss if you can make it to Dixon, IL and back to Peoria, IL without stopping for fuel?

You and 11 other coworkers need to make a round trip from Springfield, IL to Little Rock, AR (443 miles) for a conference. In order to save the company money, you will need to rent vehicles from the IPRB Rental Agency list. (Supply students will a list of possible cars from the Summary of Car Tags). The cost of rental is the same for each vehicle ($50 per day). Your task is to rent a combination of vehicles to transport your work groups to Little Rock, AR in the most efficient (i.e. cheapest) manner. Note: Only one of each vehicle on the list is available for rental. Students should put together a document with vehicles requested and the cost of travel for the vehicles chosen. Remember to include the cost for each vehicle.

Example Answer:

Vehicle 1: Suburban

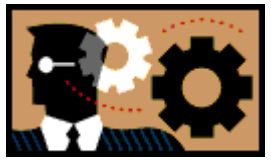
Vehicle 2: Dodge Caravan

$100 rental fees

$121 gas for Suburban with gas @ @2.74/gallon

$126 gas for Dodge Caravan with gas @ $2.74/gallon

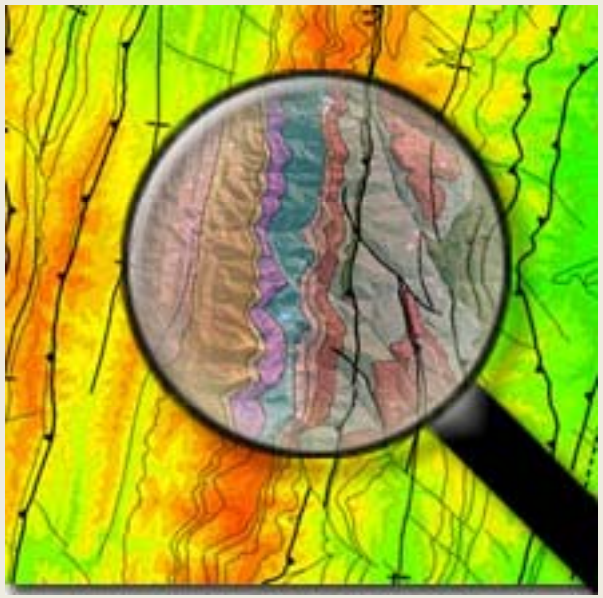
Thinking about your Career path?

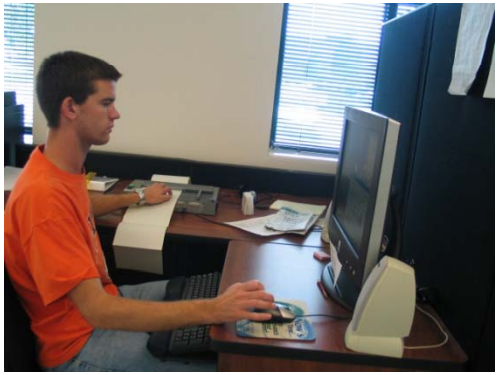


THINK OIL AND NATURAL GAS

CHEMISTS
MANAGERS
ENGINEERS
GEOLOGISTS
ADMINISTRATIVE
DRILLING RIG OPERATOR

Petroleum is more than just gas. Just about everything we use comes from petroleum or uses petroleum energy in some way. The petroleum industry offers a wide-range of career choices. Take a look.





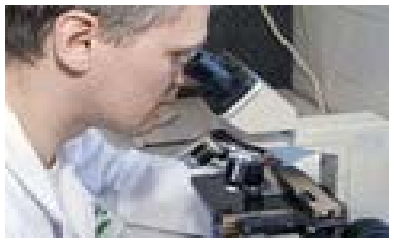
ENGINEERS

There are many career opportunities in the petroleum industry for engineers. Chemical, industrial, electrical, civil and petroleum engineers all play a part in the petroleum industry. Most common are petroleum engineers.

Petroleum engineers
search the world for reservoirs containing oil or natural gas.

GEOLOGISTS

Geologists are employed to explore for crude oil and natural gas and to help develop reservoirs. Geologists search for oil and gas by studying rock formations and using microscopes to examine rocks fragments (cuttings) from wells that are being drilled.



GEOSCIENTISTS

Geoscientists study the composition, structure, and other physical aspects of the Earth. Their knowledge can help companies find oil and natural gas.

The Oil and Gas ***Administrative Assistant*** performs a variety of duties in today Petroleum-related offices. They provide support to all of the engineering technicians inside the office and are responsible for gathering information for engineering techs and producing production reports, tracking safety records and booking training based on the information gathered.

ADMINSITRATIVE

DRILLING CREWS

Drillers are directly responsible for the drilling of the hole. They supervise other crew members and operate drilling controls.

Derrickhands handle the upper end of the pipe as it is hoisted out of or lowered into the well hole. They are also responsible of the circulating machinery and the conditioning of the drilling fluid.

Rotary helpers or roughnecks help handle the lower end of the pipe and help maintain the rig.

SCHOOL

Many schools in Illinois offer excellent programs in engineering and science to prepare you for a career in the Petroleum industry.

THE OIL INDUSTRY…….A LOT OF DIFFERENT PROFESSIONS ENGAGED IN FINDING OIL

	LEVEL OF EDUCATION
• Geologists	Bachelors, Masters
• Chemists	Bachelors, Masters
• Engineers	Bachelors, Masters
• Accountants	Associates and Bachelors
• Oil and Gas Attorneys	Bachelors + Law Degrees
• Landmen – leasing of properties	Varies; usually some college
• Safety and Environmental Workers	Varies; usually some college
• Secretaries, Receptionists, Data Management, Office Management	Varies
• Regulatory Compliance	Associates or Bachelors
• Drilling - Rig Hands, Tool Pushers	High School
• Roustabouts, Pumpers	High School
• Welders, Electricians	High School or Associates
• Mechanics	High School or Associates
• Heavy Equipment Operators, Truck Drivers	Varies; usually High School
• Service Company Professionals – chemical, logging, cement, fracking, welding, testing, contract services	Varies, depending on job
• Sales and Service of oil field supplies and equipment	Varies, depending on job
• Refinery workers	Associates preferred

Careers in Geology

WHAT DOES A GEOLOGIST DO?

- Search for economic resources:
  - Oil and Gas
  - Coal
  - Uranium
  - Groundwater
  - Precious metals
  - Industrial metals and materials
- Solve problems:
  - Earthquakes
  - Volcanics
  - Groundwater resources
  - Construction (e.g. dams, highways)
  - Physical Hazards (e.g. landslides, floods)
  - Environmental Hazards (landfills, groundwater pollution)
- Other:
  - Education
  - Resource management (state or federal)

WHAT EDUCATION DOES A GEOLOGIST NEED?

- Bachelor's degree is mandatory; a master's or doctorate is preferred.
- Must be strong in math and sciences.

WHERE DOES A GEOLOGIST WORK?

- Geology today is largely an <u>indoor</u> job.
- The job market can be volatile; geologists with graduate degrees will have the advantage. Many geologists may change jobs several times in a career.
- Movement is common; a geologist may work in many different regions over the course of a career.

OIL & NATURAL GAS TECH SHORT CERT

SOUTHEASTERN ILLINOIS COLLEGE

Certificate

Minimum 17.5 Hours

Career & Technical Education • Certificate • Minimum 2.0 OGPA • Major Code: CSONT

One Semester		Credit Hrs
ONGT 110	Introduction to Petroleum Industry	1
ONGT 111	Oil & Gas Production I	3
DSL 131	Engine Electronics	3
DSL 158	Hydraulics I	3
ONGT 112	Artificial Lift Systems	3
ONGT 113	Oil & Gas Production II	3
CPR 112	Heartsaver First Aid w/CPR	.5
SAFE 133	SAFELANDUSA™ Training	1
	Total Hours	17.5

Occupational information about this program is available at O*NET online www.onetonline.org. Once at that website enter the SOC Code that is listed for this program.
O*NET – SOC Code:
47-5071.00
47-5013.00
47-5012.00
47-5011.00

Career Opportunities:
Roustabouts, Service Unit Operators, Drilling Operators

Major Employers:
Oil and Gas Companies, Drilling Companies

02/14