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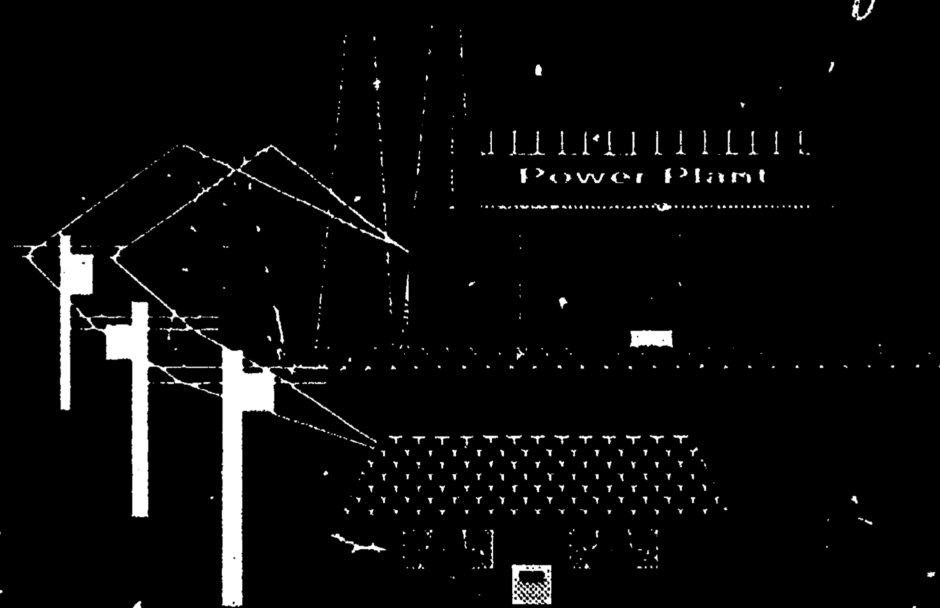
ABSTRACT

This teacher's guide and its accompanying supplement were prepared for use with the U.S. Department of Energy's Dinosaurs and Power Plants, a publication designed for students in grades 5-8 about the history, detection, extraction, transportation, use, environmental problem/solutions, and future of fossil energy. The study of energy science shows the close interrelationships of all creatures and phenomena. Therefore, attempts have been made to incorporate information in all three documents (publication, teacher's guide, and supplement) that involves history, geography, geology, biology, language studies, etc. Although the text of the teacher's guide closely follows "Dinosaurs and Power Plants," some additional or more explicative information is included in the guide for teachers to use in classroom discussions. The suggested lesson introduction methods and follow-up activities encourage the student to use or develop skills of leadership, deduction, communication, organization, socialization, observation, interpretation, and creativity. The guide is divided into five lessons about fossil fuels: (1) "Importance and Formation"; (2) "Discoveries and Uses"; (3) "Detection, Extraction, and Transportation"; (4) "Environmental Problems/Solutions"; and (5) "Energy for the Future." The first page of each lesson plan shows a summary of the key questions to be covered, the lesson objectives, time allotment, and suggested materials to be used. The second (and sometimes third) page of each lesson plan suggests one or two methods for introducing the lesson topic. Key questions are answered by the italicized text seen with brackets on the right side of the page. The graphics point out a picture or series of pictures that can be used with a particular portion of the lesson text. Boxes are used in the guide to provide additional information, offer suggestions for activities or graphics, or show needed materials. Student activities are offered at the end of each lesson plan. "Student Activity Options" are listed that can be performed in class at the time of the lesson. "Student Follow-Up or Extension Options" that can be done as homework, classroom activities separate from the lesson, or as refresher activities in the days or months following the lesson series are also provided. The supplement contains 8 1/2" x 11" versions of the graphics and materials mentioned in the teacher's guide. The materials in the supplement are presented in the five lesson plan format followed in the teacher's guide. Materials in the supplement may be used for vu-graphs, bulletin boards, reproduction for individual student use, or any classroom activity. (KR)

Dinosaurs and Power Plants



~ Energy from the Past for the Future ~

Teacher's Lesson Plan and Activity Guide

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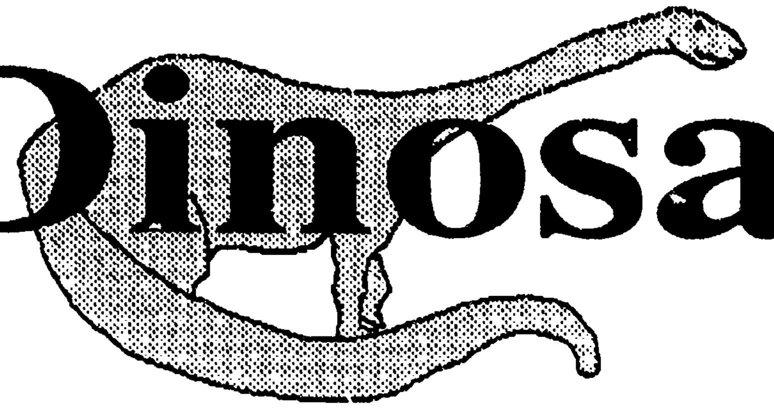
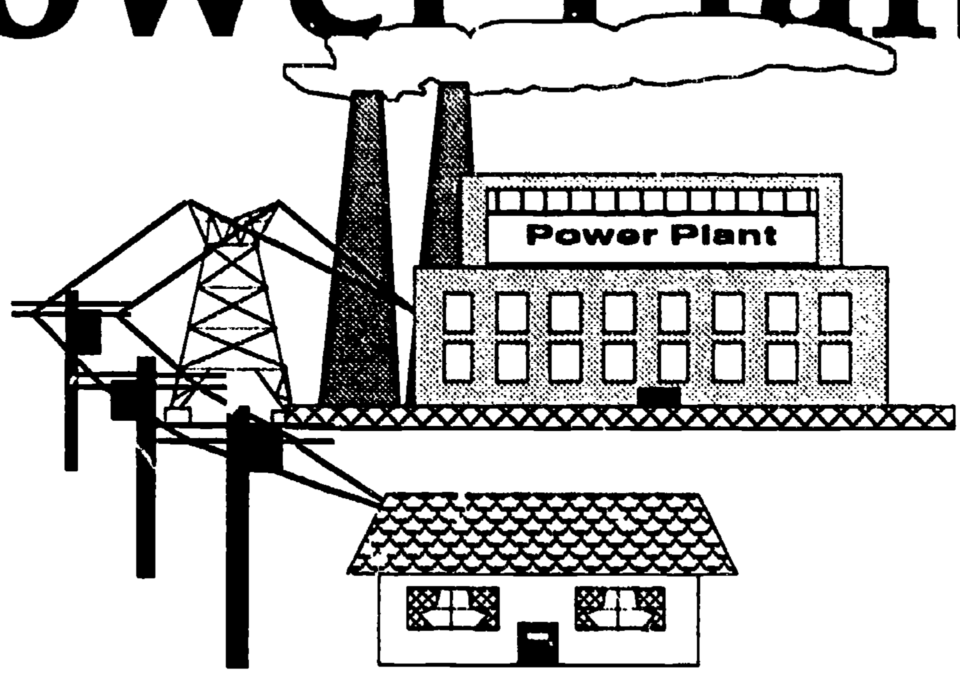


Dinosaurs and Power Plants



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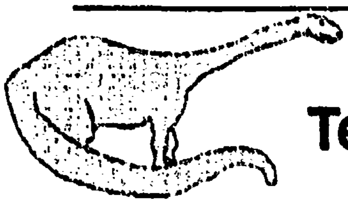


Teacher's Lesson Plan & Activity Guide

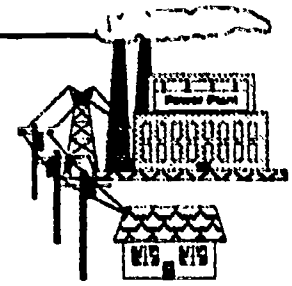


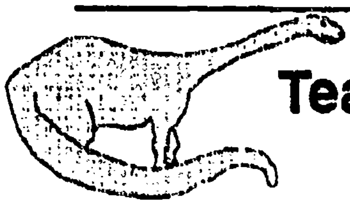
Table of Contents

Short Titles and Abbreviations

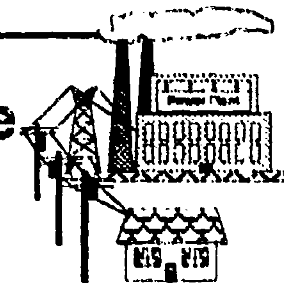
1) The *Dinosaurs and Power Plants* booklet for students will be abbreviated as *"D&PP."*

2) The *D&PP Teacher's Lesson Plan and Activity Guide* (this document) will be referred to as the *"Teacher's Guide"* or as the *"Guide."*

3) The *D&PP Teacher's Guide Supplement* of pictures, lists, and games will be called the *"Supplement."*



Teacher's Lesson Plan and Activity Guide



Fossil Energy Lesson Plan Series

Introduction

This *Teacher's Lesson Plan and Activity Guide* and its accompanying *Supplement* have been prepared to use with the U.S. Department of Energy's *Dinosaurs and Power Plants*, a publication designed for students in grades 5–8 about the history, detection, extraction, transportation, use, environmental problems/solutions, and future of fossil energy.

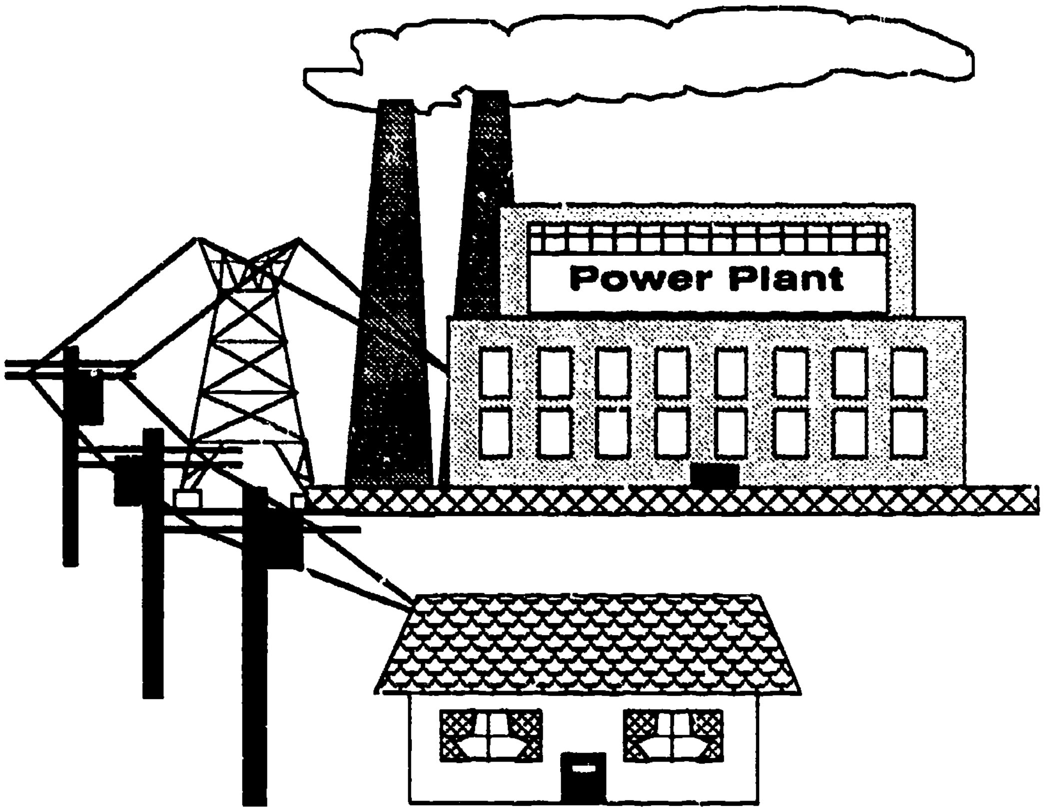
The study of energy science shows the close interrelationships of all creatures and phenomena. Therefore, attempts have been made to incorporate information in all three documents that involves history, geography, geology, biology, language studies, etc. Although the text of the *Teacher's Guide* closely follows *Dinosaurs and Power Plants*, some additional or more explicative information is included in the *Guide* for teachers to use in classroom discussions. The suggested lesson introduction methods and follow–up activities encourage the student to utilize or develop skills of leadership, deduction, communication, organization, socialization, observation, interpretation, and creativity.

Dinosaurs and Power Plants Teacher's Lesson Plan and Activity Guide

The *Teacher's Guide* is divided into five lessons: Fossil Fuels— 1) Importance and Formation; 2) Discoveries and Uses; 3) Detection, Extraction, and Transportation; 4) Environmental Problems/Solutions; and 5) Energy for the Future. Each lesson plan section is divided into four parts: Summary, Introduction Method, Key Questions and Answers, and Student Activities. The first page of each lesson plan shows a summary of the key questions to be covered, the lesson objectives, time allotment, and suggested materials to be used. The second (and sometimes third) page of each lesson plan suggests one or two methods for introducing the lesson topic. Key questions are answered by the italicized text seen within brackets on the right side of the page. The graphics (found on the left side of some pages in the *Teacher's Guide*) point out a picture or series of pictures that can be used with a particular portion of the lesson text. These small pictures can be found in an 8 1/2" x 11" format in the *Supplement*. Boxes are used in the *Guide* to provide additional information, offer suggestions for activities or graphics, or show needed materials. Student activities are offered at the end of each lesson plan. "Student Activity Options" can be performed in class at the time of the lesson. "Student Follow-up or Extension Options" can be done as homework, as classroom activities separate from the lesson, or as refresher activities in the days or months following the lesson series.

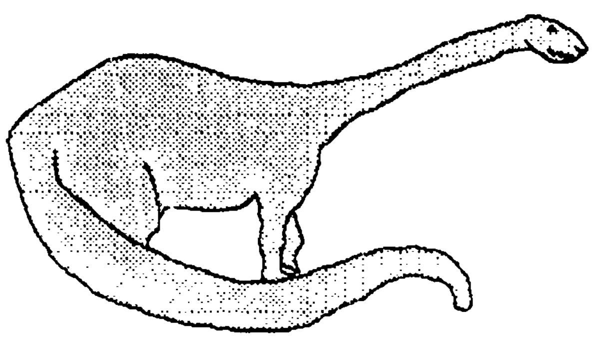
Dinosaurs & Power Plants Teacher's Guide Supplement

The *Teacher's Guide Supplement* contains 8 1/2" x 11" versions of the graphics in *Dinosaurs and Power Plants* and materials mentioned in the *Teacher's Guide*. The materials in the *Supplement* are presented in the five lesson plan format followed in the *Teacher's Guide*. Materials in the *Supplement* may be used for vu-graphs, bulletin boards, reproduction for individual student use, or any classroom activity.



Teacher's Guide

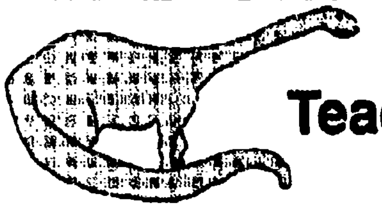
Lesson One



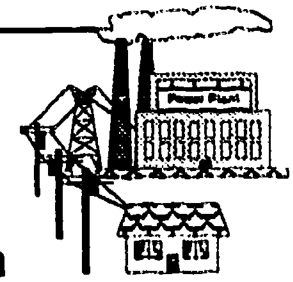
Fossil Fuels

Importance and Formation

Dinosaurs and Power Plants



Teacher's Lesson Plan & Activity Guide



Lesson 1: Fossil Fuels—Importance and Formation

Key Questions:

Why is fossil energy important in our lives? What are fossil fuels? How were fossil fuels formed?

> "Fossil energy" is a term for the group of energy resources formed from prehistoric plants and animals. "Fossil fuels" refer to the members of this group--coal, natural gas, and petroleum.

Objectives:

Students should be able to:

1. List at least three things that people and animals do that uses energy. *(D&PP page 1)*
2. Name three fossil fuels. *(D&PP page 1)*
3. Describe how fossil fuels were formed. *(D&PP page 1)*
4. Tell how much plant debris it took to form one foot of coal. *(D&PP page 1)*
5. List at least three things (more will be covered later) that run on energy products produced from fossil energy sources. *(D&PP page 1)*

Time Allotment:

30–45 minutes

Suggested Materials:

Dinosaurs and Power Plants ("*D&PP*"), pages 1 & 14
D&PP Teacher's Guide Supplement ("Supplement"),
Lesson 1
- Drawing-"Using Energy: Dinosaur Jumping Rope"
- Drawing-"The Human Body: That Marvelous Machine"
- Drawing-"Gasoline...is Used... to Power Cars"
- Drawing-"The Energy Needed to Power Our Lights..."
- Drawing-"How was Coal Formed?" (also *D&PP*, pg 1)
- Drawing-"Underground Geological Layers of the Earth"
- Word List
- Graphic-"Energy Equivalents" (also *D&PP*, pg 14)
- Copy of "Energy Uses" sheet for each student (need pencil or pen to answer questions)

Yardstick or Tape Measure (not included)

Dinosaurs and Power Plants

Introduction Method:

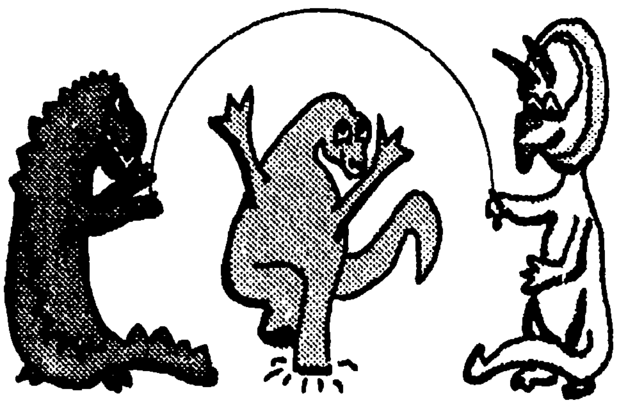
Purpose-

To introduce the student to the concept of energy as a common factor among all things

Activity-

Ask, "What do a dinosaur and you have in common?"

Using Energy



Dinosaur Jumping Rope

Supplement—Lesson 1 only

SUGGESTION: Give a short time for answers then show the picture of the "Using Energy: Dinosaur Jumping Rope" (found in the *D&PP Teacher's Guide Supplement*-Lesson 1) and ask "What does your body need to allow you to jump rope, run, or hit a ball?"

Answer, "*Energy*"

One Copy Per Student Needed of *Dinosaurs and Power Plants* and "Energy Uses Quiz"

Hand out to each student a copy of *Dinosaurs and Power Plants* and of the "Energy Uses Quiz" (found in Lesson 1 of the *Supplement*). Have the class read page 1 of *Dinosaurs and Power Plants* and then complete the "Energy Uses Quiz." Follow these activities with a class discussion utilizing the Key Questions found in this *Teacher's Guide* on pages I-3 — I-6.

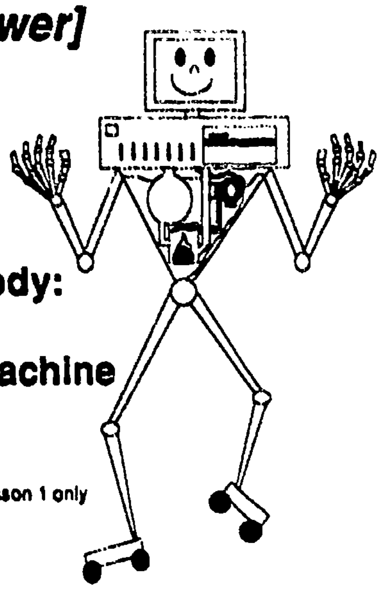
To begin finding out more about energy and how it is used, the class will read Page 1 of *Dinosaurs and Power Plants,* complete the "Energy Uses" quiz, and participate in a class discussion.

Dinosaurs and Power Plants

Key Question:

Why do you and every person, plant, and animal ever living on earth need energy?

[and Answer]



The Human Body: That Marvelous Machine

Supplement—Lesson 1 only

[All living things, including dinosaurs, roses, butterflies, and you, have needed energy to move, eat, sleep, play, or even unfold a petal.

Your body is like a machine. You must have a fuel to run your engine because it is your engine (heart) that enables your levers (arms), wheels (feet), computer (brain), etc. to operate. Energy is the fuel you use to power your engine. People get energy from consuming many kinds of food. After we eat the food, our bodies digest and then burn it to produce energy.]

Key Question:

Why are fossil fuels important?

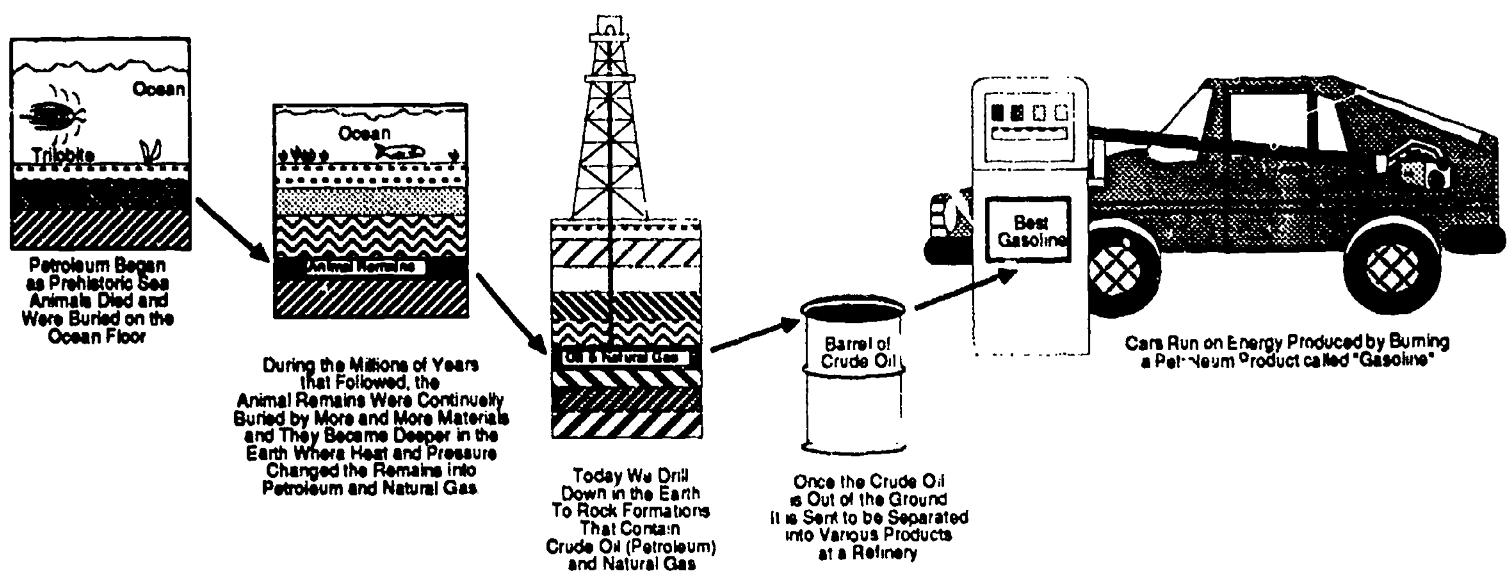
[Machines, such as the televisions, cars, and computers we take for granted in our daily lives, also need energy to run. Many times the energy used to power these things comes from "fossil fuels."

We burn natural gas, a fossil fuel, to heat our homes. We use gasoline, a product made from a liquid fossil fuel named "petroleum," to power our cars.

We get energy for our bodies when we eat food or for our cars when we burn fossil fuels.]

Gasoline, A Liquid Fossil Fuel, Is Used As Energy To Power Cars

Supplement—Lesson 1 only



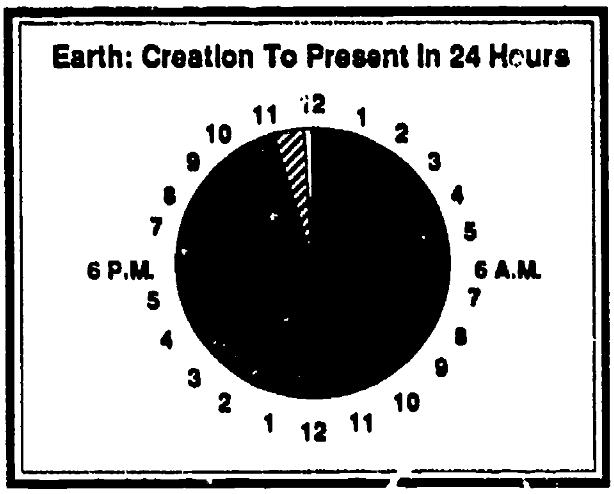
Dinosaurs and Power Plants

Key Question:

What has a dinosaur got to do with the lights in your home?

[Energy again! The dinosaur ate and used food as fuel to produce the energy it needed to move, play, and even sleep. Our bodies need energy for the same reasons. However, we need energy also to power many things that we use in our everyday lives, such as the lights that help us see at night. The energy that makes your lights possible is called electricity. This electricity is produced mostly from fossil fuels that were formed from plants and animals that lived and died millions of years ago.

Much of our electricity is produced by burning a fossil fuel rock called "coal." Coal is a very, very old type of fossil. It was formed from plants that flourished in the great swamp forests over 300 million years ago. The Earth's climate, soil, and atmosphere were favorable for thick plant growth. Many large areas of flat swampy land of perpetual summer existed where plants grew profusely, died, and fell into the shallow waters. These plants could be enormous. Plants, that today occasionally grow to three feet in tropical forests, grew to heights of 30-125 feet (impressively tall oak trees today are 100 feet tall). Some of the these plants had branches that grew directly out of their trunks making them look like 100 foot tall bottle brushes. Over millions of years these dead plants became coal. Anthracite coal can be over 100 million years <u>older</u> than a dinosaur fossil. Even the youngest member of the coal family, lignite, had been formed <u>before</u> the last dinosaur died.]

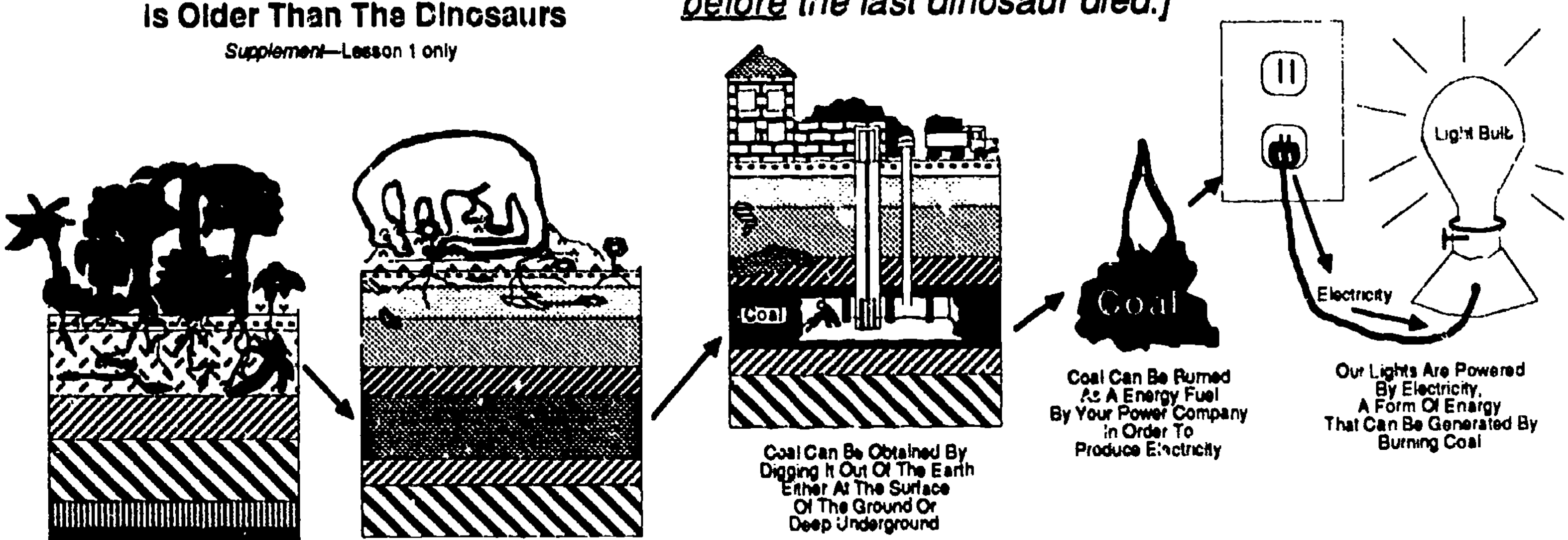


More Specific Information Shown On 8 1/2 x 11" Version In The *Supplement*

Supplement—Lesson 1 only

Most Coal That Is Used To Produce Electricity To Power Our Lights Is Older Than The Dinosaurs

Supplement—Lesson 1 only



Coal Began Forming From The Remains Of Plants That Died During Prehistoric Times Long Before The Dinosaurs Roamed The Earth

After The Plants Were Buried Deep In The Earth, Heat And Pressure Combined To Turn The Plant Remains Into A Fossil Fuel Rock Called "Coal"

Coal Can Be Obtained By Digging It Out Of The Earth Either At The Surface Of The Ground Or Deep Underground

Coal Can Be Burned As A Energy Fuel By Your Power Company In Order To Produce Electricity

Our Lights Are Powered By Electricity, A Form Of Energy That Can Be Generated By Burning Coal

Dinosaurs and Power Plants

Key Question: **What are fossil fuels?**

[The word "fossil" is defined as hardened remains of plant or animal life from some previous geological period that are preserved in the Earth's crust. Therefore, "fossil fuels" are materials that can be used today to produce energy (heat or power) that were created from plants and animals that lived millions of years ago. Like many fossils, these fossil fuels may be found deep in the layers of the Earth.]

Key Question: **Name three fossil fuels.**

[coal, natural gas, & petroleum]

Key Question: **Do you know which of the three states of matter (solid, liquid, or gas) each fossil fuel is?**

[Coal is a solid, petroleum is a liquid (although some may be very thick), and natural gas is a gas.]

> To prevent confusion, while we are studying fossil fuels we will use the word "gas" to refer to a substance that is readily dispersed throughout the atmosphere (i.e., the gaseous state of matter). The term "natural gas" will be used to refer to the fossil fuel. When we are discussing the petroleum product that powers most cars we will use the word "gasoline."

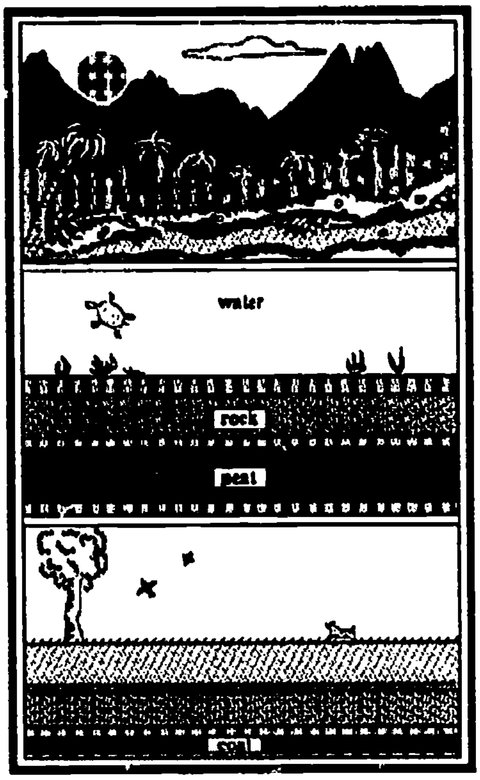
Key Question: **When and how were fossil fuels formed?**

a. When did fossil fuels begin forming?

[Some began forming from plants over 100 million years before the dinosaurs appeared.]

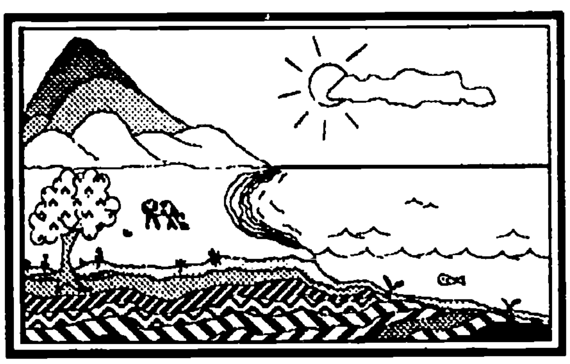
b. What were the original things that became fossil fuels?

[Coal was commonly formed from plant debris and natural gas and petroleum were formed from tiny organisms found in the prehistoric seas.]



How Was Coal Formed?

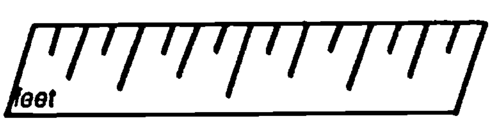
D&PP—Page 1
Supplement—Lesson 1



Underground Geological Layers of the Earth

Supplement—Lesson 1 only

SUGGESTION: Show the difference in the amount of plant remains needed and amount of coal produced by marking the two lengths on the floor or wall with masking tape.



Yardstick or Tape Measure and Masking Tape Required

c. How were fossil fuels formed?

[When the plants died, they fell into the shallow swampy water and were buried over millions of years by increasing amounts of plants, mud, sand, water, and rock. Bacteria attacked the cellulose in the plant cell walls breaking up the large pieces of plant tissue. One of the products of this bacterial activity is methane gas, which sometimes can be seen bubbling up through the water and is called "swamp gas."

The pressure of the weight of the upper layers compacted the plant materials on the bottom into a dense substance called "peat." Peat forms relatively quickly in geological time, but slowly in human perception. A 2-3 inch layer of peat can form in about 100 years. Some of our modern swamps have peat layers over 30 feet in depth that represent relatively steady growth for 15,000 years. For instance, the Great Dismal Swamp in Virginia and North Carolina contains about 3/4 billion tons of peat today. It may take only a few thousand years to form peat, but it takes millions of years to form coal from this peat. As the peat is compacted by the weight of the increasing layers above, it is also buried deeper and exposed to heat deep in the Earth. During this final stage, temperature is the primary agent responsible for the change to coal. However, pressure can still play a big part also. For example, much of the anthracite coal in the U.S. was formed during the ancient formation of the Appalachian Mountains when Ancestral Africa collided with North America as the Earth concentrated its land masses into one continent called "Pangaea." The special combination of time, pressure, and heat changed these ancient plants and animals into the fossil fuels we use today.]

d. How much buried plant matter did it take to form a foot of coal?

[It took 10 feet of plant matter to make 1 foot of coal.]

e. Were there equal amounts of coal, natural gas, and petroleum formed?

[No, coal is much more common than natural gas or petroleum. The composition of the original materials, the amount and duration of pressure and heat, and the length of the formation period varied for each fossil fuel. The timing and the composition had to be just right for each one. These complex conditions evidently happened much more commonly in the case of coal than they did for natural gas or petroleum.]

Key Question:

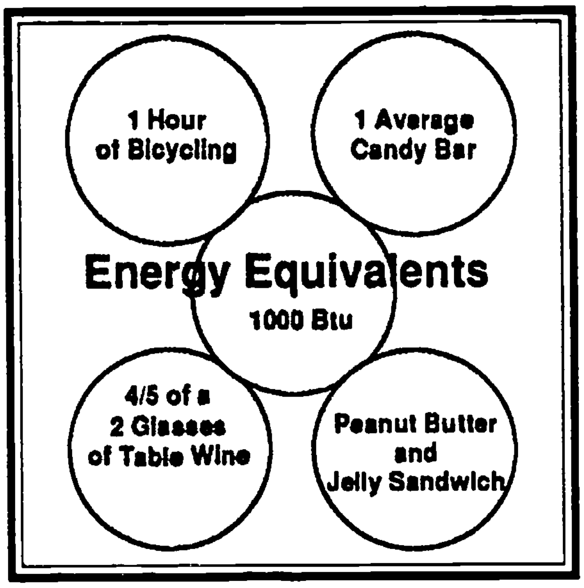
What keeps petroleum (a liquid) and natural gas (a gas) from escaping to the surface of the Earth?

[Petroleum and natural gas are often found under rock formations called "caprock" that are dense enough to trap the petroleum and natural gas and keep it from seeping to the surface. Some petroleum and natural gas have been found at the surface of the Earth and recorded by man. Marco Polo, an Italian explorer, wrote of seepages of oil in the Caspian Sea region. The "eternal fires" reported by Plutarch, a Greek historian, in the area of present day Iraq probably were natural gas seepages that had been ignited by lightning.]

Dinosaurs and Power Plants

Student Activity Options:

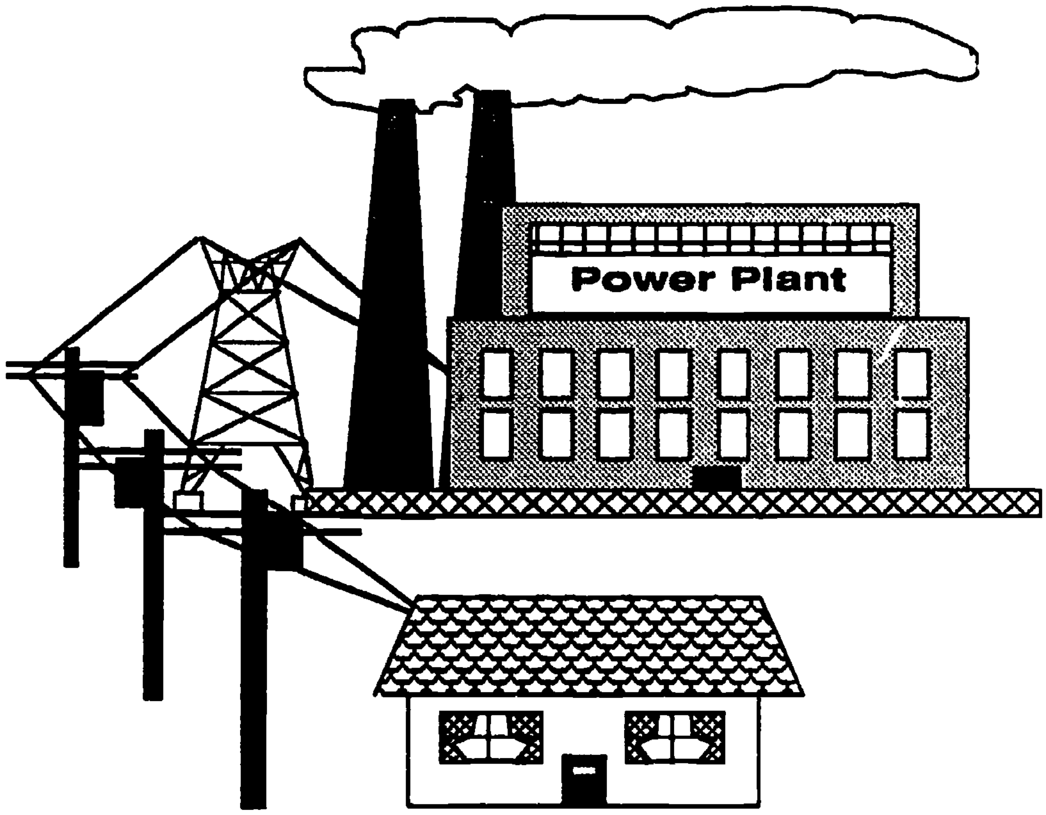
1. Read *D&PP*, page 1.
2. On the "Energy Uses Quiz" (found in the *Teacher's Guide Supplement*-Lesson 1) provided by the teacher, quickly LIST:
   a) the ways a dinosaur used energy, *[finding food, running, swimming, etc.]*
   b) the ways your body uses energy, and *[playing baseball, holding a pencil, running, eating, watching TV, playing video games, etc. Even sitting or sleeping require energy.]*
   c) three machines that use energy (electricity, coal, natural gas, or petroleum). *[television, clock, furnance, bus, car, lights, computer, typewriter, intercom, air conditioner, fire or attendance bell, fan, cafeteria ovens & refrigerators, etc.].*
3. Discuss the "Energy Equivalents" in *D&PP*, page 14, (also in the *Supplement*-Lesson 1).



D&PP—Page 14
Supplement—Lesson 1

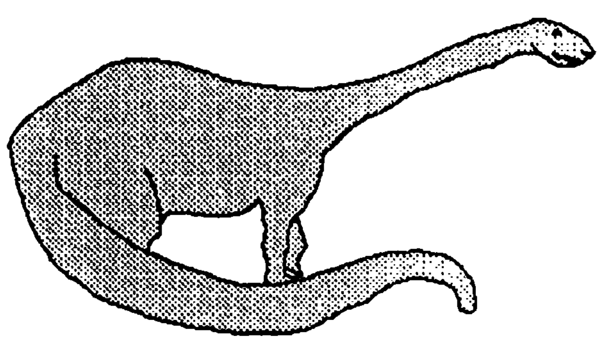
Student Follow-up or Extension Options:

1. Cut out pictures at home for a collage (to be finished at the end of the lesson series) of prehistoric animals and plants or pictures about coal, gas, or petroleum.
2. Read *D&PP*, pages 2 & 3, for the next lesson: Fossil Fuels–Discoveries & Uses.
3. Practice spelling words from the word list (found in the *Supplement*-Lesson 1) for this lesson or write a definition for each word or word group.
4. Designate a small square of space on a table top that can be left undusted for at least two weeks. Check the space after 24 hours to see what has collected. Check again each day for two weeks. Discuss 1) what has happened on your space and 2) how this small example can relate to soil layers outside. In two weeks, note how much material collected in your space. Then think how much could collect in a month, a year, 10 years, 50 years, 100 years,1000 years, one million years or in five billion years (the time that has passed since Earth formed).



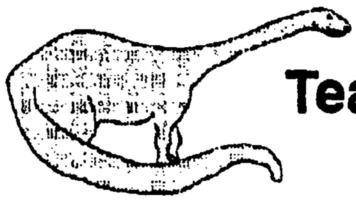
Teacher's Guide

Lesson Two

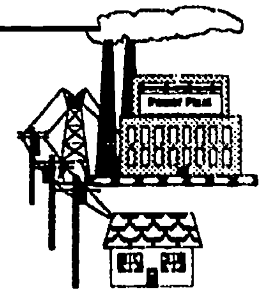


Fossil Fuels

Discoveries and Uses



Teacher's Lesson Plan & Activity Guide



Lesson 2: Fossil Fuels—Discoveries and Uses

Key Questions:

Who first discovered fossil fuels? Where did they find them? How did we use U.S. fossil fuels in the past? How do we use fossil fuels today? How do we make our fossil fuel resources last longer?

Objectives:

Students should be able to:

1. List at least two people from the past who either used or reported sighting fossil fuels. *(D&PP page 3)*
2. List the dates and places that coal, natural gas, and petroleum were first used commercially in the United States. *(D&PP page 3)*
3. Name the reason why Americans needed both the natural gas and petroleum that came from the first commercial wells. *(D&PP page 3)*
4. List at least 10 things that are made from or run on fossil fuels or fossil fuel products. *(D&PP page 2)*
5. List three simple conservation methods that can be used to save energy. *(Teacher's Guide & Supplement-Both Lesson 2)*

Time Allotment:

30–45 minutes

Suggested Materials:

Dinosaurs and Power Plants ("D&PP"),
pages 2, 3, 13, & 15
Fossil Energy products for the Introduction (option)
D&PP Teacher's Guide Supplement ("Supplement"),
Lesson 2
Drawing-"The First Incandescent Lamp..."
Drawings (7)-"First Uses of Fossil Energy"
Drawing-"Today's Fossil Fuel Uses: Clock, Glasses, Telephone, School Bus, & Lawn Mower"
Drawing-"Fossil Fuels and Electricity"
Map-U.S. Strategic Petroleum Reserve Sites
Word List
"Fossil Energy Uses" List
"Things Powered by Electricity..." List
"Resource Conservation" List

Dinosaurs and Power Plants

Introduction Method 1:

Purpose-

To demonstrate to the student the close relationship between fossil energy and our daily lives.

Preparation-

If possible, turn off the classroom lights.

Activity-

Ask, "What do we need to make it possible to have lights in our room?" Turn the lights back on.

[Energy or electricity.]

If answer was "energy" ask, "In what form does this energy exist?"

[Electricity.]

"Where does electricity come from?"

*[It is produced in a power plant from fossil energy, nuclear energy, solar energy, etc. Over **half** of the electricity in the United States is produced from COAL, a fossil fuel rock.]*

Introduction Method 2:

Purpose-

To demonstrate to the student the close relationship between fossil energy and our daily lives.

Preparation-

Display a group of fossil energy related items.

Items that were made from or use fossil fuels are needed for this introduction

SUGGESTION: See *D&PP Teacher's Guide Supplement*-Lesson 2 "Fossil Energy Uses List" for ideas of what items to use.

Activity-

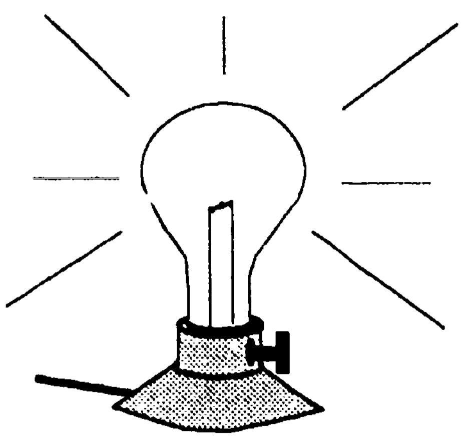
Ask, "What do all these things have in common?"

[They were all made using fossil fuels. Fossil fuels were either used to power the machinery needed to produce the products or to heat the materials used in manufacturing the product. Fossil fuels are also used as the base materials needed to produce plastic, paint, tape, etc. For instance, petroleum is required to make plastics and many types of medicines.]

Stop and Think Exercise

(Either Introduction)

How many of you can remember when video games or personal computers were unheard of? What about air conditioning? Can someone in your family remember when no one they knew had television? Can another person in your family remember when there were no electric refrigerators and they had to buy ice every day to keep the food from spoiling? Have you ever asked someone how they traveled before cars, buses, and planes existed?



The First Incandescent Lamp (Electric Light Bulb) was Invented in 1880

[Electricity for homes was not common until almost 1900 in large cities. It was around that date that most of our inventions that use electricity were created. Before then, many things we have now, such as washing machines, sewing machines, etc., were hand powered. When electricity first began to be distributed to homes, it was then, as now, mostly generated by burning fossil fuels. Some of the inventions made possible by electricity produced by fossil fuels, inventors, and dates are: electric (incandescent) light bulb (Thomas Edison & Joseph Swan-1880), sewing machine (Isaac Singer–1889), vacuum cleaner (1901), refrigerator (1917), & dishwasher (1918).]

Dinosaurs and Power Plants

Key Question: **Do you know when and where fossil fuels were first discovered and used?**

[and Answer]

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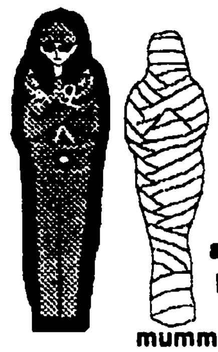
Supplement—Lesson 2



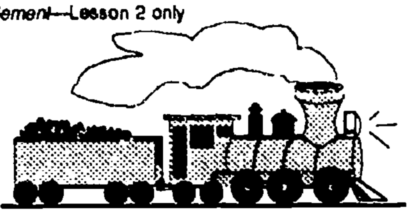
Egyptians used asphalt in the process that perserved human remains and created the ancient mummies seen now in museums

[Fossil fuels have been used since cavemen discovered how to burn peat (decayed plant materials that have not reached the coal stage) or coal for heat. Plutarch, a Greek historian, wrote about the "eternal fires" in the area of present day Iraq. These fires were probably caused by natural gas that was seeping through cracks in the ground and ignited by lightning. Alexander the Great burned petroleum to scare the war elephants of his enemies. The Egyptians used asphalt, a derivative of petroleum, to preserve human remains. The mummies seen in museums were produced using this process.]

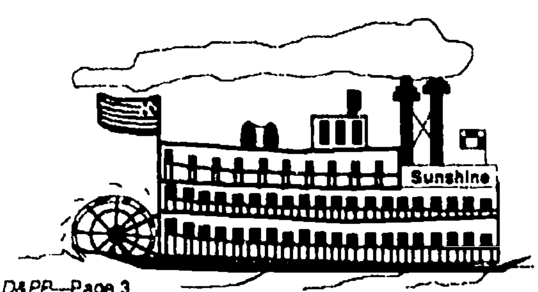
Key Question: **Can you tell me when fossil fuels were first utilized commercially in the United States?**

Coal *[Coal was discovered by explorers in 1673, but it was not mined commercially until the 1740's in Virginia. Before then, coal had been used by the Hopi Indians in the 1300's for heating and cooking. However, it was the Industrial Revolution that provided the real opportunity for coal to become the primary provider of energy for the Age of Machinery. Coal is still the number one fuel used to produce electricity. Today over half of the electricity in the United States is produced by burning coal in power plants. However, it was barely 100 years ago that burning coal became one of the leading ways to produce electricity so generation of electricity is a relatively new use for coal. Long after electricity was used for lighting, coal was still burned in home furnances for heating and in stoves for cooking. It was also used for powering various types of transportation machinery, such as trains and ships.]*

Supplement—Lesson 2 only



Coal powered many types of transportation



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Natural Gas *[Natural gas was first sought commercially in 1821 when William A. Hart drilled a 27 foot deep well in Fredonia, NY, to get a larger flow of gas from a naturally occurring surface seepage. This natural gas was sent through <u>wooden</u> pipes to nearby homes for lighting. These wooden pipes allowed some gas to escape and was not an effective way to send natural gas long distances. It was more than 100 years before a efficient distribution system allowed natural gas to be*

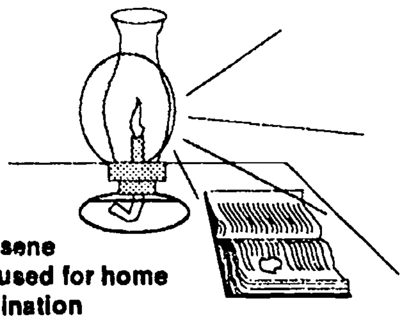
Natural gas provided many towns with outdoor lighting

D&PP—Page 3
Supplement—Lesson 2

sent long distances to homes, factories, and businesses. As the people near these early wells could not use the large quantities of natural gas that was found and did not have good methods for containing the natural gas in the well, much of it was lost or wasted. For example, in towns with outdoor natural gas lighting, the lamps were left burning day and night.]

Petroleum

[In 1859, Edwin L. Drake began the modern day petroleum industry in Titusville, Pennsylvania, when he drilled a 69 foot deep well and discovered crude oil. There was a shortage of whale oil that was used for lighting in some homes and for lubrication of machinery gears in some industries. The crude oil that was obtained from this well was used to form kerosene to use in lamps for illumination and to form grease for machinery.



Kerosene was used for home illumination

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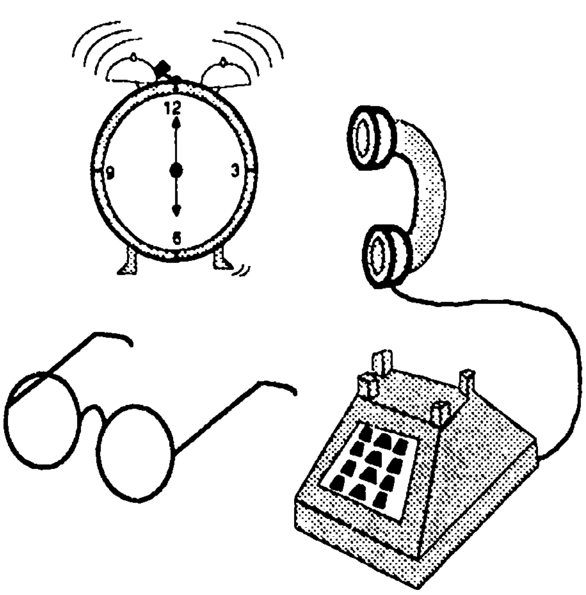
"Petroleum" is used to refer to crude oil and all oil products. "Crude oil" is the actual unrefined petroleum that reaches the surface of the ground in a liquid state.

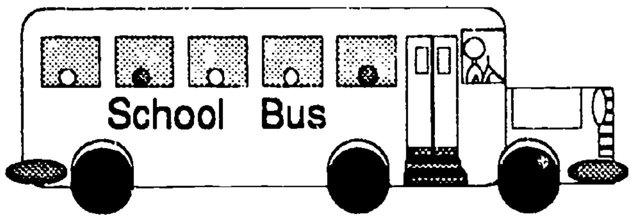
Before this time, a number of uses had been made of the asphalt, tar, etc. from the above ground seepages of petroleum in the U.S., but one of the most important historical uses was when the survivors of the DeSoto expedition utilized pitch to repair and make their ships watertight.]

Key Question:

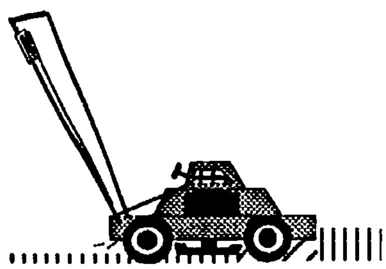
How are fossil fuels used today?



[Fossil fuels touch every moment of our lives — when we wake up or sleep, when we eat, when we use our eyes to see, when we play or work, or when we are ill. For instance, petroleum not only can be refined into fuels, such as gasoline, to power engines; it can also be separated into petrochemicals from which plastics, medicines, paints, etc. can be made. The plastic of the alarm clock that wakes us up can come from petrochemicals. The farmer who raises our food may depend on fossil fuels for fertilizers to make his crop grow. When we read our eyeglass frames or lenses may be of plastic made from petroleum. When we listen to a cassette player or telephone we are using



School buses need fossil fuel to run



Lawn mowers use energy to turn the blade that cuts the grass

equipment that is made from fossil fuels. The synthetic fibers that keep sheets on our bed from wrinkling are produced from fossil fuels. Photographic film for our cameras also is made from petroleum as are many medicines used when we are sick. When we go to work in an office much of the equipment, such as typewriter ribbons and computer disks, depend on fossil fuels for their composition. When we work in an industrial facility we may depend on coal to fuel the huge furnances or petroleum products to lubricate the gears of the machinery.

We also depend on petroleum products for transportation when we ride a bus or other vehicle to school. Even the school we go to probably was built using fossil fuels, such as coal to manufacture the bricks and petroleum for the tarring and waterproofing the roof. The heat in our homes or schools may come from natural gas. Clothes dryers or water heaters may also use natural gas to heat the air or water. Even the lawnmower runs on gasoline or electricity that both come from fossil fuels.

Most of our lives depend upon fossil fuels — not just for the energy, such as the electricity we take for granted, but many times for jobs, such as steel making or building construction or bus driving, and sometimes even for the manufacturing of the clothes we wear on our backs.]

Key Question:

How is electricity produced by fossil fuels?

> Can you find out what each of these people did that helped lead to our present system for generation of electricity?
> *(Refer to each name or to "electricity" in an encyclopedia.)*

[Many inventors paved the way to modern day electric generation. Some of these people, the date of their work, and their country are: Thales (600 b.c. Greece), Benjamin Franklin (1752 USA), Andre Ampere (1820 France), Michael Faraday (1831 England), Zenobe Gramme (1870 Belgium), Thomas Edison (1880 USA), George Westinghouse (1887 USA), and Nikola Telsa (1890 USA).

Thomas Edison opened the Pearl Street steam electric Station on September 4, 1882, in New York City. It was the first commercial power station in the U.S. for incandescent lighting. By October of that year, the station was providing 59 customers in a square mile area with electricity for lighting 1284 incandescent

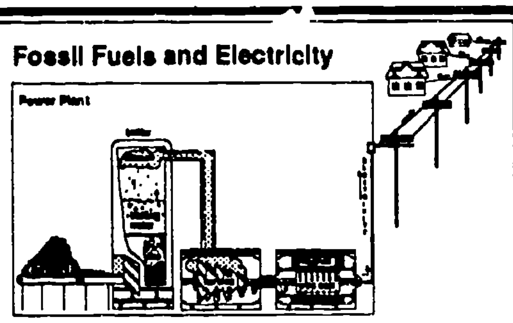
Who can find out how much
we pay today per kilowatt
hour for electricity?
(Check your home electrical bill or call your local electrical company.)

lamps (electric lights) at about 25 cents per kilowatt hour. The station had a total capacity of 600 kilowatts. (Today's fossil fuel power plant may have a capacity of over one million kilowatts.)

Electricity was first produced in two kinds of power plants: Fossil fuel steam electric plants and hydroelectric plants (the first hydroelectric plant opened on the Fox River in Appleton, Wisconsin, 26 days after the Pearl Street steam electric plant opened in New York).

SUGGESTION: Show the drawing "Fossil Fuels and Electricity" found in the *Supplement*-Lesson 2 or refer to the picture with the same title on page 2 in *D&PP*. Trace each step on the picture.

Fossil Fuels and Electricity



Burning Coal to Generate Electricity

D&PP—Page 3
Supplement—Lesson 2

Electricity today can be produced by your utility (electric) company at a power plant by burning a fuel, such as coal, to heat a large quantity of water in a giant closed tub (sometimes 15 stories tall) called a "boiler." As the water boils, it produces steam (like boiling water in a covered pan on your stove). The steam is collected at the top of the boiler and sent through pipes to another enclosure called a "turbine" that has large blades (somewhat like propeller blades on an airplane).

The steam rushes in causing these blades — and the shaft the blades are mounted on — to turn. Since this turbine uses steam to turn the blades, it is called a "steam turbine." The rotating shaft in the turbine also extends into a last box called a "generator" where it turns a wire coil attached to it.

The generator also contains a magnet. The wire coil is inside this magnet. The electrical current that is generated by moving the wire coil inside the magnet is collected by the wire coil and sent out of the power plant as electricity to your school or home.

The electricity is carried by wires usually strung from pole to pole (sometimes referred to as "telephone poles") to your home.]

Dinosaurs and Power Plants

Key Question: **Will our fossil fuel resources last forever?**

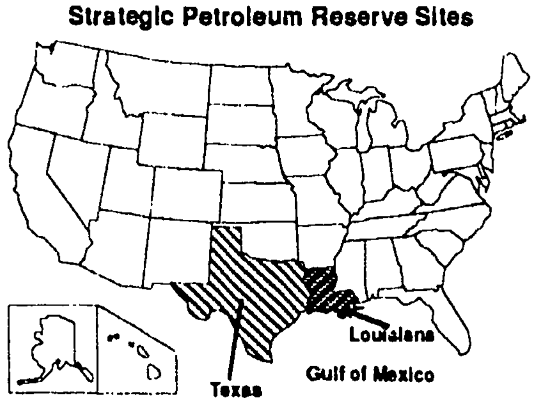
[Fossil fuels we use today began to form millions of years ago. Due to several factors, such as the length of time required to form these fuels, increasing population, and wasteful usage, we are using fossil fuels faster than they are being formed. However, we still have enough coal, petroleum and natural gas on earth to last many years. In fact, within the U.S. boundaries, we have 1/4 of the world's supply of coal. That amount is enough to last, using today's consumption rates, approximately 300 years.

However, we are not so lucky when it comes to petroleum and natural gas. They are less plentiful, more elusive to find, and harder to get out of the ground. The United States uses each day an average of 16 million barrels of petroleum. We use more oil than we produce within our borders and have to buy oil from other countries. We have crude oil left in the U.S., but much of it is difficult or very expensive to get out of the ground.

The U.S. Department of Energy is funding research about how to get more oil out of these reservoirs at lower costs. The next lesson will cover some of these ways.

As of yet, we are still having to depend on foreign countries for much of our oil. The oil embargo of 1973–1974 when many Arab nations cut off the oil flowing into the U.S. and created long waiting lines at our gas stations dramatically demonstrated the need for a national oil stockpile. In the aftermath of the oil crisis, America established the Strategic Petroleum Reserve, an emergency supply of crude oil stored in underground salt dome caverns along the Gulf Coast in Louisiana and Texas. It is our national "insurance policy" in case of oil disruption emergencies and is the largest stockpile of crude oil in the world.]

Strategic Petroleum Reserve Sites



Supplement—Lesson 2 only

SUGGESTION: Show the location of the Gulf of Mexico, Louisiana, and Texas on a classroom map of the United States or show the map found in the *Supplement*-Lesson 2.

Dinosaurs and Power Plants

Key Question:

If we have this stockpile of oil and have an abundant supply of coal, why do we need to make our fossil fuel resources last longer?

[There are several reasons to help conserve our fossil energy resources, including:

1) *The* ***costs for heating, lighting, cooling, electricity, cooking, and fossil fuel products can consume a large portion of a household budget.*** *The money we save by not wasting energy and fossil fuel products is money we can use in other ways.*
2) *The* ***more*** *fossil fuel products* ***we use and throw away,*** *such as plastic cups, disposable diapers, computer disks,* ***the more solid waste we must bury or burn.***
3) ***Your parents may have plenty of fossil fuels*** *to use,* ***but what about*** *later when* ***you*** *(age 10 now) are 25 years old? (15 years from now)* ***Or your children*** *when they are 25? (having a child at age 25–only 40 years away)* ***Or your children's children****? (just 65 years in the future)*

We have to become more responsible in our use of all of our resources. We have to learn to think beyond today to tomorrow when we will have to face the consequences of what we do today. We have to think of the world we will live in tomorrow or we will leave for others. Even now, we are facing challenges caused by previous years of careless living. Without careful planning and consideration, we may have to face even more severe future challenges to the environment, our health, and the cost of living.]

Key Question:

How can we make our fossil fuel resources last longer?

Resource Conservation

Resource Conservation Methods List Available in the Supplement—Lesson 2

[There are simple actions, called "conservation" methods, we can take to save energy and natural resources.

1) *Turn off lights when you leave the room and turn off the television or radio whenever you go to do something else.*
2) *Decide what you want from the refrigerator* ***before*** *opening the door. Do not hold the door open for a long time and let the cold air out. Check to make sure you shut the door completely.*

Resource Conservation (cont'd)

3) *Whenever possible walk or ride your bicycle instead of taking a car.*
4) *Test your windows and doors to see if air leaks in or out. (See "Student Activity Options #2: Making a Draft Detector:) If it does, apply weatherstripping to those with air leaks to seal the heating or air conditioning in and reduce your utility bill.*
5) *Wear warmer or cooler clothing that allows you to set your thermostat lower in the winter (keep your home cooler) and higher in the summer (keep your home warmer).*
6) *Take short showers rather than baths to save on hot water (and wastewater that will have to be cleaned at the local water treatment facility).*
7) *Use as few disposable items as possible. The more items we throw away, the more land we will have to use for solid waste disposal. And the more it will cost you for collection and disposal of these waste items.*
8) *Recycle as many reusable items as possible. Recycling helps us reuse the resource that originally created the product rather than having to use more raw resources to make new products. For instance, recycling newspapers will reduce the number of trees required to make paper.*
9) *There are many other conservation methods that will help save our resources. Check with your local power company or recycling center for additional information.*

Student Activity Options:

1. Half of the class will list things that are made from fossil fuels and half of the class will list things that run on fossil fuels. Determine which group produces the longest list.

> Suggestion: See the "Fossil Energy Uses" and the "Things that are Powered by Electricity..." lists found in the *Supplement*.-Lesson 2.

2. Check the classroom for heating and cooling loss by producing a draft detector and checking the windows and doors in your room.

> **Making a Draft Detector**
>
> Cut out a piece of clear plastic food wrap about five inches by 10 inches. Tape the five inch end to a short stick so the long end hangs freely. For the stick, you could use a pencil or a ruler.
>
> Test the draft detector by blowing very slightly on the plastic hanging down. Notice that even when you blow ever so lightly, the plastic moves and shows the movement of the air. Then hold the draft detector close to where the window or door meets its frame. Determine whether there are drafts stealing the heat or air conditioning from your room by watching to see if the plastic moves.

Check the Conservation Methods list to see what can be done to prevent energy from being lost through your window and doors.

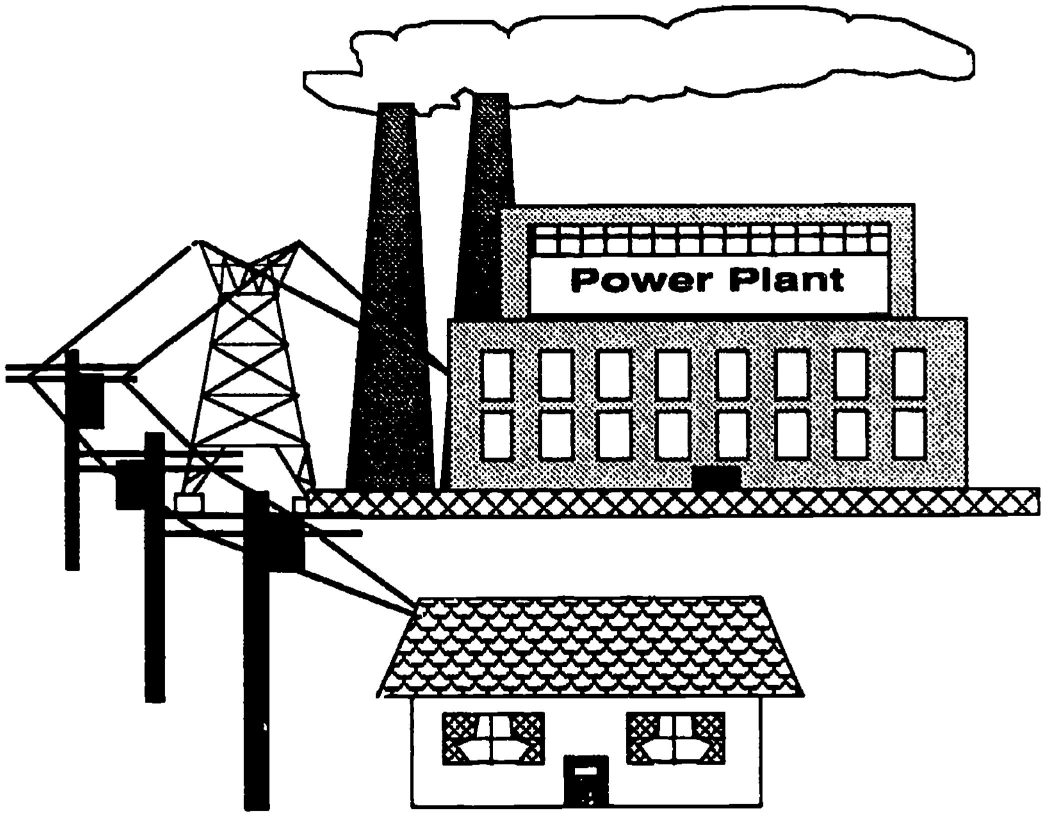
Student Follow-up or Extension Options:

1. Read *D&PP*, pages 4–7 and 11, for the next lesson: Fossil Fuels–Detection, Extraction, and Transportation.
2. Write a letter to the local power company for information on what fossil fuels it uses to generate electricity and on how much electricity various applicances and audio equipment use per hour. (See "Things to Do" in *D&PP*, page 13)

continued...

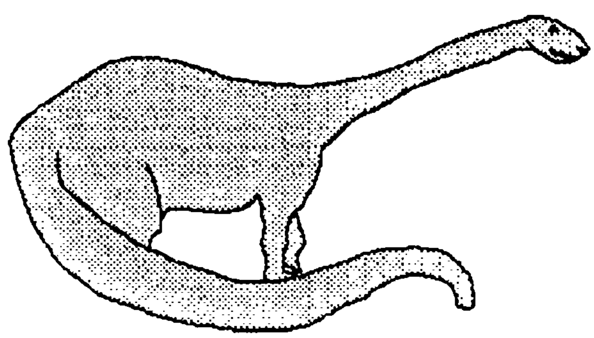
Student Follow-up or Extension Options (cont'd):

3. Write a story about a day in the life of a pioneer student without electricity, central heat, cars, video games, television, radio, etc. (See "Things to Do" on *D&PP*, page 13).
4. Give a report on how much it costs to run the family vehicle for one year (See "Things to Do" in *D&PP*, page 13).
5. Clip pictures at home (for the collage) of things that are run on fossil fuels (e.g., car) or electricity made by burning fossil fuels (e.g., refrigerator) or things that are made from fossil fuels (e.g., plastics, paint, medicines, adhesives, etc.).
6. Each time you use something that uses electricity or a fossil fuel, write down its name (e.g., TV, radio, car, hot water [heater], lights, refrigerator, toaster, microwave, garage opener, telephone, escalator, bus, computer, etc.) and the type of fossil fuel.
7. Ask a resource speaker from the local power company to discuss energy resources, uses, and conservation.
8. Write the U.S. Department of Energy Office of Conservation and Renewable Energy for information on ways to conserve energy. (See "For More Information" in *Dinosaurs and Power Plants*, page 15).
9. Write a report on automated inventions (no later than 1930) that were made possible by electricity produced from fossil fuels and on the inventors of these machines.
10. Talk to relatives and older friends to find out what people did before electric washing machines, refrigerators, televisions, radios, typewriters, computers, fans, air conditioners, elevators (how tall were buildings before there were elevators?), lights, etc. were available to the average person. What did they do without buses, cars, trucks, and airplanes that are powered by fossil fuels?
11. Practice spelling words from the word list for this lesson (found in the *Supplement*-Lesson 2) or write a definition for each word or word group.
12. Determine how much the lights in your classroom/ school cost per year (use the exercise sheet found in the *Supplement*-Lesson 2).



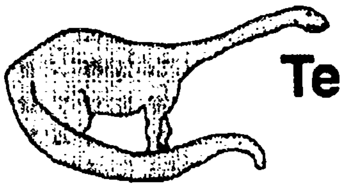
Teacher's Guide

Lesson Three

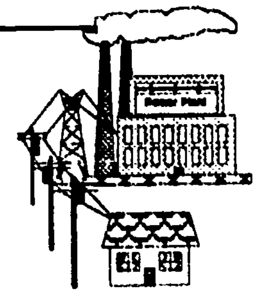


Fossil Fuels

Detection, Extraction, and Transportation



Teacher's Lesson Plan & Activity Guide



Lesson 3: Fossil Fuels—Detection, Extraction, and Transportation

Key Questions:

Where do we find fossil fuels? How do we get them out of the ground? How do we get them to the people who need them?

Objectives:

Students should be able to:

1. Name, describe, and give a general mining location for each of the four kinds of coal. *(D&PP page 4)*
2. Name two types of coal mining. *(D&PP page 4)*
3. Name at least two places "unconventional" gas deposits may be found. *(D&PP page 5)*
4. Tell why we need Enhanced Oil Recovery (EOR) and describe one EOR technique. *(D&PP page 6)*
5. List one way each to transport coal, natural gas, and petroleum. *(D&PP page 11)*

Time Allotment:

One or two 30–45 minute lessons

Suggested Materials:

Dinosaurs and Power Plants ("D&PP"), pages 4–7, 11–13, 15 & 16

Small aquarium or container with glass sides, sand, one quarter, 4 small wrapped candies, some cola sealed in a sandwich bag, and six pennies

D&PP Teacher's Guide Supplement ("Supplement"), Lesson 3

- Drawings (3)-"Finding Natural Gas"
- Photo-"Scientists with Methane Hydrate Crystals"
- Drawings (4)-"Coal Mining"
- Photo-"Coal Mining Equipment"
- Drawing-"Drilling for New Oil"
- Photo-"Workers Operating a Drilling Rig"
- Drawing-"Petroleum Formations"
- Drawings (3)-"Recovery of Oil from Deep in the Earth"
- Drawing-"Petroleum Pumping Unit"
- Photo-"Pumping Units in an Oil Field"
- Drawing-"Offshore Drilling Rig"
- Drawing-"Transportation" (see D&PP pg 16 for <u>quiz</u>)
- Maps (3)-"Fossil Fuel Producing States"
- Word List
- Copy of "Coal Facts and Quiz" for each student (need a pencil or pen to fill in answers)

Introduction Method:

Purpose-

To give the student a better understanding of the complexities of finding and producing fossil fuels, this Introduction will acquaint the student with the challenges that geologists and miners/drillers face trying to find and extract resources that are underground.

Preparation-

Small aquarium or container with glass sides, sand, one quarter ($.25), 4 small wrapped candies, cola sealed in a sandwich bag, & 6 pennies needed for this exercise

Before class, fill a small aquarium or container with glass sides about 3/4 full of sand. Bury in different locations in the sand, 1) one quarter, 2) a short row of four small wrapped candies, and 3) a sandwich bag partially filled with cola and sealed. Make sure that none of the items can be seen from any side of the aquarium. Keep the six pennies on hand for use during the demonstration.

Activity-

Gather the students around the aquarium.
Ask them what is in the aquarium. The answer will probably be "just sand." Tell them that there are actually some "resources" under the sand.

Ask how they would tell what the "resources" are, where they are, and how would they get the them out. If someone suggests digging up or pouring out all the sand, explain that this exercise is designed to imitate on a small scale the process of finding and extracting fossil fuels. The sand in the aquarium is like a cross section of the Earth.

It is difficult to locate fossil energy resources that are buried deep in the Earth. It is made more difficult when the land to be explored has homes, industries, schools, or wildlife sanctuaries located on the surface. (Place the pennies around the surface to represent these situations.)

Ask the students how they would feel if their home or school was represented by one of the pennies that is near or on an area of potential "resource" mining or drilling. Would careful planning be important?

If lesson 3 is split into 2 days, allow the students to think of solutions overnight and present their ideas as the introduction to the second day of the lesson.

List on the chalkboard the ways students decide these underground "resources" can be found and removed. Allow the students with ideas voted to be the best to extract and keep the "resources." Note any problems that occur on the surface of the sand (e.g., landslides around the "houses" or other pennies).

Key Question: **Do you know how today's "explorers" find fossil fuels?**

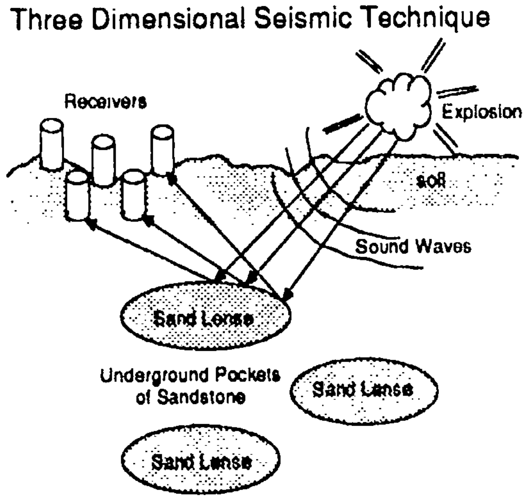
[and Answer]

[Geologists are explorers, but they are historians also. They study the history of the Earth to be able to determine today's structure of the Earth's crust, the composition of the earth's interior, individual rock types, forms of life found as fossils, etc. By studying the geology of a region, they can determine general areas that are likely to have coal, sandstone, limestone, etc. formations. It is then up to exploration teams to go to the area, pinpoint the location, and drill or mine the coal, natural gas, or petroleum. Using the current technology, we still sometimes explore locations that look very promising only to spend money drilling a "dry well" (no oil or gas found). Therefore, researchers throughout our country are working to find more accurate, quicker ways that cost less to find our underground (or undersea) resources.

Natural gas and petroleum are found by bouncing sound waves off of underground land formations and measuring the time it takes for the sound to travel from the sound source (usually an explosion set off by geologists looking for natural gas) to mechanical receivers that record the data. Each formation has certain characteristics that geologists look for in the data that is recorded by the receivers. This technique allows us to "see" the formation below the surface.

There are three methods used for detecting natural gas located within sandstone formations. These three are: Three Dimensional (3D) Seismic , Vertical Seismic Profiling, and Cross–bore Seismic.

Three Dimensional Seismic Technique



Finding Natural Gas
(1 of 3 Examples)

D&PP—Page 5
Supplement—Lesson 3

"Seismic"is defined as of or having to do with earthquakes or <u>man–made</u> ground tremors.

SUGGESTION: To demonstrate the differences in the techniques, show the three pictures of "Finding Natural Gas" on *D&PP*, page 5, or in the *Teacher's Guide Supplement*-Lesson 3.

Key Question: **How are fossil fuels obtained from the Earth?**

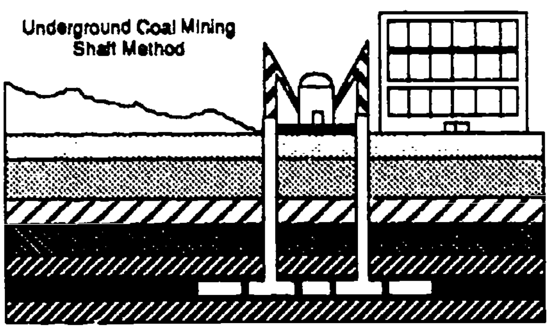
Coal

Surface Mining

Underground Mining

[Coal was initially obtained from the surface or near surface where it was easily mined. Today where coal is found somewhat near the surface and the overlying layers of materials can removed at a reasonable cost, it is mined using surface mining techniques. Where coal lies in deeper layers of the Earth, it is reached through underground mining. There are different kinds of underground mines, such as drift, slope and shaft. The type of mine depends on where the coal is located.

SUGGESTION: Show types of coal mines by using the four "Coal Mining" pictures from the *Supplement*-Lesson 3 or referring to pictures on page 4 of *D&PP*.



Coal Mining
(1of 4 Examples)

D&PP—Page 4
Supplement—Lesson 3

All types of underground mines use one of three methods of digging out the coal. These methods include room–and–pillar, long wall, and bord–and–pillar techniques. The room–and–pillar method is used frequently in mines in the United States.

Using this technique, the coal is mined or carved out and pillars (like huge columns) of coal are left to support the walls and ceilings of the passageways. Room–and–pillar does leave a substantial portion of the coal unmined. However, where possible some of the pillars are mined also.

In each underground mine, large holes (shafts) are also cut from the surface to the underground mining area for air and transportation for workers and for hauling coal out of the mine. Coal can be carried out of a mine on a conveyer belt or in small railcars on a track.

A type of coal mining equipment called a "longwall mining machine" can be shown by using the photograph by the same name in the *Supplement*-Lesson 3.

There are ***four types (or "ranks") of coal*** *mined today:* ***Anthracite, bituminous, subbituminous, and lignite.*** *Anthracite is the hardest and gives off much heat when burned but little smoke. Unfortunately, there is little anthracite in the world. The other ranks of coal are softer , give out less heat , and increasingly more smoke. Bituminous coal is the next rank, followed by subbituminous coal. Lignite, the youngest coal, is at the lowest end of the coal family and emits the most smoke. In some pieces of lignite, you can even see the texture of the original plants (as in other fossils you may have seen) that formed the coal.]*

Can you find on a map the regions or states where the four ranks of coal are found in the United States? See *D&PP* page 4 for information.

Natural Gas

Unconventional Deposits

[Natural gas has collected in a variety of locations and conditions. It is not only found in pockets by itself or with petroleum, but may also be present in "unconventional" gas deposits. These deposits include 1) shale formations, 2) sandstone beds (tight sand lenses), 3) coal seams, and 4) deep, salt water aquifers (underground pools of water).

These underground sources are more difficult and more expensive to produce than the conventional deposits (where natural gas is found by itself or with petroleum), but they hold the potential for vastly increasing the nation's available gas supply and, therefore, are being studied as potentially valuable resources.

Tight Sand Lenses

Tight sand lenses (the type of formation found by the seismic reading technology discussed earlier) are called "tight" because the holes that hold the natural gas in the sandstone are very small. It is very hard for the natural gas to flow through these tiny spaces. To get the gas out, drillers must first crack the dense rock structure to create ribbon–thin passageways through which the gas can flow.

Methane Hydrates

SUGGESTION: Show the photograph found in the *Supplement*-Lesson 3 of two scientists holding pieces of methane hydrate

Scientists with Methane Hydrate Crystals

(This drawing is only a representation of the photograph)

Supplement—Lesson 3 only

Research is also continuing on possible ways to extract natural gas from other types of deposits. The U.S. Department of Energy is funding studies to determine the causes of a type of gas, called "methane hydrate." Methane hydrate is a cage of ice in which molecules of natural gas are trapped. It is found in deep ocean beds or in cold areas of the world, such as the North Slope of Alaska or Siberia in the U.S.S.R. It can also be found in deep waters of the Gulf of Mexico.

There are even theories about additional formations where natural gas may occur. For instance, the federal government is funding research on the theory that there are pockets of natural gas very deep in the ground that were formed at the time of the creation of the Earth rather than later when animals began to swim the seas.]

Petroleum

If the Lesson is to be divided into two parts, begin the second session at this point.

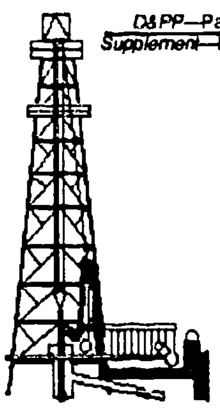
[Petroleum can also be difficult to get out of the ground. It can be as thin as kerosene (like nail polish remover) or as thick as tar.

Contrary to popular belief, petroleum in underground reservoirs does not act like soda in a bottle where you put in a straw and the soda comes right up.

(A "reservoir" is a place on the surface or below ground — this is the case for petroleum — where a substance is collected and stored. There may be an above ground reservoir near you. Sometimes cities set aside a man–made lake of water as a source of drinking water.)

SUGGESTION: For the following discussion, show the rotary drilling rig from "Drilling for New Oil" found in Lesson 3 of the *Supplement* or refer to page 7 of *D&PP*.

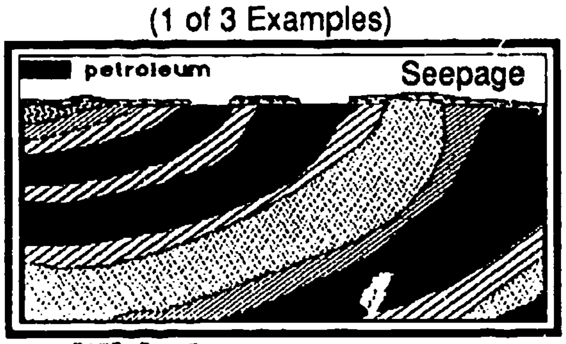
Rotary Drilling Rig



Drilling Equipment

Petroleum reservoirs are tapped by drilling down through the overlying layers of dirt, rock, etc. until the reservoir is found and the petroleum comes to the surface. Most drillers looking for oil use a rotary drilling rig to dig from the surface down to the petroleum reservoir. A tall support shaped like an upside down ice cream cone holds a strong shaft that has a "drill bit" with "teeth" that rotate and chew through the rock. Another part of the rotary drilling rig is a "mud pump" at the surface that assists in pulling mud and debris out of the hole as it is being dug.

Petroleum Formation
(1 of 3 Examples)



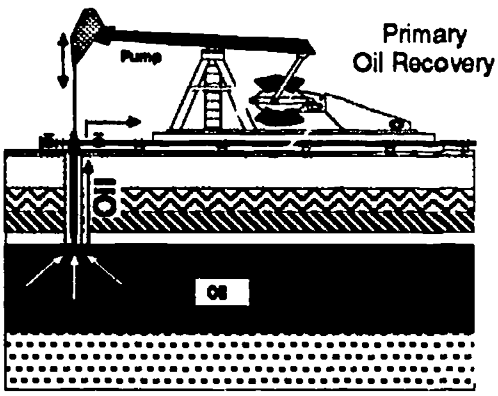
D&PP—Page 7
Supplement—Lesson 3

SUGGESTION: To show underground formations where petroleum may be found, show "Petroleum Formations" from the *Supplement*-Lesson 3 or refer to *D&PP*, page 7.

Petroleum Formations

During the millions of years that petroleum took to form, the Earth has changed many times. Therefore, the formations in which petroleum may be found vary greatly. In the past, petroleum could be found seeping to the surface from where it had formed underground (seepage formation).

Today, it is found mainly underground and in strikingly different places. One reservoir may be found where the layers of the Earth have buckled and formed small waves (anticline formation). Another reservoir may be at the edge of a fault where the layers of rock, dirt, etc. underground have split and one side of the split is trying to ride over the other (fault formation). The types of materials on top of the petroleum reservoir may also vary tremendously. Many times the overlying layers are very dense or hard and may wear out several drill bits before the reservoir is reached.



Recovery of Oil from Deep in the Earth
(1 Of 3 Examples)

D&PP—Page 6
Supplement—Lesson 3

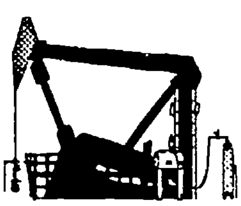
SUGGESTION: To show methods of extracting crude oil, use the three "Recovery of Oil" pictures found in the *Supplement*-Lesson 3 or on *D&PP*, page 6, with the following text.

Primary Oil Recovery

As a petroleum well first comes in (when the reservoir is first tapped and some petroleum comes forth), a portion of the crude oil — and possibly some natural gas — will be expelled from the rock formation due to natural pressure. After the initial pressure is depleted, a mechanical pump is used to pull the oil out of the ground. The movement of the pump may look like the head of a rocking horse bobbing up and down. This first method is called "primary" recovery.

Oil Well Pumping Unit

D&PP—Page 7
Supplement—Lesson 3



SUGGESTION: See page 7 of *D&PP* for an illustration or show "Petroleum Pumping Unit" or "Pumping Units in an Oil Field" pictures found in the *Supplement*-Lesson 3.

However, much of the petroleum left now in the U.S. cannot be forced up even with a pump at the surface. As a result, we have to use other methods to get the crude oil out of the ground.

Secondary Oil Recovery

Another technique that can be tried is "waterflooding" where water is forced down a pipe to the petroleum reservoir to displace and force the crude oil to the surface. This is called "secondary" recovery. However, this method will only produce a little more crude oil from the reservoir than primary recovery did.

Enhanced Oil Recovery

Therefore, we must devise even more advanced ways, called "enhanced oil recovery," of getting oil out of the ground. These advanced methods must also keep costs low so that this crude oil will not exceed the current market price. If the costs do exceed the price consumers are currently paying, this crude oil becomes too expensive to recover.

Have you ever noticed how chocolate goes from a solid state to a thick liquid to a thin, runny liquid as it gets warm? It will even melt in your hand!

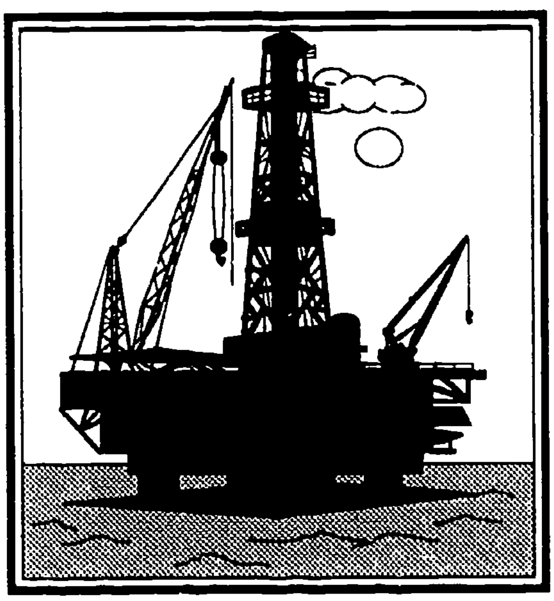
One enhanced oil recovery (EOR) method utilizes steam to heat the petroleum where it is trapped underground. The steam is pumped down through a pipe and left for a period of time. As the petroleum heats up, it thins. When the petroleum thins it becomes much easier to pump from the ground. This enhanced oil recovery method is nicknamed "huff and puff."

MEOR

Another EOR method called "microbial enhanced oil recovery" or MEOR sends living bacteria down a pipe to one side of the petroleum reservoir. These bacteria or "microbes" are fed a substance, such as molasses, that causes them to "burp" gas that pushes the petroleum to the other side of the reservoir and up a pipe to the surface.]

Key Question:

Is petroleum only found on dry land?



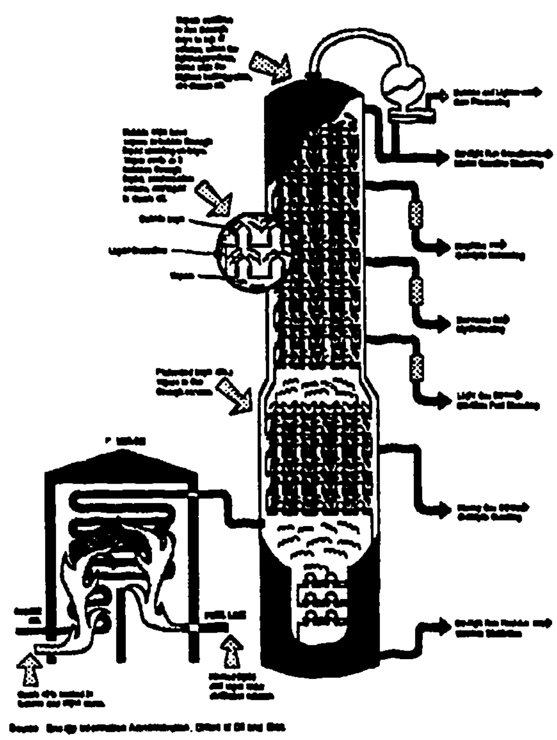
Offshore Drilling Rig

D&PP—Page 7
Supplement—Lesson 3

[No, petroleum is also found and extracted from the waters surrounding the United States and other countries. The first "offshore drilling" in the United States was in 1897 off a pier near Santa Barbara, California. Offshore drilling methods and equipment are similar to those on land except the workers have to build a man-made island or platform over the water to support the drilling rig and other equipment. In addition, the platform must also have space for sleeping and eating as the well may be too far out for the workers to travel to it each day. Many offshore platforms also have landing platforms for helicopters to deliver workers, equipment, and supplies.]

Key Question:

What happens to crude oil once we get it out of the ground?



Fractionating Tower

Petroleum Refining by Distillation

Supplement—Lesson 3 only

[The crude oil is delivered by tanker truck, ship, or pipeline to a refinery where it is separated into its various basic components. This is called "refining." Petroleum can be many things besides just gasoline and lubricating oils for our cars.

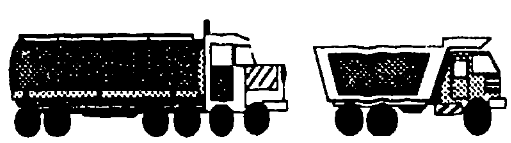
One way crude oil can be separated or "distilled" into its various components or "fractions" is by heating it. Distillation can occur in a fractionating tower. Each one of the various components has a different point at which it turns into a gas. At the point it becomes a gas, it can be drawn off of the original crude oil. The new product is then condensed back into a liquid and stored separately.

(This is like boiling water on your stove. When the water reaches its boiling point the water turns to steam and rises. The steam can then be drawn off.)

After the petroleum products leave the refinery, they are delivered to users for either more processing or for their specific use as a fuel, lubricant, or petrochemical (to create plastic, adhesive, insulation, medicine, detergent, or textiles.]

Key Question:

How do Fossil Fuels get to the user?

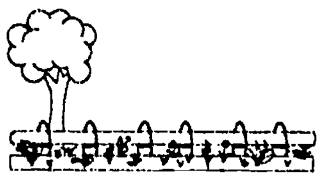


Trucks

D&PP—Page 16
Supplement—Lesson 3

[Many fossil fuel mining or drilling sites are remote from the location of the ultimate user. Therefore, it is necessary to have an extensive transportation and storage system to get the fossil fuel to the consumer. Fossil fuels may be transported by land or sea. Because it is a liquid, petroleum is generally easier and cheaper to transport than is coal, a heavy solid. Natural gas is even less expensive to transport than is petroleum.

Petroleum & Natural Gas

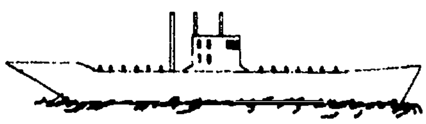


Pipeline
D&PP—Page 16
Supplement—Lesson 3

One of the least costly and most convenient methods of transportation is by underground pipeline. The first major cross–country oil pipeline of 110 miles was laid in Pennsylvania starting at the site of the first well in Titusville. The pipeline system for natural gas is even more extensive than for petroleum. In fact, the U.S. network of pipelines for natural gas, if connected end to end, would stretch to the moon and back twice.

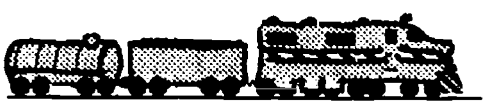
Barge
D&PP—Page 16
Supplement—Lesson 3

Petroleum can also be shipped by land in barrels on flatbed trucks or on rivers in barges. Tank trucks and railroad tank cars are really just large barrels designed to carry many, many barrels of crude oil or petroleum products. Oceangoing ships or "supertankers" have divided compartments where vast quantities of crude oil can be stored for delivery overseas.



Supertanker
D&PP—Page 16
Supplement—Lesson 3

Natural gas may also be shipped by tanker truck or railroad tanker. It can also be cooled to 100 degrees or more below zero (F) where it changes to a liquid that can be carried in huge insulated ships.

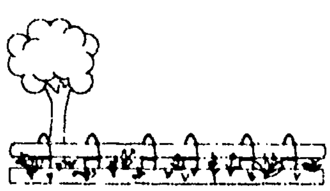


Railroad
D&PP—Page 16
Supplement—Lesson 3

The transportation and distribution system also has to provide for storage of petroleum that arrives for processing at a refinery. These storage facilities called "tanker farms" have many huge storage tanks with rounded tops that will hold millions of barrels of petroleum.

Coal

As mentioned before, coal can be brought out of the mine in small rail cars or on a conveyor belt (similar to ones used at grocery store checkout counters). After leaving the mine, it is carried by truck to be crushed into smaller pieces (these are easier to ship, clean, burn, etc.)

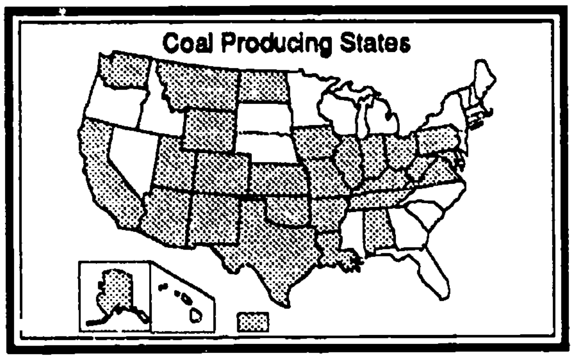


Pipeline
D&PP—Page 16
Supplement—Lesson 3

The crushed coal can then be sent by truck, railroad, barge, ship, or pipeline. Yes, it can be sent through a pipeline if it is mixed with oil or water. The mixture of finely crushed coal and oil or water is called a "slurry." Some of the coal mined in the U.S. is sold to foreign countries. This coal is sent overseas in huge ships.]

Dinosaurs and Power Plants

Student Activity Options:



Fossil Energy Producing States
(1 of 3 Examples)

D&PP—Page 12
Supplement—Lesson 3

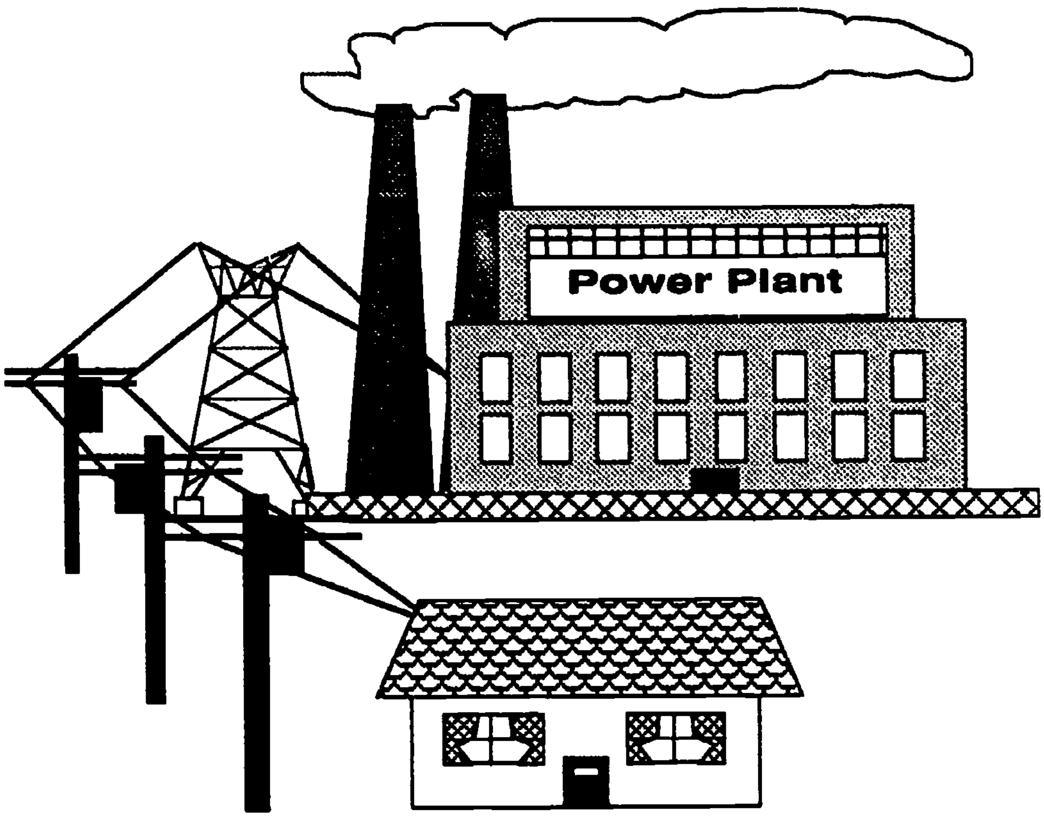
1. Discuss the three U.S. Fossil Fuel Production Maps on *D&PP*, page 12, or in the *Supplement*-Lesson 3.

NOTE: These maps depict states that currently have recorded amounts of fossil fuels in production. Other states may have fossil fuel resources that are not in production. Check with the U.S. Geological Survey or the Department of Natural Resources of your State for data on actual deposits of fossil fuels in your area.

2. Answer the "Coal Quiz" located in the *Supplement*-Lesson 3.
3. Answer the "Transportation Quiz" from *D&PP*, page 16.

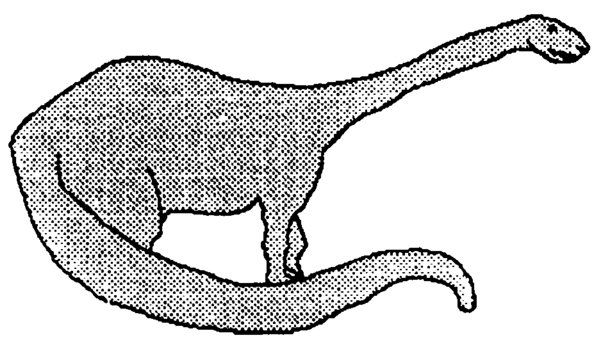
Student Follow-up or Extension Options:

1. Read *D&PP*, pages 8–10, for the next lesson: Fossil Fuels–Potential Environmental Problems and Solutions.
2. Write the U.S. Geological Survey or the local Department of Natural Resources (both usually located in your capital city) for information on what fossil fuels are located in your specific area (See "Things to Do," page 13, and "For More Information," page 15, in *D&PP*).
3. Cut out pictures of oil drilling rigs, coal mines or miners, layers of the Earth, trains, barges, ships, tanker trucks, etc. for the collage.
4. Ask a resource speaker from an oil, natural gas, or coal company to discuss detection and extraction of fossil fuels.
5. Ask a resource speaker who is employed as a coal miner or oil or natural gas driller to speak about their working experiences.
6. Ask a resource speaker from the local power company to discuss obtaining fossil fuels for generation of electricity.
7. Show a film or video tape on coal mining or oil and natural gas drilling (See "For More Information" in *D&PP*, page 15, for ideas where to obtain audio visuals).
8. Practice spelling words from the word list for this Lesson (found in the *Supplement*-Lesson 3) or write a definition for each word or word group.



Teacher's Guide

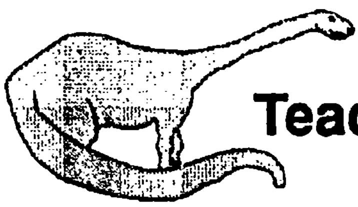
Lesson Four



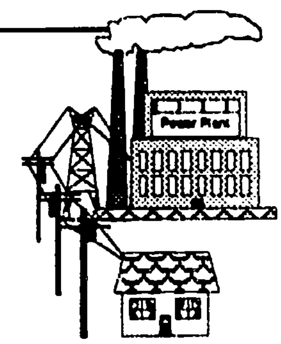
Fossil Fuels

Potential Environmental Problems and Solutions

Dinosaurs and Power Plants



Teacher's Lesson Plan & Activity Guide



Lesson 4: Fossil Fuels—Environmental Problems and Solutions

Key Questions:

What are the potential environmental problems that fossil fuels can cause? What answers have we developed to solve these problems? What is global warming?

Objectives:

Students should be able to:

1. Name one way to clean up an oil spill. *(D&PP page 8)*
2. Name one way to control air pollution from cars. *(D&PP page 8)*
3. Name at least one pollutant in coal. *(D&PP page 9)*
4. Name two types of sulfur. *(D&PP page 10)*
5. List four ways to make cleaner use of coal. *(D&PP pages 9 & 10)*

Time Allotment

One or two 30–45 mir.ute lessons

Suggested Materials:

Dinosaurs and Power Plants ("D&PP"), pages 8–13
Two raisin or chocolate chip cookies for each student
D&PP Teacher's Guide Supplement ("Supplement"), Lesson 4

- Drawing-"Environment"
- Drawing-"Spaceship Earth"
- Drawing "Early Natural Gas Lights"
- Drawing-"Natural Gas Pipelines...to the Moon"
- Drawing-"Air Pollution...Car Maintenance"
- Drawing-"Oil Spills Can Harm Wildlife"
- Drawing-"Oil Spill Containment"
- Drawing-"Improper Waste Disposal Can Pollute Steams"
- Drawing-"...Pollution Is Everyone's Responsibility"
- Drawing-"Making Coal Easier to Clean and Burn"
- Drawing-"Cleaner Use of Coal"
- Drawing-"Cleaning Coal: Coal Washing"
- Drawing-"Coal with Sulfur"
- Drawing-"Sulfur in Coal: Pyritic & Organic"
- Drawing-"Clean Coal: Limestone and Clean Coal"
- Drawing-"Coal Conversion"
- Word List
- "The Road to Clean Coal" Maze Puzzle
- Fossil Energy Word Puzzle

Dinosaurs and Power Plants

Introduction Method:

Purpose-

To acquaint the student with challenges associated with using the Earth in an environmentally responsible manner, today's Introduction will involve the concept of reclaiming the land after coal mining.

Activity-

1. Give each student one cookie and ask them to remove and eat all the raisins or chocolate chips. Tell the students to be sure to save all of the cookie except the raisins or chips.
2. After they have eaten the raisins or chips, tell them to rebuild the cookie from the pile that remains on their desks.
3. Ask them to share their experiences in rebuilding the cookie. List their difficulties on the chalkboard.

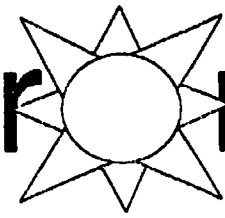
This activity allows us to see how difficult it is to put the land back as it was before coal mining occurred. Today's surface coal mining practices allow each mining company to restore the land after it is mined. Dirt is filled in and grass and trees are planted. However, years ago, we did not think of the future and we misused the land through practices such as strip mining where huge holes were cut in the ground as we mined for coal or other minerals. Once we got all the coal we could, we left gigantic holes in the Earth that eroded when it rained and were lifeless and unsightly.

Today, we think ahead before we mine the land to see how it can be restored for other uses, such as housing or farming, after the coal is mined. We no longer "strip" the land of its valuable resources and then leave it. We have developed improved surface mining and land reclamation methods.

This is similar to what happened to the cookie. We mined the raisins or chips from the cookie without thinking. Next time we will know that planning ahead is important in being able to restore the leftover cookie; we will also know that planning and careful thought is important in using our Earth in a responsible manner.

If the Lesson is split into two parts, steps 4 and 5 may be used as an Introduction on the second day.

4. Distribute a second cookie to each of the students and tell them to again remove the raisins or chips then restore or "reclaim" the leftover cookie.
5. List on the chalkboard what the students did differently that made the reconstruction of the cookie easier.

Envirnment

D&PP—Page 8
Supplement—Lesson 4

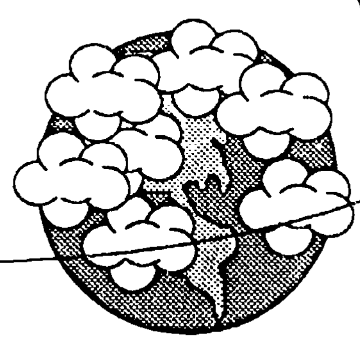
Key Question: **Why should we be concerned about how our use of fossil fuel resources affects the Earth?**

[and Answer] *[Our Earth is like a giant spaceship travelling through space. Years of planning and development occur long before astronauts can take off in a spaceship. The spaceship will be their home. It must protect and sustain the astronauts. There has to be air they can breathe; food they can eat; space for work as well as exercise, bathing, and sleep; effective waste disposal; etc. These things constitute their "environment." They are things the astronauts require to exist while on their journey through space.*

Spaceship Earth *Our environment is what the plants and animals of our world need to live as we travel around the Sun on the Spaceship Earth.*

We have to be concerned about anything that contaminates our air, water, or land as without these three things we would surely die. We have to be aware of past problems, today's problems, and tomorrow's potential problems. Just as an astronaut has to conserve and protect his resources of air, food, and the spaceship itself, so do we. We have only one Spaceship Earth. If we destroy the Earth, we will not survive.]

Spaceship Earth,
Our Home,
Carries Us Through
Outer Space and
Around the Sun



Let's discuss how our use of fossil fuels might affect Earth and our lives.

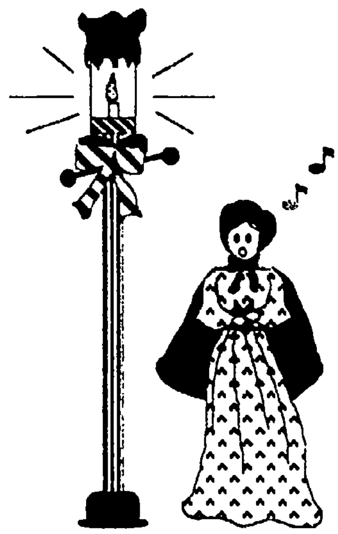
Supplement—Lesson 4 only

Dinosaurs and Power Plants

Key Question: **What potential environmental problems can <u>natural gas</u> cause? What answers have we developed to solve these problems?**

Early Use

[Burning of natural gas contributes the smallest amount to air pollution of all of the fossil fuels. It is also colorless and odorless. The odor you might smell for a <u>short time</u> in your home when you <u>first</u> turn on a burner on a stove that uses natural gas is due to a chemical added as a safety feature by the company offering the natural gas as a fuel. The chemical they add is called "mercaptan." It is used to cause an unpleasant odor that customers will notice in case of a natural gas leak.



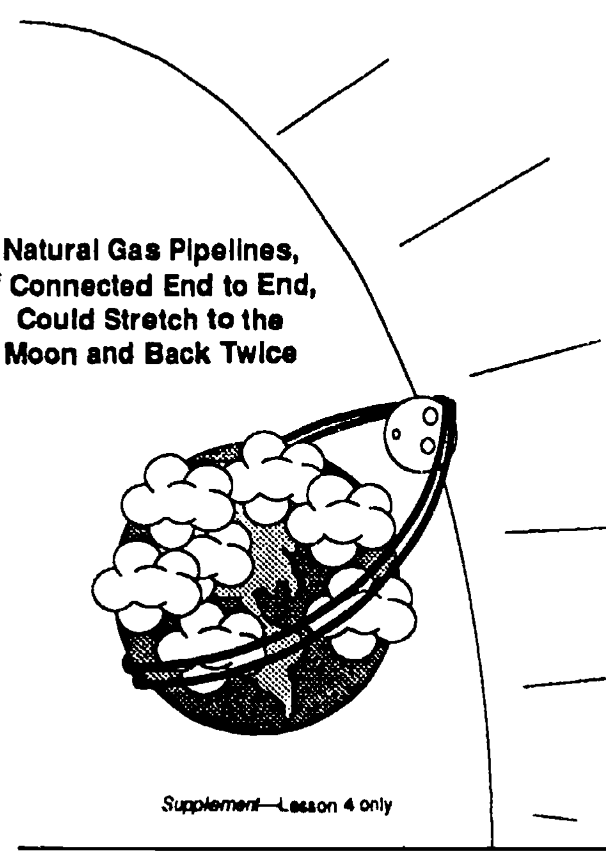
Early Natural Gas Lights

D&PP—Page 2
Supplement—Lessons 2 & 4

In the early days of natural gas use, the wooden pipes went only as far as the homes and businesses near the well. Even at this short distance, much gas was lost because the natural gas seeped out of the wooden pipes. Towns that had a natural gas well to furnish fuels for outdoor lighting many times let the lamps burn day and night because they had more of a supply of natural gas than they could use.

Drilling

Another early problem that has been solved by improved technology is the loss of natural gas when drilling for petroleum. As there was no distribution system for transporting natural gas to far away users, drillers exploring for petroleum did not welcome the discovery of natural gas. When a natural gas pocket was struck, they let the natural gas blow into the air and burn off in "flares" until the pressure was reduced enough to resume work on finding petroleum.



Natural Gas Pipelines, If Connected End to End, Could Stretch to the Moon and Back Twice

Supplement—Lesson 4 only

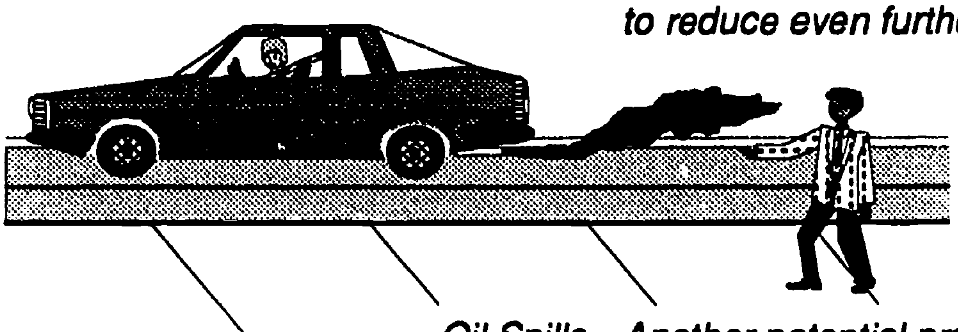
Today with modern equipment and drilling technology plus a vast pipeline system for distribution (a network of pipelines that, if connected end to end, would stretch to the moon and back twice) much of the natural gas that was lost is now saved for use in homes and factories.]

Dinosaurs and Power Plants

Key Question: **What potential environmental problems can petroleum cause? What answers have we developed to solve these problems?**

[Petroleum and its products are continually studied so that they can be used in a increasingly environmentally safe manner. Petroleum was first used for the asphalt, tar, kerosene, grease, etc. that could be formed from it. After the automobile was invented, petroleum use skyrocketed due to increasing demand for gasoline.

Air Pollution *The United States has more vehicles per household that any nation in the world. Associated with that large number of cars, trucks, and vans is the problem of the air pollution those vehicles emit from their tailpipes. To reduce this problem, we have developed unleaded gasoline and catalytic converters. In some states, all vehicles must pass a test that analyzes the gases coming out of exhaust pipe before a license plate authorizing that vehicle to be on the road is issued. Considerable research is continuing on ways to reduce even further the air pollution from vehicles.*



Air Pollution Can Be Reduced By Proper Car Maintenance

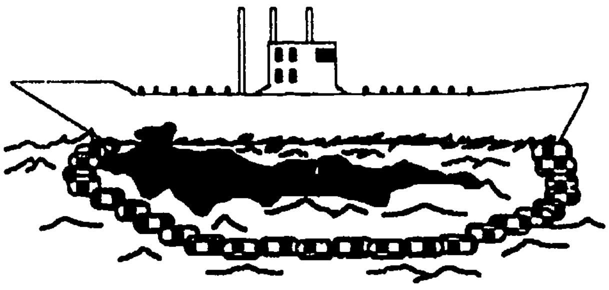
Supplement—Lesson 4 only

Oil Spills *Another potential problem is caused when petroleum or its products are spilled on bodies of water, such as rivers, lakes, or oceans. Oil floats on top of water and can cause serious harm to wildlife and the environment. Fish can die from lack of oxygen in oil covered waters. Other animals that swim in or depend on food from these waters can also die from exposure to the cold, ingestion of oil when cleaning themselves, or starvation when the food source they usually depend on from the water, such as fish or clams, dies. Our beaches also become oil coated. Harbors are closed. Fishermen cannot earn their living. Oil spills are serious and expensive to clean up. Research is continuing on improved equipment and technology for transporting petroleum and its products safely. There are also intensive studies being funded to find quicker and more effective ways to clean up spills when they do occur.*

Oil Spills Can Harm Wildlife

Supplement—Lesson 4 only

What is Done After a Spill



A Floating Fence of "Booms" Can Keep Oil From Spreading on Water after a Spill

Supplement—Lesson 4 only

*The **first** thing that is done in case of an oil spill is to find the source of the spill and prevent more oil from escaping.*

*The **next step** is "containment" where "booms" or floating fences are put around the source of the spill to keep as much oil as possible from spreading. This has to be done very quickly as the oil can move rapidly across the water, particularly in rough seas. Then there are four ways that the oil can be cleaned up.*

Cleaning up the Oil

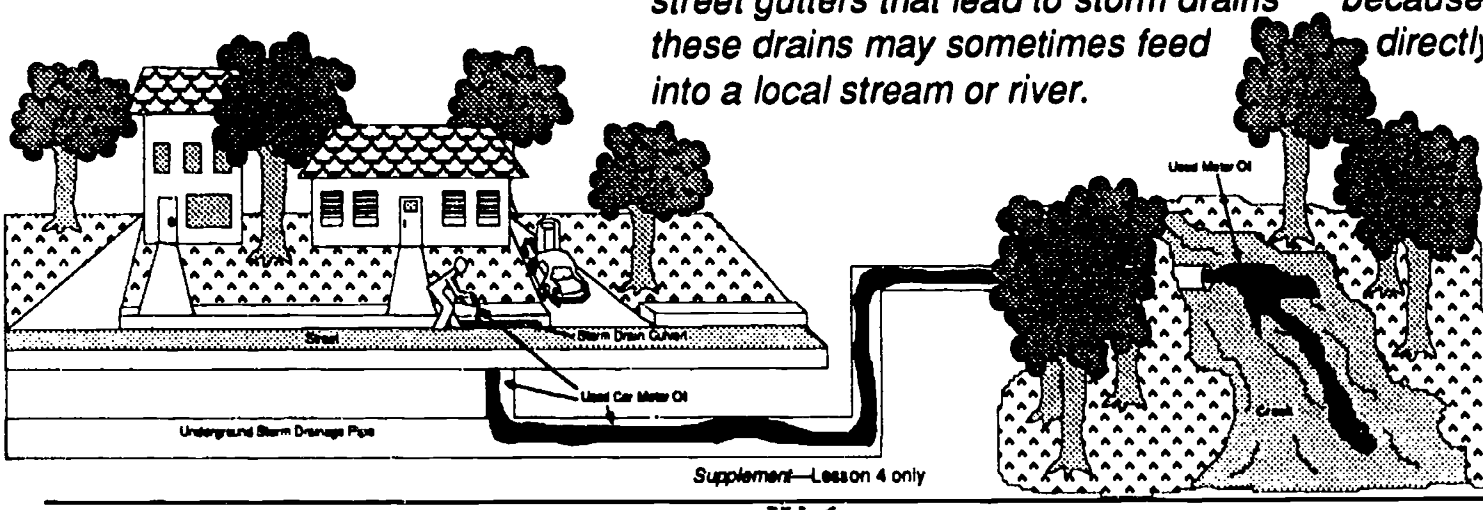
1. *The most common clean up method is by skimming or scooping up the oil.*
2. *Another method is absorption where materials are spread on the oil slick that can absorb and prevent further spread of the oil. This procedure is followed by skimming the absorbent with the oil off the water.*
3. *A third technique is chemical dispersal that involves spreading chemicals on the slick that cause the oil to break up into tiny droplets and sink to the bottom.*
4. *A fourth option is burning the oil off the surface of the water. Rags are set on fire and dropped from the air on the water to ignite the oil.*

There is also research being conducted on the use of oil-eating microscopic "bugs" or microbes. These naturally occurring microorganisms digest the oil and convert it into less harmful materials.

Waste Disposal

Waste petroleum products also can pose problems if not disposed of in an environmentally safe manner. Used lubricants (such as grease), waste oil (such as the used oil drained from the motor of the family car), antifreeze, or brake fluid should not be poured into street gutters that lead to storm drains because these drains may sometimes feed directly into a local stream or river.

Improper Waste Disposal Can Pollute Streams



Supplement—Lesson 4 only

The motor oil from one oil change in the family car can pollute one million gallons of water (enough water for 50 families for one year), if the oil is disposed of improperly.

Hazardous Problems

Even if the storm drains feed into the local water treatment plant, the used oil and the materials it has picked up from the vehicle can cause major problems for the clean up process at the treatment plant. Used motor oil can be particularly hazardous as it contains toxic metals such as lead. If incompatible chemicals, such as brake fluid and pool cleaner, get mixed after they are dumped into a drain, they could form a deadly gas, ignite, and explode.

Dumping petroleum waste products on land will also kill vegetation and pose a threat to wildlife as well as causing an environmental eyesore.

Safe Disposal

Each area of the United States has means of recycling or disposing of these wastes properly. You should contact your city or county waste disposal office for more information before disposing of these materials.]

Key Question:

If the Lesson is to be divided into two parts, begin the second session at this Key Question.

What potential environmental problems can coal cause? What answers have we developed to solve these problems?

[As shown in the exercise at the beginning of this lesson, it takes careful planning to use the land in a responsible manner. Surface mining for coal is certainly a good example of this fact. Areas of the country still bear the marks of the poor mining practices of the past. However, mining companies today with thoughtful planning not only are able to obtain the coal, but are also able to restore the land to other useful purposes.

In the past, coal fueled the machinery that allowed the U.S. to become an industrial giant. Many homes also used coal for heating and cooking. But in those days little was known about cleaning pollutants from coal. When coal was burned it released the sulfur and other impurities trapped within it. Where coal was used in large amounts, the air was often full of soot and foul odors.

Preventing Pollution Is Everyone's Responsibility
Supplement—Lesson 4 only

Today, we are learning how to use coal in cleaner ways. Scientists have found ways to remove sulfur and other impurities from coal. They are teaching us how to burn coal without releasing the impurities and how to change coal into a clean burning gas or liquid before it is burned.

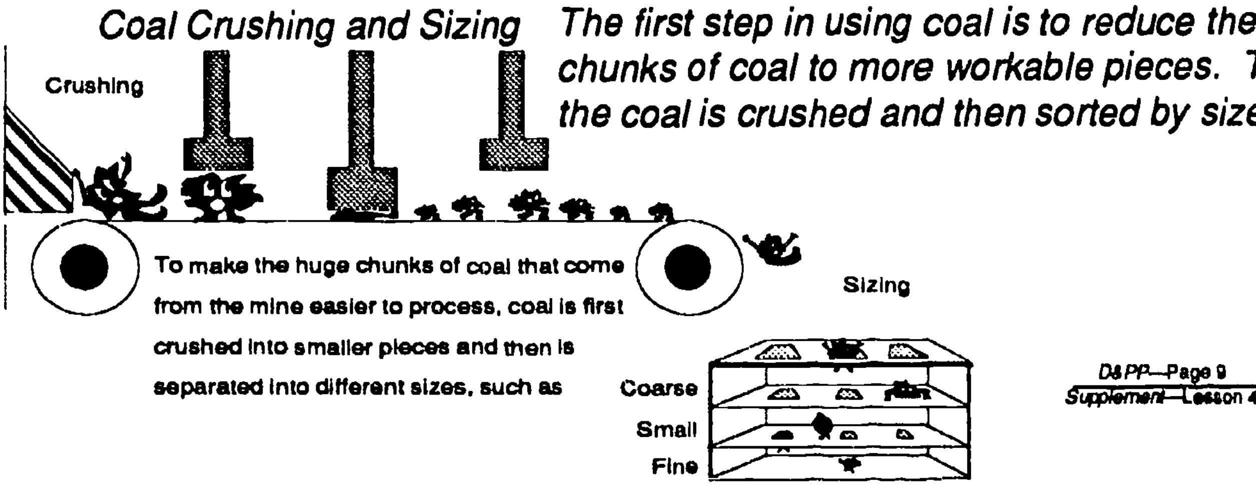
Do you remember from the past lesson what fraction of the world's coal America has? *D&PP*— page 4.

The U.S. has more coal resources for generating electricity than it does other fossil energy resources. At this time, ***coal is used to produce over half of the electricity in this country****. In the future as our population increases and more people need electricity at home and at work, it may be increasingly important to be able to use our coal resources in an environmentally clean manner. If we are to use more coal to produce energy and other products, we must find ways to prevent two kinds of pollutants from being released to our air. One of the pollutants is* ***sulfur*** *and the other is a form of* ***nitrogen****.*

Sulfur pollutants can be reduced by finding ways to take sulfur our of the coal or to remove it from the smoke produced when coal is burned.

Nitrogen is a little different. When coal is burned some nitrogen is released from the coal. However, some nitrogen also comes from our atmosphere. Nitrogen is harmless in the air until it is heated to high temperatures. Then some of the nitrogen is changed into an undesirable gas (nitrogen oxide). Burning coal at low temperatures (1500 – 3000 degrees F) will keep nitrogen pollutants low.

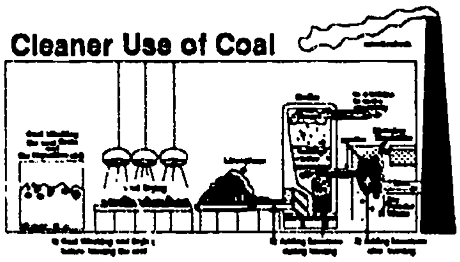
Coal Crushing and Sizing



The first step in using coal is to reduce the huge chunks of coal to more workable pieces. Therefore, the coal is crushed and then sorted by size.

After these steps, the coal begins the cleaning processes that will reduce any pollution that could harm us or our environment.

4 Ways for Cleaner Use of Coal



D&PP—Page 9
Supplement—Lesson 4

There are 4 ways that we can make cleaner use of coal:

1. ***Cleaning** the coal **before** it is burned,*
2. ***cleaning during** coal burning,*
3. ***cleaning after** the coal is burned, and*
4. ***changing** coal **to a clean burning liquid or gas**.*

1) Clearing Before Burning

D&PP—Page 10
Supplement—Lesson 4

After coal is crushed and sized, it can be cleaned before it is burned. One method to do this is by washing.

The Structure of Coal

To understand how coal washing works, imagine the structure of coal as a pile of marbles. Most of the marbles would be carbon, a basic element found in all living things. The plants that lived millions of years ago and formed today's coal were composed of the this carbon so it is reasonable to find it as part of coal composition. But there are other substances in coal.

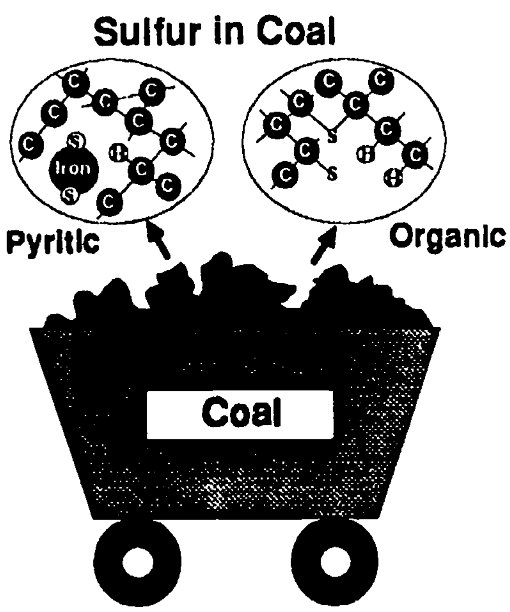
D&PP—Page 10
Supplement—Lesson 4

Sulfur in Coal

Acid Rain

Some of the marbles are the sulfur we discussed earlier. Sulfur, in its pure form, is very useful. It is often used in medicines used by doctors to treat illnesses. In coal, sulfur is a problem. When coal burns the sulfur breaks loose and forms a foul smelling gas. In our air, sulfur gases can combine with water vapor (visible particles of moisture floating in the air) and form a weak acid that can fall to earth as "acid rain." Studies are being funded to determine what effect this "acid rain" has on vegetation (such as trees), on lakes, on wildlife, and on our health.

Two Kinds of Sulfur



D&PP—Page 10
Supplement—Lesson 4

*Sulfur in coal exists in two forms. Some of it is bound to the carbon and is know as **"organic"** sulfur. The rest of the sulfur is not connected to the carbon but is glued to other elements such as iron. The sulfur connected to iron is called **"pyritic"** sulfur.*

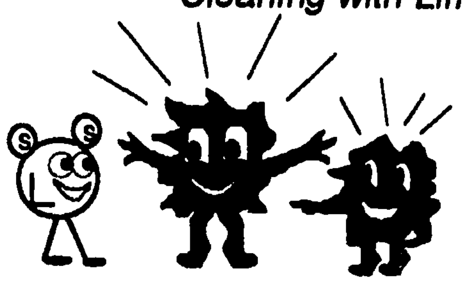
The distinction is important because different kinds of cleaning processes are needed to remove the two types of sulfur. Whereas much of pyritic sulfur can be removed by washing the coal, better methods are need to remove organic sulfur.

Some of the clean coal technologies that government and industry are studying may provide the extra cleaning required to remove organic sulfur.

If sulfur can be removed before the coal reaches the power plant to be used to generate electricity, utility companies would not have to install expensive cleaning devices onto the plant. Unfortunately, today's coal cleaning methods do no remove enough sulfur to meet air quality laws, so more sulfur must be removed at the power plant.

2) Cleaning During Burning

Cleaning with Limestone



Limestone and Clean Coal

D&PP—Page 10
Supplement—Lesson 4

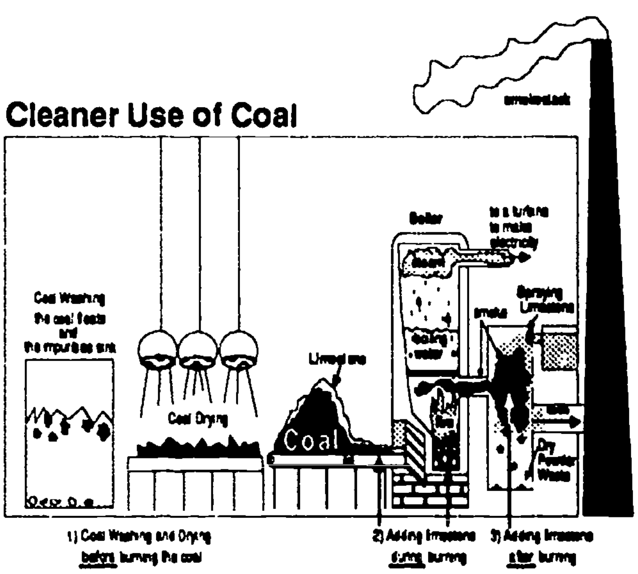
Coal can be cleaned at the power plant while it burns. In one advanced coal burner, called a fluidized bed combustor (burning is also called "combustion"), the coal is mixed with ***limestone****. This limestone acts as a sponge soaking up the sulfur as the coal burns. Since organic and pyritic sulfur are released during burning, both can be removed inside the combustor.*

More than 90% of the sulfur can be removed before the exhaust is released to the environment. The coal burns at a lower temperature so the formation of nitrogen pollutants is also reduced.

3) Cleaning After Burning

All types of coal produce at least a little smoke when they are burned. Most of the smoke is water vapor, but it can also contain sulfur and nitrogen if these pollutants have not been removed by coal washing before burning or by a removal procedure during burning. Many power plants use "scrubbers" after burning to remove sulfur pollutants before they release the smoke to our air.

Cleaner Use of Coal



D&PP—Page 9
Supplement—Lesson 4

Again limestone is used, but in a scrubber it is sprayed along with water into the smoke. Scrubbers are expensive (higher electricity bills to you and me), they do not remove nitrogen, and they produce a wet, pasty waste product call "sludge" that the utility company must find a way to dispose.

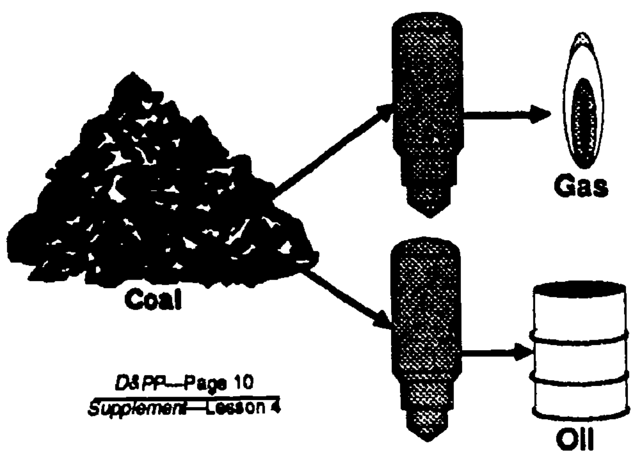
The clean coal technologies being developed will help overcome these drawbacks. One technology injects dry limestone into the ductwork (the pipes leading out of a boiler) rather than waiting for the smoke to reach the smokestack (pipe leading out of the plant through which smoke is emitted to the atmosphere).

The sulfur is removed as a dry powder rather than a wet sludge. The dry waste is much easier to dispose. In sc me cases, the dry powder can be used to make builc ing materials or as a soil conditioner.

Another clean coal technology uses special chemicals called "catalysts" to change nitrogen oxide pollutants back into harmless nitrogen before they are released into the air.

4) *Coal Conversion*

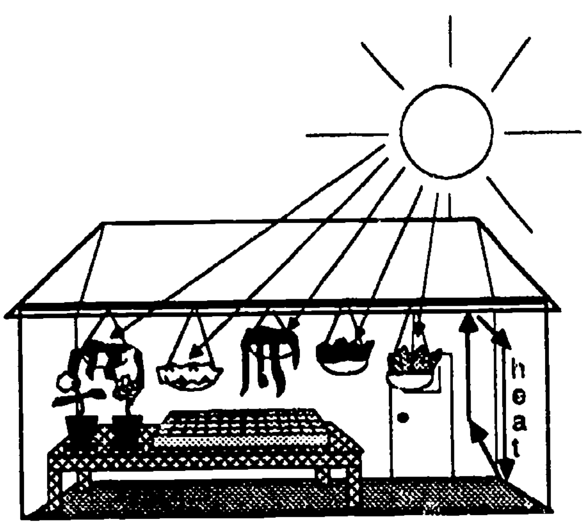
Coal can also be ch·nged into a clean burning gas or a liquid fuel. The techniques involve heating and squeezing coal under high pressure until the coal breaks down into a gas or liquid. The processes that allow these conversions are calleć ***coal gasification*** *and* ***coal liquefaction.***



Changing coal to a gas or liquid has a number of advantages such as easier sulfur removal and easier handling and burning. Also, these gases and liquids can often be used in equipment originally designed to burn oil without making major changes to the current equipment thus saving the company (and the customers) money.

Key Question:

What is global warming? What causes it to occur? Why is global warming a concern? How can we reduce it?



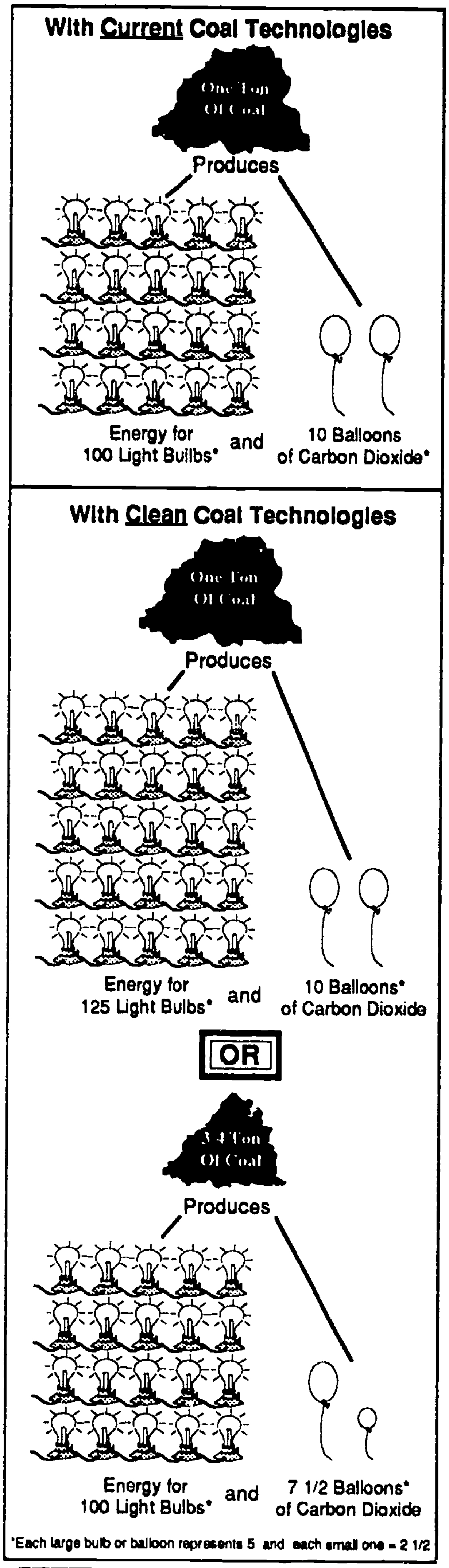
The Greenhouse Effect

The glass roof of a greenhouse allows the rays of the Sun to penetrate but does not let any heat escape. The climate in the greenhouse stays very warm and humid. Carbon dioxide and other gases in our atmosphere could have the same effect on Earth and cause the temperature to rise worldwide.

All fossil fuels release carbon dioxide when they burn. (People also exhale carbon dioxide when they breathe.) Much of this carbon dioxide is used by green plants during photosynthesis in order to produce oxygen (which we, in turn, need to inhale). Some carbon dioxide is even trapped in the oceans. But since the world's population began using more machinery and burning more fossil fuels, larger amounts of carbon dioxide have been released into the air than either plants or the oceans can capture.

In the air, carbon dioxide (and several other types of gases) act like the glass roof on a plant greenhouse. The gases let sunlight in and do not let heat out. Scientists are concerned that this "greenhouse effect" could make our planet warmer. Raising the temperature of Earth could have many consequences, such

Dinosaurs and Power Plants



as the loss of shoreline areas because the oceans rise as the ice caps of the North and South Poles melt, change of semi-arid land into desert, change of the areas where temperature sensitive crops can be grown, etc.

Many ways are being examined to reduce the release of carbon dioxide, but one of the best ways available now is to produce more energy while using the same amount of, or less, fuel (in other words, increase the efficiency of the energy process). Since coal releases more carbon dioxide then any other fossil fuel, most of the research has focused on the efficiency of coal use.

Many clean coal technologies achieve the higher efficiencies. Think of a typical coal-burning electric plant as consuming a single ton (2000 pounds) of coal every hour (actual plants consume several thousand tons of coal every hour). Let's say that from the ***one ton of coal,*** *we can produce enough* ***electricity to light 100 light bulbs****. But in addition to energy, the ton of coal produces enough* ***carbon dioxide to fill 10 balloons****.*

Suppose we replace the oil coal-burning technology in the plant ***with new clean coal technology****. As a result, the plant can now produce* ***enough electricity for 125 light bulbs*** *— not 100 — while* ***still burning a single ton of coal and releasing the same amount of carbon dioxide****.*

Or *you can look at our power plant another way. Perhaps we only need enough* ***electricity for 100 light bulbs*** *rather than 125. Instead of burning one ton of coal, we can* ***burn 3/4 of a ton*** *if we use new clean coal technologies. Because the same amount of electricity is produced with less fuel,* ***only 7 1/2 balloons of carbon dioxide are produced.*** ***The same amount of energy is made but with less carbon dioxide released into the air.***

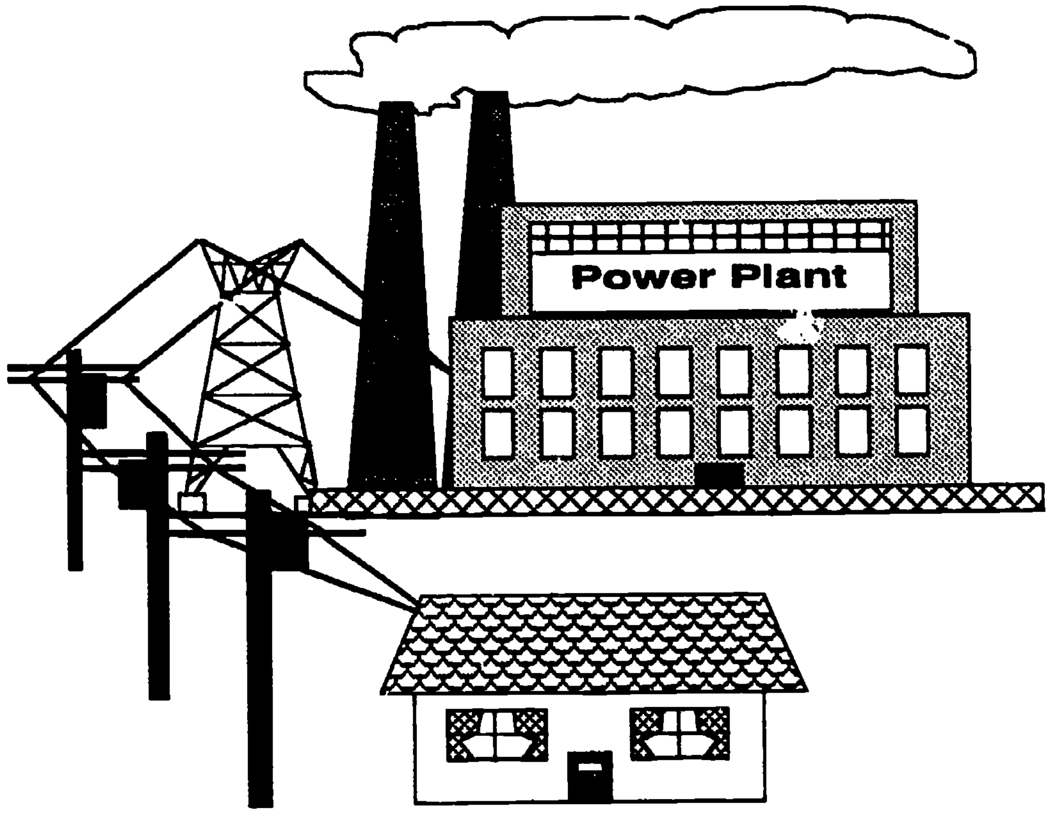
Until better ways are found to prevent carbon dioxide from being released into the atmosphere from fossil fuel burning plants, using less energy and increasing plant efficiency are the most practical ways to avoid problems from the "greenhouse effect," such as global warming.

Student Activity Options:

1. Complete "The Road to Clean Coal" Maze, *in D&PP*, page 11, or in the Supplement-Lesson 4.
2. Answer the "Fossil Energy Puzzle," *in D&PP*, page 13, or in the Supplement-Lesson 4.

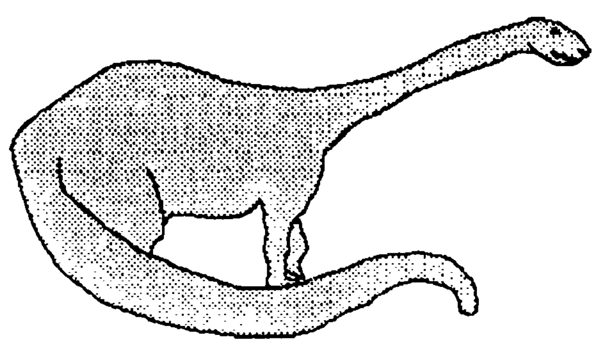
Student Follow-up or Extension Options:

1. Read *D&PP*, page 12, for next the lesson on Fossil Fuels–Energy for the Future.
2. Draw a scene that shows problems caused by pollution. Then draw how we can prevent or clean up pollution.
3. Cut out pictures about environmental problems caused by fossil fuels and pictures of how clean the environment will look as we use fossil fuels in cleaner ways. (Have clippings ready to finish collage on last day.)
4. Have a resource speaker from the Environmental Protection or Pollution Control Agency in your State discuss what fossil fuels are used in your area, how fossil fuels influence environmental problems, and what is being done to clean up past problems (e.g., strip mining) and prevent future problems (e.g., air pollution).
5. Practice spelling words from the word list for this lesson or write a definition for each word or word group.
6. Report on educational or news programs you see on television about the environment.
7. Start a recycling program at your school.
8. Find out and report to the class what plans your city or county has to keep the air, water, and land clean.
9. Watch films on the environment (especially those concerning showing new concepts in using fossil fuels in more environmentally safe ways).



Teacher's Guide

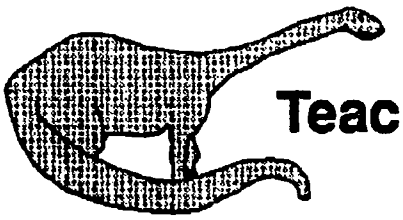
Lesson Five



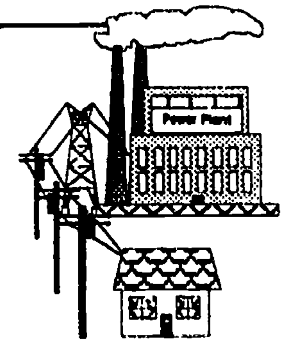
Fossil Fuels

Energy for the Future

Dinosaurs and Power Plants



Teacher's Lesson Plan & Activity Guide



Lesson 5: Fossil Fuels—Energy for the Future

Key Questions:

What will our energy needs be in the future? How will we meet these needs? What are we doing to assure a secure energy future for our nation?

Objectives:

Students should be able to:

1. Complete this sentence. "As fossil energy resources are ____________, population and industrial needs are ____________ in the U.S. and the world." *(D&PP page 12)*
2. Name two things that the U.S. will need as a result of population growth. *(D&PP page 12)*
3. Name the resource used to produce electricity that is most abundant in the U.S. *(D&PP pages 2, 4, & 12)*
4. Name two ways we can save fossil fuel resources. *(D&PP page 12)*
5. Name the programs funded by the federal government that are developing methods 1) to use coal in cleaner ways and 2) to improve recovery of crude oil and natural gas. *(D&PP page12)*

Time Allotment:

30–45 minutes

Suggested Materials

Dinosaurs and Power Plants ("D&PP"), pages 12–15
D&PP Teacher's Guide Supplement (*"Supplement"*), Lesson 5
- Drawing-"Our Increasing Population"
- Drawing-"More Power Plants..."
- Drawing-"Ways to Assure a Secure Energy Future"
- Drawing-"Be a Discoverer...Explore Your World"
- Drawing-"Be An Intelligent Shopper"
- Drawing-"Voting Booth"
- Drawing-"Our World Depends on...Technology"
- Word List
- Copy of the Summary Quiz for Each Student
- Fossil Energy Feud/Super Feud
- Energy Spin

Supplement Lessons 1-5: Word Lists
Classroom Map of the World
Collage Activity Materials

Introduction Method:

Purpose-

To challenge the student to put knowledge gained from these lessons into action.

Preparation-

1. If the "Fossil Energy Feud/Super Feud" games are to be played, follow the instructions for preparation found with the game board in the *Teacher's Guide Supplement*–Lesson 5.

2. If "Energy Spin" found the the *Supplement*-Lesson 5 will be played, follow the instructions with the game.

3. If a Spelling Bee or "Word Power Challenge" is to be used as an introduction, compile a list of words that will challenge the class. Words can be taken from the word list found with each Lesson Plan in the *Supplement*, from the "Fossil Energy Glossary" (*D&PP*, page 14), or throughout the text of *D&PP*.

Activity-

Play Fossil Energy Feud/Super Feud or Energy Spin or conduct a Spelling Bee or Word Power Challenge (see Student Activity Options at the end of this Lesson Plan).

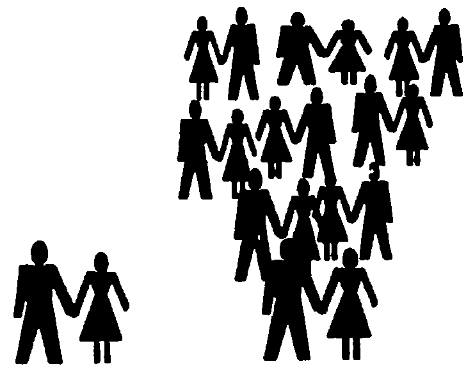
Then follow with the discussion questions in this last lesson for a look at our energy future, at the role fossil fuels may play, and the reasons that education of today's youth will be critical to every person in the United States.

Dinosaurs and Power Plants

Key Question: **Will our energy needs change in the future?**

[and Answer] *[Fossil energy resources are shrinking as population and industrial needs are growing. More people are living longer and more children are born every minute. For each person, there is a related increase in the need for building materials for homes and offices, energy for lighting and power equipment, ways to grow more food on less land, etc. Many, if not most, of these things depend on fossil fuels in some way.]*

Our Increasing Population



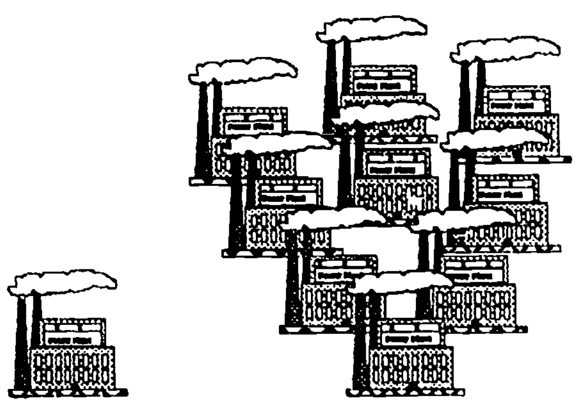
Key Question: **How will we meet these needs?**

[We will likely need to build more new U.S. power plants for electricity generation in the next 10 to 15 years than all the ones that presently exist in countries such as Japan and Germany.

Some of these plants could use solar or nuclear power, but coal is abundant and affordable. Properly cleaned, it could be used to satisfy much of our future demand for electricity and other fuel needs. Natural gas is also readily available and likely will be used in greater amounts in power plants.

The U.S. supply of petroleum, however, probably will continue to decline faster than we can find new oil fields. Better technology will get more crude oil out of the fields we have already found, but it will not be enough to satisfy our future demand for oil. Therefore, it becomes even more important to use petroleum wisely (e.g., recycling plastics and used oil) and to find new fuels that someday can substitute for the crude oil we use today (e.g., liquids produced by coal liquefaction).

More Power Plants Will be Needed to Produce Energy

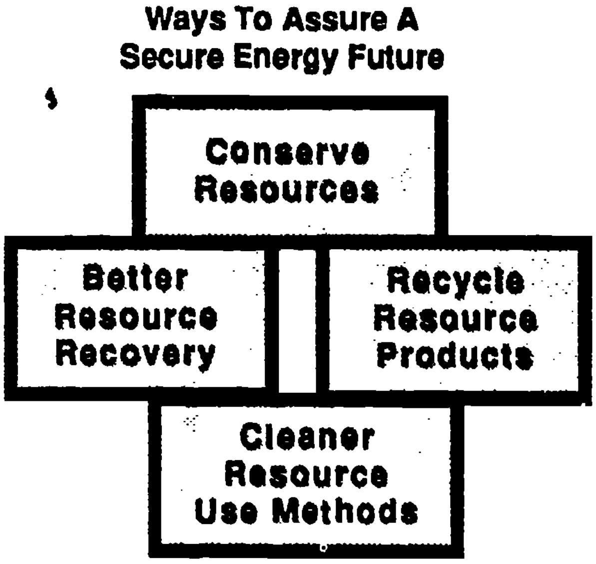


As the population increases, more power plants will need to be built to produce the energy required by new jobs and homes

Dinosaurs and Power Plants

Key Question:

What are we doing to assure a secure energy future in the United States?



[We can all help ensure a secure energy future by helping to not waste our fossil energy resources. We can save fossil energy by turning off lights and electricity using machines, such as radios and televisions, when we leave and go on to another activity or room. We can walk or ride our bikes on short distance errands. We can recycle products made with fossil fuel resources.

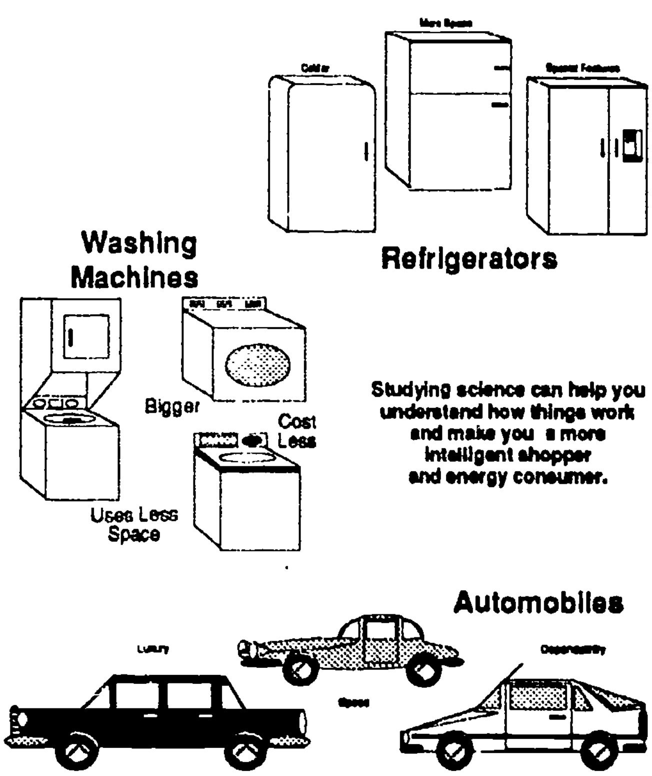
We must also continue our research into new ways of obtaining all of our resources in an effective, less costly manner. We must use our more abundant resources in every way that is safely feasible. The clean coal technology and the enhanced oil and gas recovery research programs are two ways the federal government is working to provide new options to Americans for a secure energy future.

Young Americans** can help by finishing their education and continuing their interest in science and math. Each day you learn how something works or delve into something you have not studied before, **you are discoverers. You are scientists.

*In the years to come, America will need to make critical decisions concerning energy options for its future. America will need citizens who understand why one option would be better for the Nation than another. You will need to be a **wise energy consumer** and an **educated voter** to help your country evaluate these costly and important options.*

You will need to be aware of why your area needs a new power plant; why increased usage (caused by more people and jobs) will cause higher utility bills; why it's important to know how to use less heat, air conditioning, and electricity; what type of heating and air conditioning you want in your home (natural gas for heat and electricity for air conditioning?); how improvements in the ways we use energy related fuels will assist in protecting our environment, etc.

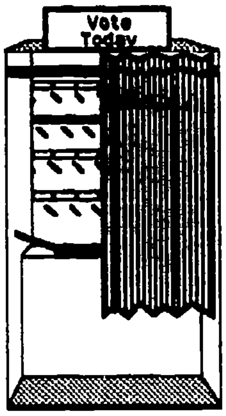
Explore Your World



Be An Intelligent Shopper

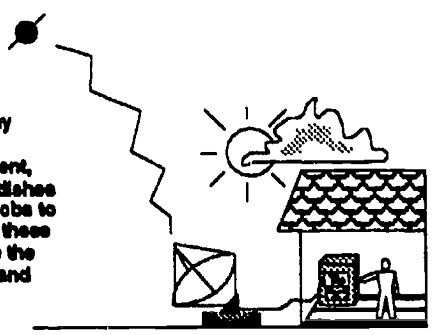
Dinosaurs and Power Plants

Our Country Relies on its Voters



Elected officials and voters must be able to understand the problems and potential solutions in order to make the decisions that will keep the United States strong and healthy. Will YOU be ready when it is your turn?

Voting Booth



Even our everyday lives depend on technical equipment, such as satellite dishes for televisions. Jobs to install and repair these machines require the ability to understand new technology.

Our World Depends On Complex Technology

> **SUGGESTION: Cut out magazine photographs of people representing various professions to display on the bulletin board. Think of some way that each person uses math or science in his/her work.**

You will need to comprehend the issues behind our problems if you want to able to be one of our elected representatives who are faced with these challenges. You will also be responsible when you step into the voting booth to choose leaders who are knowledgeable about critical issues. You will have to understand what their proposals will mean to you and your family, community, country, and world.

By studying science and math now, you will have a strong base of understanding to apply in making these decisions.

As our society increasingly becomes more technical in the future ***(in the early 1950s there were few televisions — now think how we depend on technical machines, such as computers, VCRs, telephones, and satellites)****, the problems and solutions will become more technical.*

America is also going to need its young people to continue their studies in science and math and so that our Nation will have the scientists and technicians it needs to have a secure future. Many people in careers that depend heavily on science and math are and will be retiring in the next 10 to 20 years. The United States will need the young people of today to fill the jobs these people will be leaving. Some of these careers are: engineers, electricians, surveyors, biologists, geologists, computer specialists, draftsmen, carpenters, physicists, marine biologists, nurses, pipe fitters, etc. Our manufacturing processes that create such products as baseball bats are also highly technical.

Whether the work requires the ability to give correct change to a customer, to figure the amount of pipe needed for a job, to adjust the amount of chemicals needed at the local sewage treatment plant, or to load the correct amount of rocket fuel needed to reach a far planet, some science or math is necessary

America needs the students of today to get a good education so that the United States will continue to be a strong leader tomorrow.

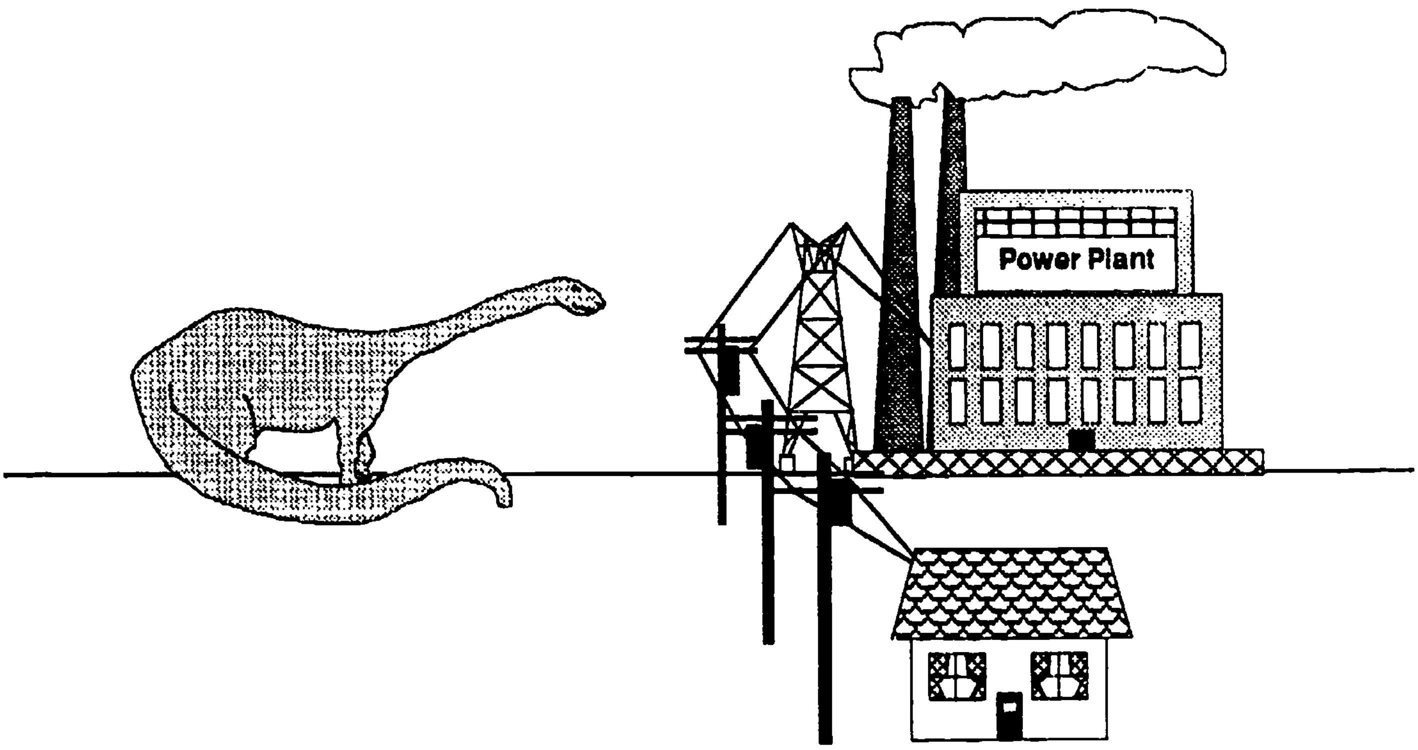
America is depending on YOU!]

Student Activity Options:

1. Hold a Spelling Bee using words in *D&PP* (start with words in "Fossil Energy Word Puzzle," page 13, and "Glossary," page 14, then go to word lists found in each lesson section of the *Supplement*).
2. Have a verbal "Word Power Challenge" to see how many students can correctly define the words that have been used during the lesson series. (See the "Glossary" in *D&PP*, page 14, or the word list in each lesson section of the *Supplement*).
3. Complete a quiz on the lesson series (see the short quiz in *D&PP*, page 15, or the quiz in the *Supplement*-Lesson 5 that was developed from the objectives listed for each lesson plan).
4. Play the "Fossil Energy Feud/Super Feud" games found in the *Supplement*-Lesson 5.
5. Play the "Energy Spin" game found in the *Supplement*-Lesson 5.

Student Follow-up or Extension Options:

1. Paste pictures collected for the collage into a representation of the creation, extraction, usage, etc. of fossil fuels and write a one page paper on why those pictures were chosen (display the collages then have some students read their papers to the class).
2. Have students give reports developed from information they have obtained on fossil fuels.
3. Have a resource speaker from the Energy Office of your State discuss energy production and conservation in your area.



This series of classroom publications was produced by the Office of Fossil Energy of the U.S. Department of Energy. If you have questions or need addtional materials, please contact:

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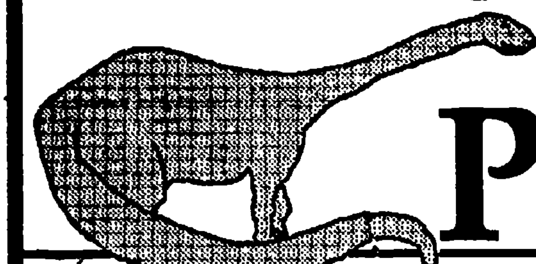
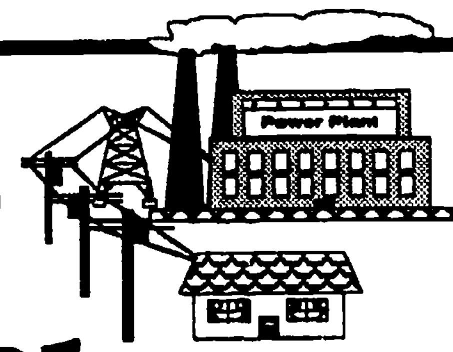
DOE/FE-0200P

Dinosaurs and Power Plants





~ Energy from the Past for the Future ~

In what way is a dinosaur similar to the lights in your home?

What one thing do you have in common with every person, plant, and animal ever living on Earth?

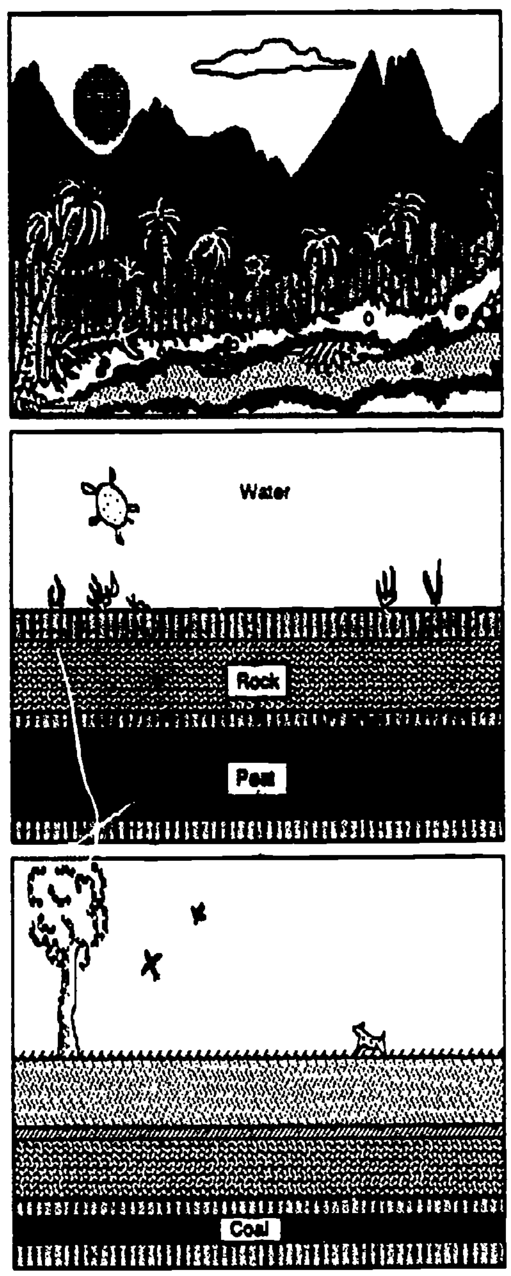
The answer to each question is the same:

"Energy."

Just as you have needed energy to run, hit a ball, do school work, or read, so the dinosaur needed energy to move from place to place, protect its young, and sleep — yes, even to sleep. During both your lifetimes, the dinosaur and you have gotten your energy from the food you have eaten.

We also need energy to operate our lights, elevators, televisions, cars, and computers. Most of this energy comes from what we call "fossil fuels," which includes coal, petroleum, and natural gas (in the three states of matter — solid, liquid, and gas). These fossil fuels were formed from plants and animals that lived on Earth over 300 million years ago. Some plant debris had already been buried and was on its way to becoming coal for over 100 million years by the time the dinosaurs began to roam the Earth!

After the prehistoric plants and animals died, they were covered with many layers of mud, rock, and sand that collected on the Earth's crust due to natural events, such as floods, volcanic eruptions, landslides, and earthquakes. Sometimes the materials were then covered by the sea that over time has again receded. During the millions of years that passed, the dead plants and animals decomposed underground into organic materials and formed pockets of coal, gas, and petroleum, depending on what combination of materials (animal remains and wood debris produced different types of fossil fuels) were present and what conditions of temperature, pressure, etc. to which they were exposed.



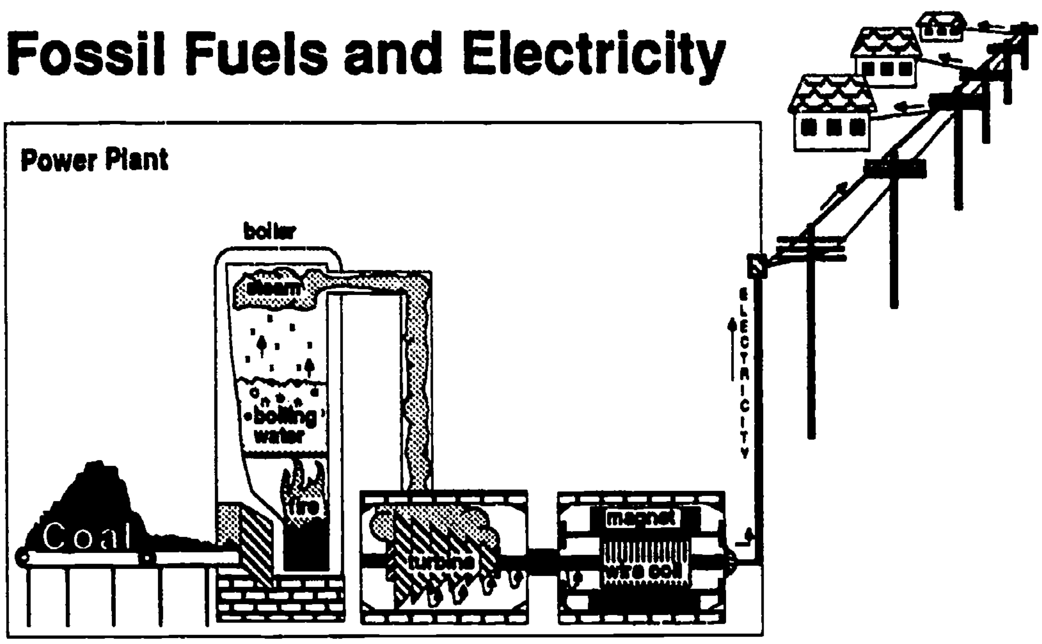
THE FORMATION OF COAL

Ten feet of prehistoric plant debris was needed to make one foot of coal

Petroleum and natural gas were created by sea organisms that died and were buried under ocean sediment. Long after the great prehistoric seas vanished, heat, pressure, and bacteria combined to compress and "cook" the organic matter under more and more layers of silt. Petroleum was formed first, but in deeper, hot regions underground, the cooking process continued until natural gas was formed. Many of the pockets of petroleum and gas sought today are trapped under rock formations ("caprock") that are dense enough to prevent them from seeping to the surface.

Prehistoric animal and plant remains are important because they were the beginnings of the energy we use today in our homes, offices, schools, and vehicles.

Fossil Fuels and Electricity

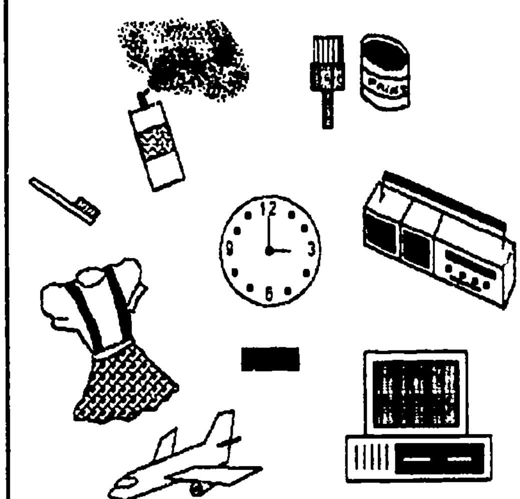


When you turn on the light switch you are using electricity that is produced mostly from fossil fuels. Coal, for instance, can be burned at a power plant in a giant closed tub (a "boiler") that contains water. As the fossil fuel is burned, the water in the boiler gets hot and turns into steam (like boiling water on your stove in a pot covered with a lid). The steam is piped into another enclosure called a "turbine" which has blades that turn as the steam rushes in — much like a pinwheel turns when you blow on it. The turning motion of the turbine blades causes an attached shaft (pole) to rotate a wire coil inside a magnet. This device is called a "generator." An electrical current is created and is collected by the coil of wire. The current is sent as electricity from the power plant to your home through wires strung on poles (the "telephone poles" in your neighborhood). You use this electricity when you turn on your lights, television, or computer.

YOUR TURN

Fossil fuels have other uses besides being used as fuels for producing electricity. They can be changed into other forms. For instance, petroleum can be converted into gasoline for cars, jet propellant for airplanes, and plastics for your toothbrush. They have many, many uses everyday in each person's life.

Can you think of other things produced with coal, natural gas, or petroleum? How about crayons, eyeglasses, telephones, and ...?



Fossil Fuels Go To School

Let's imagine that a new school is going to be built for you and your classmates. It is to be several stories high and will be finished with brick.

First, the builders will want to make sure the school has a very strong frame so it will stand up to the hundreds of students who will use it actively each school term for many years. A solid foundation will be laid with steel beams put in place to form a strong core for the floors and walls that will follow. Coal is used in the processes that produce both the cement for the foundation and the steel beams for the frame of this new school. Later coal will also be used in manufacturing the bricks for the exterior. In addition, the paint for the walls will come from petroleum products. The gasoline or diesel fuel powering the vehicles that bring building materials to the construction site will also come from petroleum.

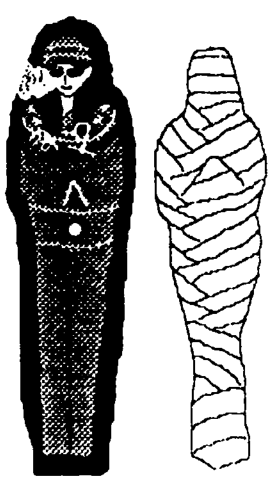
Once the school is finished and you have taken your place in your classroom, fossil fuels will continue to help you through your day. The plastic of the pen with which you write comes from petroleum as does the plastic exterior of the computer and the tape for the video cassette player you may use in class. The food in the cafeteria may be grown by farmers who depend on fertilizer to help their crops grow and on pesticides to protect the crops from insects. Pesticides and fertilizers can be derived from fossil fuels.

Even if you scrape an elbow and go to the health room, the adhesive on the bandage put on your arm may be made from fossil fuel products. At the end of the day, the last thing your teacher does is turn out the lights in your classroom. Over 1/2 of the U.S. electricity used for lighting is produced from burning coal.

Fossil Energy: First Discoveries

Most fossil fuels exist in rock deposits underground, although there has been evidence of each found on the surface of the earth. Alexander the Great supposedly used burning petroleum to frighten the war elephants of his enemies. Marco Polo during his trips in the 13th Century recorded oil seepages in the Caspian Sea region. Inscriptions found by archeologists indicate that oil and asphalt (a hard form of oil) were even used in 4000 B.C. in this area. Other archeological evidence indicates that early ships were caulked (cracks sealed to keep water out) with a form of asphalt, sometimes called bitumen or pitch.

The ancient "eternal fires" reported by Plutarch in the area of present day Iraq probably were from natural gas escaping from cracks in the ground and ignited by lightning.



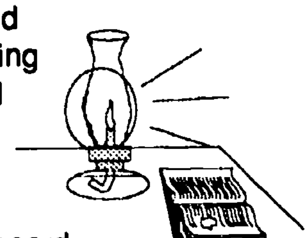
Asphalt was also used by the Egyptians to embalm mummies.

Natural Gas

In 1821 in Fredonia, New York, William A. Hart drilled a 27 foot deep well in an effort to get a larger flow of gas from a surface seepage of natural gas. This was the first well intentionally drilled to obtain natural gas. The gas was fed through *wooden* pipes to nearby houses and stores where it was used for illumination. It was many years before a system was devised to distribute natural gas to homes, street lamps, and businesses beyond those that were close to the gas well site.

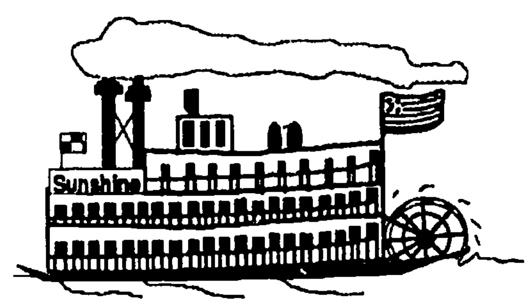
Petroleum

Petroleum was reported by Juan Rodriquez, a Spanish explorer, in 1542 near Santa Barbara, California. Oil residues from surface seepages near Nacogdoches, Texas, were used to repair the boats of the DeSoto expedition in 1593. Edwin L. Drake began the modern day petroleum industry in 1859 when he discovered oil 69 feet below the surface near Titusville, Pennsylvania. This petroleum was needed to supply kerosene to fuel lamps used for indoor lighting since whale oil (the common illuminant and lubricant) had risen to an unheard of price of $2.50 a gallon due to a severe shortage.



Coal

Coal is the most plentiful fuel in the fossil family and it has the longest and, perhaps, the most varied history. Coal has been used for heating since the cave man. Archeologists have also found evidence that the Romans in England used it in the second and third centuries (100-200 A.D.). During the 1300's, the Hopi Indians in what is now the U.S. Southwest used coal for cooking and heating. In the 1700s, the English found that coal could produce a fuel that burned cleaner and hotter than wood charcoal. However, it was the overwhelming need for energy to run the new technologies invented during the Industrial Revolution that provided the real opportunity for coal to fill its first role as a dominant worldwide supplier of energy.



Coal was discovered in the United States by explorers in 1673. However, commercial coal mines did not start operation until the 1740's in Virginia. The burning of coal to generate electricity is a relative newcomer in the long history of this fossil fuel. It was just about 100 years ago that coal became one of the fuels producing most of the electricity for homes and factories.

Long after homes were being lighted by electricity produced by coal, many of them continued to have furnaces for heating and some had stoves for cooking that were fueled by coal. Many types of transportation, such as trains and ships, were also run on coal.

Mining & Drilling

In the centuries since early man learned the pieces of black rock he picked up on the ground would produce heat when burned, we have had to look for coal beyond the places where we could find it on the ground. One of the areas it was easiest to find was where it appeared as one of many layers of materials along the side of a hill. Then we found we could follow the coal layer (seam) deeper and deeper into the Earth. Some mining sites today in the United States may be close to 500 feet underground.

Mining is classified by the method needed to reach the coal seam. When the coal is found close to the Earth's crust and taking away the overlying layers of material is not too expensive, *surface* mining is used to remove the top layers of materials and expose the coal.

Where coal is found in layers deep in the Earth *underground* mining is the preferred technique. Vertical or slanted holes ("shafts") are cut down to the mining area underground for ventilation for the workers and for transporting the miners, equipment, and coal. Common types of underground mining are the drift, shaft, and slope mining methods.

America has more coal than any other fossil energy resource. The U.S. has more coal reserves than any other single country in the world. In fact, 1/4 of of all the known coal in the world is in the United States. Large coal deposits can be found in 38 of the 50 states.

The material that formed fossil fuels varied greatly over time as each layer was buried. As a result of these variations and the length of time the coal was forming, several types of coal were created. Depending upon its composition, each type of coal burns differently and produces varying amounts of substances related to pollution. The four types (or "ranks") of coal mined today are: anthracite, bituminous, subbituminous, and lignite.

Anthracite is a hard coal that gives off a great amount of heat but very little flame or smoke. In the United States, as elsewhere in the world, there is little anthracite coal to be mined. The U.S. reserves of anthracite are located in Pennsylvania. Bituminous coal is relatively soft and yields tar when burned and produces smoke and ashes. It is primarily found east of the Mississippi River in the United States. Subbituminous coal (or "black lignite") ranks between bituminous coal and lignite and is mined mostly in Montana and Wyoming. The largest portion of the world's coal reserves is made up of lignite, a soft, brownish-black coal that forms the lowest level of the coal family. You can even see the texture of the original wood in some pieces of lignite that is found west of the Mississippi River in the United States.

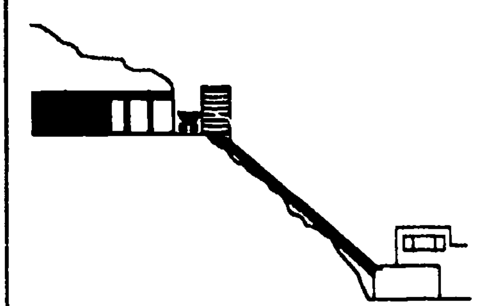
To learn more about coal, how it burns, and what we can do to make use of it in an environmentally safe manner, see the information on pages 9 and 10.

COAL

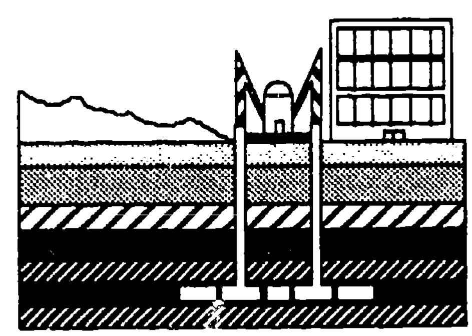
Types of Coal Mines

(Based upon where the coal is found)

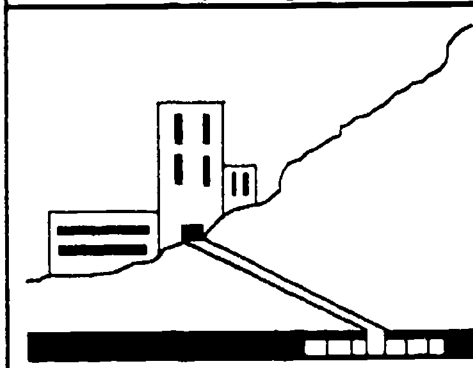
■ = coal



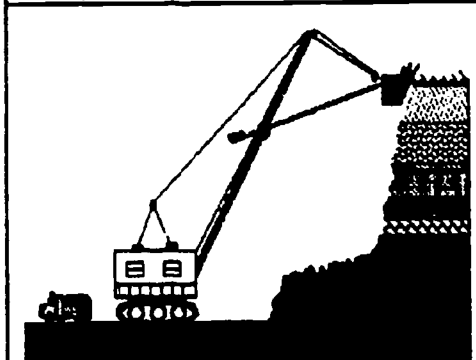
Drift Mine (Underground Mining)



Shaft Mine (Underground Mining)



Slope Mine (Underground Mining)

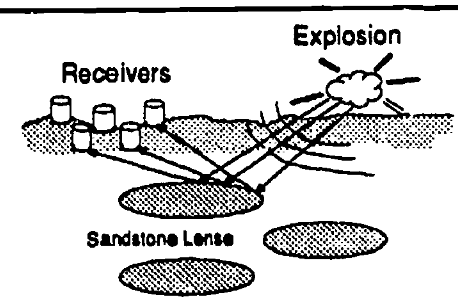


Surface Mine

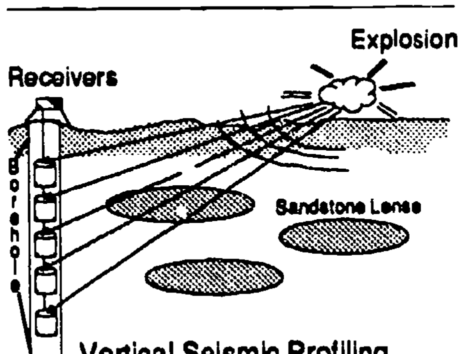
GAS

Finding Gas

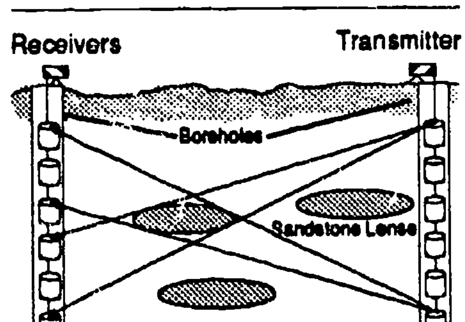
Natural gas can be especially hard to locate underground as it can be found trapped between rocks thousands of feet below the surface. To improve our chance for success in finding gas, we have invented devices that bounce sound waves underground and allow us to "see" pockets of gas below the surface.



Three Dimensional (3D) Seismic deflects sound waves off the sandstone formations (lenses) and measures the time it takes for sound to travel from the explosion to the receivers. This technique is used to tell the shape (3 dimensions—length,width,depth) of the lense.



Vertical Seismic Profiling is usually used with 3D seismic and measures the thickness of the lenses. Both this technique and Cross-Bore measure the degree to which sound slows down as it passes through the lense.



Cross-bore Seismic is the most accurate of the three methods. The cross checking allows determination of the depth and thickness of the sand lense.

Natural gas is, in many ways, the ideal fossil fuel. It is clean, easy to transport, and convenient to use. Industrial users use almost half of the gas produced in the U.S. A large portion is also used in homes for heating, lighting, and cooking. However, there are limits on how much natural gas we can find and get out of the ground with today's technologies.

Researchers are continuing to study about how natural gas was formed and where it has collected within the earth's crust. They have found that gas is not only found in pockets by itself or with petroleum but also may be present in so-called "unconventional" gas deposits, such as 1) shale formations, 2) sandstone beds, 3) coal seams, and 4) deep, salt water aquifers (underground ponds of water). These "unconventional" formations are more difficult and more expensive to produce than "conventional" deposits, but they hold the potential for vastly increasing the nation's available gas supply.

The Department of Energy has funded research into how to obtain and use gas from these sources. Some of the work has been in Devonian shales, which are rock formations of organic rich clay where gas has been trapped. Dating back nearly 350 million years (to the Devonian Period), these black or brownish shales were formed from sediments deposited in the basins of inland seas during the erosion that formed the Appalachian Mountains.

Devonian shale actually gave birth to the natural gas industry in this country. The first commercial natural gas well was drilled into a shale formation in New York. It produced only a few thousand cubic feet of gas per day for 35 years, but it heralded a new energy source.

Other sources of unconventional gas include "tight sand lenses" (see graphic on left). These deposits are called "tight" because the holes that hold the gas in the sandstone are very small. It is hard for the gas to flow through these tiny spaces. To get the gas out, drillers must first crack the dense rock structure to create ribbon-thin passageways through which the gas can flow.

Coalbed methane gas that is found in all coal deposits was once regarded as only a safety hazard to miners but now, due to research, is viewed as a valuable potential source of gas.

Department funded scientists are studying the causes of a type of gas, called methane hydrate, found in deep ocean beds or in cold areas of the world, such as the North Slope of Alaska or Siberia in the U.S.S.R. A methane hydrate is a tiny cage of ice, inside of which are trapped molecules of natural gas.

Research is also continuing on a theory that gas pockets that were not formed from decaying matter but were formed during the creation of the Earth may be found deep in the ground.

More research is needed to allow full use of these, and other, valuable gas resources.

Oil

Contrary to popular belief, petroleum reservoirs are not like soda bottles where you stick in a straw and the contents come right up. A typical reservoir is mostly sandstone or limestone in which tiny droplets of oil are trapped. Petroleum in it may be as thin as kerosene or as thick as tar.

As a petroleum well is first drilled, a portion of the contents of the underground reservoir will be expelled from the rocks where it is trapped due to natural pressure. However, much of the petroleum in the U.S. will not come to the surface due to this natural pressure or even with the simple action supplied by the mechanical pump above ground.

To get more of these resources out of the ground when the natural pressure is not enough to push the oil out we have to find a way to force it out artificially.

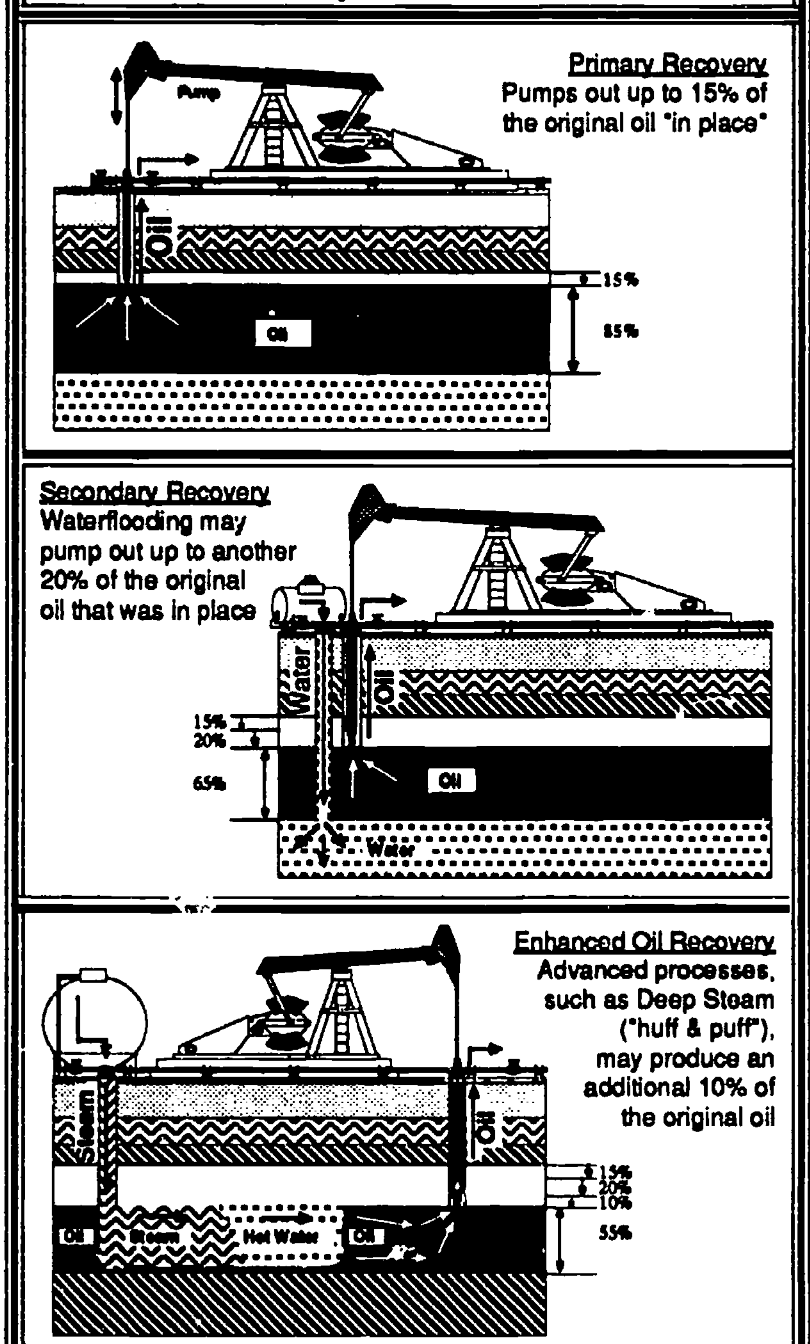
The methods we currently might use cost a lot of money compared to the current price of crude oil. So, the U.S. Department of Energy is funding research to find new ways to find and get this petroleum out of the ground.

in petroleum research, these new methods are called "enhanced oil recovery" techniques.

One method ("huff & puff") pumps steam underground through a pipe. The steam heats the petroleum and makes it thinner and easier to move toward a pipe that takes the crude oil to the surface. (Have you ever seen what happens to chocolate when it get hot? It changes from its solid candy bar form to a runny liquid!)

Another method pumps a gas from the surface into the oil-bearing rock formation. The effect is much like blowing up a balloon. The pressure of the gas squeezes more oil out of the rocks. Still another method makes gas underground by pumping microbes (living bacteria) down to one side of the subsurface reservoir. These microbes are fed a substance, such as molasses, which causes them to "burp" gas that pushes the petroleum through the reservoir to a pipe that takes the crude oil to the surface.

Oil Recovery
(How to Pump More from the Ground)



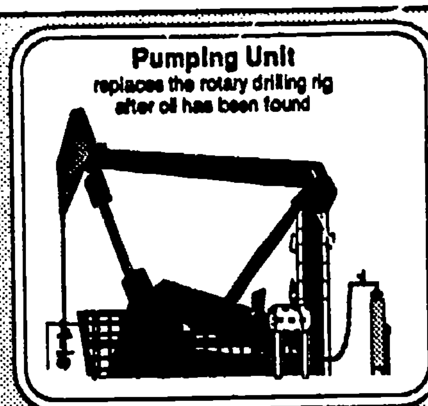
A tanker truck or ship or a pipeline distribution system then delivers the petroleum to a refinery where it is separated into its various components or "fractions" by a series of complex physical and chemical processes. For instance, in a distillation process, the petroleum is heated in a "fractionating tower." Each component of petroleum has a certain temperature at which that component turns into a gas. This process is comparable to heating water on your stove. As the water boils, it turns into a gas (steam). As the temperature for each component, such as 210° F for gasoline, is reached and the component rises in the fractionating tower as a gas, the vapor is drawn off in a pipe, condensed back into a liquid, and stored separately.

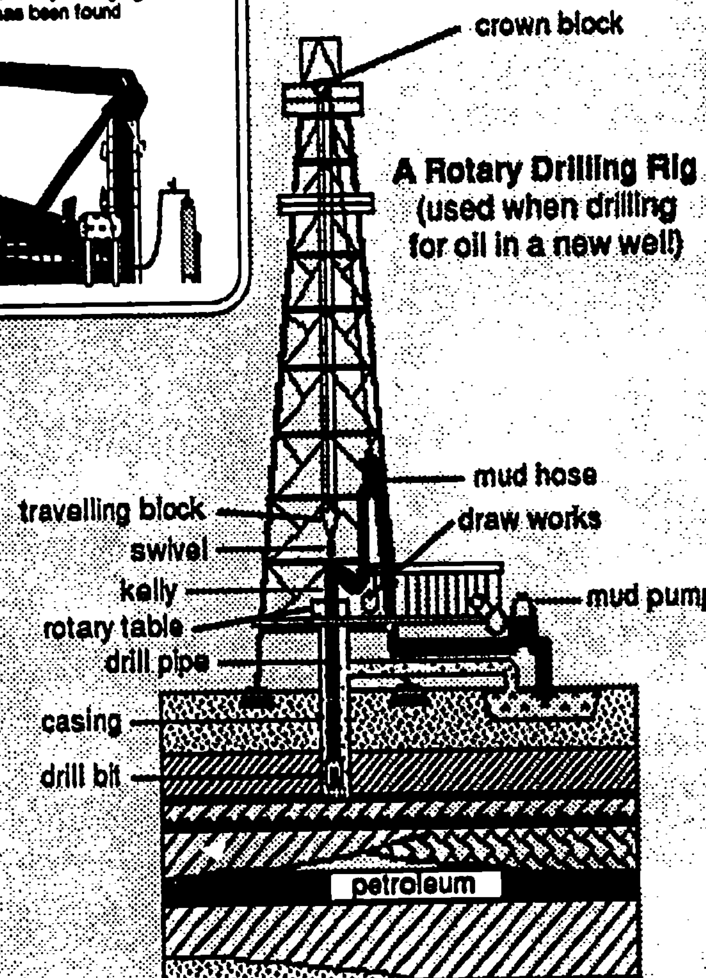
After the petroleum products leave the refinery, they are delivered to various users for either further processing or their specific use as a fuel, lubricant, or petrochemical (to create plastic, adhesive, insulation, medicine, detergent, or textiles).

68

Oil Drilling Equipment

Offshore Drilling





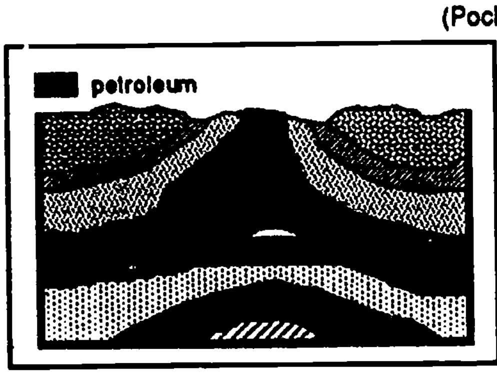
Land Exploration

Petroleum is also found in areas covered by water. Large fields have been found worldwide, such as in the Gulf of Mexico. In California, oil has been produced from piers extending offshore since the first well was drilled near Santa Barbara in 1897. In the Gulf of Mexico, most of the early activity was in marshlands and near-shore areas under state jurisdiction. The first offshore well on a platform out of sight of land was completed in 1947 off the coast of Louisiana.

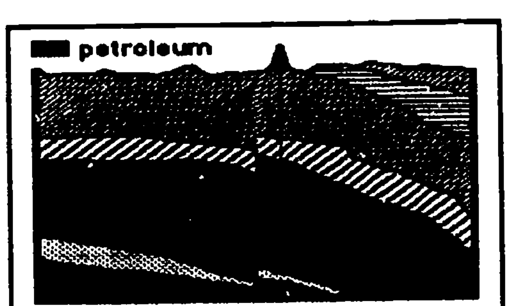
The drilling equipment used for drilling offshore exploratory wells is similar to that used on land. The most significant difference is that offshore operations require a platform to support the drill rig and associated equipment. The offshore platform is essentially an expensive man-made island containing well drilling equipment, living quarters and provisions for the workers, power supplies, and sometimes even a helicopter landing pad.

Types of Petroleum Formations

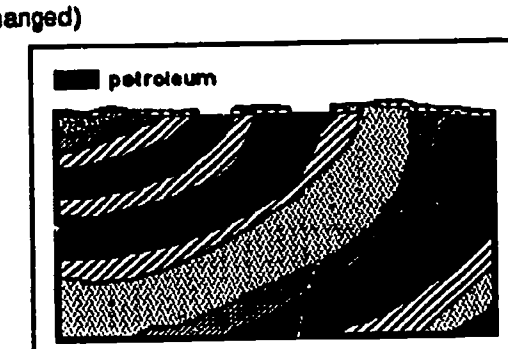
(Pockets of petroleum created as land was formed & changed)



Anticline

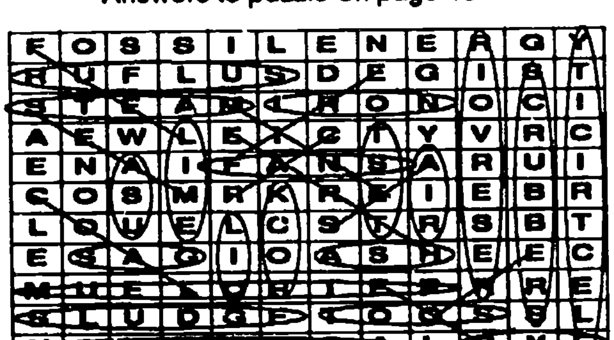


Fault



Seepage

Answers to puzzle on page 13



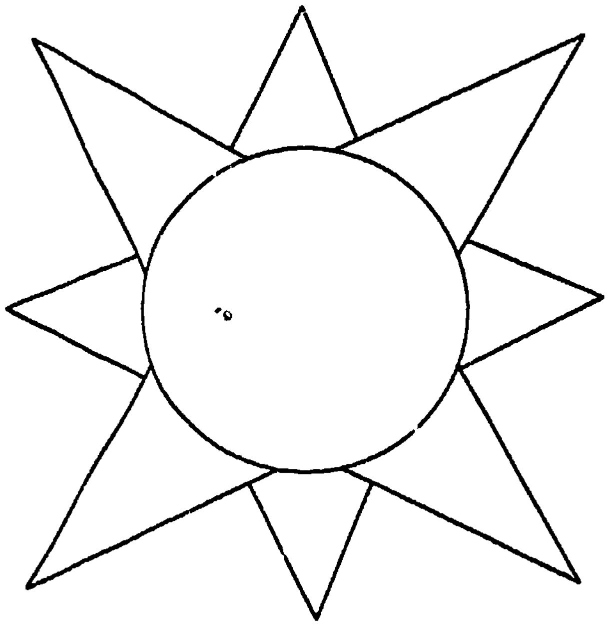
Answers to the Transportation Quiz on page 16

1. COAL - A,B,C,D,E
(Remember, although coal is a solid, it can be sent by pipeline if it is ground into fine pieces and mixed with water or oil. This type of mixture is called a coal/water or coal/oil "slurry." Coal sold (exported) to foreign countries overseas can be sent by ship.)

2. NATURAL GAS - B,C,D,E
(After natural gas is cooled below freezing and forms a liquid, it can be transported in insulated ships.)

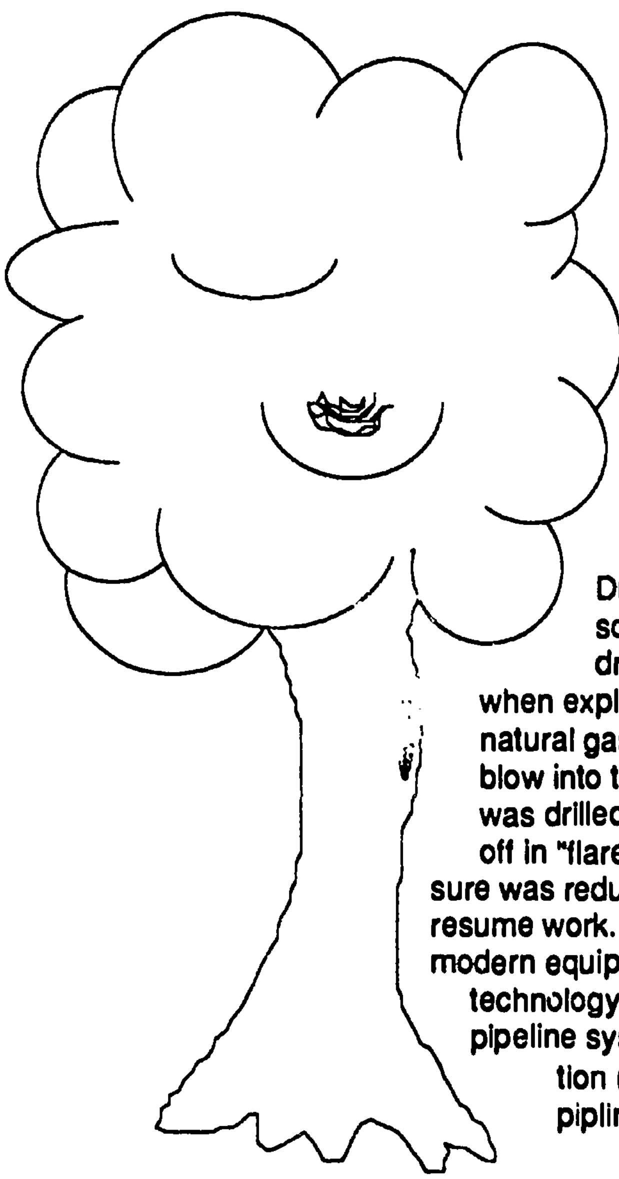
3. PETROLEUM - A,B,C,D,E
(Some oil we buy (import) from foreign countries is delivered in oceangoing supertanker ships.)

ENVIRONMENT



Burning any fuel — coal, gas, oil, wood etc. — releases gases into the air. These gases can cause pollution. Perhaps the most important part of the Department of Energy's fossil fuel research program is to find ways to make the gases from burning fossil fuels as clean as possible.

Natural gas releases the smallest amount of air pollution of all the fossil fuels. Natural gas is also odorless. However, companies offering the gas as a fuel add a chemical called "mercaptan" to cause an unpleasant odor that customers will notice in case of a gas leak.



In the early days of gas use, the pipes distributing the gas only went as far as homes or stores near the gas well. In towns that were the sole users of gas wells, the gas street lighting was allowed to burn day and night. Due to the lack of sophisticated drilling techniques when exploring for oil, natural gas was allowed to blow into the air as the well was drilled and then burned off in "flares" until the pressure was reduced enough to resume work. Today with modern equipment and drilling technology plus a vast pipeline system for distribution (a network of piplines that, if connected end to end, would stretch to the moon and back twice), much of the natural gas that was lost in the past is now saved for use in homes and factories.

For years petroleum and its derivatives have been studied so that their use would be environmentally safe. Unleaded gasoline and catalytic converters for vehicles are two ways we have developed to control air pollution from petroleum products.

Petroleum can also be detrimental to wildlife and the environment when spilled on rivers or oceans. Research is continuing to improve equipment and techniques involved in transporting petroleum and its products and in cleanup technology for when spills do occur.

After a spill, the oil must first be contained to prevent further spreading of the potential damage. Then several methods of cleanup can be employed.

Four cleanup techniques now used are 1) collection by skimming (scooping up the oil), 2) absorption (adding materials that can absorb the oil and prevent further spread of the slick) followed by skimming, 3) chemical dispersal (adding chemicals that cause the oil to break up into tiny droplets and sink to the bottom), and 4) burning oil off the surface. Another method being studied is the use of oil-eating microscopic "bugs" or microbes. These naturally occurring microorganisms would digest the oil and convert it into less harmful material.

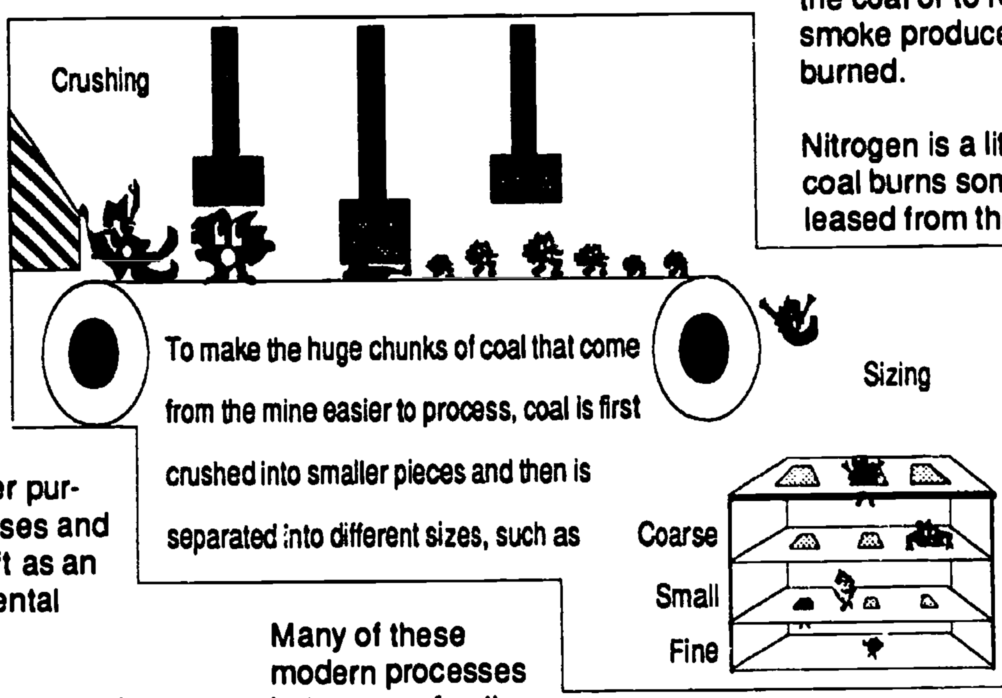
Waste oil (for example, the oil drained from your family car) and used lubricants also pose environmental problems when disposed of improperly. It is important that these wastes be disposed of carefully. One safe way is to take them to a used oil recycling center.

Although **coal** is plentiful, it can have detrimental effects on the environment if care is not taken to obtain and use it in a manner that protects the environment. For instance, there are laws that require operators involved in surface mining of coal to "reclaim" the land where the coal is mined. Once the coal from a section of land is mined, the pit from the mining has to be filled in and replanted to prevent erosion. As a result, the land is then usable for other purposes, such as houses and farms, and is not left as an unsightly environmental problem.

As already mentioned, coal is beneficial to us through its many uses in our everyday lives. Unfortunately, locked within coal are impurities such as sulfur. When coal burns to produce energy, these impurities are released. Unless they can be removed or captured before they escape into the air, the impurities in coal can cause pollution.

America used a lot of coal earlier in this century. It was coal that fueled the machinery that turned the United States into a major industrial nation. In the 1940s and 50s, nearly all of our electricity once came from coal burning power plants. Many homes were heated by coal and cooking was often done on a coal stove. But little was known in those days about cleaning coal. Where coal was used in large amounts, the air was often filled with soot and foul odors.

Today, we are learning how to clean coal. Scientists have found ways to remove sulfur and other pollutants from coal. They are showing us ways to burn coal without releasing pollutants into the air. We are also learning how to change coal into clean-burning gases and liquid fuels.



Many of these modern processes belong to a family of energy methods called "clean coal technology." The government is planning to spend more than $2.5 billion in the next few years to test these processes in power plants and factories across the country.

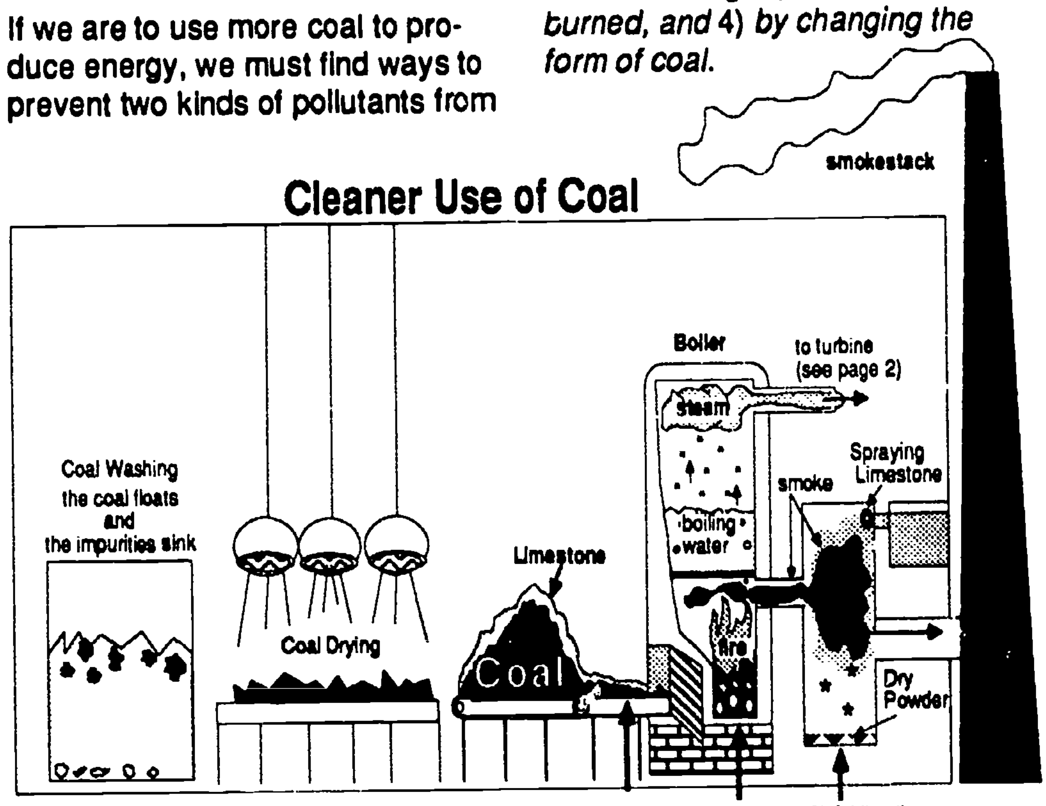
If we are to use more coal to produce energy, we must find ways to prevent two kinds of pollutants from being released. One of the pollutants is sulfur. The other is a form of nitrogen.

Sulfur pollutants can be reduced by finding ways to take sulfur out of the coal or to remove it from the smoke produced when coal is burned.

Nitrogen is a little different. When coal burns some nitrogen is released from the coal itself, but some also comes from our atmosphere. Nitrogen is harmless in the air until the air is heated to high temperatures. Then some of the nitrogen is changed into an undesirable gas. Burning coal at low temperatures — say, around 1500° F rather than 3000° F — will keep nitrogen pollutants low.

There are four ways that we can make cleaner use of coal: 1) *before the coal is burned,* 2) *while the coal is burning,* 3) *after the coal is burned, and* 4) *by changing the form of coal.*

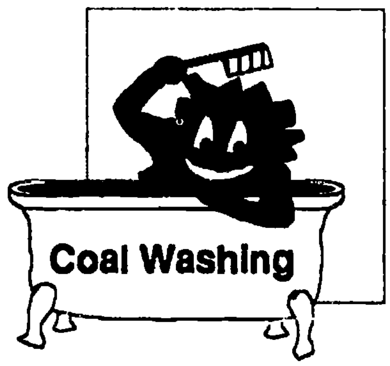
Cleaner Use of Coal



1) Coal Washing and Drying

2) Adding limestone during burning

3) Adding limestone after burning

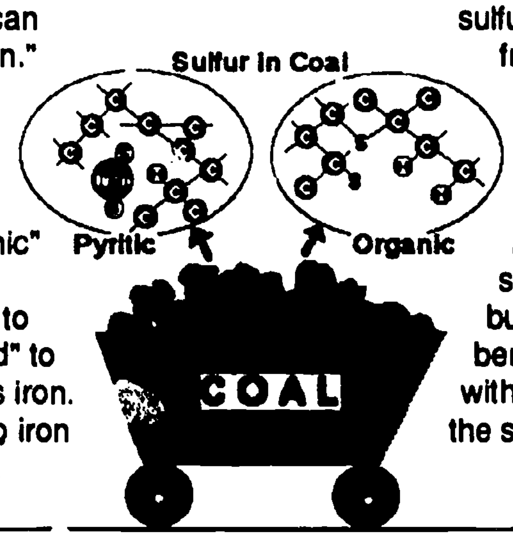


1. Coal can be washed after it leaves the mine to remove some impurities.

To understand how coal washing works, imagine the structure of coal as a pile of marbles. Most of the marbles would be carbon, a basic element found in all living things. Finding carbon is reasonable since coal is made of plants that lived millions of years ago. But there are other substances in coal.

Some of the marbles in coal are sulfur. Sulfur, in its pure form, is a very useful chemical. It is often used in drugs prescribed by doctors to treat illness. In coal, however, sulfur is a problem. When coal burns, the sulfur breaks loose and forms a foul-smelling gas. In the air, sulfur gases can combine with water vapor (visible particles of moisture floating in the air) and form a weak acid that can fall to earth as "acid rain."

Sulfur exists in coal in two forms. Some of it is bound to the carbon and is known as "organic" sulfur. The rest of the sulfur is not connected to the carbon but is "glued" to other elements such as iron. The sulfur connected to iron is called "pyritic" sulfur.

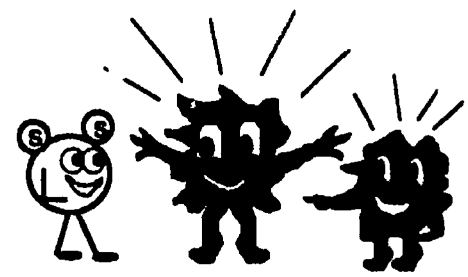


The difference between these types of sulfur is important because varying kinds of processes are needed to remove them from coal. Much of pyritic sulfur can be removed by washing the coal; however, better processes are needed to remove organic sulfur. Today's coal cleaning methods do not remove enough sulfur to meet new air quality laws, so more sulfur must be removed later at the power plant. Various types of clean coal technologies can provide this extra cleaning in many different ways.

2. Coal can be cleaned at the power plant while it burns. In one advanced coal burner, called a "fluidized bed combustor," the coal is mixed with limestone that acts as a sponge soaking up the sulfur as the coal burns.

Since both organic and pyritic sulfur are released during the burning, both can be removed inside the combustor. More than 90% of these pollutants can be removed before they are released to the environment. Coal also burns at a lower temperature so the formation of nitrogen pollutants is reduced.

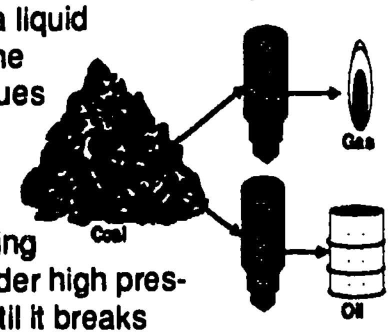
3. All types of coal produce at least some smoke when they are burned. Most of the smoke is water vapor, but if sulfur and nitrogen pollutants haven't been removed by coal washing or during burning in a new combustor, the smoke also contains pollutants. Many power plants use "scrubbers" to clean sulfur pollutants from the smoke before it is released into our air. Again limestone is used, but in a scrubber it is sprayed with water into the smoke. The limestone absorbs the sulfur. However, scrubbers are expensive, they do not remove nitrogen, and they produce a wet, pasty waste product called "sludge."



Limestone and Clean Coal

Clean coal technologies are being developed that will help overcome these drawbacks. One technology injects dry limestone into the ducts (the pipes leading out of a boiler - see the picture on page 9) rather than waiting for the smoke to reach the stack. The sulfur is removed as a dry powder rather than a wet sludge.

4. Coal can also be changed into a gas or a liquid fuel. The techniques involve heating and squeezing coal under high pressure until it breaks down into a gas or liquid. These processes are named "coal gasification" and "coal liquefaction."



This conversion has several advantages. First, when the coal particles break apart, sulfur and other impurities can be removed more effectively. Second, liquids and gases are easier to handle and burn than chunks of coal. Third, these liquids and gases can often be used in equipment designed to burn oil without making major changes to the equipment thus saving the company (and eventually the customer — YOU) money.

Transportation

Petroleum and Natural Gas

Most petroleum production in the United States and the rest of the world is located in areas somewhat remote from centers of population. Hence, to transport crude oil to refineries and its end products to consumers an extensive transportation and storage system has been built. This system includes pipelines, oceangoing supertankers (ships), river barges, railroad tank cars, and highway tank trucks.

Because it is a liquid, oil is generally easier and cheaper to transport than coal; gas is even less expensive to transport than oil. One of the least costly and most convenient methods is shipping by underground pipeline. The first major cross-country oil pipeline of 110 miles was laid in Pennsylvania starting at the site of the first well in Titusville. Today's pipeline distribution system for natural gas is even larger than that for petroleum (see the text on page 8).

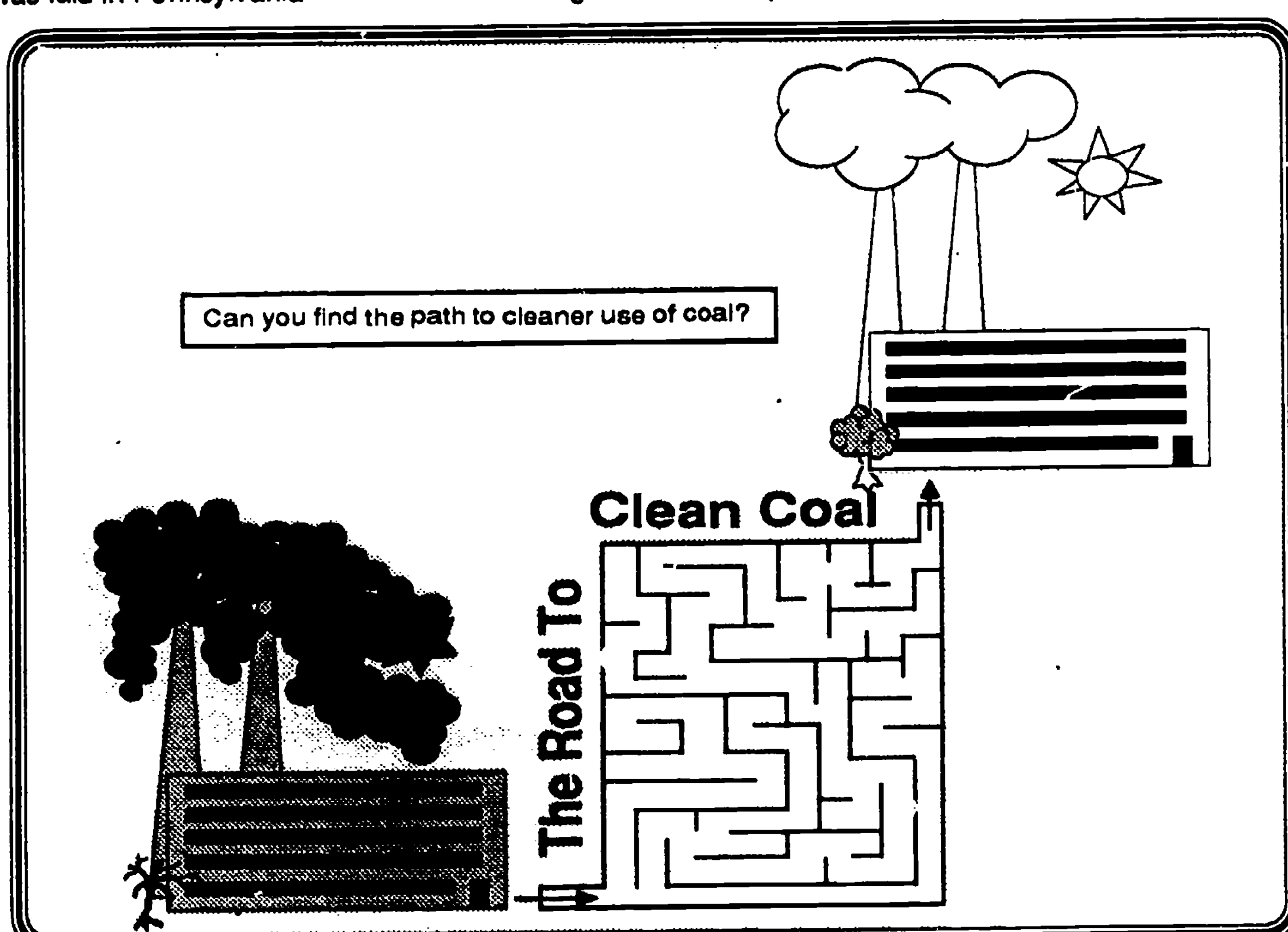
Petroleum can also be shipped in barrels by barge on rivers or by flatbed truck. Tank trucks and railroad tank cars are basically just large barrels designed to carry many, many barrels of crude oil or oil products. Ocean supertankers, which are huge oceangoing ships, have divided compartments where vast quantities of crude oil are stored for delivery overseas.

Natural gas may also be transported by tank truck or railcar. It can also be cooled to 100 or more degrees below zero (F) where it changes into a liquid that can be carried in huge insulated ships.

Many times petroleum that arrives for processing or use has to wait its turn so it is stored in huge round storage tanks that hold millions of barrels. Sites with many storage tanks are called "tanker farms."

Coal

In the mine, coal is loaded in small coal cars or on conveyor belts which carry it outside the mine to where the huge chunks of coal are loaded into trucks that take it to be crushed (smaller pieces of coal are easier to ship, clean, burn, etc.). The crushed coal can then be sent by truck, ship, railroad, or barge. You may be surprised to know that coal can also be shipped by pipeline. Crushed coal can be mixed with oil or water (the mixture is called a slurry) and sent by pipeline to the user.



The Future

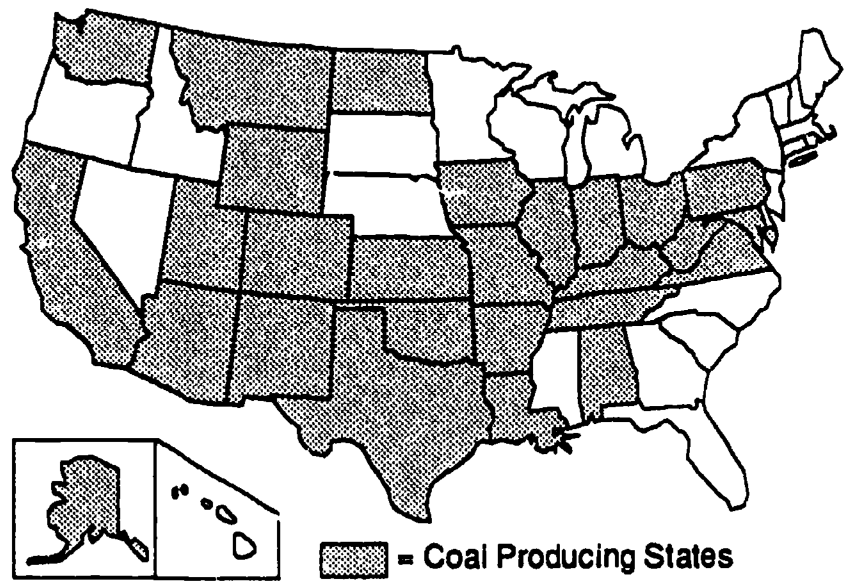
Fossil fuels are important to each of us. The things we feel are necessary in our lives place a heavy burden on our fossil fuel resources. Fossil fuels take millions of years to create and only a part of the world supplies of coal, natural gas, and petroleum are in the United States.

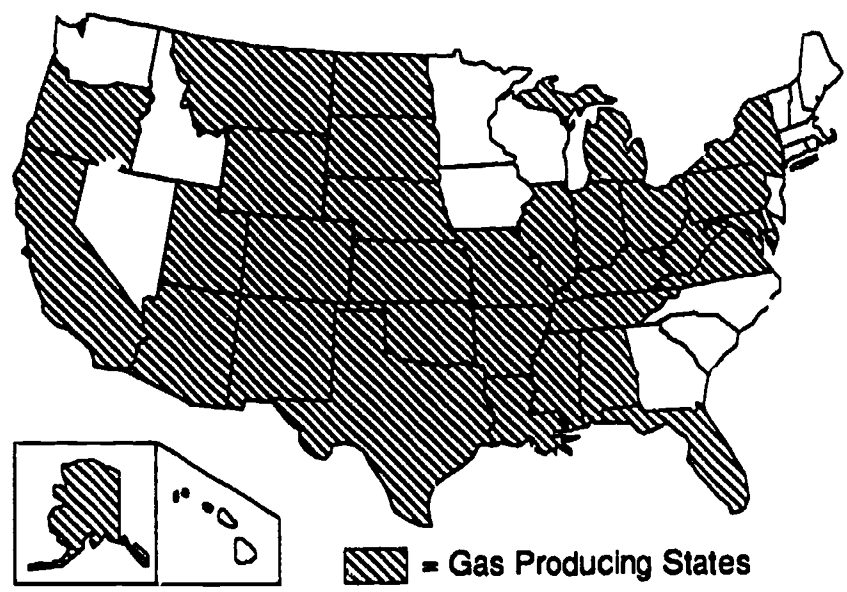
As fossil fuel resources are shrinking, population and industrial needs are growing in the U.S. and the world. America will need more electricity in the future for new homes and factories. In fact, we will likely need to build more <u>new</u> U.S. power plants in the next 10 to 15 years than already exist in countries such as Germany or Japan. Some of these could use solar or nuclear power, but coal is abundant and affordable. Properly cleaned, it could be used to satisfy much of our future demand for electricity and other fuels. Natural gas is also abundant and clean. In the future, more petroleum may be available from our current oil fields due to better recovery methods. However, we will eventually have to find new fuels to replace our declining oil resources.

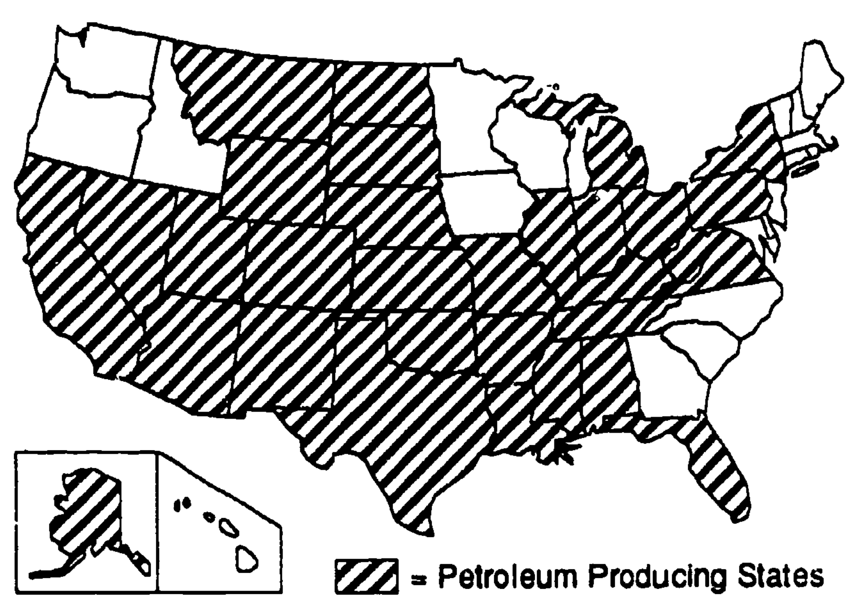
Better use of all of our fossil fuels will be needed to help make America's resources last longer. So we must also think of ways to use the fossil fuels we do have wisely such as turning off lights when we leave a room and riding our bikes or walking instead of taking the car.

We must continue our research into new ways of obtaining all of our resources in an effective, less costly manner and of using our more abundant resources in every way safely feasible. The development of clean coal technologies and enhanced oil and gas recovery techniques are two ways the federal government is working to provide new options to Americans for a secure energy future.

Does Your State Produce a Fossil Fuel?







Things to Do

Find out what fossil fuels your state has. Ask in what types of formations the fossil fuels occur. Inquire about what methods are used to mine or drill for these fossil fuels. For instance, if there is coal, is it obtained through surface or underground mining? Find out how many years of these fossil fuels are left with current extraction methods.

Find out what fossil fuels your power plant uses. Where do they obtain those fuels? Find out how much of those fuels the company uses per year to produce electricity. Learn more about power shortages, such as "blackouts" and "brownouts."

Compare how much electricity various types of equipment (i.e., lights, washing machine, air conditioner, refigerator, radio, etc.) use per hour. Make a list of how many things in your home were made from fossil fuels or run on fossil fuel energy.

Discuss what a student's day would be like without electricity, plastics, paint, gasoline, etc. produced by fossil fuels. Think what it would be like to study by candlelight and how long it would take to ride to school by horse drawn wagon. Would your family go as many places without a car or bus to ride? Think of what it was like to cross the country in months by wagon rather than by hours by jet. Think about heating your room with one woodburning stove.

Calculate how many gallons of gas your car would use in a year by first asking a family member how many miles your car is driven a year and how many miles your car gets per gallon of gas. Divide the number of miles per gallon into the total miles driven to get the number of gallons of gas used per year. Then find out how much gasoline costs a gallon and figure how much your family spends a year on gasoline.

Learn more about how catalytic converters in cars help curb air pollution.

F	O	S	S	I	L	E	N	E	R	G	Y
R	U	F	L	U	S	D	E	G	I	S	T
S	T	E	A	M	I	R	O	N	O	C	I
A	E	W	L	E	I	C	T	Y	V	R	C
E	N	A	I	F	A	N	S	A	R	U	I
C	O	S	M	R	K	R	E	I	E	B	R
L	O	U	E	L	C	S	T	R	S	B	T
E	S	A	G	I	O	A	S	H	E	E	C
M	U	E	L	O	R	T	E	P	R	R	E
S	L	U	D	G	E	T	O	O	S	S	L
N	I	A	R	D	I	C	A	L	R	Y	E

Fossil Energy Puzzle

Can you find the following words in the puzzle on the left? They may be up or down, backwards, across, or diagonal. "Fossil Energy" has been marked for you. See the answers on page 7.

air	coal	earth
gas	oil	soot
fire	electricity	rock
car	scrubbers	USA
seam	acid rain	sludge
mine	petroleum	sulfur
rye	reservoir	test
ore	steam	sea
lime	fuel	EOR
ash	fans	iron

Fossil Energy Glossary

ANTHRACITE COAL: A hard, jet black, solid fossil fuel with a ligh luster. It is the highest rank of coal. It is primarily mined in northeast Pennsylvania.

BARREL: A liquid measure defined as 42 U.S. gallons.

BITUMINOUS COAL: Most common type of solid fossil fuel. It is soft, dense, and black with well defined bands of bright and dull material. It is mined chiefly east of the Mississippi River.

Btu (BRITISH THERMAL UNIT): A standard unit for measuring the quantity of heat required to raise the temperature of 1 pound of water by 1 °F.

COAL: A black or brownish-black solid combustive substance formed by the partial decomposition of vegetable matter without access to air.

CRUDE OIL: Unrefined petroleum that reaches the surface of the ground in a liquid state.

FOSSIL FUEL: Any naturally occurring fuel of an organic nature, such as coal, natural gas, and petroleum.

LIGNITE: The lowest rank of coal, which is brownish-black and has a high moisture content. Used mainly to generate electricity, it is mined in Montana, North Dakota, and Texas.

NATURAL GAS: A mixture of gaseous hydrocarbons occurring naturally in the Earth — often among petroleum deposits — that is used as a fuel.

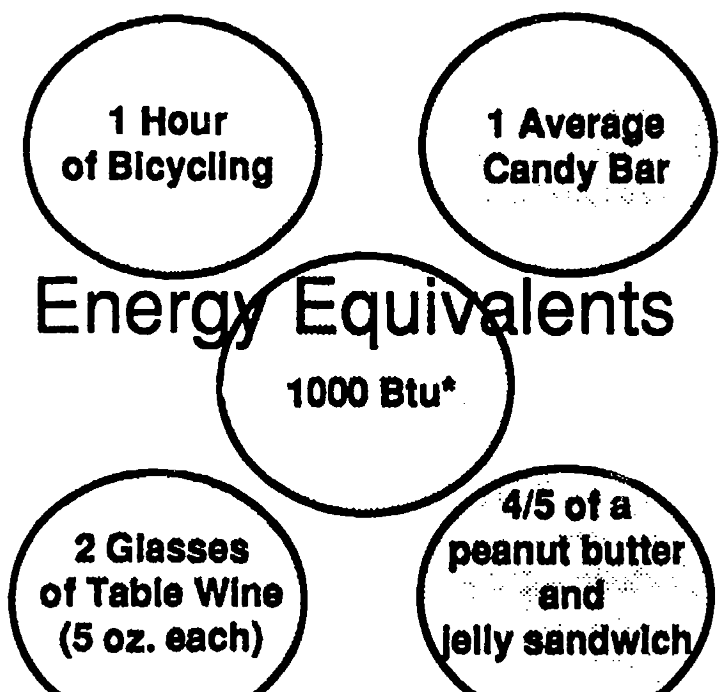
OIL PRODUCTS: Products ready for consumption through the processing of crude oil and natural gas. Refined products include jet fuel, kerosene, waxes, asphalt, motor gasoline, petrochemical feedstocks, lubricants, etc.

PETROLEUM: A term applied to crude oil and oil products in all forms.

PROVED RESERVES: The estimated quantles of crude oil and natural gas in the ground that geological data demonstrate with reasonable certainty to be recoverable under existing economic conditions with current recovery technology.

RESERVES IN PLACE: The amount of oil or gas physically contained in a reservoir (a place — usually totally underground — where oil or natural gas has collected naturally over millions of years). The "proved reserves" may only be 15 to 35 percent of the "reserves in place."

SUBBITUMINOUS COAL: A dull, black coal often referred to as black lignite. It is used for generating electricity and space heating. It ranks between bituminous and lignite and is mined in the western U.S.



*One Btu equals approximately 1 blue-tip kitchen match

"In Emergency Only"

Each day an average of 16 million barrels of petroleum is used in the United States to power or heat the nation's factories, businesses, and homes; to produce gasoline and other fuels for transportation; and to manufacture a variety of chemical products ranging from paints to plastics. Crude oil accounts for nearly 40 percent of the total energy consumed. Unfortunately, the U.S. uses more oil than it produces within its borders and has to buy oil from foreign countries.

The oil embargo of 1973-74 when many Arab nations cut off the oil flowing into the U.S. and created long waiting lines at our gas stations dramatically demonstrated the need for a national oil stockpile. In the aftermath of the oil crisis, America established the Strategic Petroleum Reserve, an emergency supply of crude oil stored in salt dome caverns along the Gulf Coast in Louisiana and Texas. It is our national "insurance policy" in case of oil disruption emergencies and is the largest stockpile of crude oil in the world.

For More Information

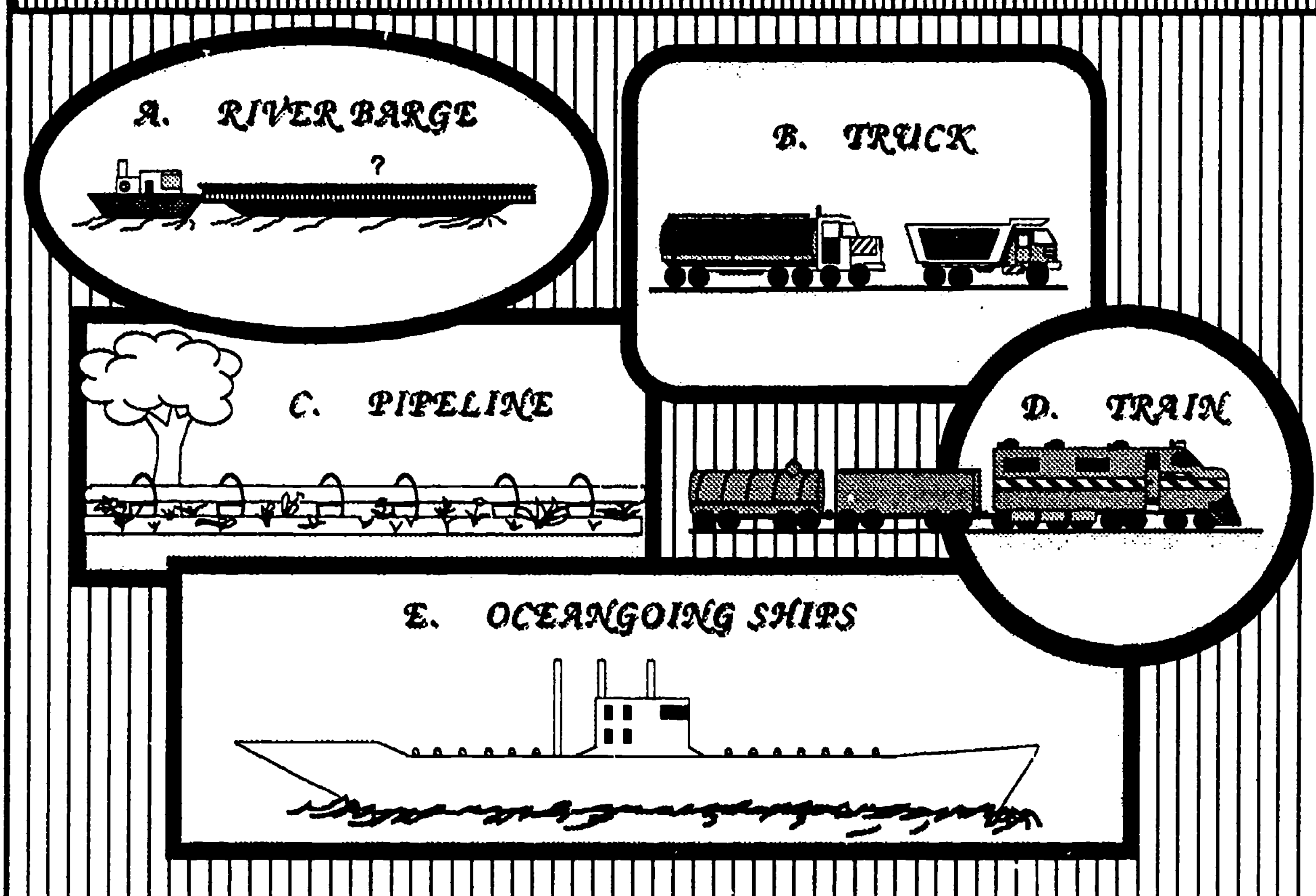
(Also check your encyclopedia and local library)

o State geological formations o State natural resources statistics	U.S. Geological Survey or Dept. of Natural Resources in your state (usually located in your capital city)
o National energy statistics	National Energy Information Center (EI-231) U.S. Department of Energy Washington, DC 20585
o Coal	American Coal Foundation Suite 220 1130 Seventeenth St, NW Washington, DC 20036
o Gas	American Gas Association 1515 Wilson Blvd Arlington, VA 22209
o Petroleum	American Petroleum Institute 1220 "L" St, NW Washington, DC 20005
o State environmental data: air, water, wastewater, and solid and hazardous waste	The Environmental Protection or Pollution Control agency of your state government
o National environmental laws and issues	U.S. Environmental Protection Agency (Public Affairs) Washington, DC 20460
o Electricity production & fossil fuel use o Gas for heating/cooling/cooking o Costs to run common appliances & equipment	Your local power company or your local gas distributor
o Mining technologies	Bureau of Mines U.S. Department of the Interior Washington, DC 20240
o Land reclamation after mining activities	Office of Surface Mining Reclamation & Enforcement U.S. Department of the Interior Washington, DC 20240
o Mineral management on government land o Offshore oil leasing	Office of Land & Mineral Management U.S. Department of the Interior Washington, DC 20240
o Safety & health of mine workers	Mine Safety & Health Administration U.S. Department of Labor Arlington, VA 22203
o Conservation of Energy	Conservation and Renewable Energy Inquiry & Referral Service U.S. Department of Energy P. O. Box 8900 Silver Spring, MD 20907
	The Alliance to Save Energy Suite 206 1925 "K" St, NW Washington, DC 20006
o General Energy Issues	U.S. Council for Energy Awareness Suite 400 1776 "I" St, NW Washington, DC 20006
	Take Pride in America P. O. Box 1339-Y Jessup, MD 20794
	National Science Teachers Association (teacher inquiries only) 1742 Connecticut Ave, NW Washington, DC 20009
	National Energy Foundation (teacher inquiries only) Resources for Education National Office Suite 200 5160 Wiley Post Way Salt Lake City, UT 84116

FOSSIL ENERGY REVIEW

1. How were fossil fuels formed?
2. Name three fossil fuels.
3. When was the first gas well drilled in the USA? by whom?
4. Name two impurities in coal. Name one of the four ways to reduce pollution from coal.
5. Name an advanced method of getting oil out of the ground.
6. Name the program that funds research into ways to use coal in cleaner, more environmentally safe ways.

TRANSPORTATION QUIZ



List the best ways to transport the three fossil fuels from where they are found in the ground to where they are used by industry, power companies, or the public. Think about whether each fuel is a solid, liquid, or gas and what type of container would be required to carry it. List more than one answer, if necessary, on the lines provided. Check your answers on page 7.

1. COAL ________________________________

2. NATURAL GAS ________________________________

3. PETROLEUM ________________________________

This brochure is provided by the Office of Fossil Energy. For technical information on coal, gas, and petroleum research & development programs contact:

Office of Communications
Office of Fossil Energy
U.S. Department of Energy
1000 Independence Ave., S.W.
Washington, D.C. 20585

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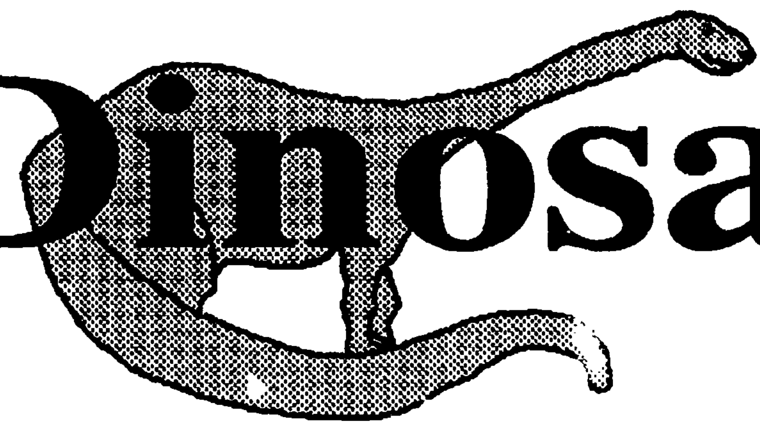
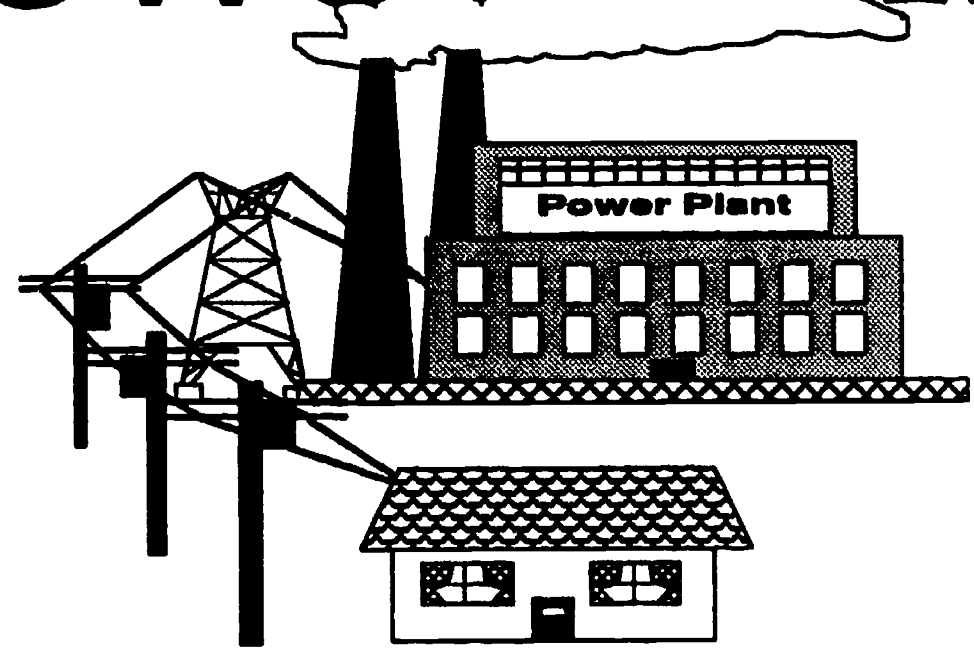


Dinosaurs and Power Plants



~ Energy from the Past for the Future ~

Teacher's Guide Supplement

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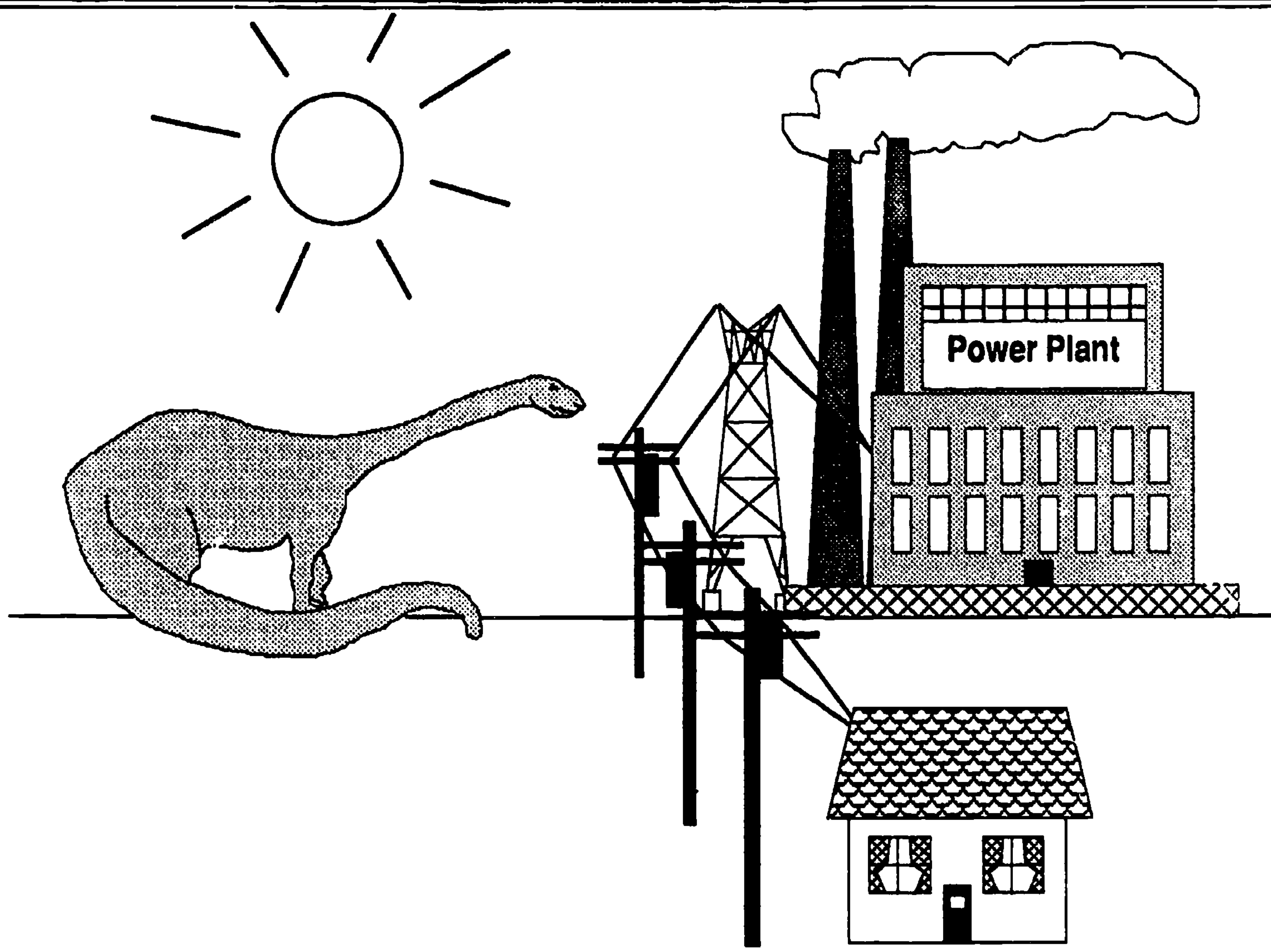
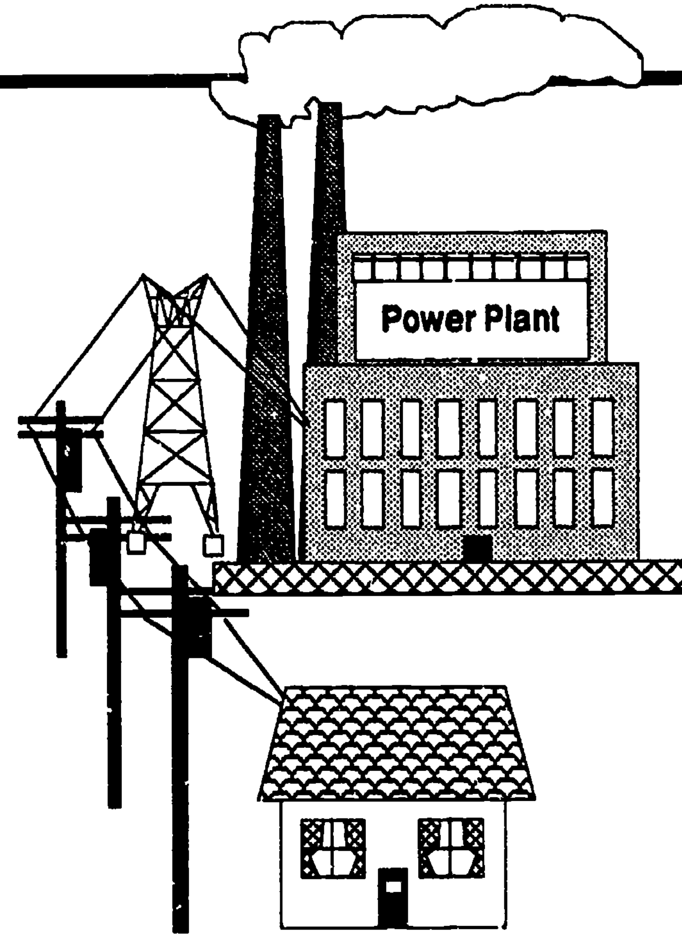
Dinosaurs and Power Plants

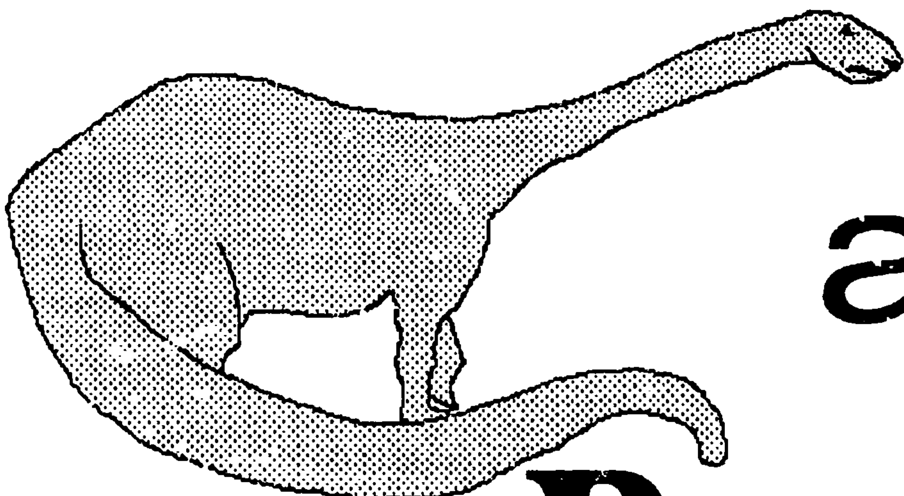


Teacher's Guide Supplement

Lesson One Supporting Materials

Dinosaurs





and

Power Plants

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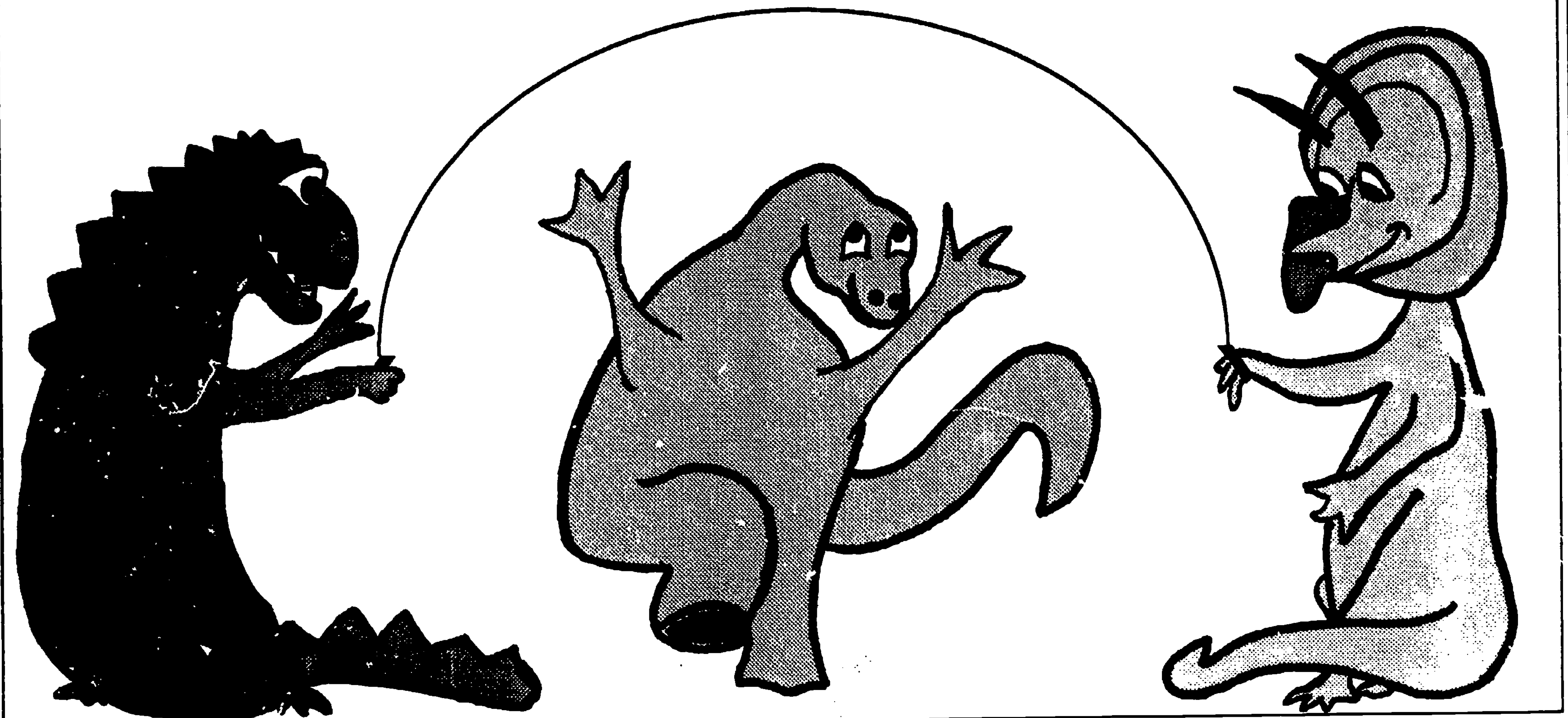


Dinosaur Jumping Rope

USING ENERGY

Using Energy

Each person, animal, plant, and machine uses energy. We need energy to run, think, grow, move a leg, or run a motor.

The sources for this energy can come in many different forms.

People and animals eat some sort of food, such as corn or meat.

Plants get their energy from the sun and soil.

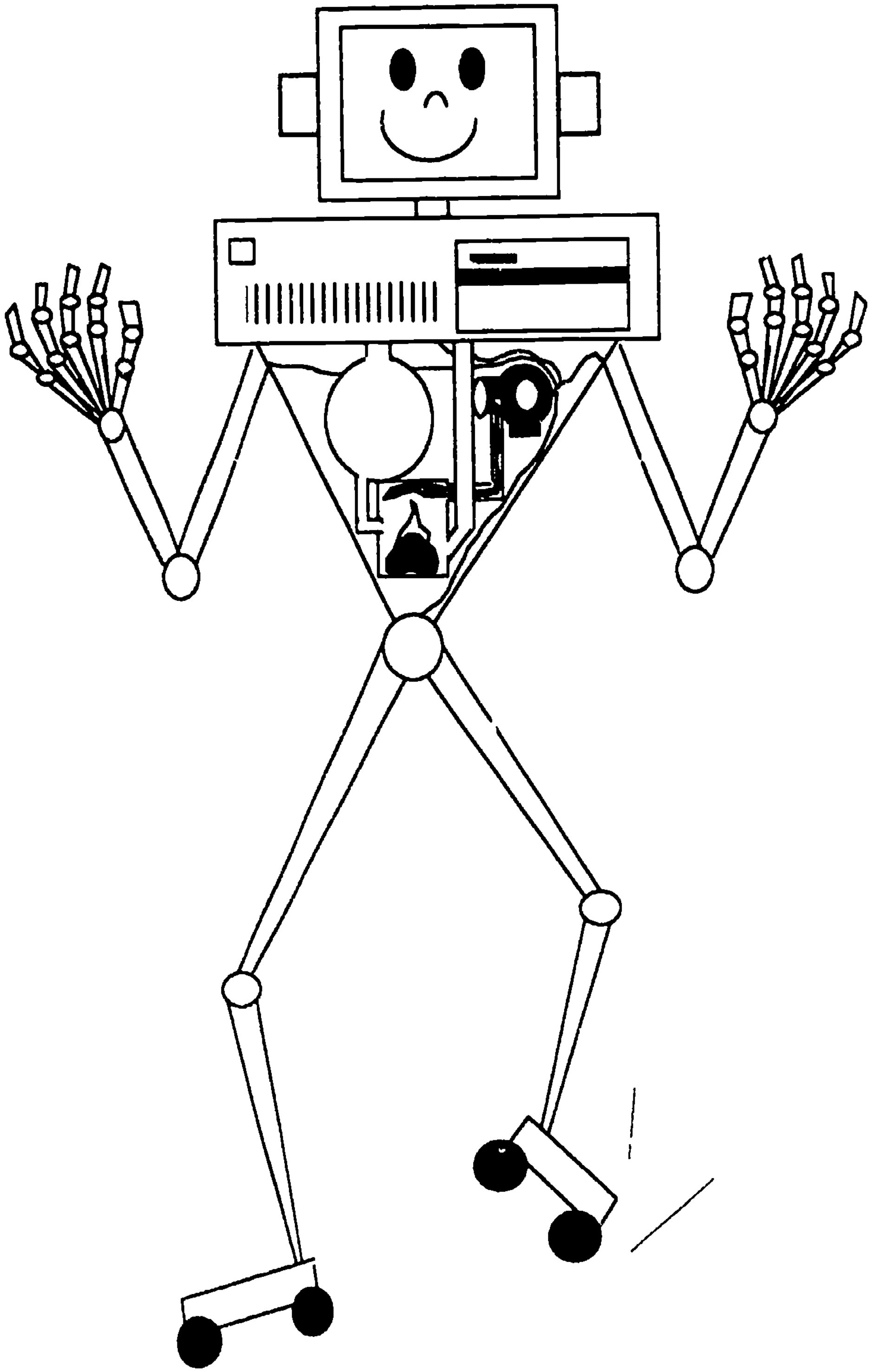
A car is a machine that burns a fuel, such as gasoline, to power its engine. Gasoline comes from petroleum.

When we turn on the lights in our homes or schools we are using electricity to power the light bulbs. Over half of the electricity in the U.S. is produced by burning a fuel called "coal" that usually looks like a black rock.

When we take a hot shower we use water that is heated by natural gas.

Coal, natural gas, and petroleum make up a group of fuels called "Fossil Energy." Just as the plant and animal fossils seen in museums today, these fossil <u>fuels</u> were created from plants and animals that lived and died millions of years ago.

The Human Body: That Marvelous Machine



Your Body Is Like A Very Complex Machine.

You Need Fuel To Run Your Engine.

Energy Is The Fuel You Use.

People Get Energy From

Eating Food, Such As Corn.

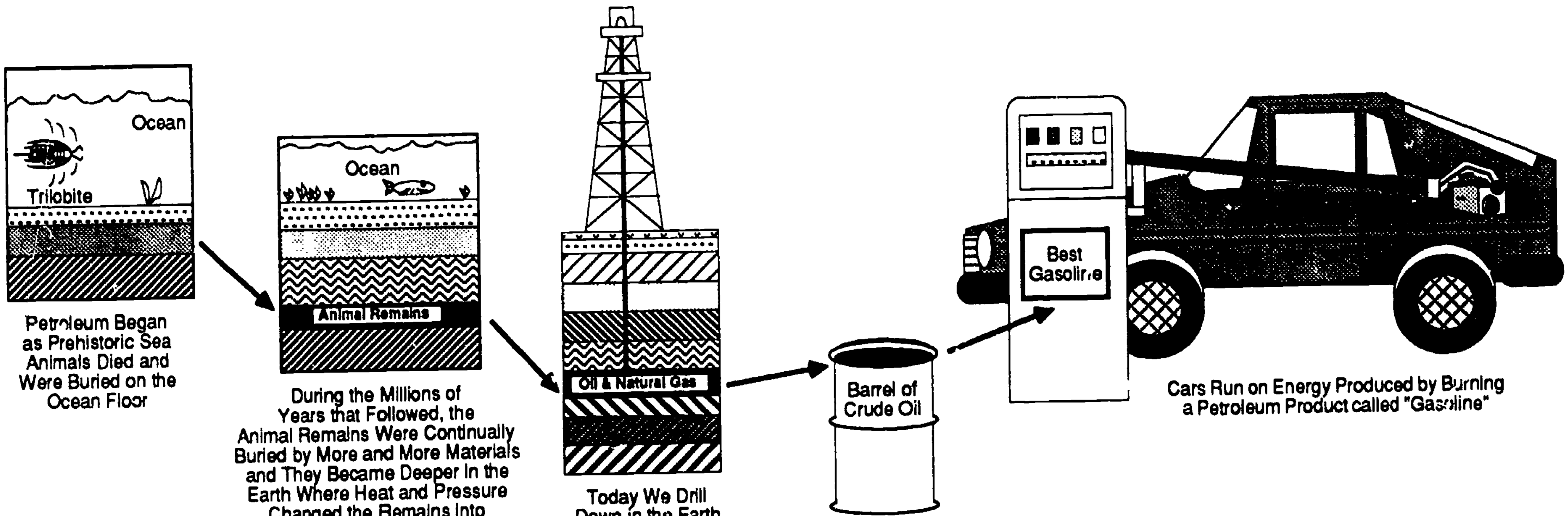
Cars Need Energy Too.

They Use Gasoline, A Product

Made From A Fossil Fuel

Called "Petroleum."

Gasoline, A Liquid Fossil Fuel Product Made From Petroleum, Is Used As Energy To Power Cars



Petroleum Began as Prehistoric Sea Animals Died and Were Buried on the Ocean Floor

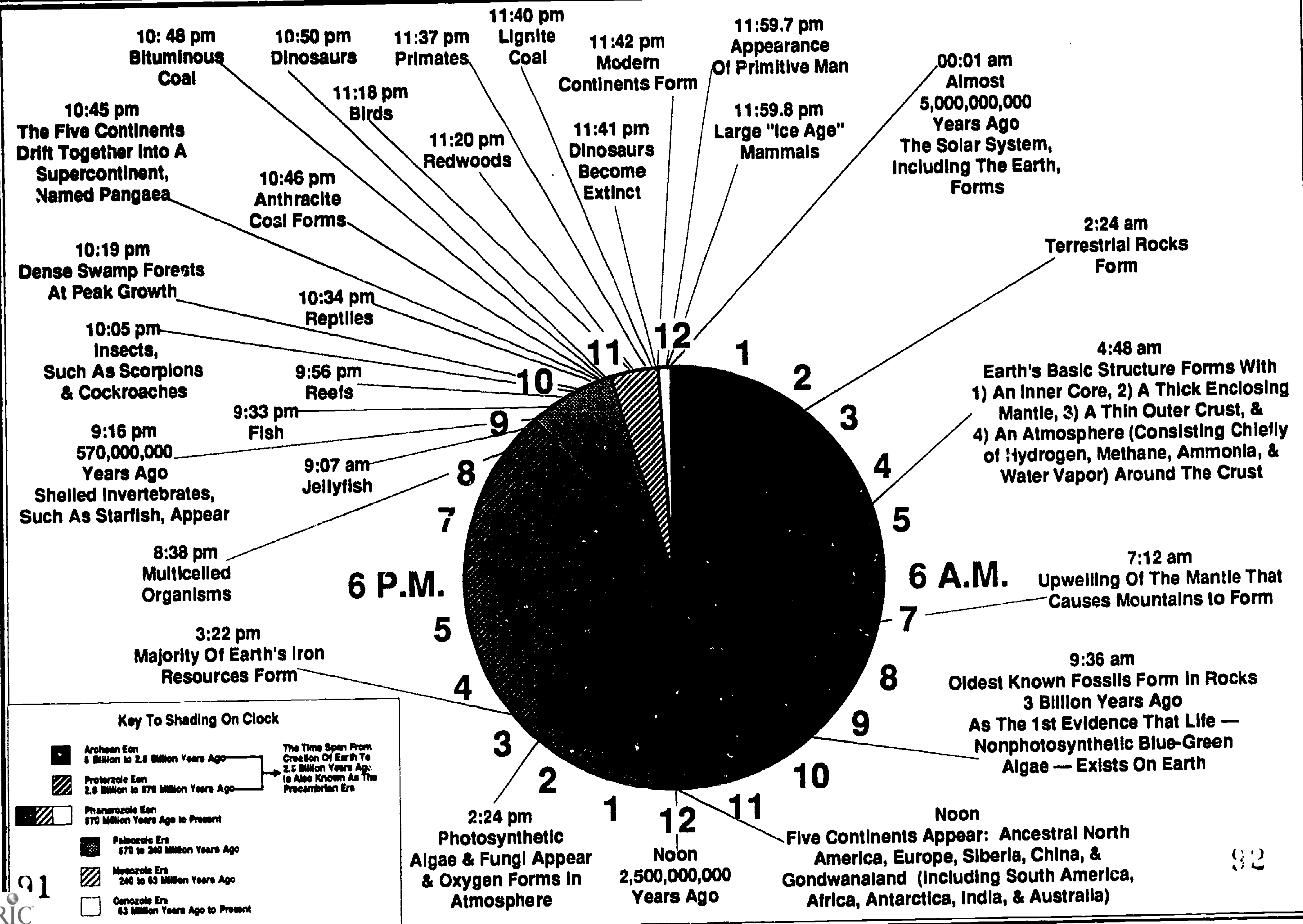
During the Millions of Years that Followed, the Animal Remains Were Continually Buried by More and More Materials and They Became Deeper in the Earth Where Heat and Pressure Changed the Remains into Petroleum and Natural Gas.

Today We Drill Down in the Earth To Rock Formations That Contain Crude Oil (Petroleum) and Natural Gas

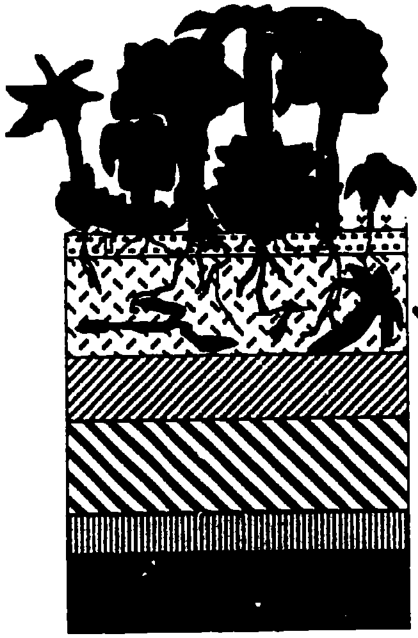
Once the Crude Oil Is Out of the Ground It is Sent to be Separated into Various Products at a Refinery

Cars Run on Energy Produced by Burning a Petroleum Product called "Gasoline"

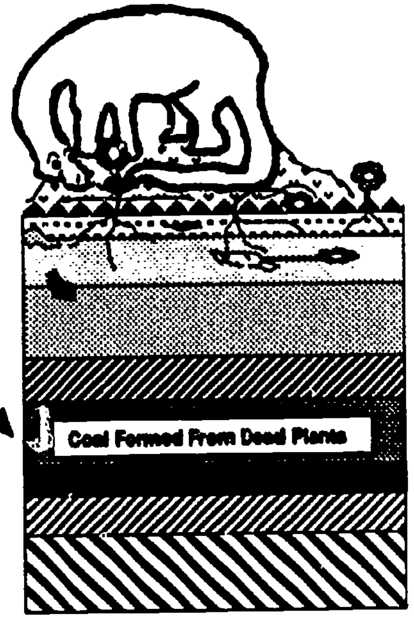
Earth: Creation To Present In 24 Hours



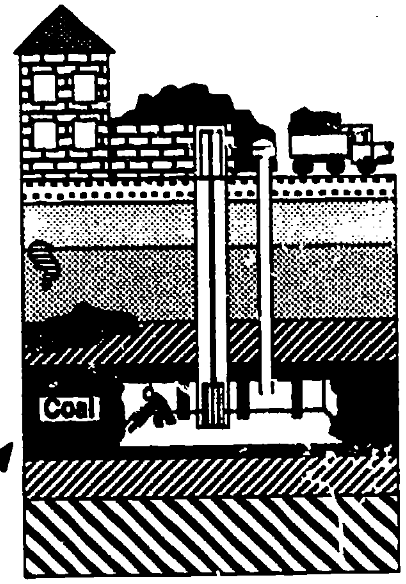
Even Lignite, The Youngest Coal Used Today, Was Formed <u>Before</u> The Dinosaurs Became Extinct



Coal Began Forming From
The Remains Of Plants That Died
During Prehistoric Times Long Before
The Dinosaurs Roamed The Earth

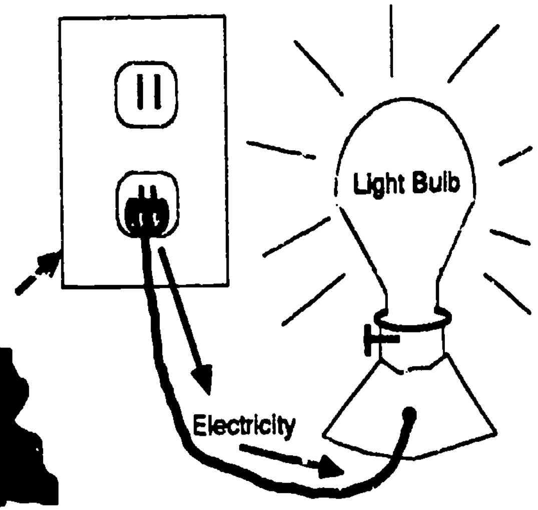


After The Plants Were Buried
Deep In The Earth,
Heat And Pressure Combined
To Turn The Plant Remains
Into A Fossil Fuel Rock
Called "Coal"



Coal Can Be Obtained By
Digging It Out Of The Earth
Either At The Surface
Of The Ground Or
Deep Underground

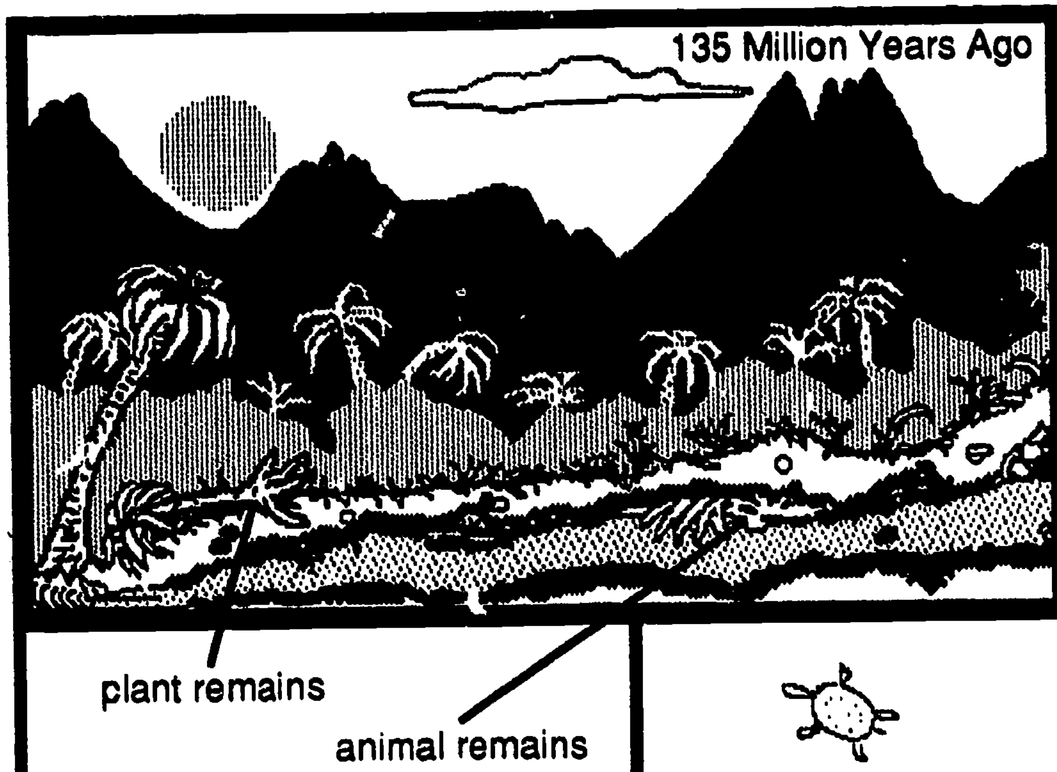
Coal Can Be Burned
As A Energy Fuel
By Your Power Company
In Order To
Produce Electricity



Our Lights Are Powered
By Electricity,
A Form Of Energy
That Can Be Generated By
Burning Coal

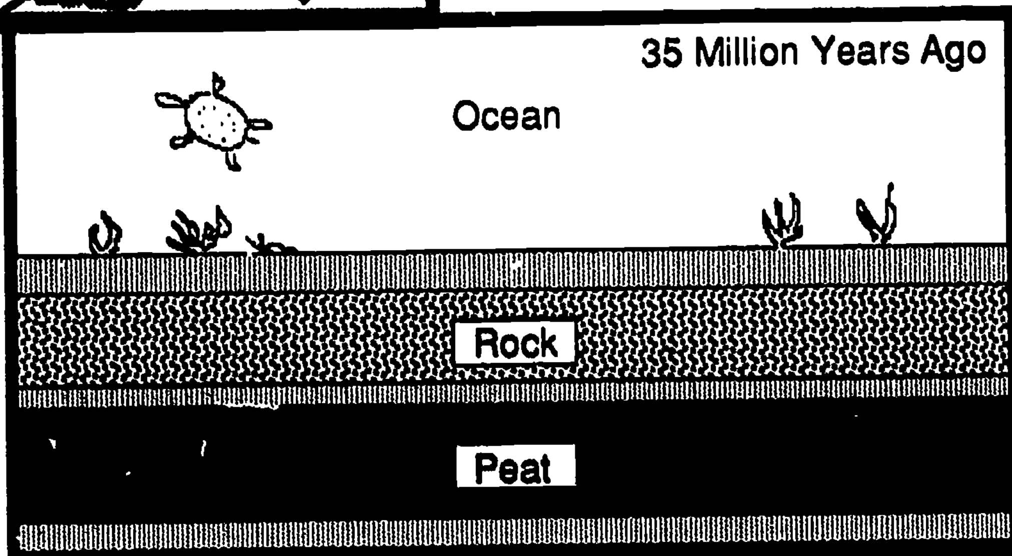
Electricity—
From Prehistoric Plants
To
The Lights In Your Home

How was Coal Formed?



Fossil fuels (coal, natural gas, and petroleum) were formed from plants and animals that lived and died millions of years ago. For example, some coal began forming from plants that died millions of years before the dinosaurs roamed the Earth.

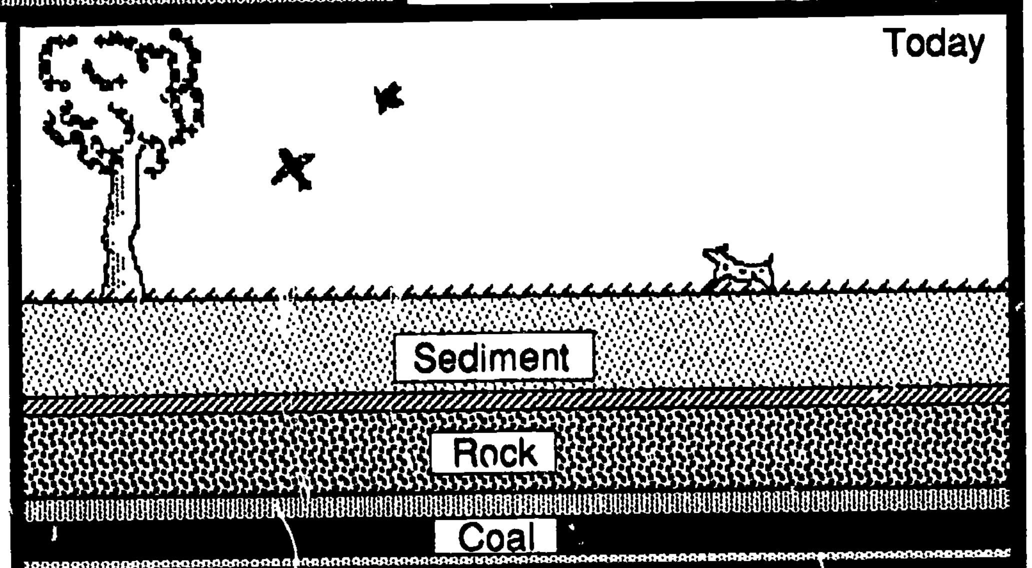
As the years passed, the remains of these dead plants were buried under many layers of mud, water, sand, and rock. Pressure of the weight of the upper layers and heat within the earth caused the dead plants to change slowly into the coal we use today to produce electricity to power the lights in our homes, offices, factories, and schools.



When you pick up a piece of coal, you are holding one of the oldest plant fossils on Earth. Similar to coal, natural gas and petroleum began forming from tiny sea organisms that died millions of years ago. Therefore, these energy sources, coal, natural gas, and petroleum, have been named "fossil" fuels.

Peat is an early stage reached before coal is completely formed.

To create 1 foot layer of coal, at least 10 feet of prehistoric plant remains were needed.

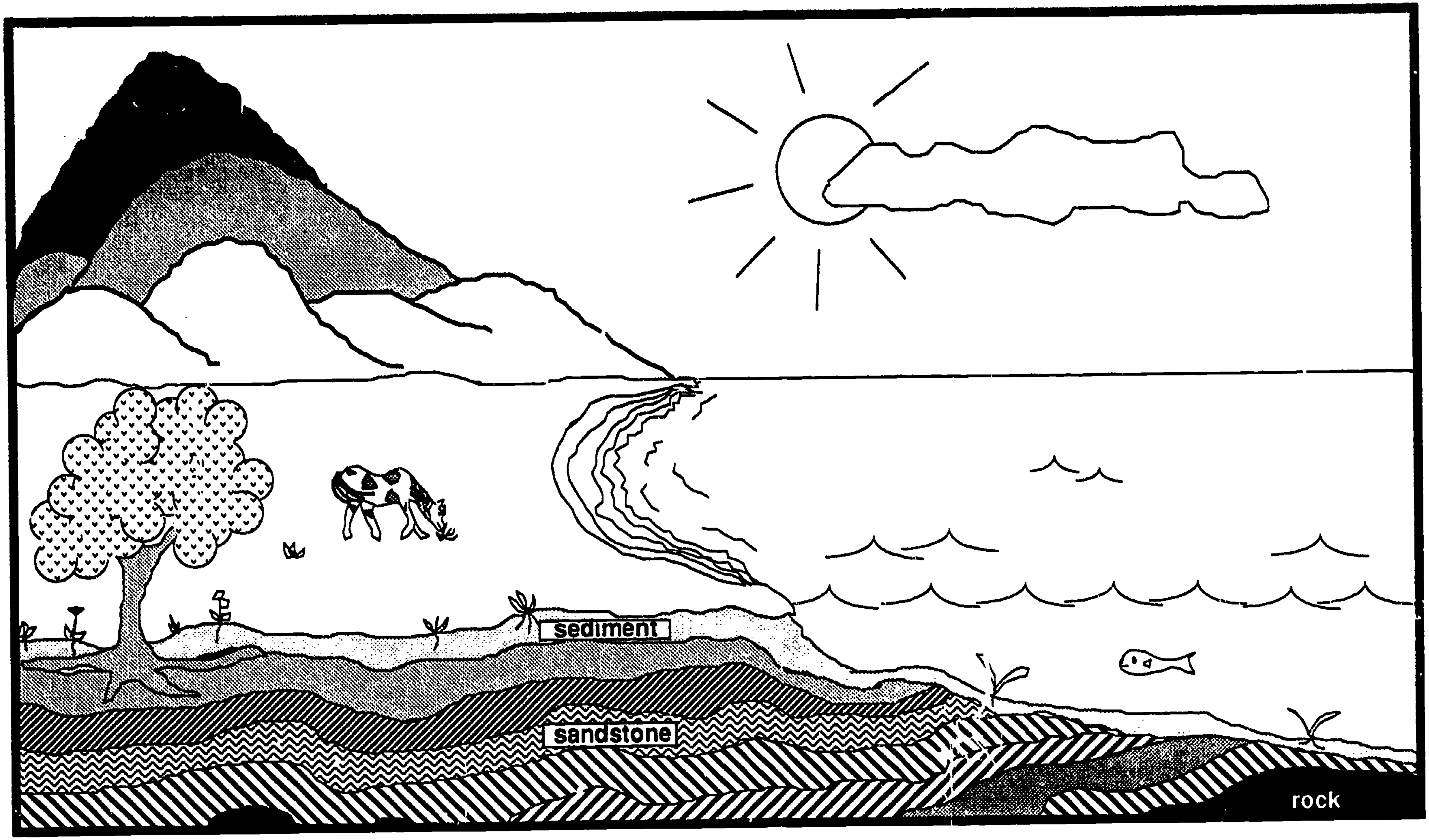


How Was Coal Formed?

Fossil Fuels (coal, natural gas, and petroleum) were formed from plants and animals that lived and died millions of years ago. After they died, their remains were covered by more and more layers of dirt, rock, and other debris deposited by wind, floods, volcanic eruptions, etc. until they were buried deep in the ground. As millions of years passed, the Earth continued to change. New plants and animals developed and then died out (such as the dinosaurs).

Deep in the ground, the plant and animal remains were changing too. They were being squeezed by the pressure of the weight of the layers on top of them and were being cooked by the heat deep in the ground. These prehistoric plants and animals were becoming Fossil Fuels. Today the coal, natural gas, or petroleum we use to power our cars, air conditioners, buses, lights, etc. are called "Fossil Fuels" because they were made from plants and animals that lived during geologic periods millions of years ago.

Even the fossils of dinosaurs seen in museums are not as old as the coal we mine today because coal began forming millions of years before the dinosaurs started roaming the Earth. When you pick up a piece of coal you are holding one of the oldest fossils on Earth.



Underground Geological Layers of the Earth

(The layers may be composed of sediment, coal, granite, sandstone, gold, limestone, copper, slate, silver, or bedrock. Each new layer contributed by wind, water, volcanic eruptions, animals, etc. adds more weight on the lower layers. This weight causes the lower layers to be compressed and become harder and harder until they form rock. Water, natural gas, or petroleum may also be trapped between the layers. It is up to geologists to determine where valuable resources can be found underground.)

Underground Geological Layers Of The Earth

The layers under the surface of the ground may be composed of coal, gold, sandstone, granite, slate, silver, copper, limestone, or bedrock. Each new layer contributed by plants, animals, volcanic eruptions, water, wind, etc. add more weight on the lower layers. This weight causes the lower layers to be compressed and become harder and harder until they form rock. The layers may buckle or crack due to volcanic eruptions underground leaving the layers in waves (anticline formations) or sliding over the other (fault formations). Water, natural gas, or petroleum may be trapped between the layers. It is up to geologists to determine where valuable resources can be found underground.

Suggested activity: Designate a small surface area on a shelf or table (be sure to clearly mark off the area so it will not be cleaned, covered, or moved). Check each day to see how much dust and debris have settled from the air on this section. Relate how quickly a layer of dust, pollen, dirt, etc. collected in your experiment to what happens each day, week, year, century, etc. on the surface of the Earth. Discuss 1) how wind or water may carry and then deposit various materials and 2) how these materials over long periods of time (or short periods in the case of natural phenomena such as volcanic eruptions) form the layers that make up the crust of the Earth.

Lesson 1 Word List

Do you know what these words mean?

Can you spell the words without looking at the list?

Can you find where the words are used on these pages in *Dinosaurs & Power Plants*?

PAGE 1

dinosaurs
lifetimes
fossil fuels
natural gas
liquid
debris
natural events
earthquakes
decomposed
combination
conditions
exposed
sediment
compress
process
dense
contributed

power plants
televisions
coal
three states of matter
gas
prehistoric
volcanic eruptions
materials
underground
animal remains
temperature
decaying
vanished
silt
rock formations
seeping

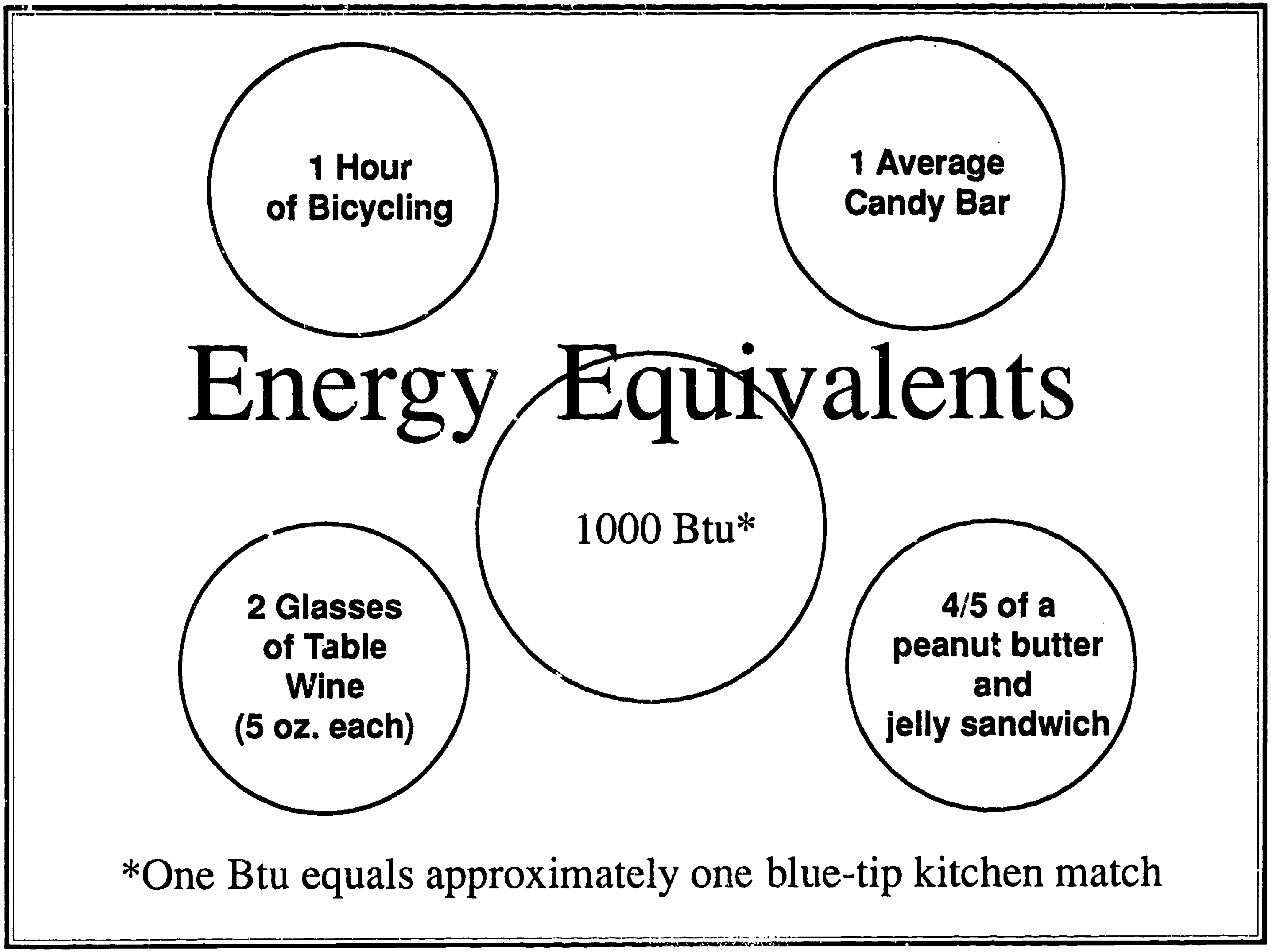
energy
computers
petroleum
solid
million
Earth's crust
landslides
receded
organic
wood debris
pressure
organisms
bacteria
regions
caprock
surface

PAGE 14("Energy Equivalents")

equivalents
oz. (ounce)

bicycling
Btu

average
sandwich

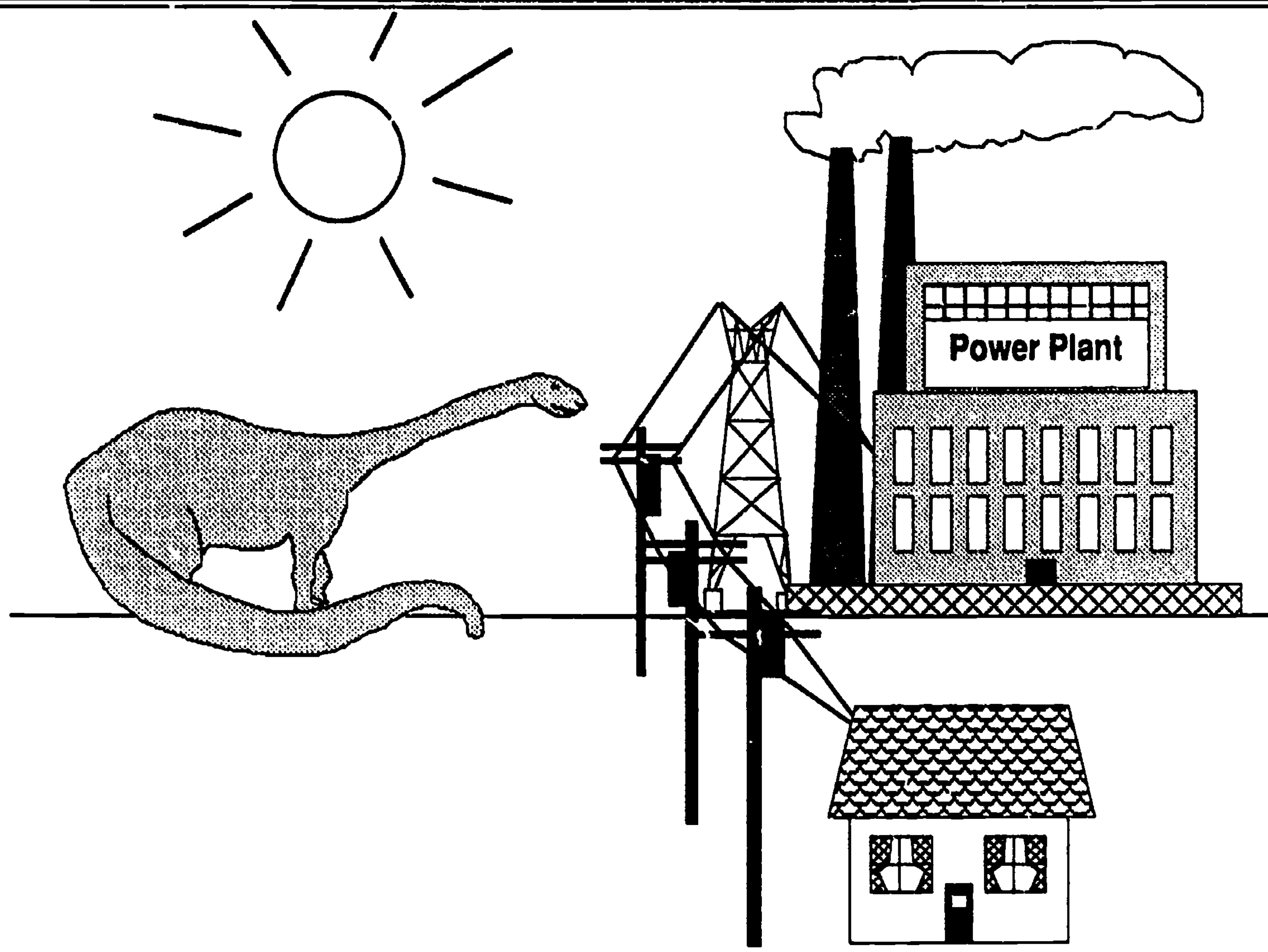

1 Hour
of Bicycling
1 Average
Candy Bar
Energy Equivalents
1000 Btu*
2 Glasses
of Table
Wine
(5 oz. each)
4/5 of a
peanut butter
and
jelly sandwich
*One Btu equals approximately one blue-tip kitchen match

ENERGY USES

LIST 3 ENERGY USING ACTIVITIES OF A DINOSAUR.

LIST 3 OF YOUR ACTIVITIES THAT REQUIRE YOUR BODY TO HAVE ENERGY.

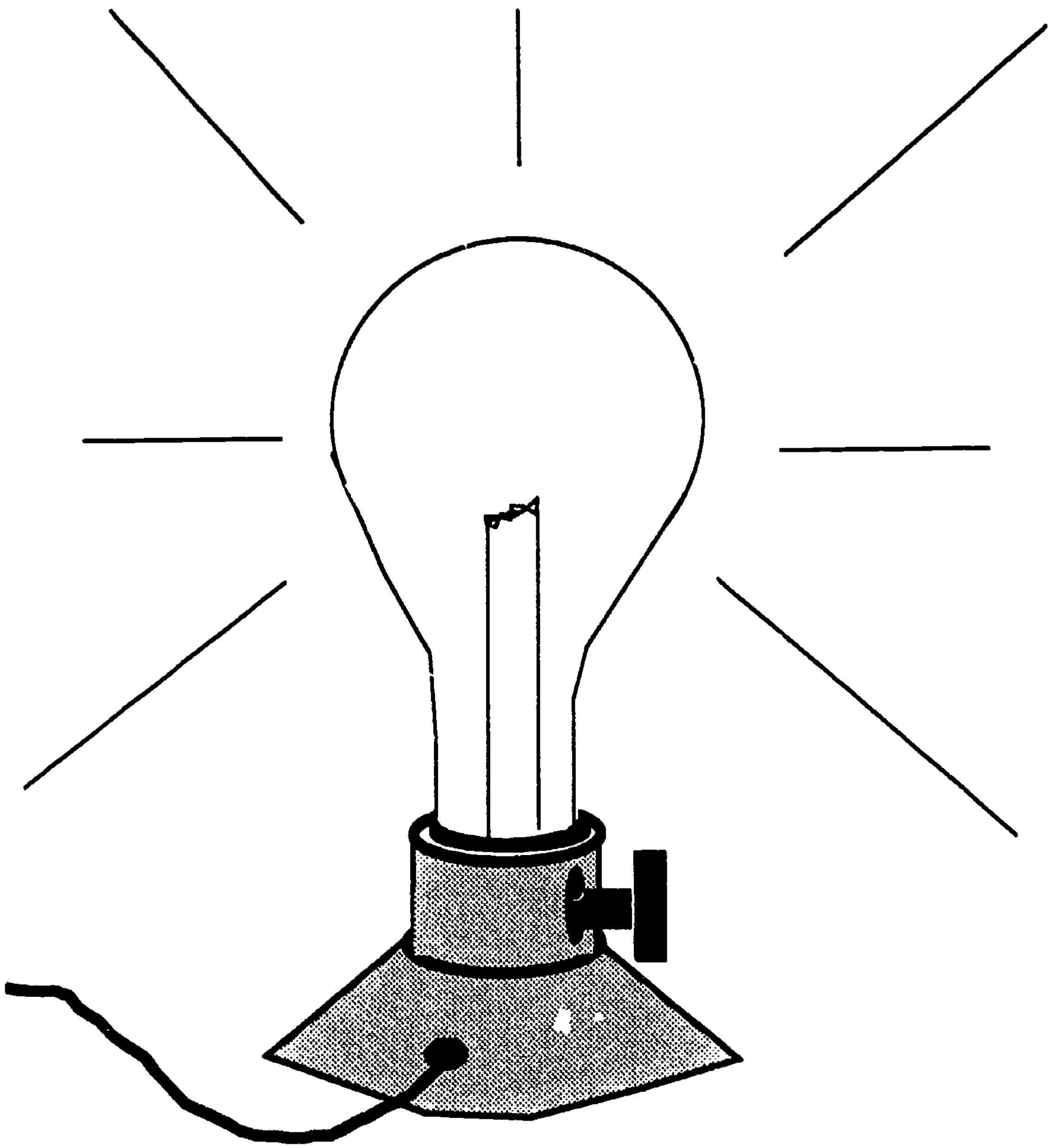
LIST 3 THINGS THAT ARE POWERED BY ELECTRICITY OR COAL, NATURAL GAS, OR PETROLEUM PRODUCTS.



Teacher's Guide Supplement

Lesson Two Supporting Materials

Electricity Made the 1st Incandescent Lamp Possible



Many Things We Take For Granted,

Such As Incandescent Lights

(The Electric Light Bulbs Of Today),

Were Not Invented Until Electricity

Became Available Around 1900.

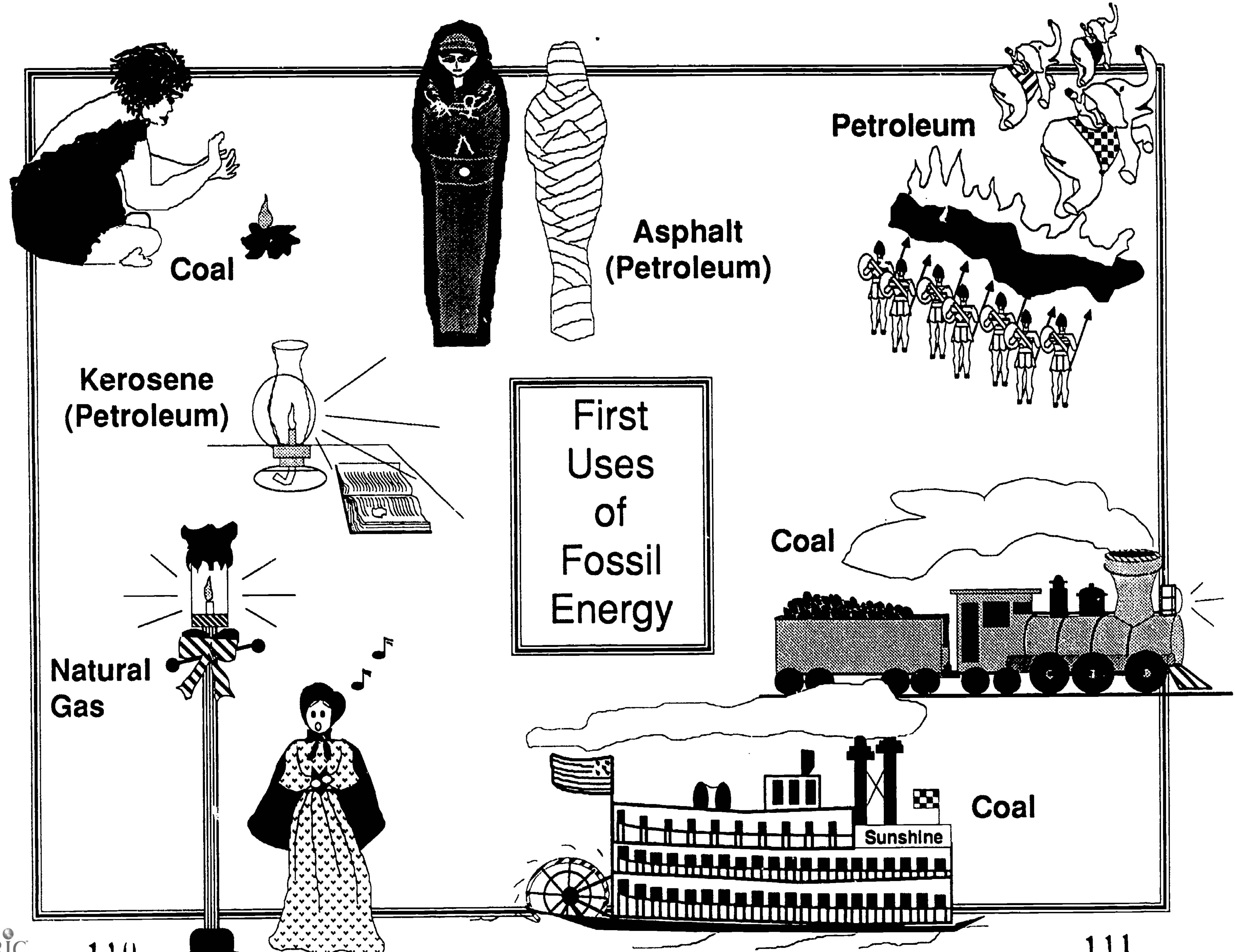
Some Of Our Machines, Such As

Sewing Machines, Clothes

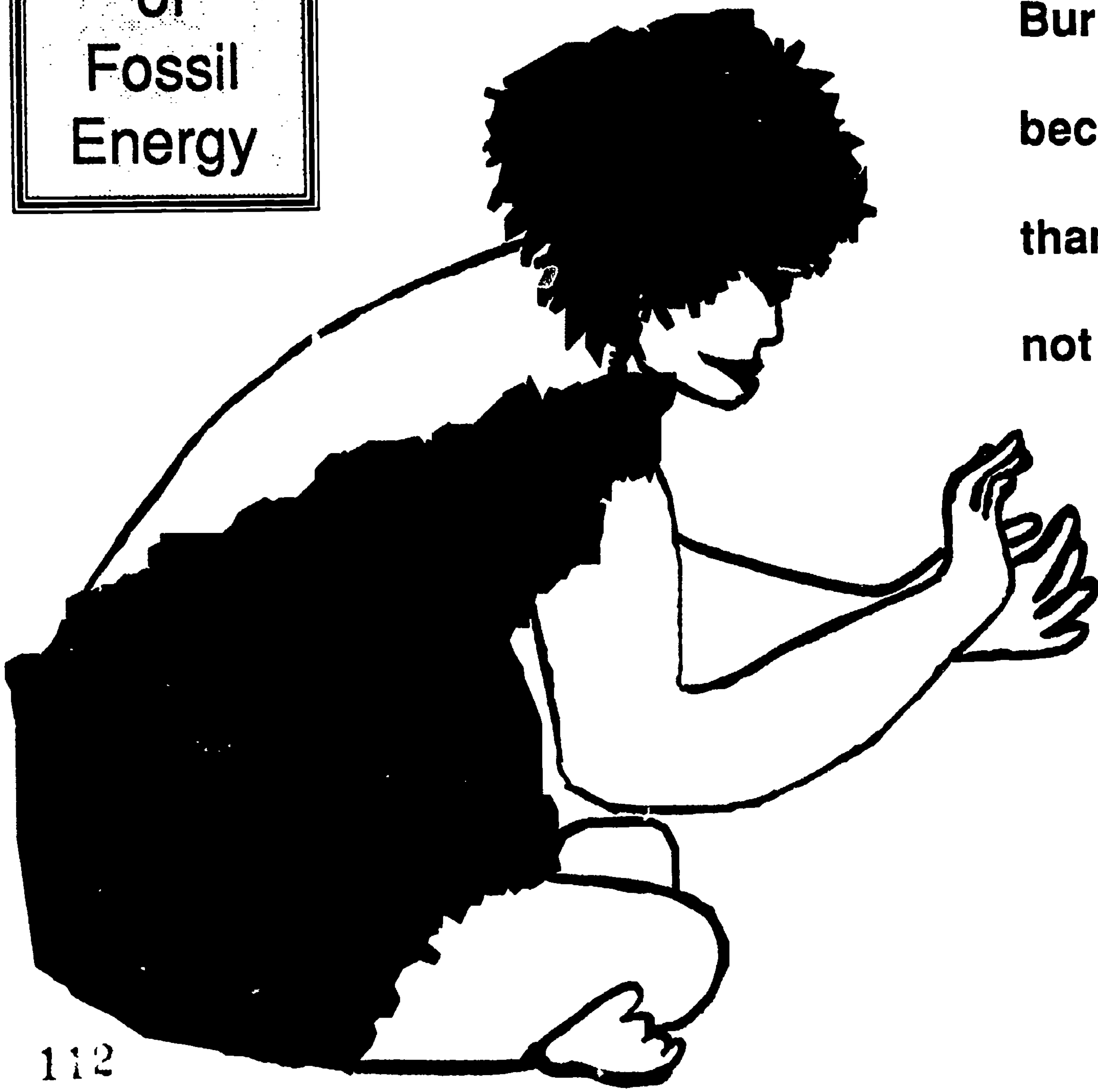
Washers, And Vacuum Cleaners,

Were Hand Powered Until Electricity

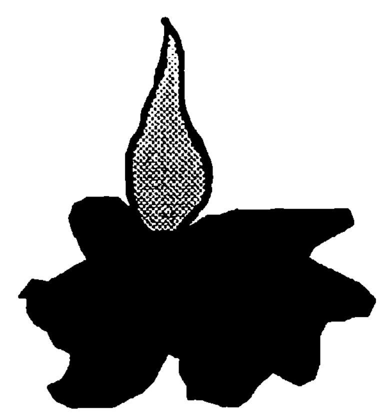
Made Automatic Machines Possible.

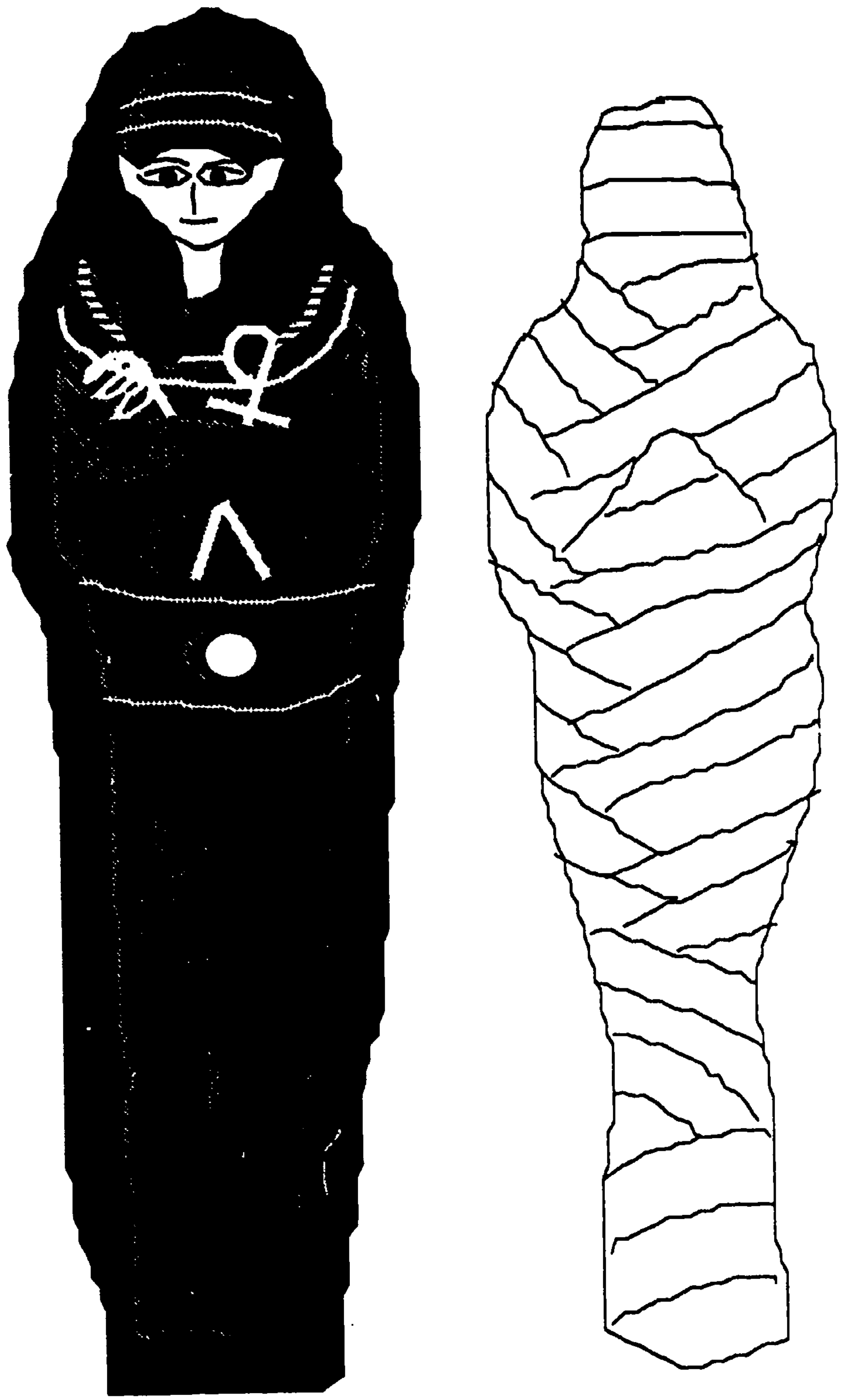

First Uses of Fossil Energy
Coal
Asphalt (Petroleum)
Petroleum
Kerosene (Petroleum)
Coal
Natural Gas
Sunshine
Coal

First Uses of Fossil Energy



The cave man used the coal for heating and, later, for cooking. Burning coal was easier because coal burned longer than wood and, therefore, did not have to be collected as often.





First Uses of Fossil Energy

Archeologists have

found that in the ancient

times of the pharaohs

Egyptians used asphalt,

a form of petroleum,

to preserve human remains.

The mummies from Eqypt we

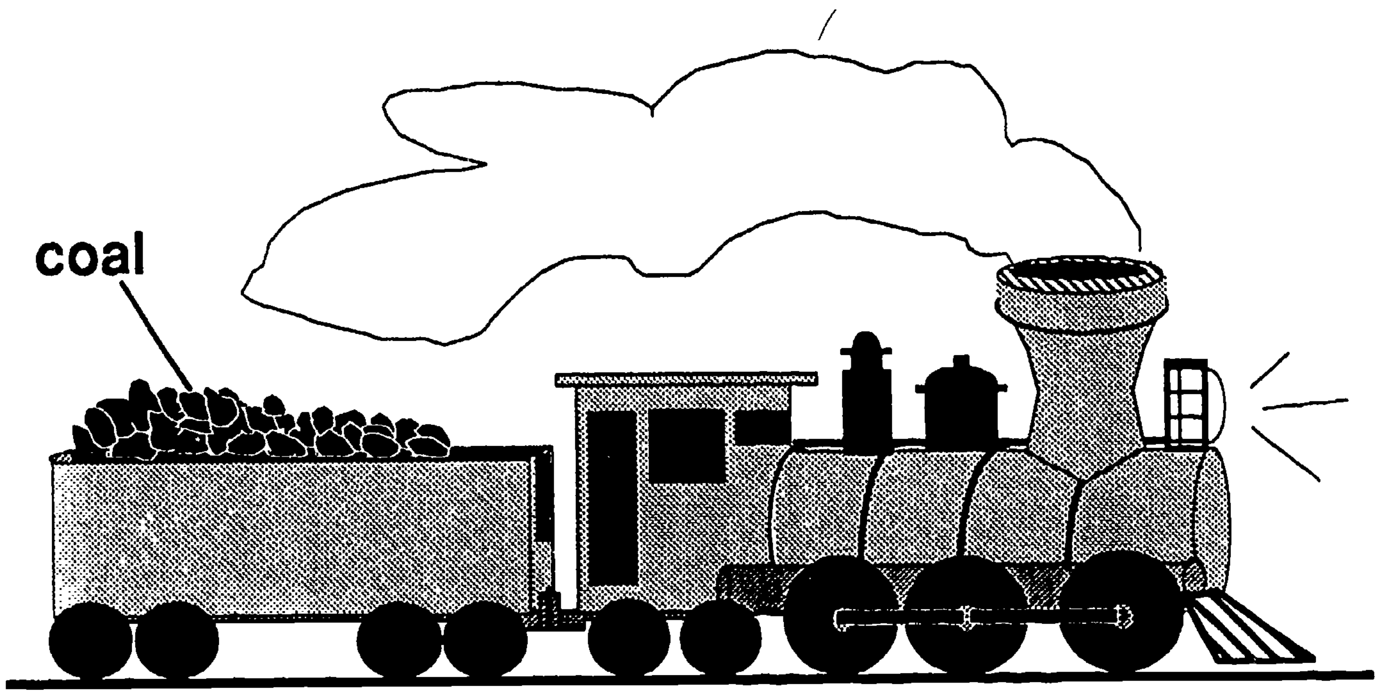
see in museums today were

preserved using this process.

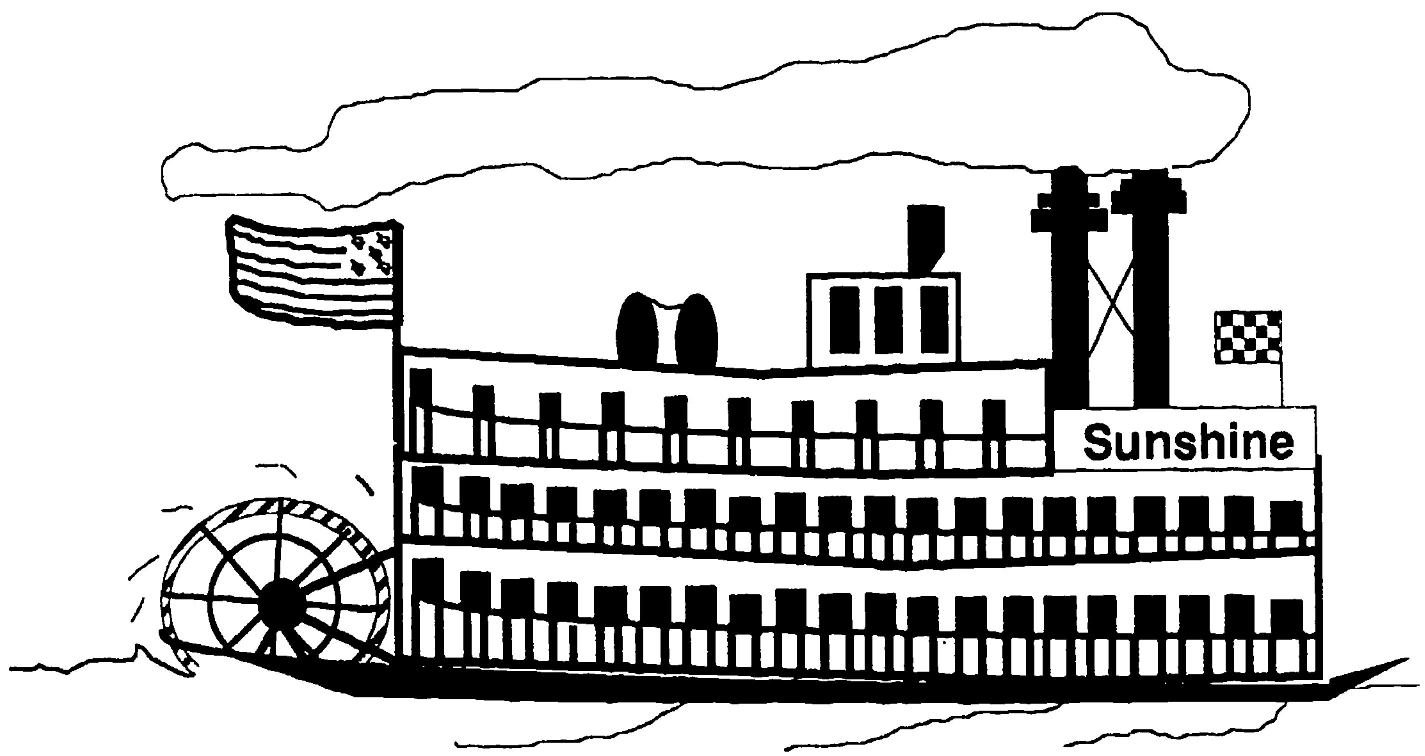
Alexander the Great burned petroleum to scare away the war elephants of his enemies.

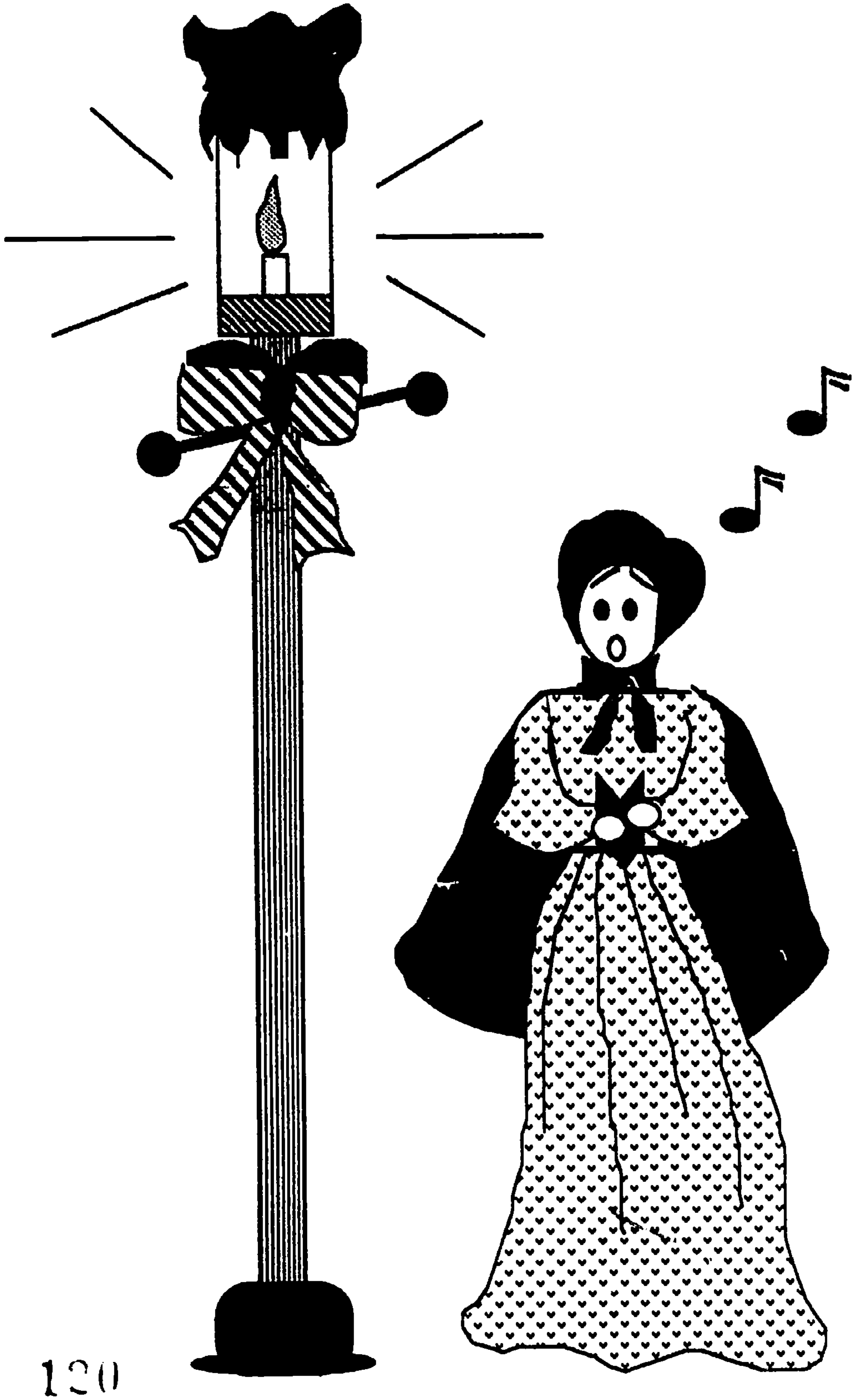
First Uses of Fossil Energy

Even after electricity began being used to power lights and small machines, coal continued to be the major fuel used to run trains and ships



First Uses of Fossil Energy

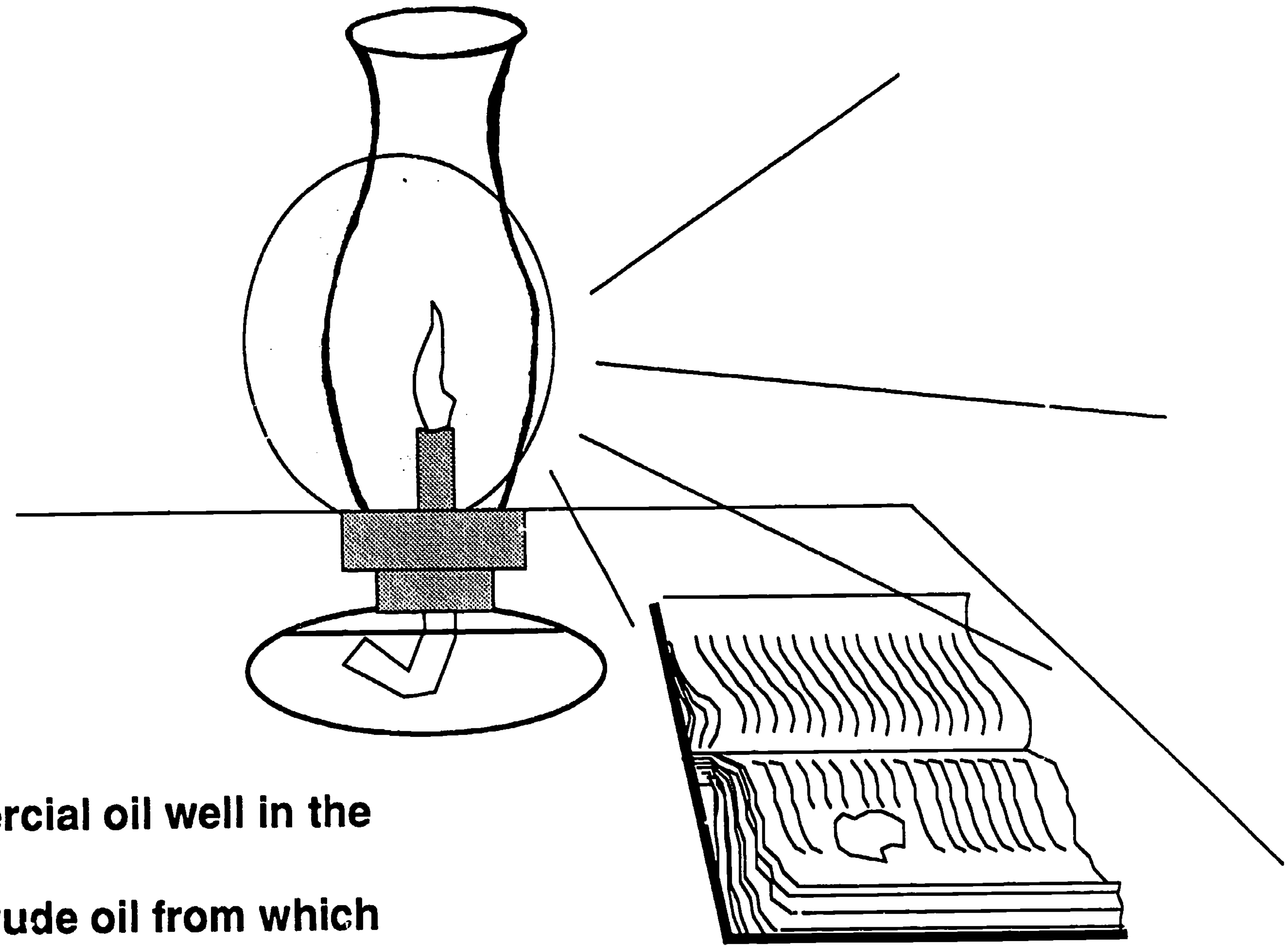




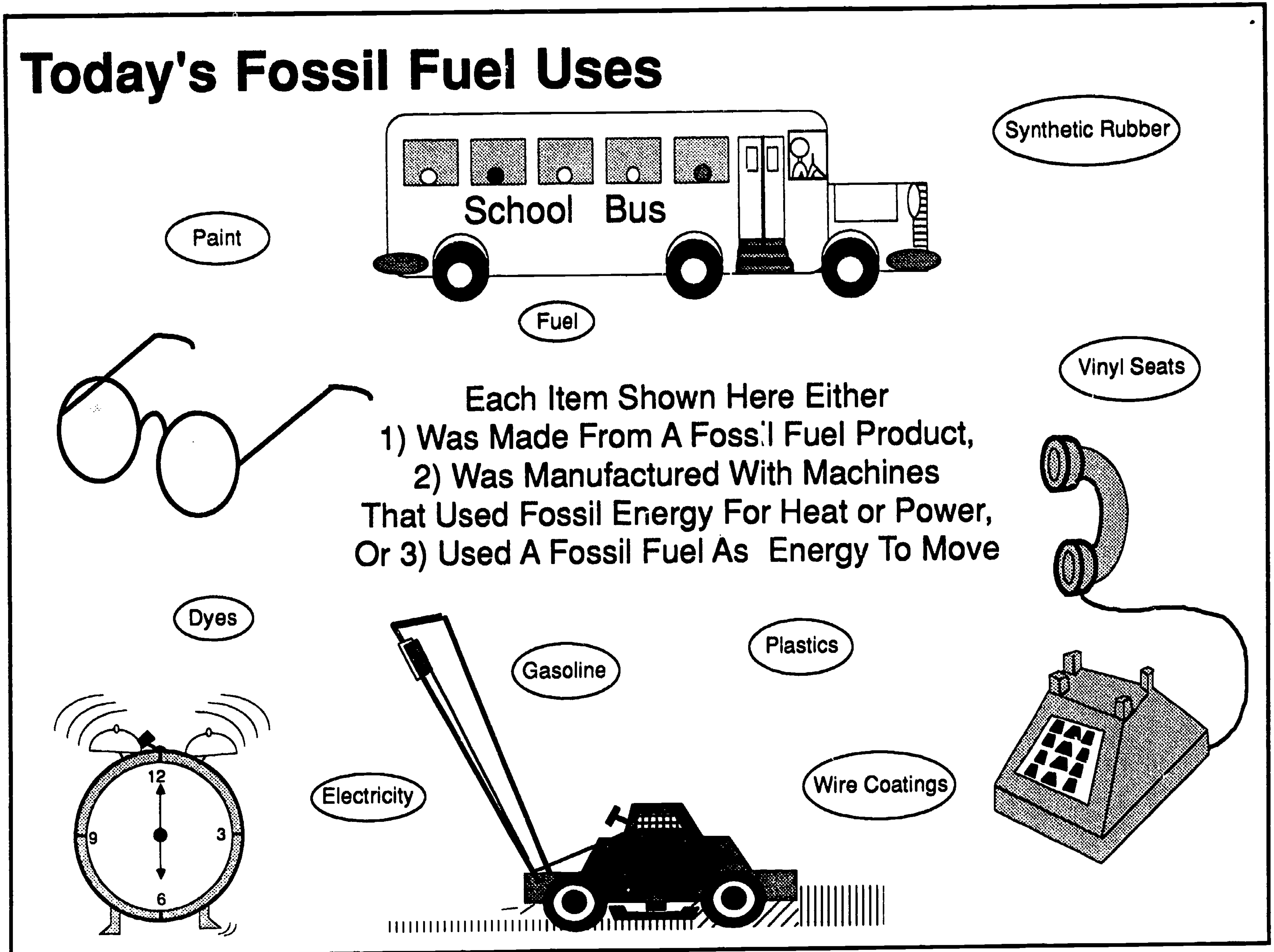
First Uses of Fossil Energy

Natural gas was first used commercially in the U.S. for lighting in homes and businesses. Due to the lack of modern pipelines that would allow long distance distribution, the natural gas could only be used by people close to the well. Some towns used the natural gas for outdoor lighting that burned day and night.

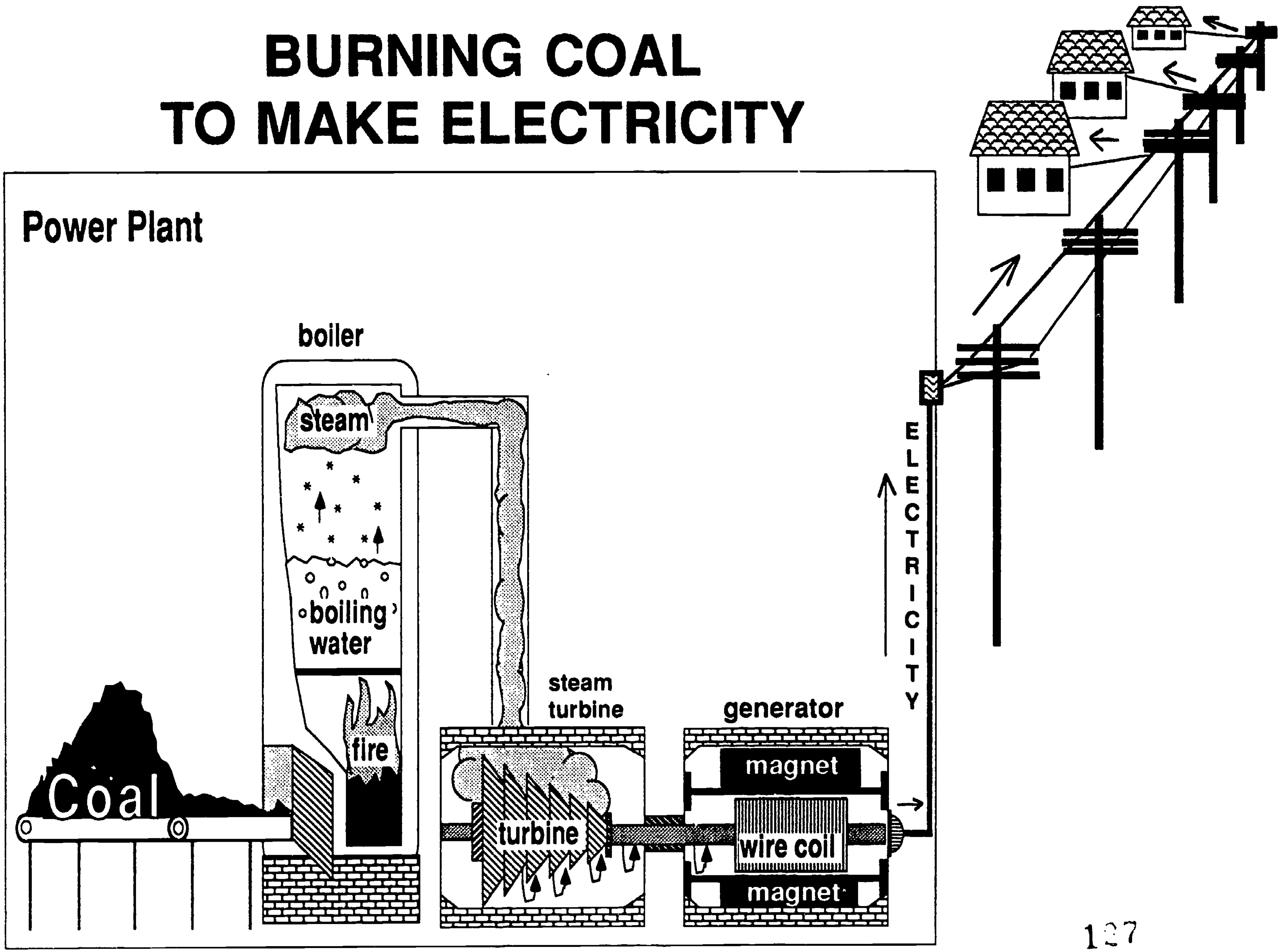
First Uses of Fossil Energy



The first commercial oil well in the U.S. provided crude oil from which kerosene was created and used to to fuel lanterns needed for home lighting.


Today's Fossil Fuel Uses
School Bus
Synthetic Rubber
Paint
Fuel
Vinyl Seats
Each Item Shown Here Either
1) Was Made From A Fossil Fuel Product,
2) Was Manufactured With Machines
That Used Fossil Energy For Heat or Power,
Or 3) Used A Fossil Fuel As Energy To Move
Dyes
Plastics
Gasoline
12
9
3
6
Electricity
Wire Coatings

BURNING COAL TO MAKE ELECTRICITY



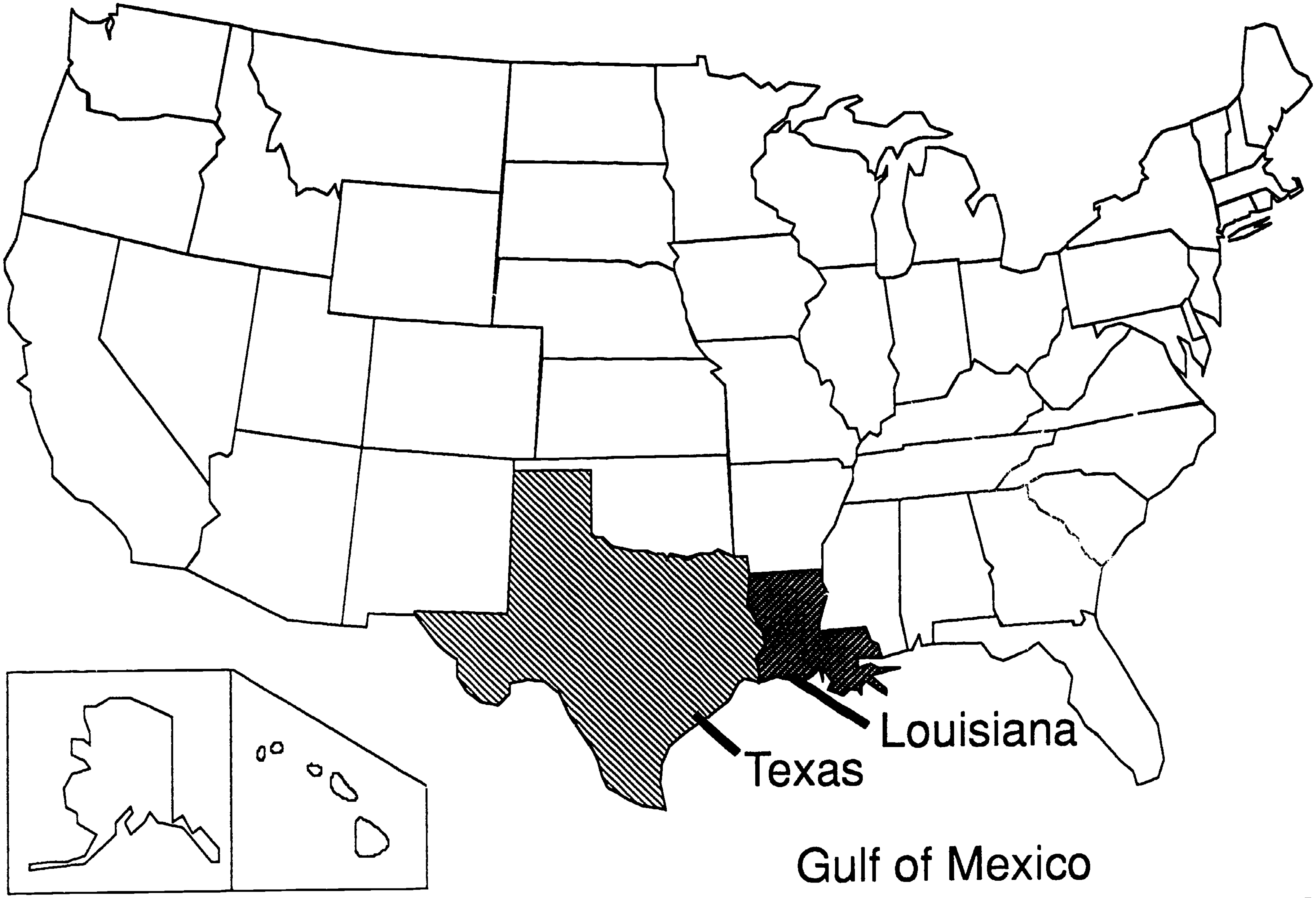
BURNING COAL TO MAKE ELECTRICITY

A power plant can burn a fossil fuel, such as coal, in a giant closed tub called a "boiler" that contains water. As the coal is burned, the water gets hot and turns into steam. (This is like boiling water in a covered pot on your stove.)

The steam is collected from the top of the boiler and sent through pipes to a "turbine" that contains a shaft or pole on which blades l(somewhat ike the propellers on a plane) are \mounted . The steam rushing in causes the blades to turn like when you blow on the blades of a pinwheel.

The turning blades cause the shaft that holds them to also turn or rotate. This shaft runs from the turbine into a "generator" unit. In this last box, a coil of wire is mounted on the shaft. Surrounding the coil of wire and the shaft is a magnet. When the shaft causes the wire coil to rotate, an electrical current is created as the magnetic field is crossed by the wire coil. The electrical current is then collected by the wire coil and is sent out on wires to your home and school as electricity.

Strategic Petroleum Reserve Locations



Resource Conservation

How can we make our fossil fuel resources last longer?

There are simple actions, called "conservation" methods, we can take to save energy and reduce the depletion of our resources.

1) Turn off lights when you leave the room and turn off the television or radio whenever you go to do something else.

2) Decide what you want from the refrigerator before opening the door. Do not hold the door open for a long time and let the cold air out. Check to make sure you shut the door completely when you are finished.

3) Whenever possible walk or ride your bicycle instead of taking a car.

4) Test your windows and doors to see if air leaks in or out. If it does, apply weatherstripping to those with air leaks to seal the heating or air conditioning in your home.

5) Wear warmer or cooler clothing that allows you to set your thermostat lower in the winter (keep your home cooler) and higher in the summer (keep your home warmer).

6) Take short showers rather than baths to save on hot water (and wastewater that will have to be cleaned at the local water treatment facility).

7) Use as few disposable items as possible. The more items we throw away, the more land we will have to use for solid waste disposal. And the more it will cost you for collection and disposal of these waste items.

8) Recycle as many reusable items as possible. Recycling helps us reuse the resource that originally created the product rather than having to use more raw resources to make new products. For instance, recycling newspapers will reduce the number of trees required to make paper.

9) There are many other conservation methods that will help save our resources. Check with your local power company or recycling center for additional information.

Lesson 2 Word List

Do you know what these words mean?

Can you spell the words without looking at the list?

Can you find where the words are used on these pages in *Dinosaurs & Power Plants*?

Can you find the cities, states, bodies of water, and countries on a map?

PAGE 2

fossil fuels
light switch
enclosure
pinwheel
wire coil
generator
neighborhood
builders
steel beams
cement
diesel fuel
classroom
fertilizer
scrape
bandage

electricity
boiler
turbine
shaft
magnet
electrical current
jet propellant
frame
core
manufacturing
vehicles
video cassette player
pesticides
health
products

power plant
steam
steam turbine
rotate
device
telephone poles
plastics
foundation
processes
exterior
construction
cafeteria
derived
adhesive
lighting

PAGE 3

discoveries
evidence
13th century
inscriptions
archeological
pitch
ignited
embalm
William A. Hart
illumination
Juan Rodriquez
Santa Barbara, California

rock deposits
Alexander the Great
oil seepages
archeologists
caulked
Plutarch
lightning
Fredonia, New York
intentionally
distribute
Spanish
Nacogdoches, Texas

underground
Marco Polo
Caspian Sea
asphalt
bitumen
Iraq
Egyptians
natural gas
drilled
petroleum
oil residues
Titusville, Pennsylvania

Lesson 2 Word List

PAGE 3 (cont'd)

Edwin L. Drake
whale oil
shortage
varied
second century
English
technologies
dominant
coal mines
Virginia
transportation

DeSoto expedition
illuminant
coal
Romans
third century
wood charcoal
Industrial Revolution
supplier
operation
generate

kerosene
lubricant
plentiful
England
Hopi Indians
overwhelming
opportunity
commercial
relative newcomer
furnaces

PAGE 14 ("For Emergency Only" section)

Strategic Petroleum Reserve

emergency
manufacture
plastics
40 percent (40 %)
borders
Arab nations
stockpile
established
Louisiana
disruption

average
variety
crude oil
consumed
foreign countries
dramatically
aftermath
salt dome caverns
Texas

transportation
chemical
accounts
unfortunately
oil embargo
demonstrated
crisis
Gulf Coast
insurance policy

Lesson 2

Energy Uses List

COAL

Acts as a Fuel to Power or Heat

Industrial Furnaces

Train Engines

Power Plant Boilers

Assists in the Production of These Products

Electricity Generation
Dyes & Paint
Perfume
Insulation
Rubber Stamp Ink
Fertilizers
Tar for Paving Roads
Photodeveloper
Insecticide
Food Preservative
Pottery (Dishes)

Iron
Synthetic Rubber
Varnish
Sugar Substitute
Baking Powder
Billiard Balls
Disinfectant
Bricks
Plastics

Steel
Insulation
Explosives
Airplane Fuel
Illuminating Gas
Laxatives
Phonograph Records
Medicines
Laughing Gas
Cement

Lesson 2

Energy Uses List

NATURAL GAS

Acts as a Fuel to Power or Heat

Home Heating Furnances	Clothes Dryers	Hot Water Heaters
Kitchen Stoves/Ovens	Incinerators	Air Conditioners
Barbeque Grills	Outdoor Lighting	Camping Lanterns

Assists in the Production of These Products

Antifreeze	Detergents	Fertilizers
Herbicides	Pesticides	Plastics
Solvents	Synthetic Fibers	Ammonia

Lesson 2

Energy Uses List

PETROLEUM

Acts as a Fuel to Power or Heat

Cars, Trucks, & Vans (Gasoline)
Large Trucks (Diesel)
Airplanes (Jet Fuel)
Home/Industrial Furnaces

Assists in the Production of These Products

Cosmetics (lipstick)	Tar Paper (roofing)	Asphalt
Lubricating Grease	Kerosene	Gasoline
Water & Gas Pipes	Detergents	Explosives
Synthetic Rubber (tires/hoses)	Fertilizers	Paint
Synthetic Fibers (clothing)	Airplane Fuel	Adhesives
Vinyl Flooring (linoleum)	Vinyl Wallpaper	Insulation
Solvents (turpentine)	Medicines	Coatings on Wiring
Photographic Film	Diesel Fuel	Motor Oil
Computer Diskettes	Ink	Cassette Tapes
Eyeglass Lenses/Frames	Toothbrush	Hair Combs
Car Upholstery	Carpets	Jewelry

Lesson 2

Energy Uses List

THINGS THAT ARE POWERED BY ELECTRICITY GENERATED FROM FOSSIL ENERGY

Grass Edgers
Telephone Answering Machines
Video Cassette Recorders (VCRs)
Vacuum Cleaners
Power Saws & Drills
Copying Machines
Ticker Tape Machines
Cassette Tape Players
Video Game Machines
Microwave Ovens
Hot Water Heaters
Portable Home Heaters
Computerized Exercise Machines
Soda Dispensing Machines
Dental Equipment
Facsimile Machines

Fans
Stereos
Radios
Clothes Washers
Typewriters
Refrigerators
Computers
Hair Dryers
Slide Machines
Clocks
Clothes Dryers
Roller Coasters
Food Processors
Movie Projectors
Church Organs
Pencil Sharpeners

Air Conditioners
Lights
Televisions
Dish Washers
Lawn Mowers
Escalators
Blenders
Curling Irons
Coffee Makers
Mixers
Microphones
Hospital Equipment
Slide Projectors
Stoves/Ovens
Elevators
Staplers

What do YOU use that runs on Electricity?

Lights In Your School: How Much Do They Cost To Run?

Start by figuring how much electrical energy it takes to light your classroom for 1 hour. Expand your findings to the cost for 1 day, 1 week, etc.

Number of Tubes in Your Classroom ____ X $.03* = $ ____ Cost Per Hour To Light Your Classroom

*Electricity costs approximately $.03 per hour to run the fluorescent tubes that are used to light most classrooms. The cost ranges $.02 to $.04 per hour across the United States.

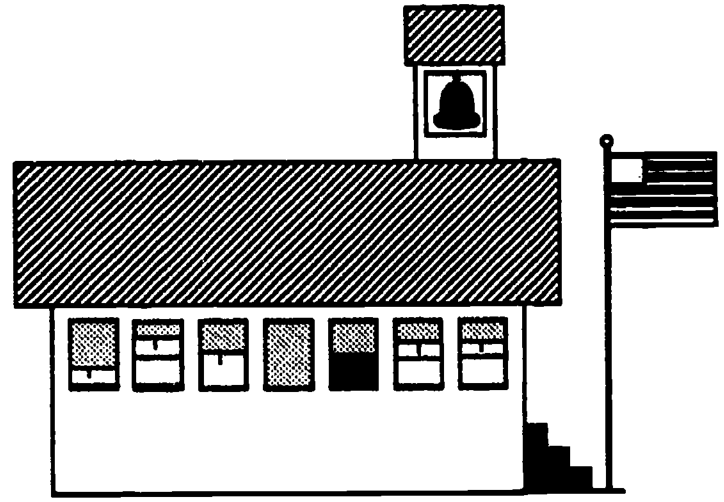
Cost Per Hour To Light Your Classroom $ ____ X ____ Hours Per Day Classroom Uses Lights = $ ____ Cost Per Day

Cost Per Day To Light Your Classroom $ ____ X ____ Days Per Week Classroom Uses Lights = $ ____ Cost Per Week

Cost Per Week To Light Your Classroom $ ____ X ____ Days Per Month Classroom Uses Lights = $ ____ Cost Per Month

Cost Per Month To Light Your Classroom $ ____ X ____ Months Per Year Classroom Uses Lights = $ ____ Cost Per Year

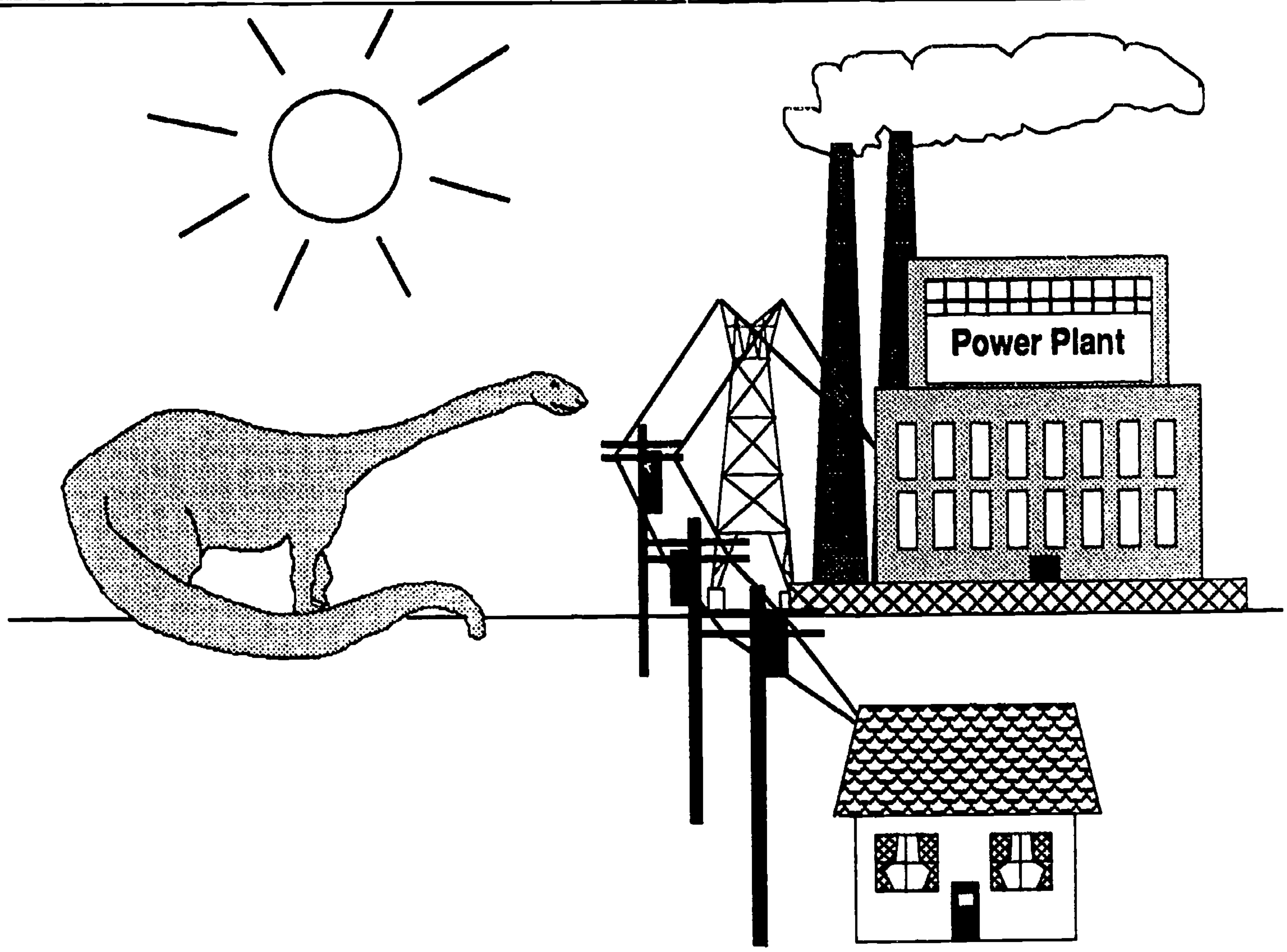
$$\frac{\text{Number of watts per tube (usually 40 watts)} \times \text{Number of tubes in the school} \times \text{Number of hours used per year}}{1000} = \text{**kwh per year}$$



Do you know how many fluorescent tubes there are in your school? Can you apply what have learned about finding the costs for your classroom to finding the costs for the entire school?

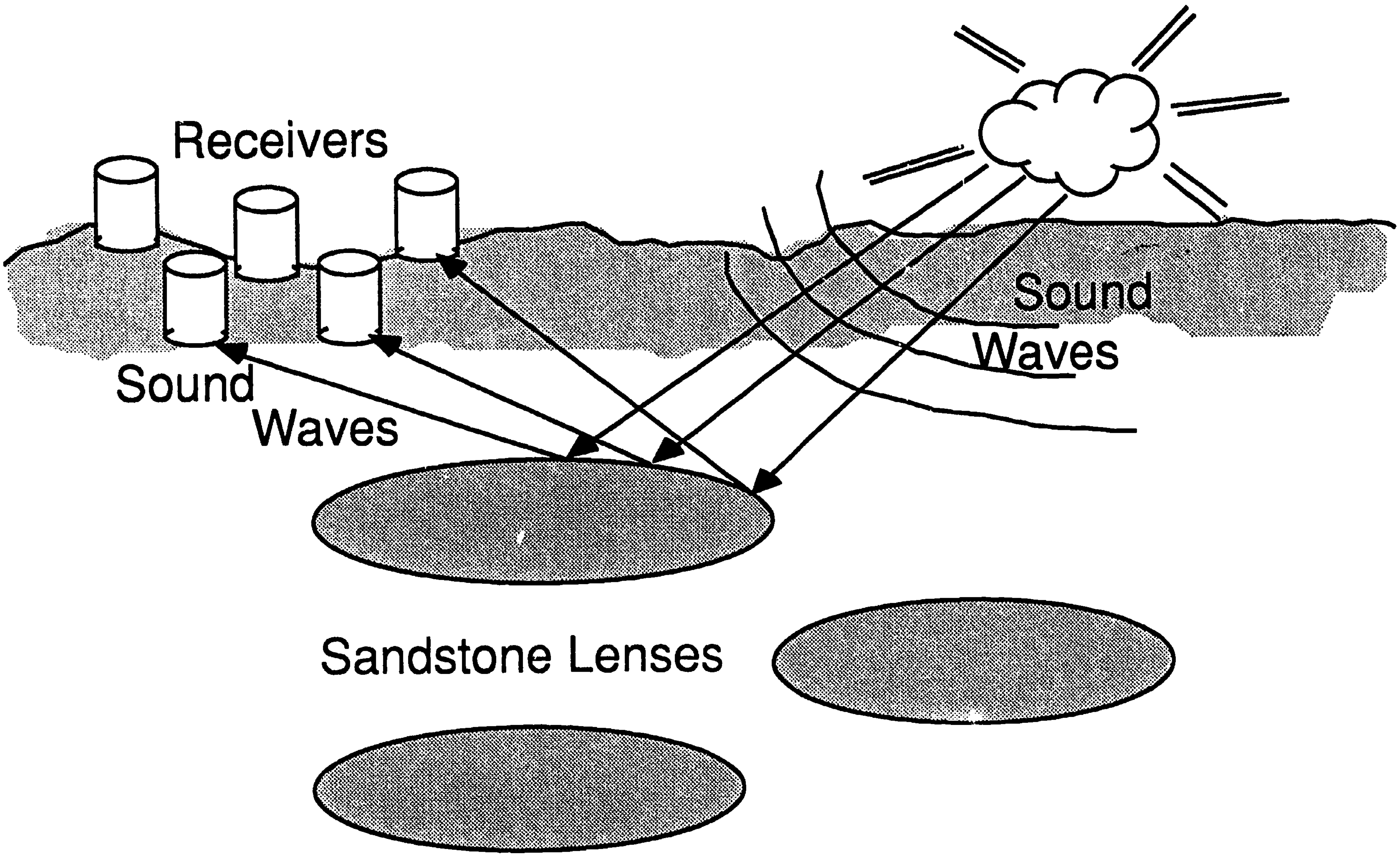
	Classroom	School
Cost Per Hour		
Cost Per Day		
Cost Per Week		
Cost Per Month		
Cost Per Year		
Kilowatt Hours (kwh) Used Per Year**		
Tons Of Coal Used Per Year		

How many kilowatt hours (kwh) per year** were your lights used? An average of **2500 kwh of electricity** are produced by burning **1 ton of coal.** How many tons of coal would it take to light your classroom for 1 year? Or your school for 1 year? Record your calculations above. (How many pounds in a ton? Compare your weight in pounds to the amount of coal needed to light your school.)



Teacher's Guide Supplement

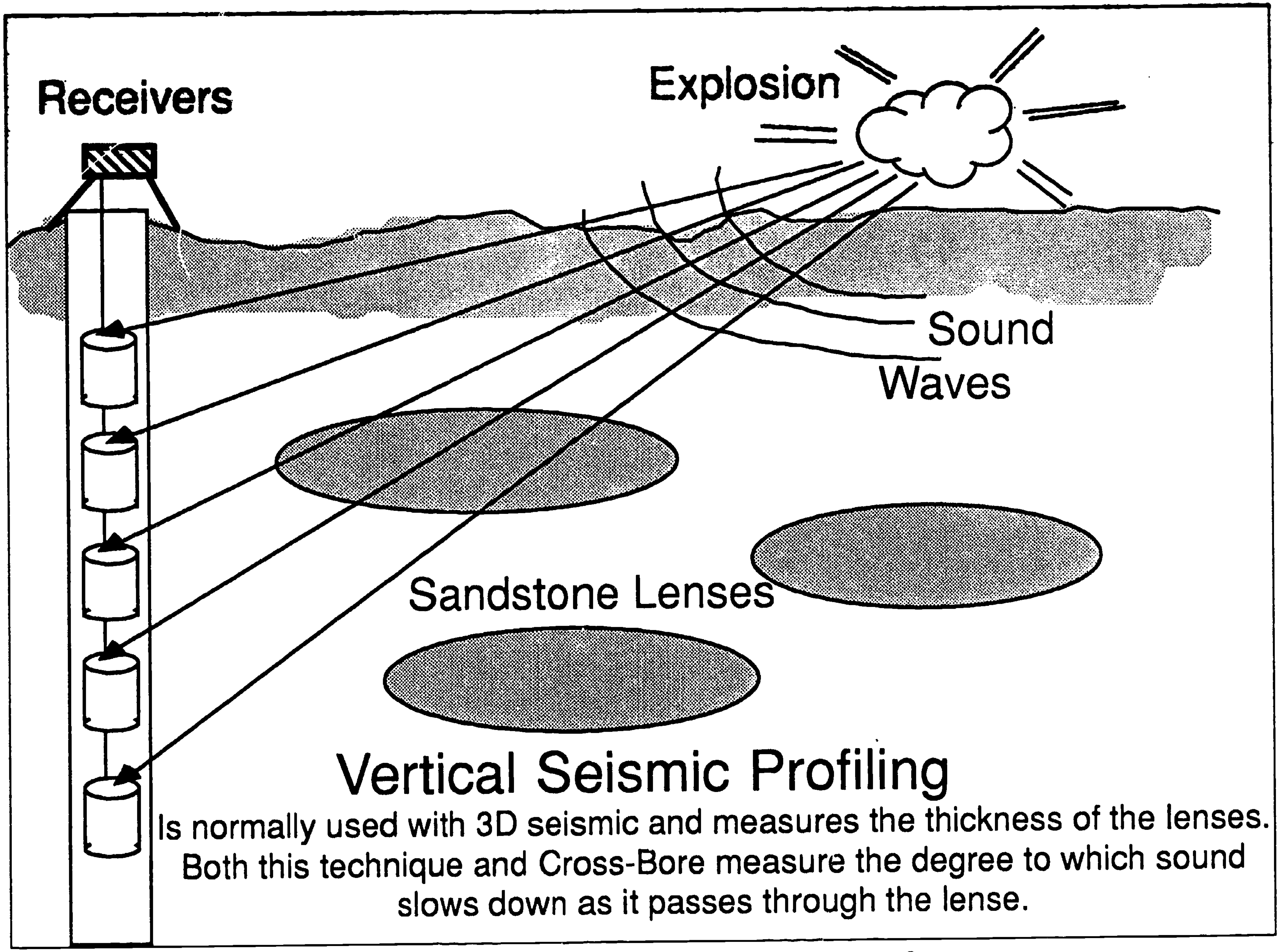
Lesson Three Supporting Materials



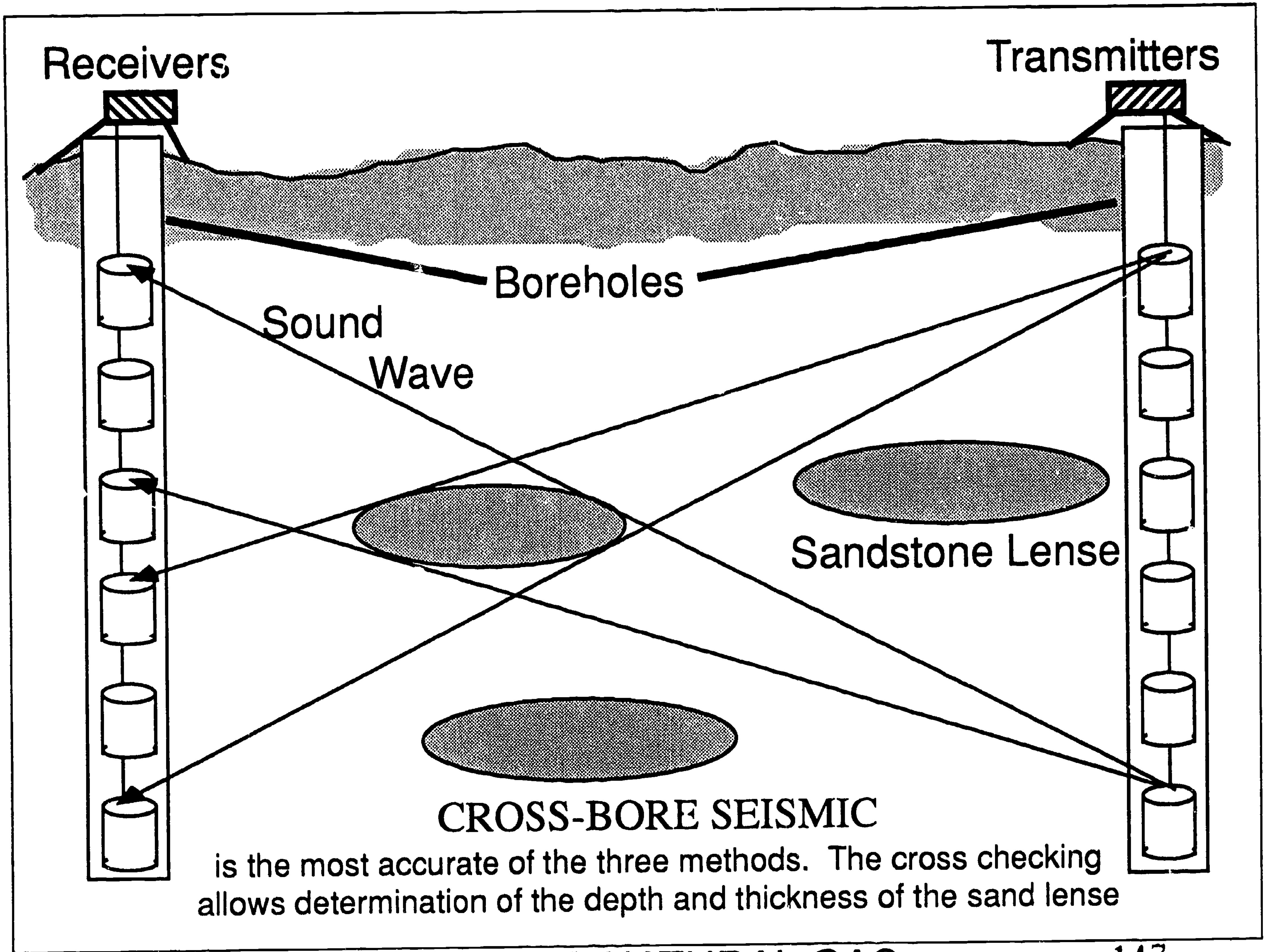
THREE DIMENSIONAL (3D) SEISMIC

deflects sound waves off sandstone formations (lenses) and measures the time it takes for sound to travel from the explosion to the receivers. This method is used to tell the shape (three dimensions-length, width, & depth) of the lense.

1) FINDING NATURAL GAS

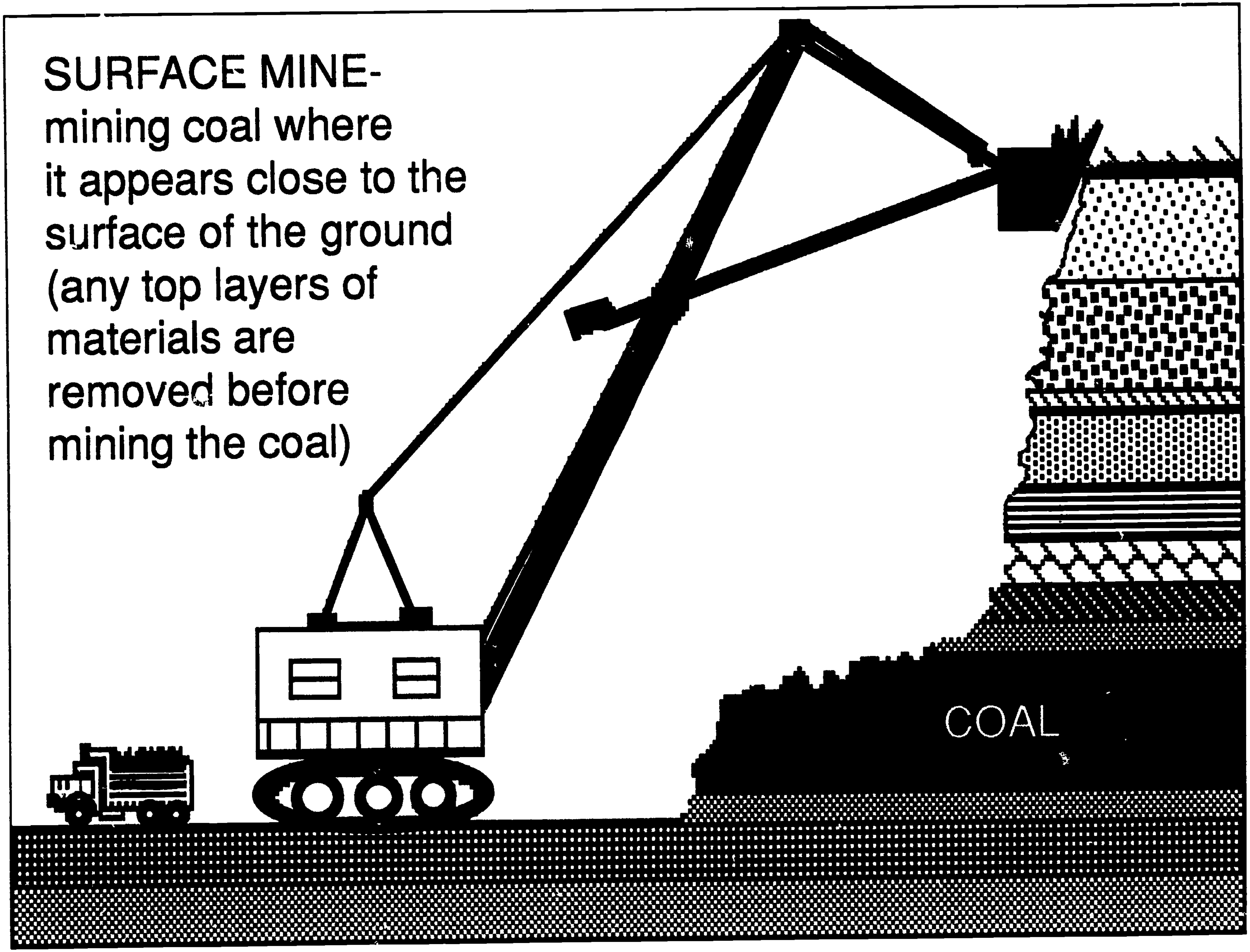


2) FINDING NATURAL GAS

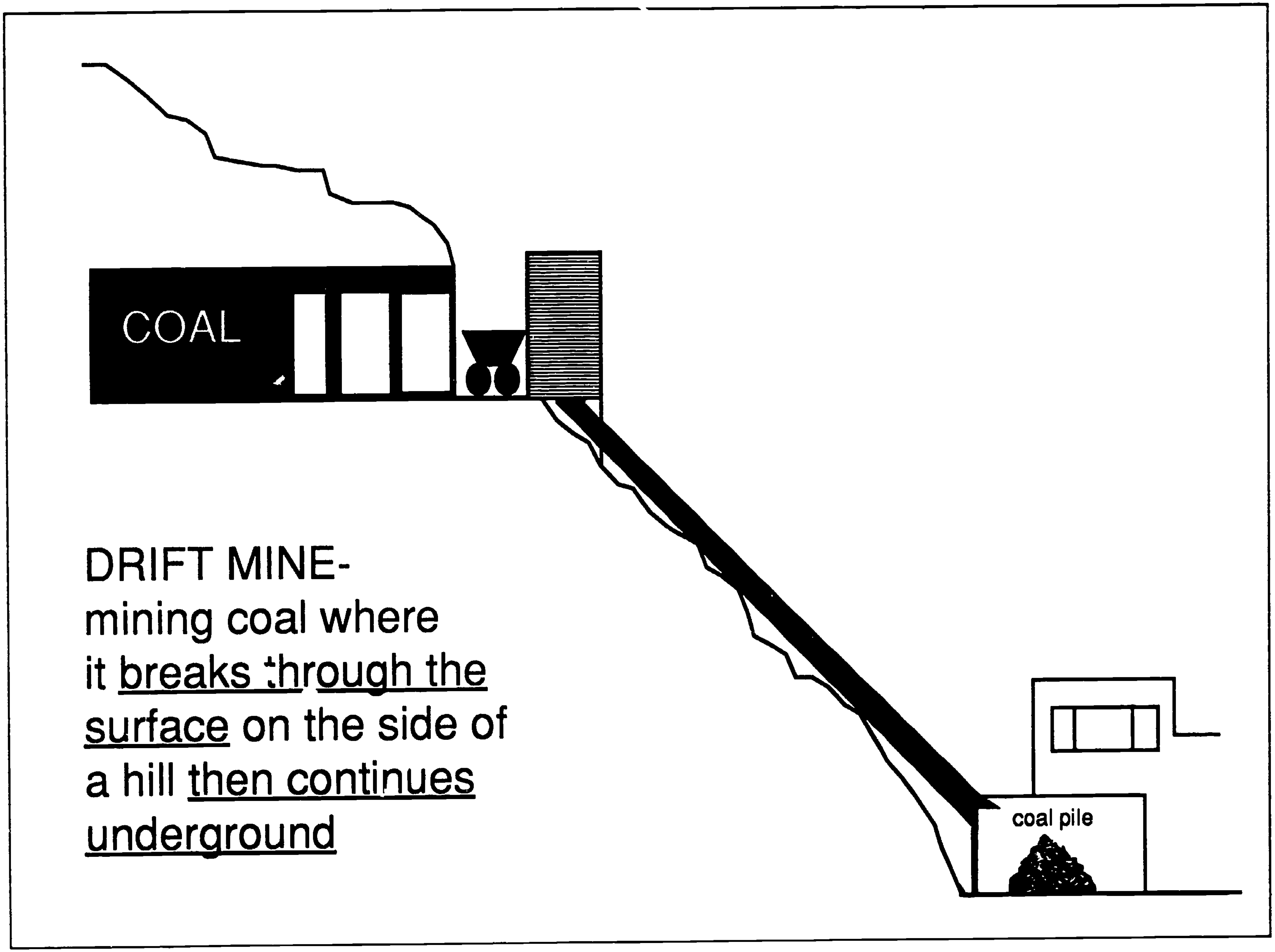


CROSS-BORE SEISMIC
is the most accurate of the three methods. The cross checking allows determination of the depth and thickness of the sand lense

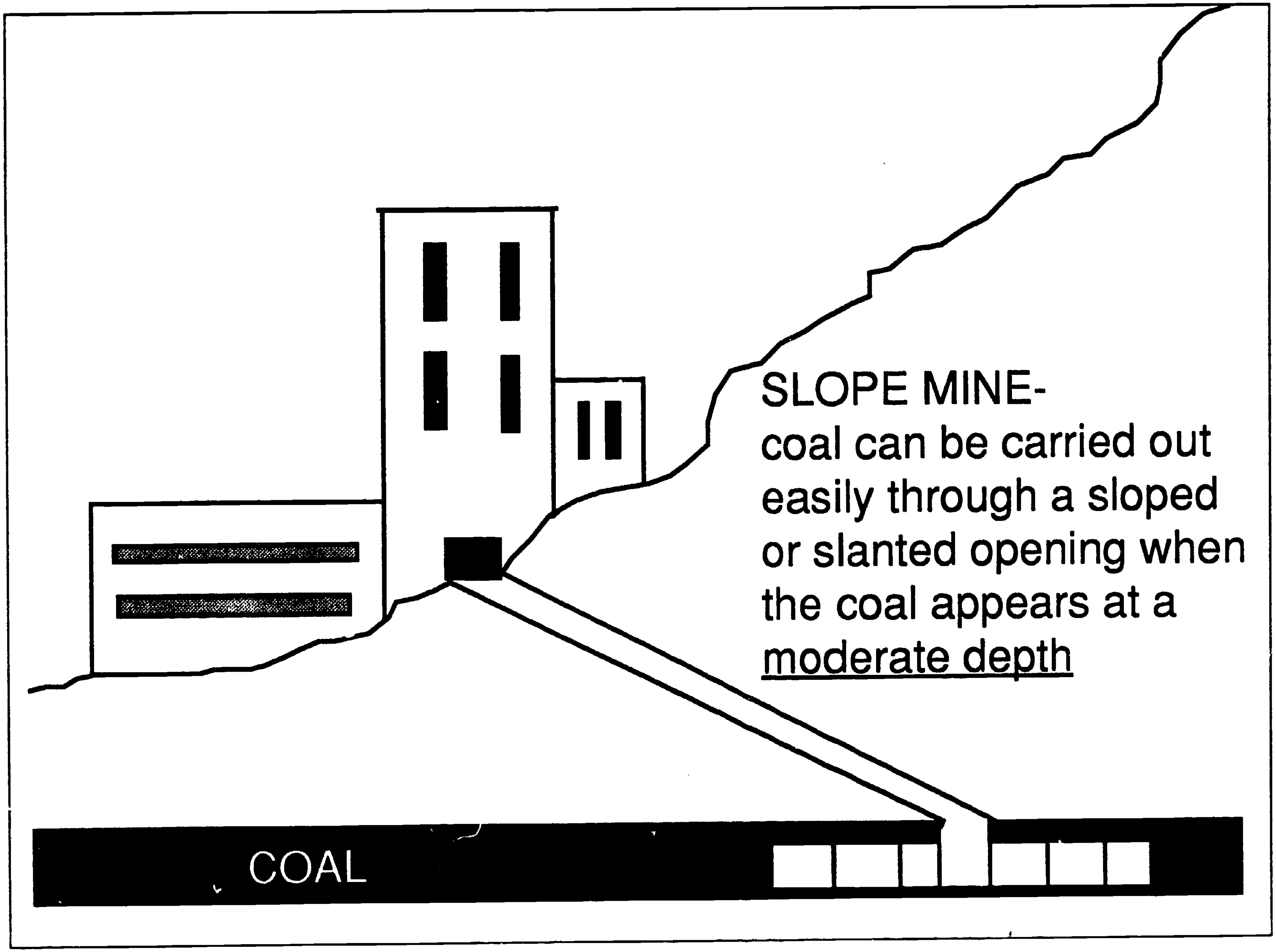
3) FINDING NATURAL GAS



1) COAL MINING - SURFACE

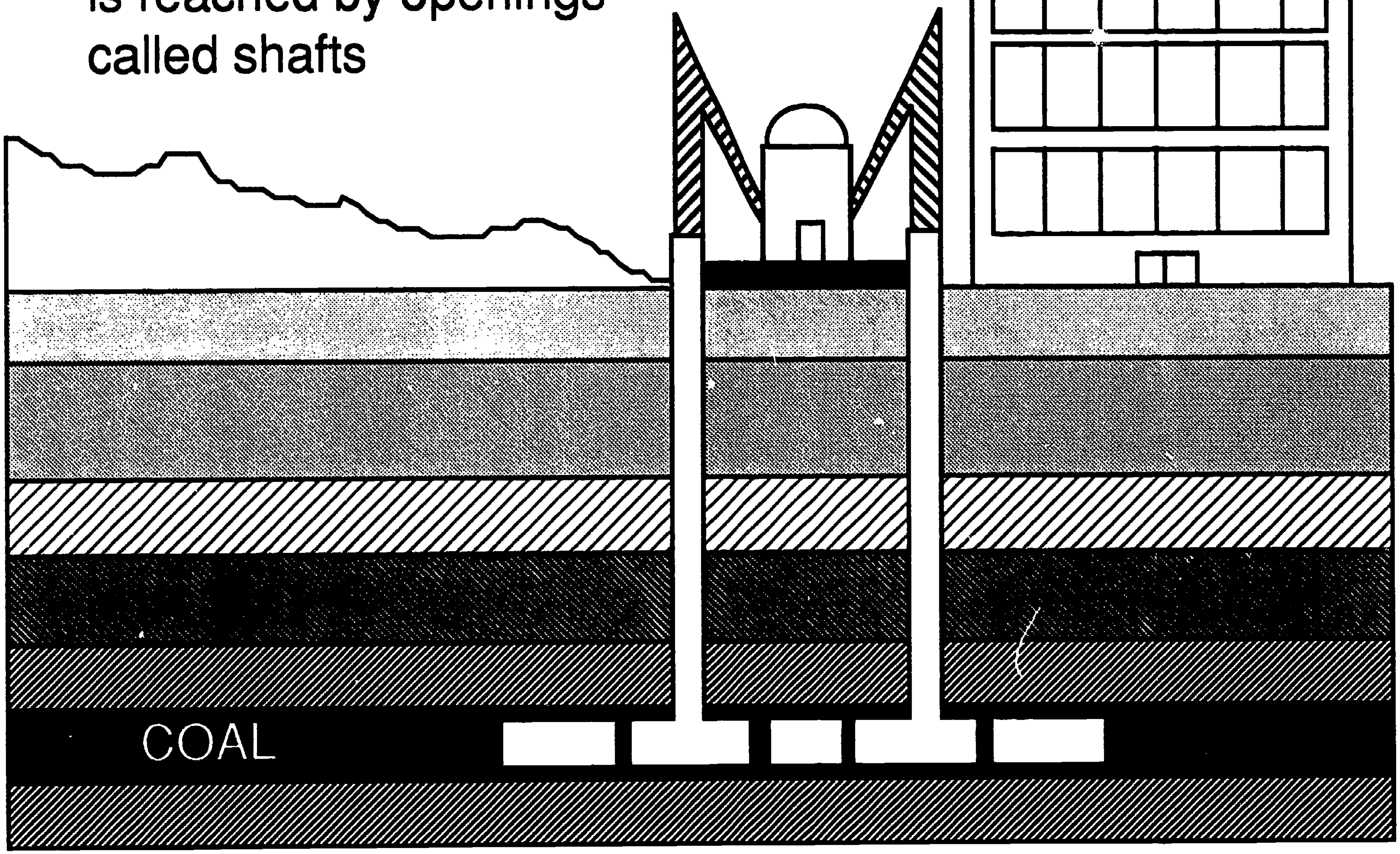


2) COAL MINING - UNDERGROUND



3) COAL MINING - UNDERGROUND

SHAFT MINE-
coal <u>deep in the earth</u>
is reached by openings
called shafts



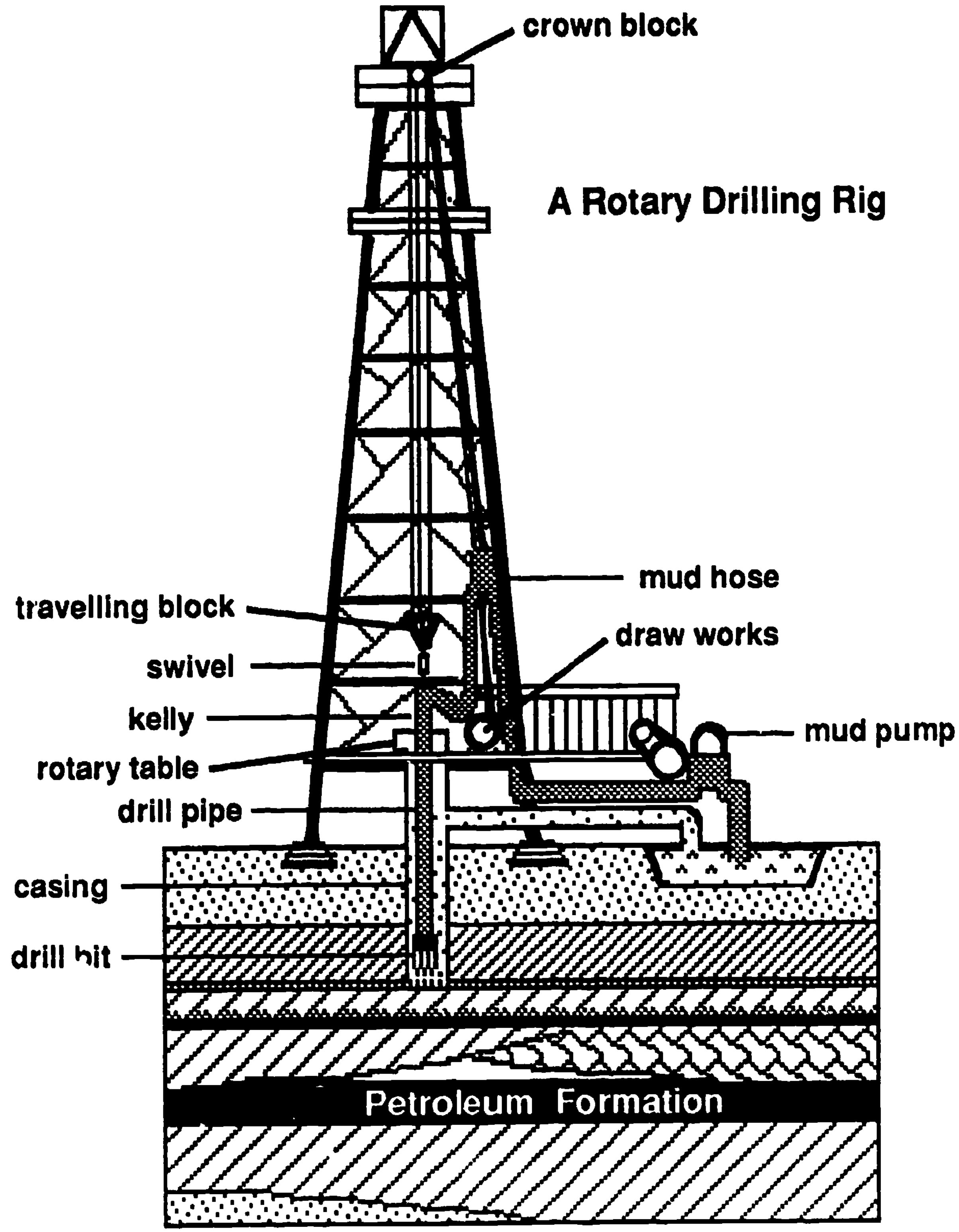
4) COAL MINING - UNDERGROUND

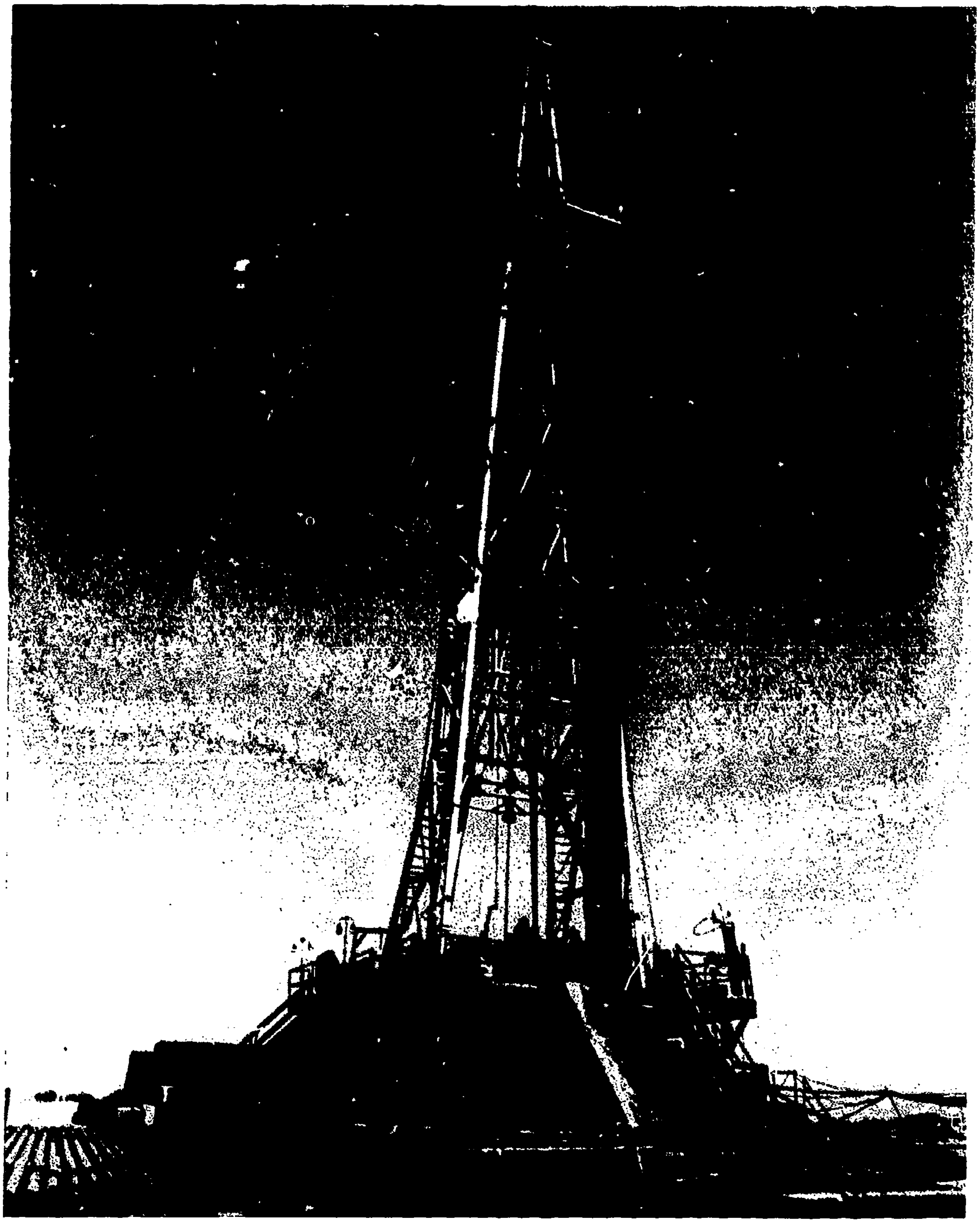
A miner examines a longwall mining machine that is being used to dig coal out of a seam inside an underground coal mine.

Two government scientists, wearing polar snowsuits as protection against the 40° F below zero temperatures in an Energy Department cold room laboratory, examine a natural gas methane hydrate sample recovered from deep in the Gulf of Mexico. In a methane hydrate, molecules of natural gas are trapped inside a cage of ice.

Drilling For New Oil

When an oil company drills a new oil well, they use a rotary drilling rig. Two main parts of the drilling rig are a christmas tree shaped support and a drill bit. The drill bit is like a giant screw that twists and digs into the earth. The bit has teeth that chew through the layers of dirt and rock to get to the underground area where geologists hope to find petroleum. A mud pump clears away any water and mud as the hole is dug. Petroleum is not found every time a well is dug. When the well does not produce any crude oil, it is called a "dry hole."



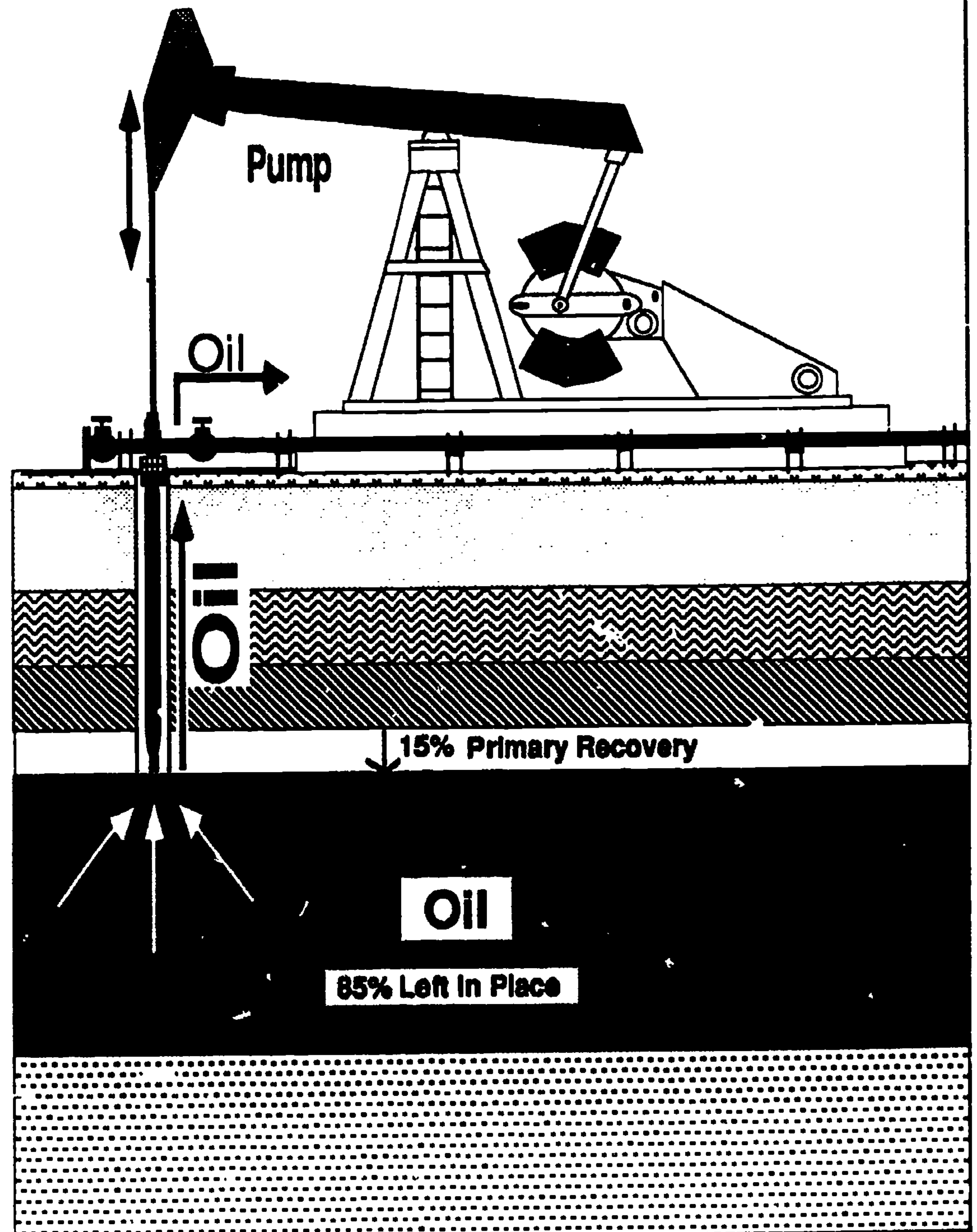


An oil drilling rig is used to bore through the ground and pierce pockets ("reservoirs") of petroleum located deep in the Earth. These oil field workers are checking the drill bit that digs through underground layers to the petroleum reservoir. The drill bit may wear out and have to be replaced several times if the underground formations are composed of extremely hard rock.

RECOVERY OF OIL FROM DEEP IN THE EARTH

1) Primary Recovery

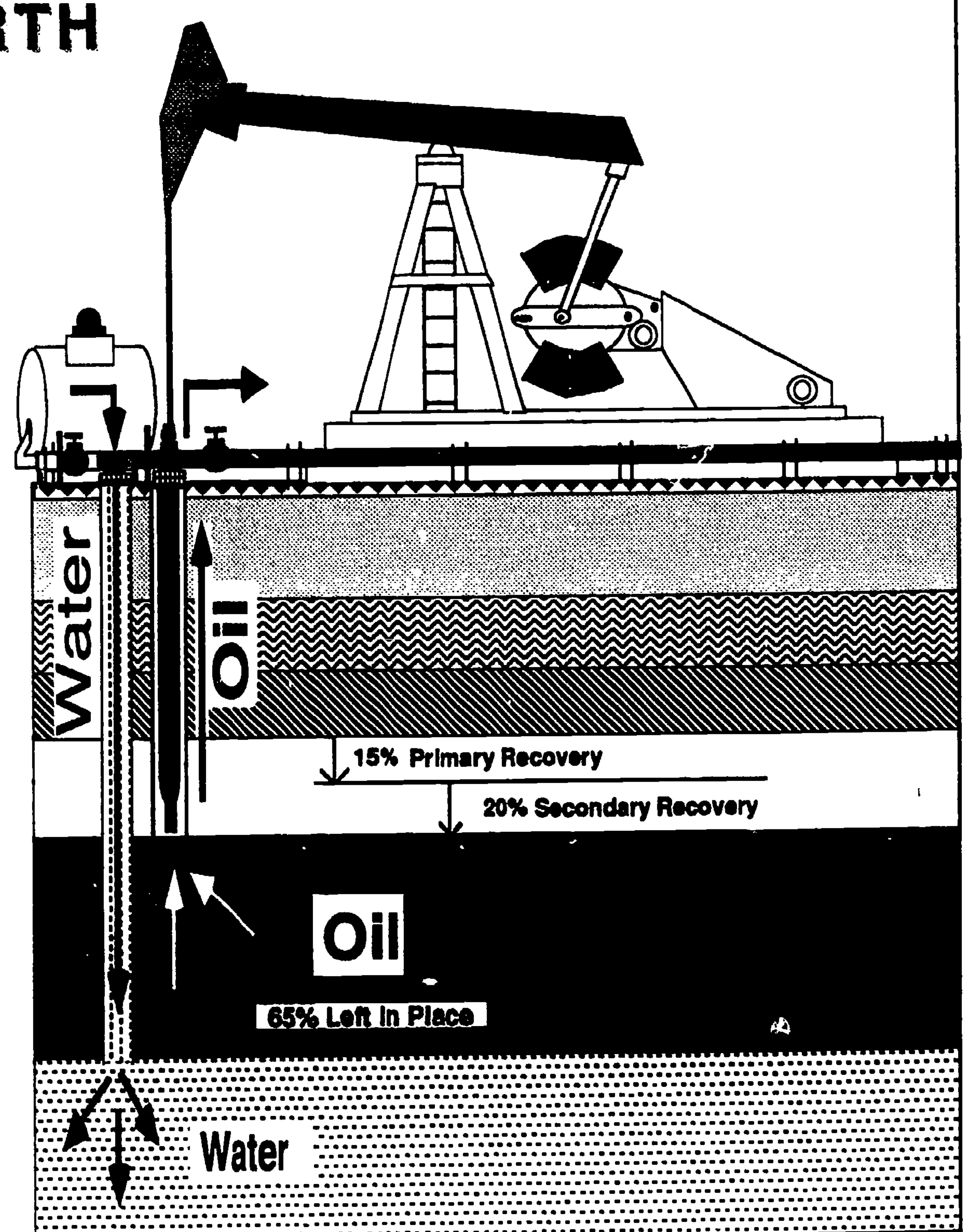
After an underground pocket of crude oil is discovered by drilling, a pumping unit (seen to the right) is set up to force the oil to the surface and transfer it to a distribution line that sends the oil to where it is stored or refined. This pumping unit by mechanical action can bring to the surface of the ground up to 15% of the total crude oil that was originally in the petroleum reservoir.



RECOVERY OF OIL FROM DEEP IN THE EARTH

2) Secondary Recovery

This metnod pumps water down to the underground reservoir where the oil is found. Since, oil and water will not mix and oil is lighter than water, the oil begins to ride on top of the water as it is pumped into the reservoir. This "waterflooding" method may force an additional 20% of the crude oil to the surface.

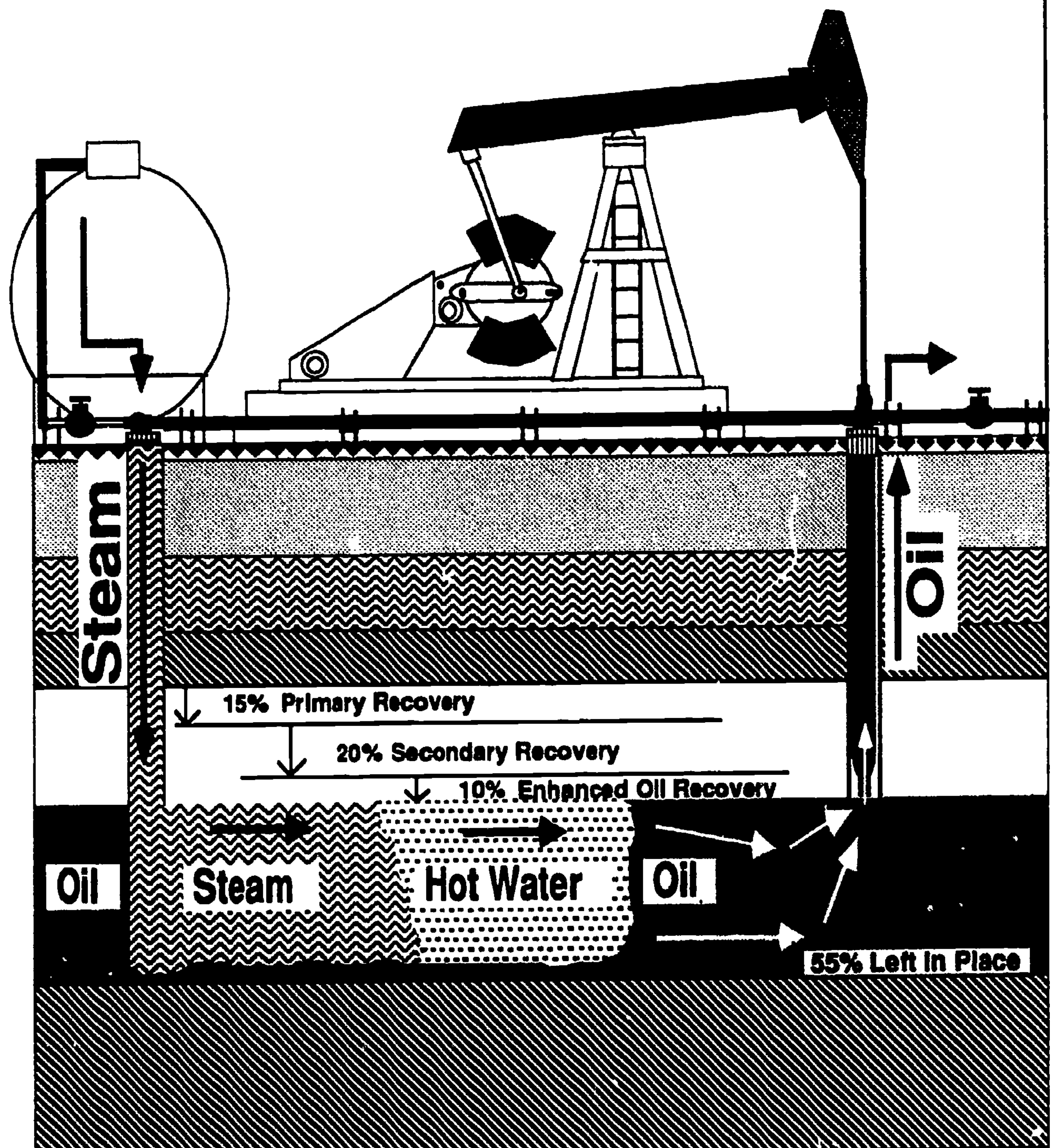


RECOVERY OF OIL FROM DEEP IN THE EARTH

3a) Enhanced Oil Recovery

Advanced pumping processes, such as Deep Steam ('huff & puff") where hot steam is pumped underground to thin and make the crude oil easier to pump to the surface, may bring an additional 10% of the oil to the surface of the ground.

That still leaves 55% of the oil underground. Today's researchers are seeking answers about how to obtain more crude oil out of the ground at less cost.

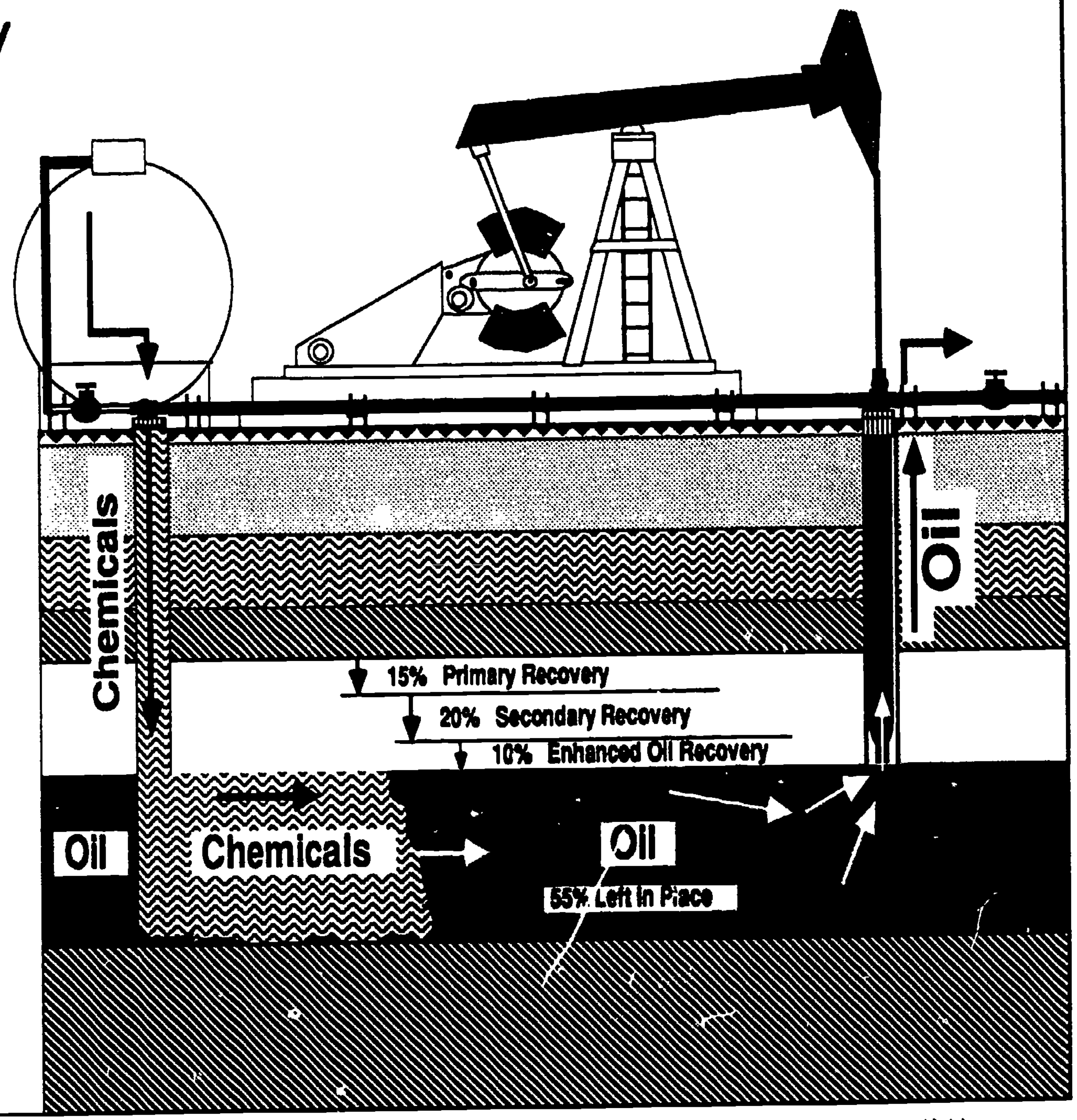


RECOVERY OF OIL FROM DEEP IN THE EARTH

3b) Enhanced Oil Recovery

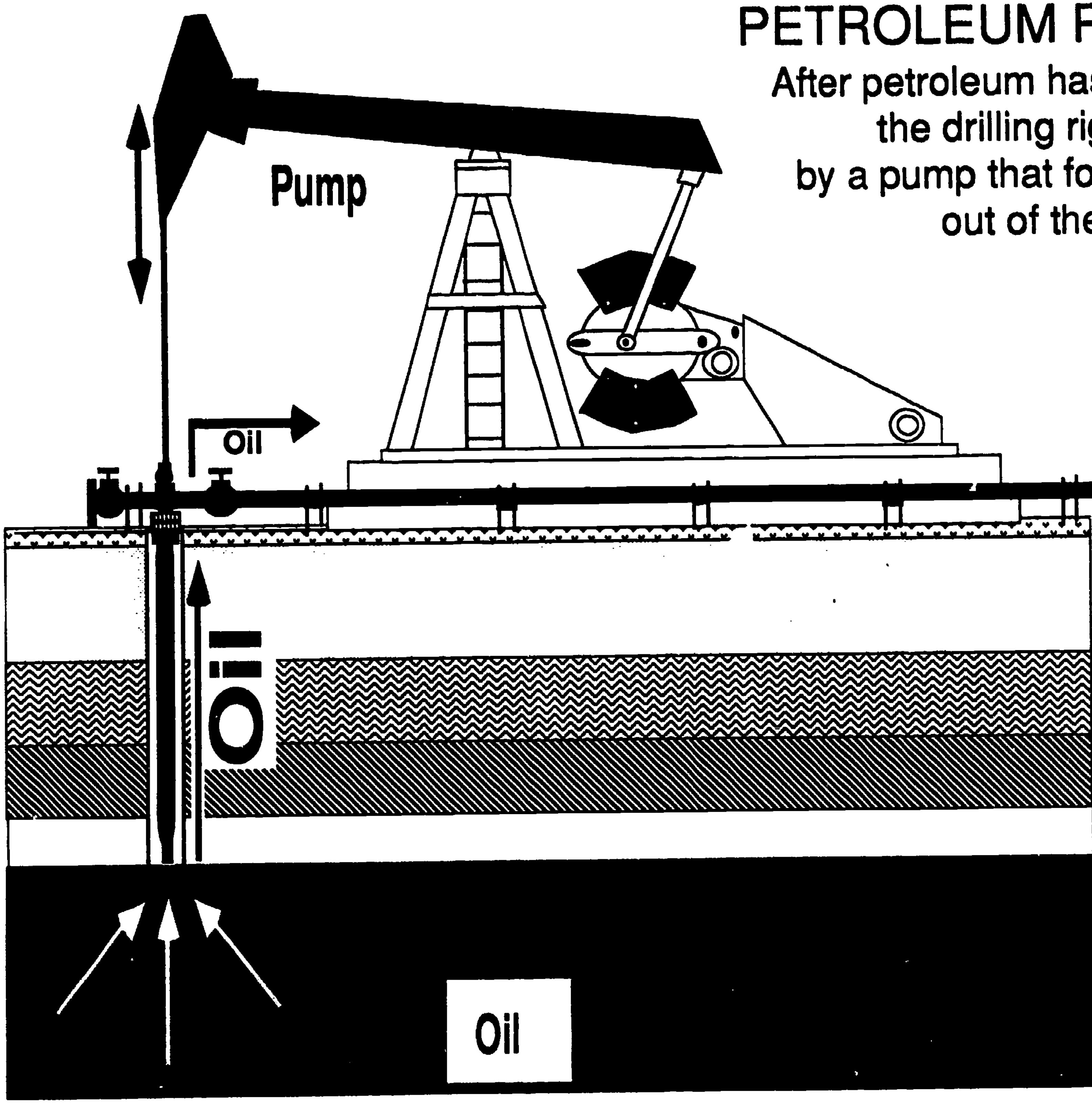
Other advanced recovery methods in which gases or chemicals are pumped underground to make the crude oil easier to pump may also bring an additional 10% of the oil to the surface of the ground.

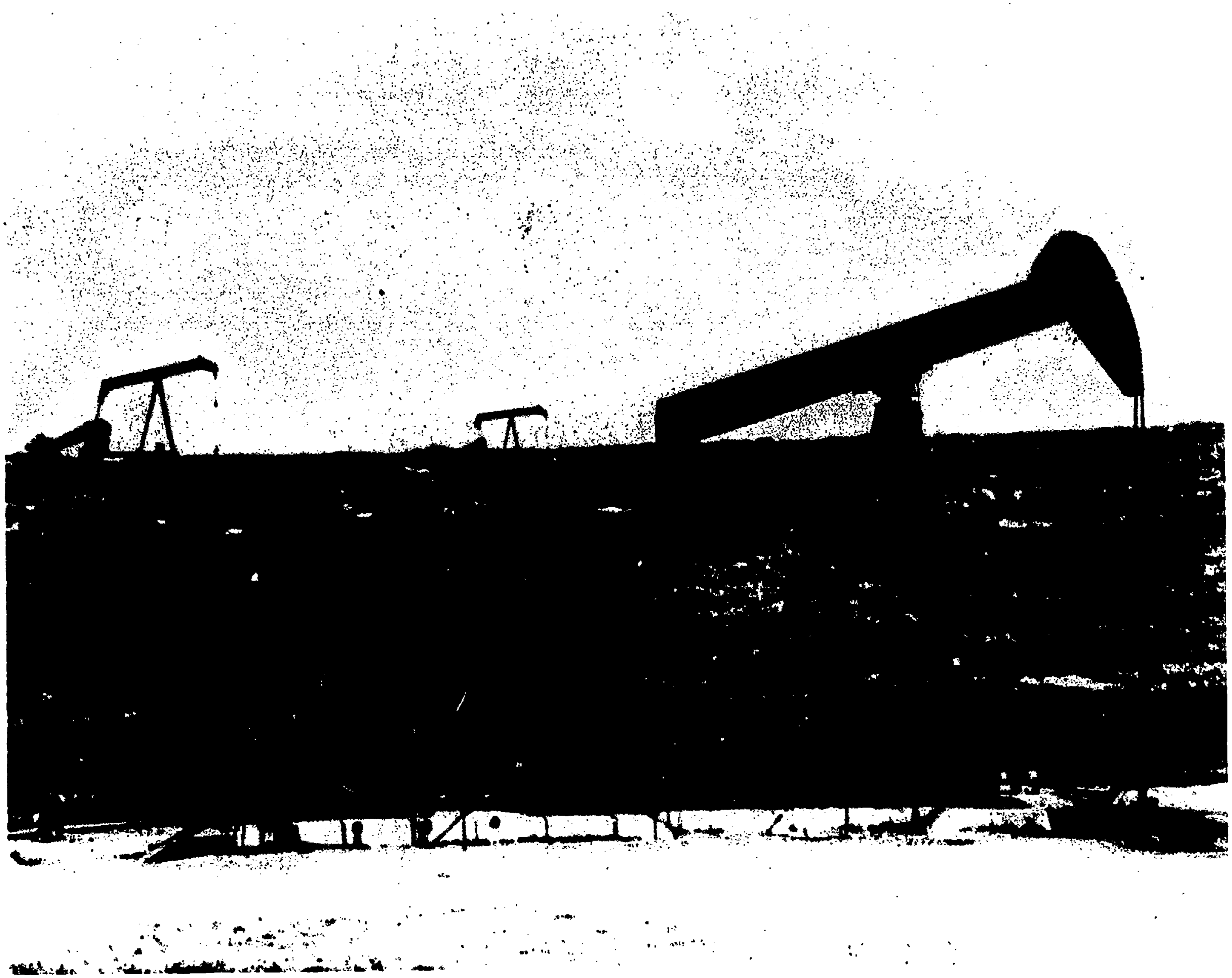
However, more research is still needed to determine how to pump more of the remaining 55% of crude oil out of the ground at a reasonable cost.



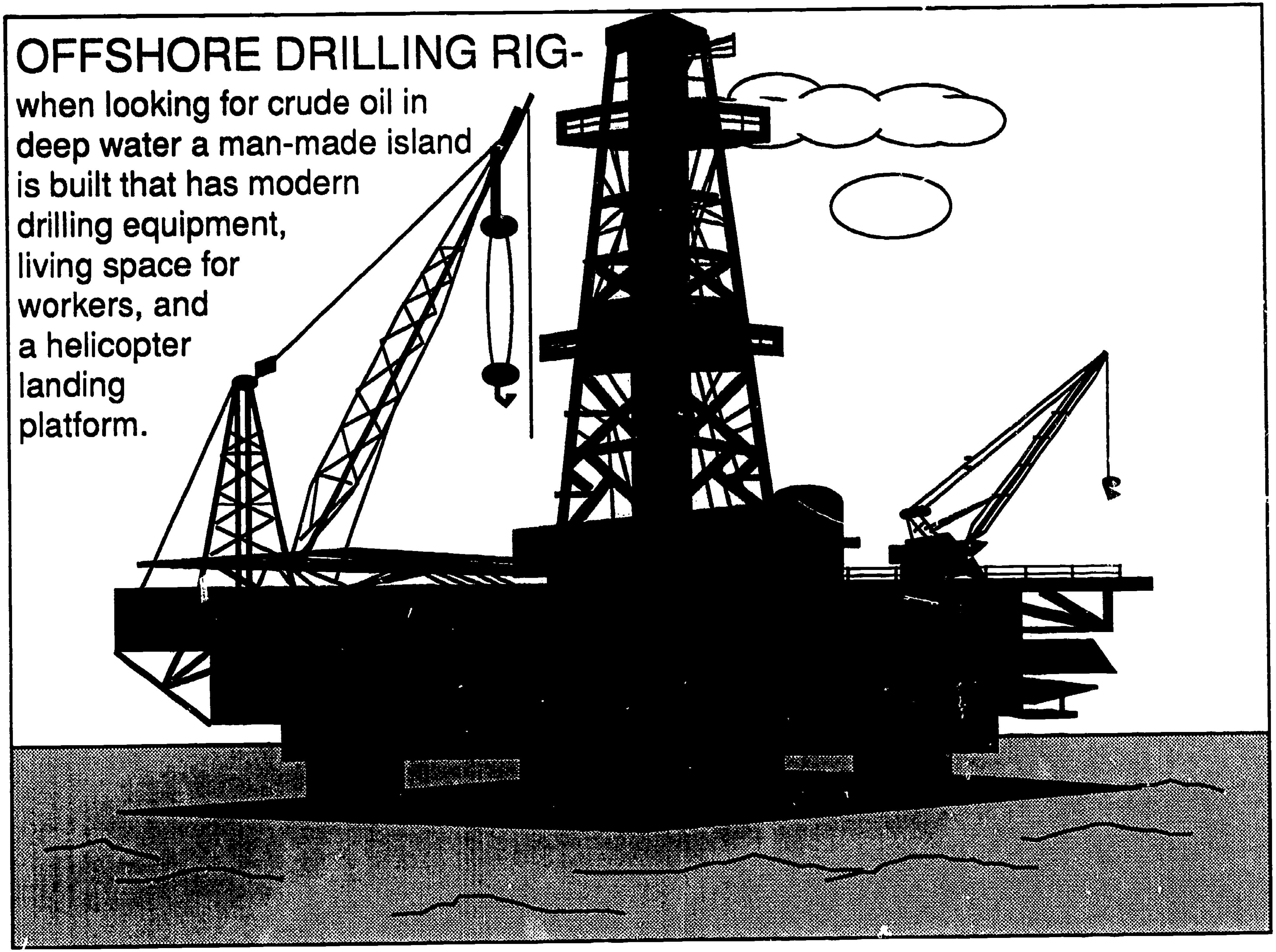
PETROLEUM PUMPING UNIT

After petroleum has been discovered,
the drilling rig is replaced
by a pump that forces the crude oil
out of the ground.

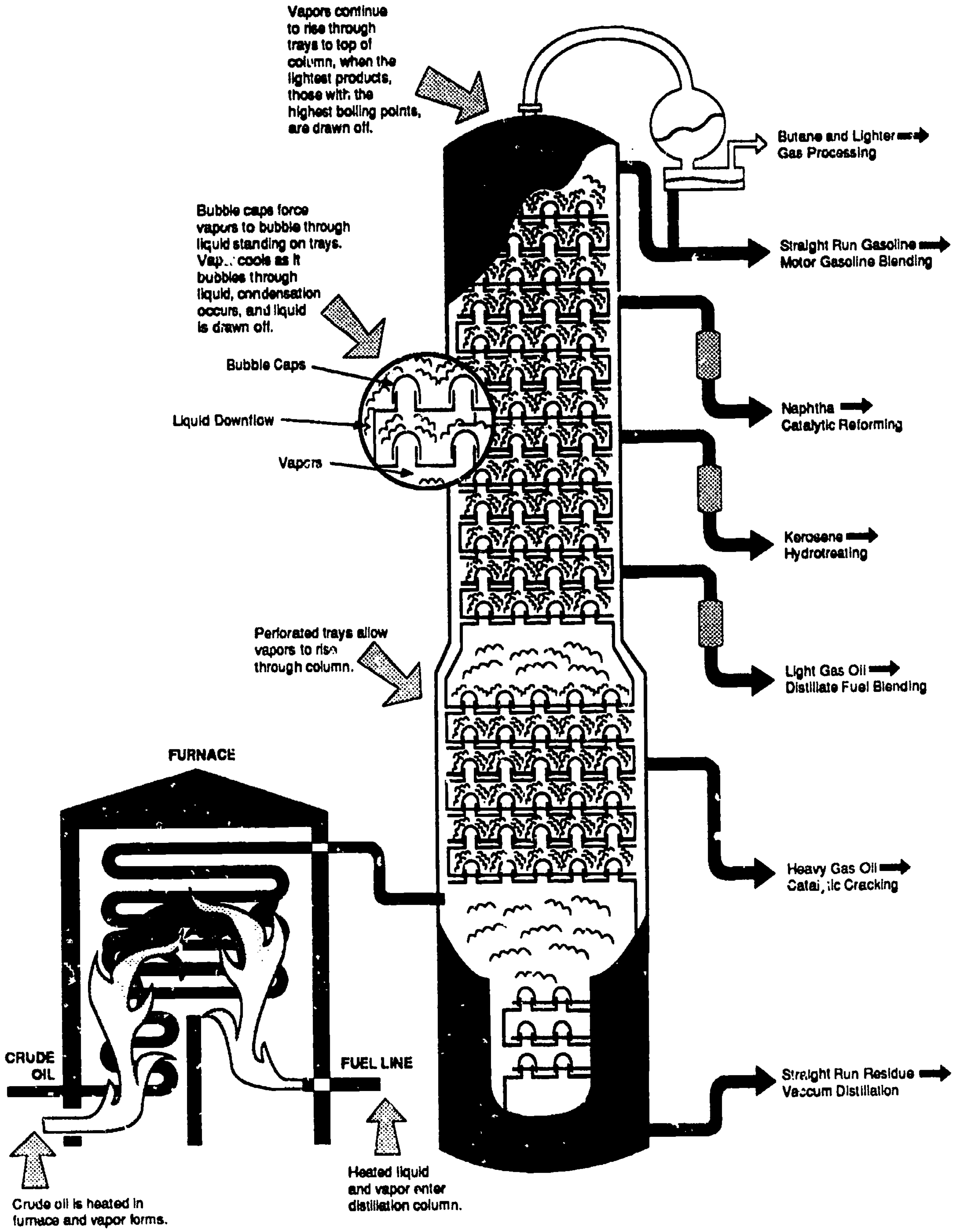




The pumps in this oil field take the place of drilling rigs after petroleum is found. The pumps force the crude oil from the underground reservoir to the surface where it is shipped by pipeline.

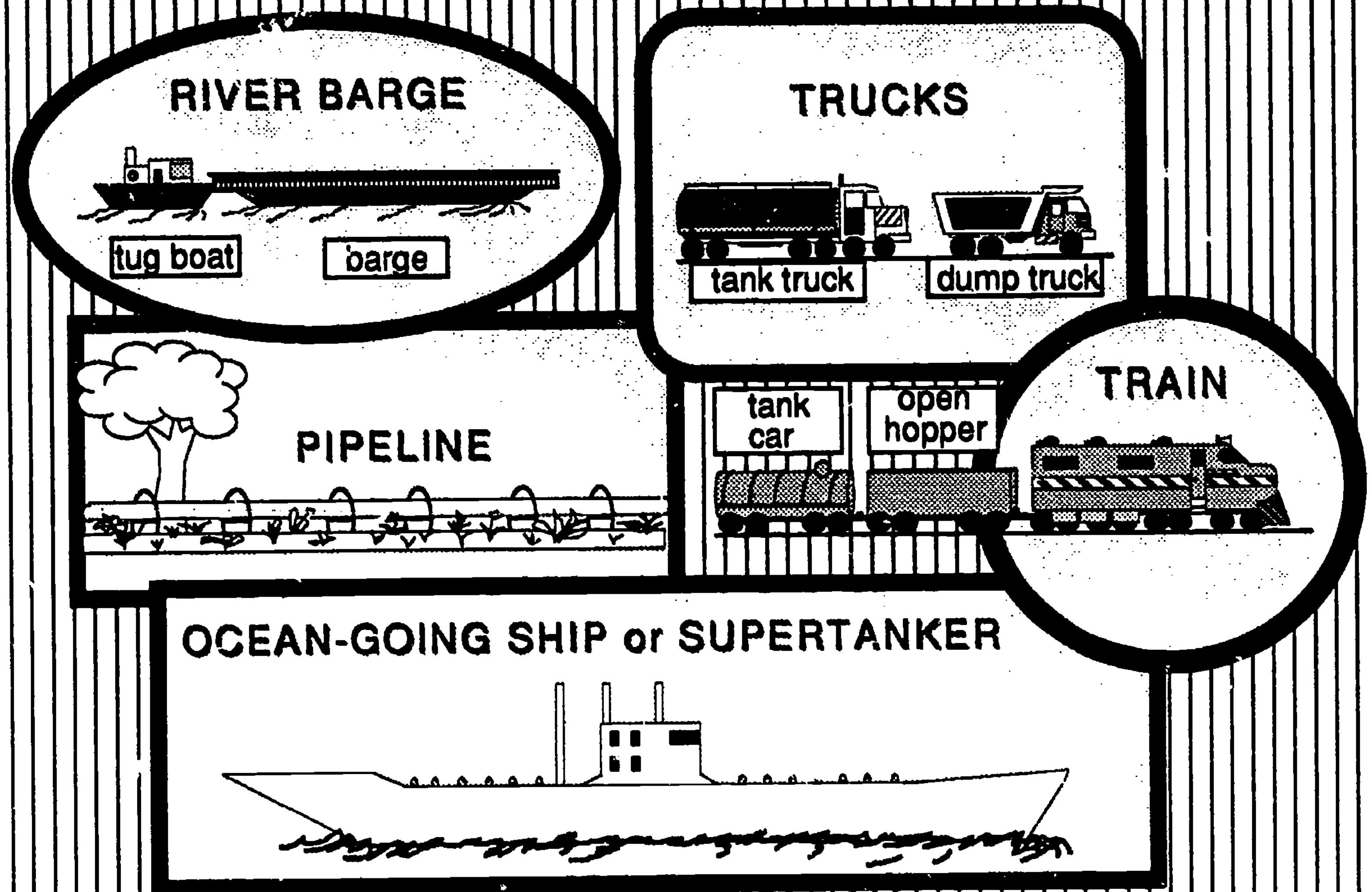

OFFSHORE DRILLING RIG-
when looking for crude oil in deep water a man-made island is built that has modern drilling equipment, living space for workers, and a helicopter landing platform.

Refining Crude Oil In A Fractionating Tower



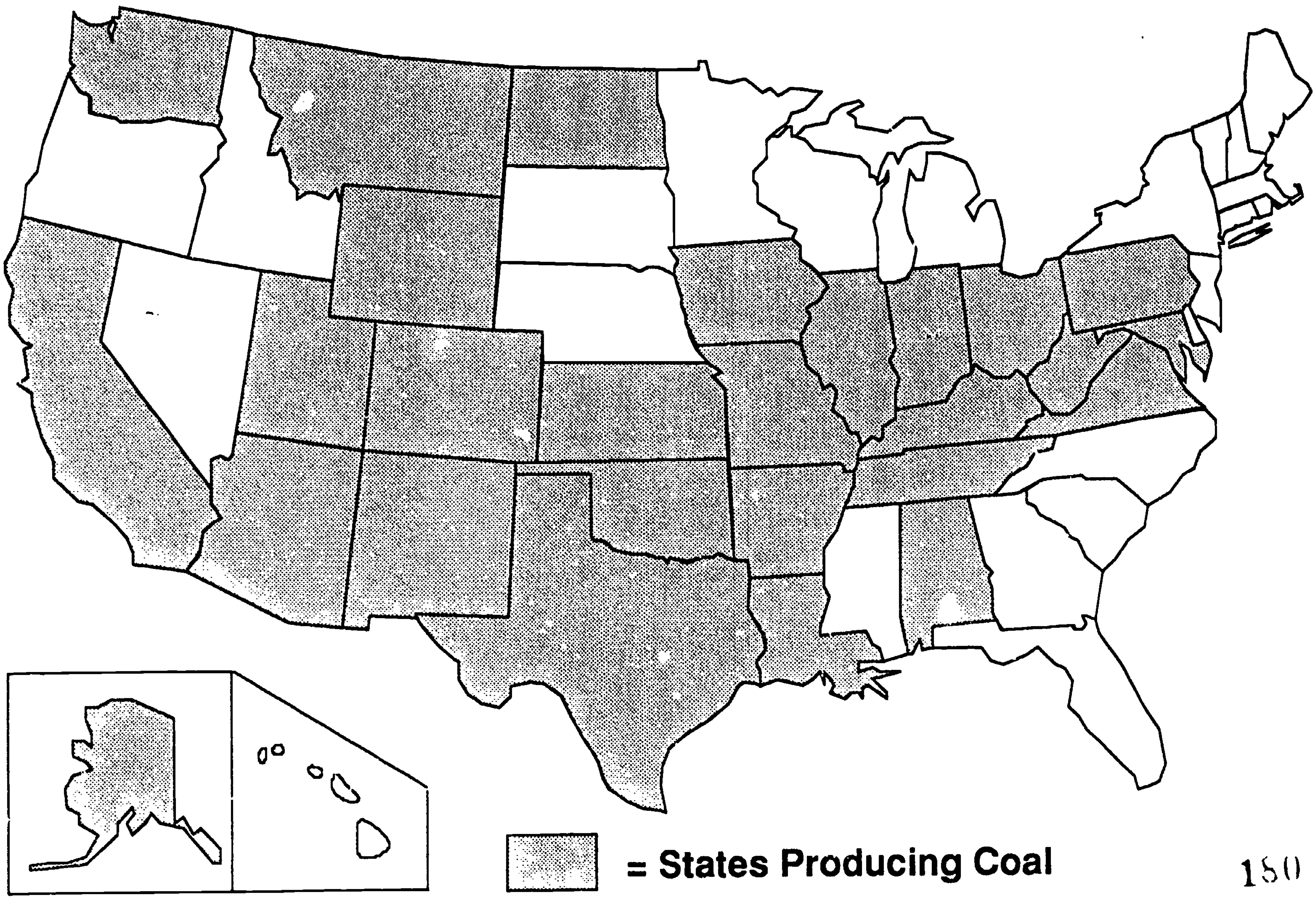
Source: Energy Information Administration, Office of Oil and Gas.

TRANSPORTATION

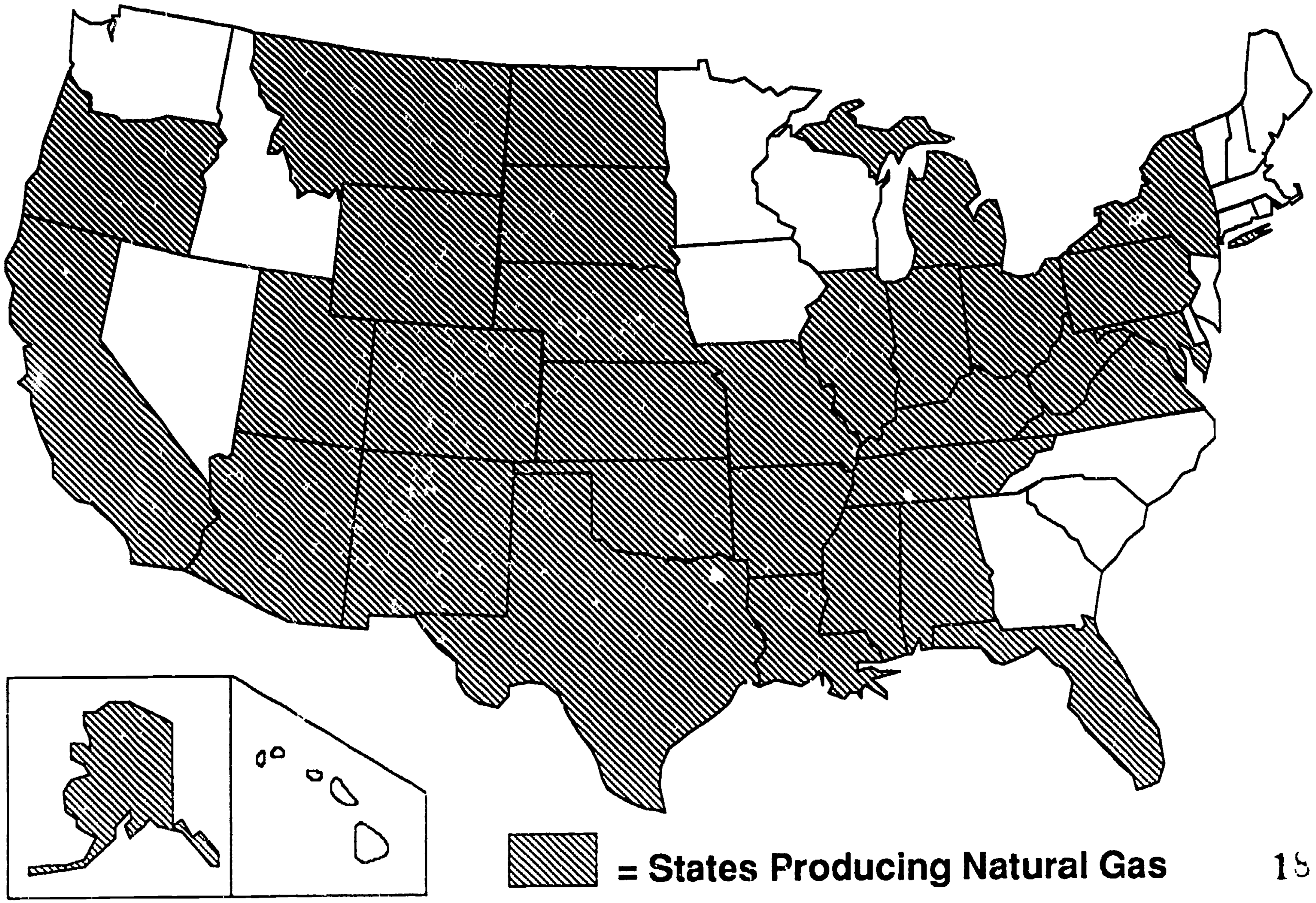


Coal, Natural Gas, and Petroleum may be sent across the country or around the world by one of the types of transportation seen above.

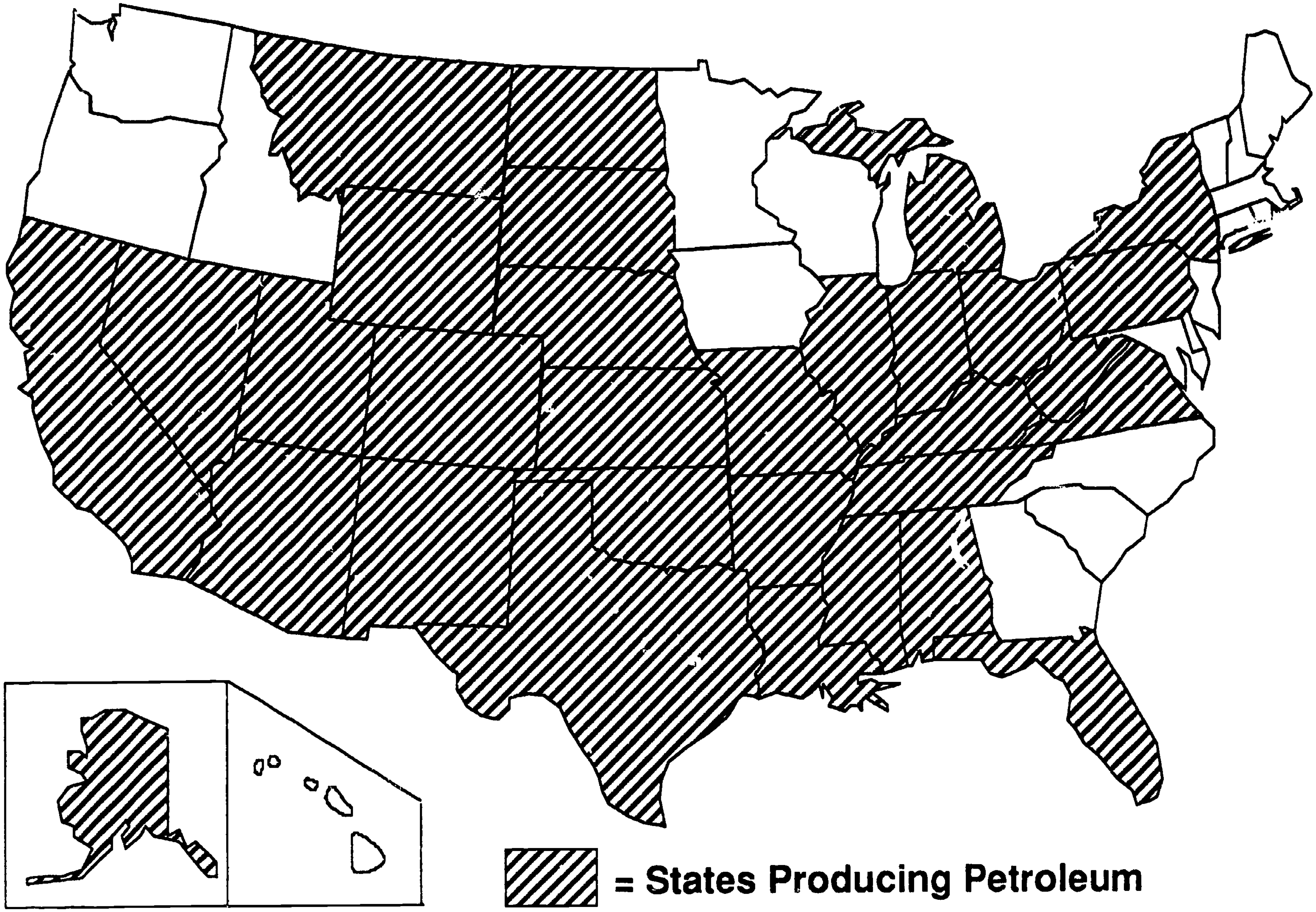
Coal Producing States



Natural Gas Producing States



Petroleum Producing States



LESSON 3

COAL FACTS

Coal Type	Hardness	Color	Heat (Energy) Potential*	Smoke/Waste Produced	Where Found in US
Anthracite -highest rank of coal -oldest coal	Hard	Black	Great	Little smoke or ash	Pennsylvania only (little found worldwide)
Bituminous	Relatively Soft	Black	Less	Tar, ash, & smoke	Mainly East of Mississippi River
Subbituminous	Soft	Black "Black Lignite"	Even Less	More ash & smoke	Mainly in Montana & Wyoming
Lignite -lowest rank of coal -youngest coal	Softest	Brown (sometimes can still see the texture of the original wood in the coal)	Least	Greatest amount of ash & smoke	Mainly West of Mississippi River

* Btus (British Thermal units)- the **greater the number of BTUs, the more heat** per ton the coal gives off and the more energy it produces.

COAL QUIZ

COAL TYPE	COAL CLUES
A. ANTHRACITE	1.____Gives the most heat per ton
B. BITUMINOUS	2.____Gives off the most smoke
C. SUBBITUMINOUS	3.____Is brown and particles of the original plant can sometimes be seen in it
D. LIGNITE	4.____Is found mainly east of the Mississippi River
	5.____Is the softest coal
	6.____Is sometimes called "black lignite"
	7.____Is the oldest coal
	8.____Is the lowest rank of coal
	9.____Produces tar when burned
	10.___Is found mainly in Montana & Wyoming
	11.___Is the hardest coal
	12.___Is found mainly west of the Mississippi River

Answer Coal Type "A," "B," "C," or "D" for Coal Clues 1 — 12

ANSWERS TO COAL QUIZ

1. A
2. D
3. D
4. B
5. D
6. C
7. A
8. D
9. B
10. C
11. A
12. d

Lesson 3 Word List

Do you know what these words mean?

Can you spell the words without looking at the list?

Can you find where the words are used on these pages in *Dinosaurs & Power Plants*?

Can you find the cities, states, bodies of water, and countries on a map?

PAGE 4

fossil fuels	electricity	power plant
light switch	boiler	steam
coal seam	classified	expensive
surface mining	underground mining	expose
technique	vertical	shafts
ventilation	drift mine	shaft mine
slope mine	resource	reserves
variations	composition	substances
pollution	ranks of coal	anthracite
Pennsylvania	bituminous coal	tar
subbituminous coal	ashes	Mississippi River
Montana	Wyoming	lignite
texture		

PAGE 5

(From the "Finding Gas" graphic)

sandstone lense	deflects	sound waves
lenses	explosion	receivers
three dimensional seismic	seismic	thickness
vertical seismic profiling	degree	accurate
cross-bore seismic	cross checking	

(From the text)

convenient	industrial	technologies
researchers	shale formation	unconventional
unconventional gas deposits	Devonian shale	Devonian period
sediment	deposited	sea basins
erosion	Appalachian Mountains	heralded
tight sand lenses	coalbed methane gas	passageways
hazard	valuable	methane hydrate
North Slope of Alaska	Siberia of the U.S.S.R.	gas pockets

Lesson 3 Word List

PAGE 6

(From the "Oil Recovery" graphic)

oil recovery	primary recovery	"in place" oil
secondary recovery	enhanced oil recovery	waterflooding
"Deep Steam" method	"huff & puff" method	produce

(From the text)

reservoir	sandstone	limestone
petroleum	crude oil	expelled
mechanical pump	enhanced oil recovery	artificially
"huff & puff" method	chocolate	microbes
bacteria	substance	molasses
tanker truck	pipeline	distribution
refinery	fractions	complex
physical	fractionating tower	chemical
distillation	component	vapor
condensed	adhesive	textiles

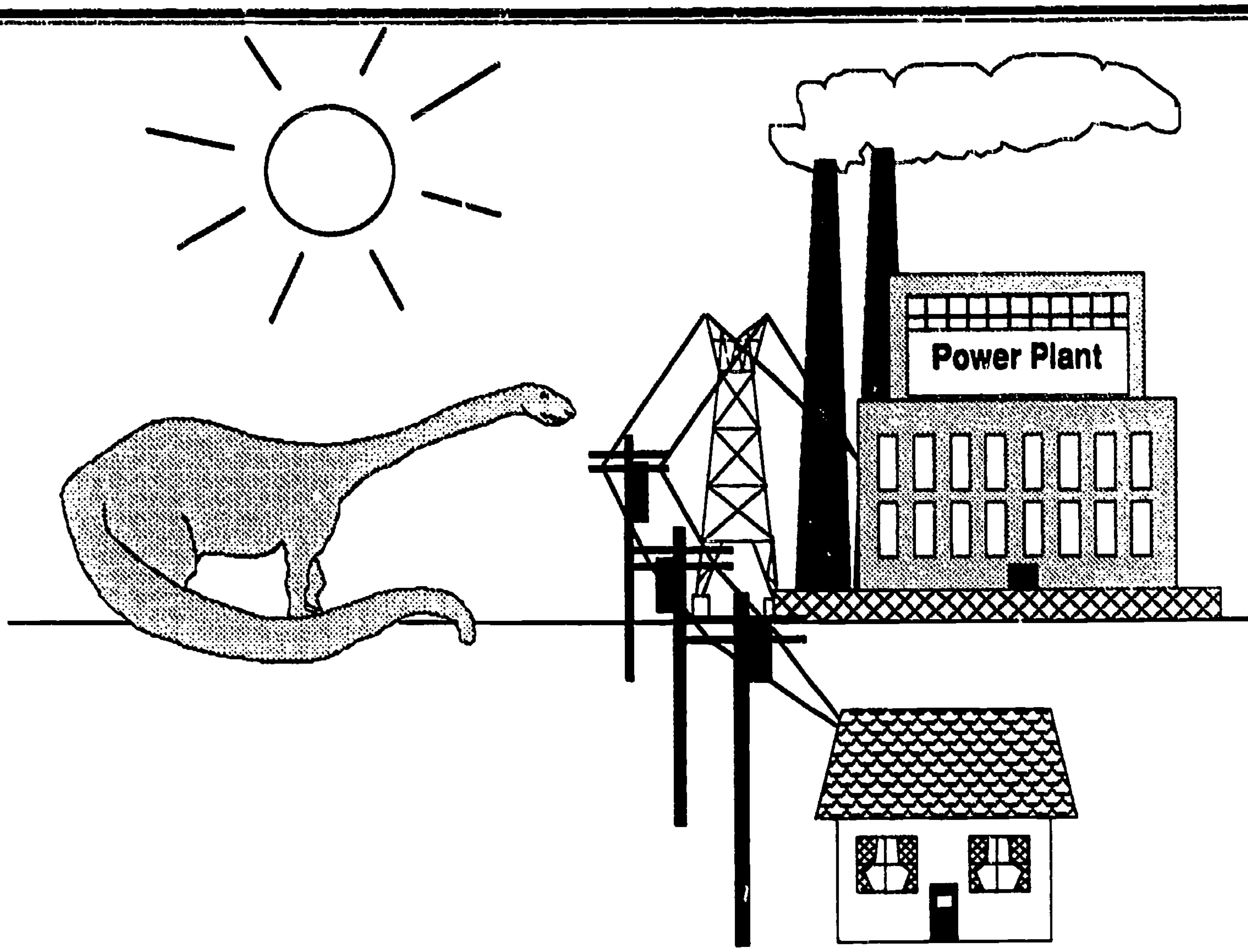
PAGE 7

Gulf of Mexico	piers	offshore
Santa Barbara, California	marshlands	state jurisdiction
drilling equipment	exploratory wells	significant
operations	associated	essentially
expensive	living quarters	provisions
helicopter landing pad	rotary drilling rig	pumping unit
petroleum formation	anticline formation	fault
fault formation	seepage formation	seepage

PAGE 11

production	remote	population
transport	end products	consumers
extensive	transportation	storage
oceangoing	supertankers	river barges
railroad tank cars	highway tank trucks	expensive
convenient	cross-country pipeline	underground
Titusville, Pennsylvania	site	distribution
barrels	flatbed truck	designed
compartments	vast	quantities
degrees F (Fahrenheit)	railcar	overseas
insulated	processing	tanker farms
conveyor belt	mixture	slurry

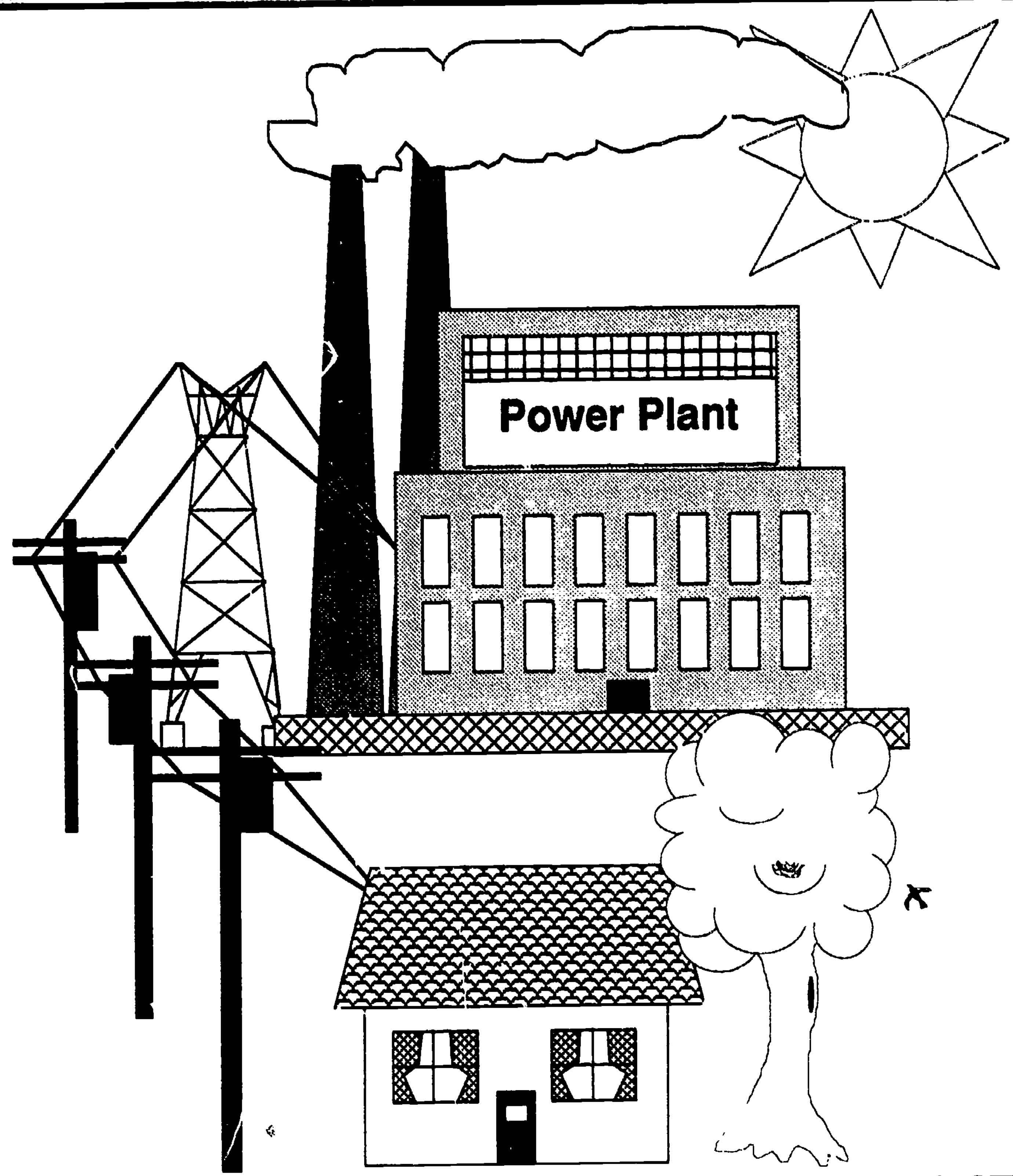
Dinosaurs and Power Plants



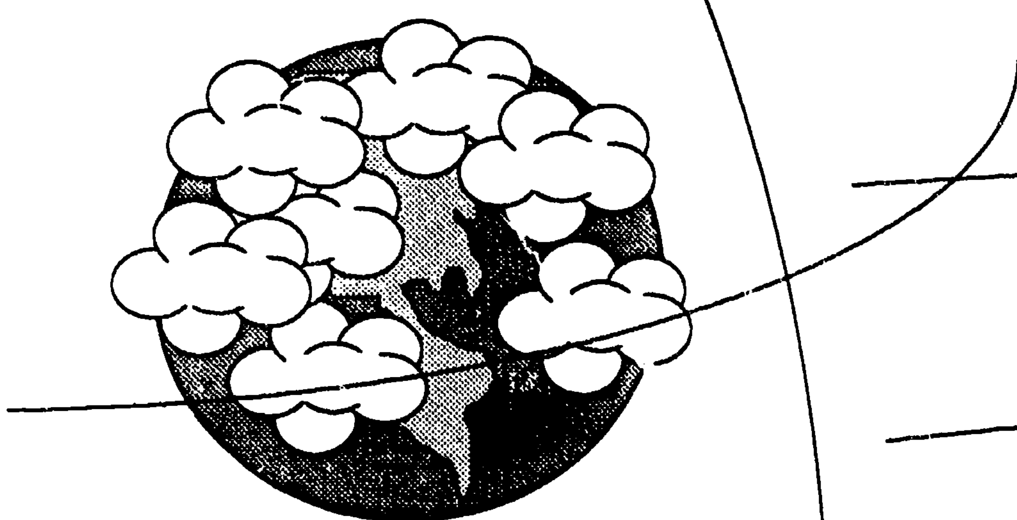
Teacher's Guide Supplement

Lesson Four Supporting Materials

ENVIRONMENT



Spaceship Earth



Our Environment On Earth

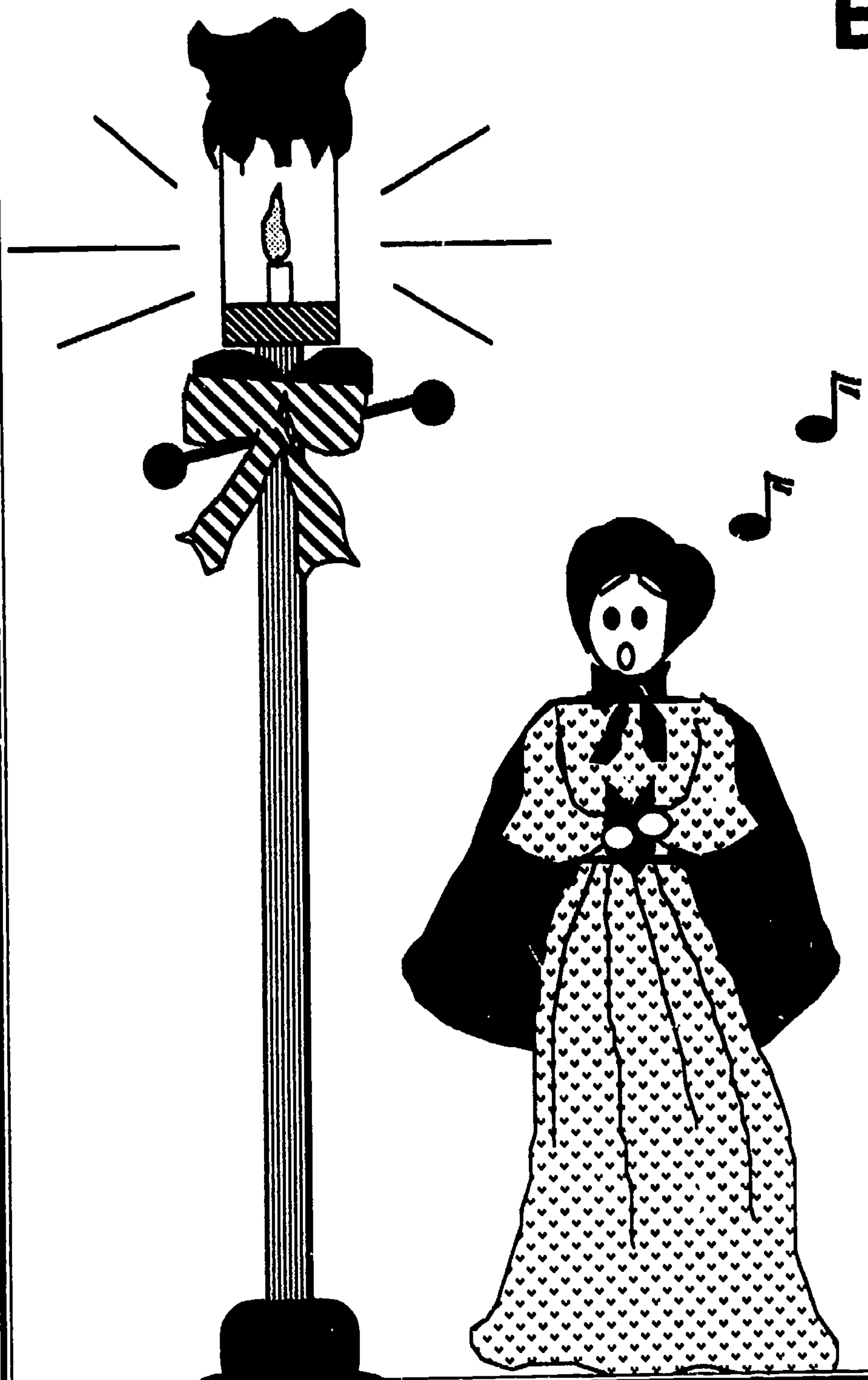
Is As Important

To Our Survival

As The Environment

On A Spaceship

Is To An Astronaut



Early Natural Gas Lights

Towns Near Natural Gas Wells

Sometimes Had Limited Ways

Of Distributing The Gas And

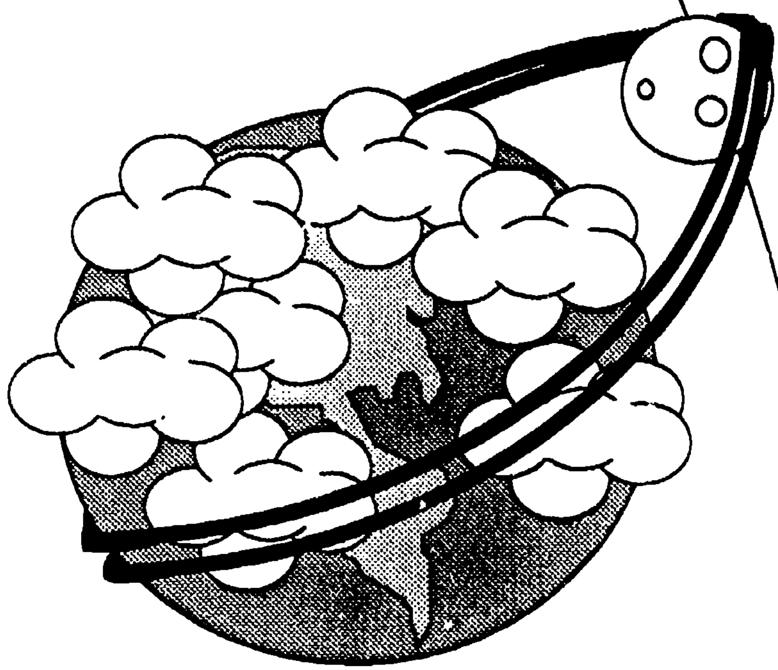
Ended Up With More Gas

Than The City Could Use

So Street Lights Were Left

Burning Night And Day

Natural Gas Pipelines



The Network Of

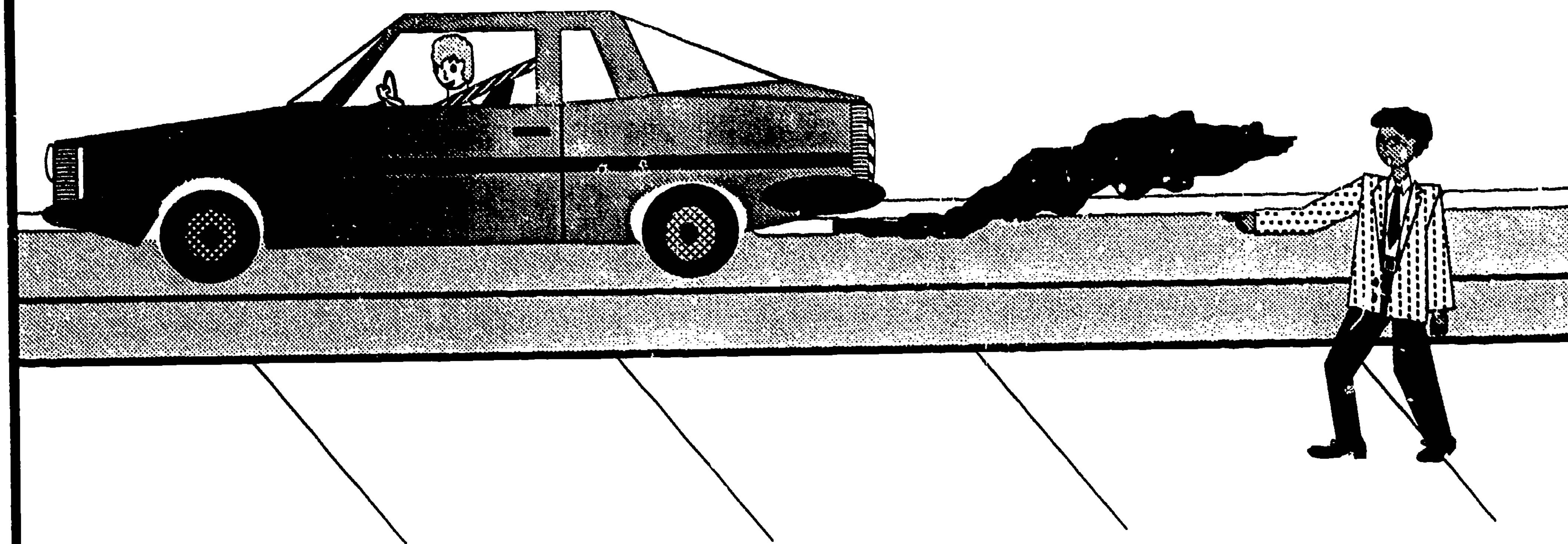
Natural Gas Pipelines

In The U.S. Would,

If Connected,

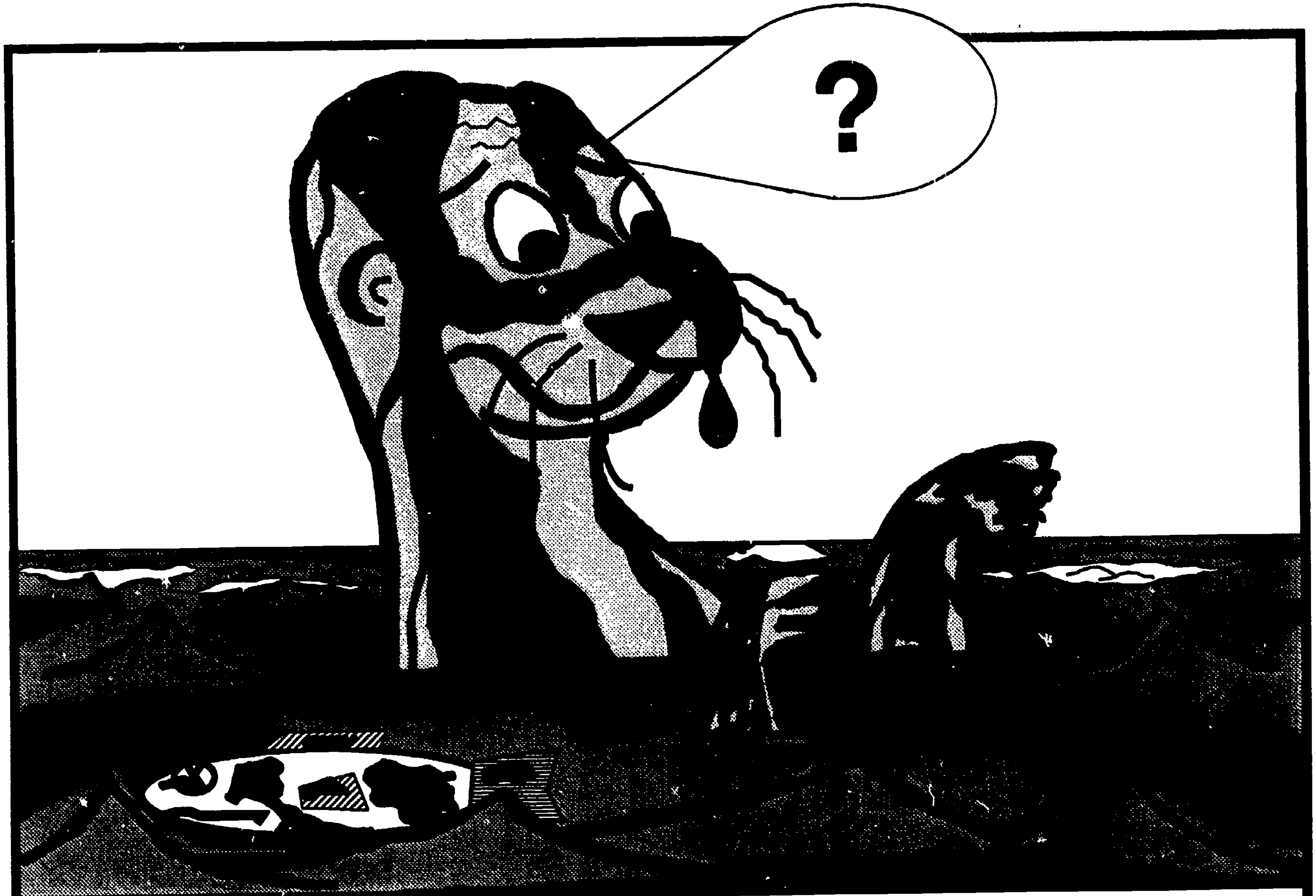
Stretch To The Moon

And Back Twice



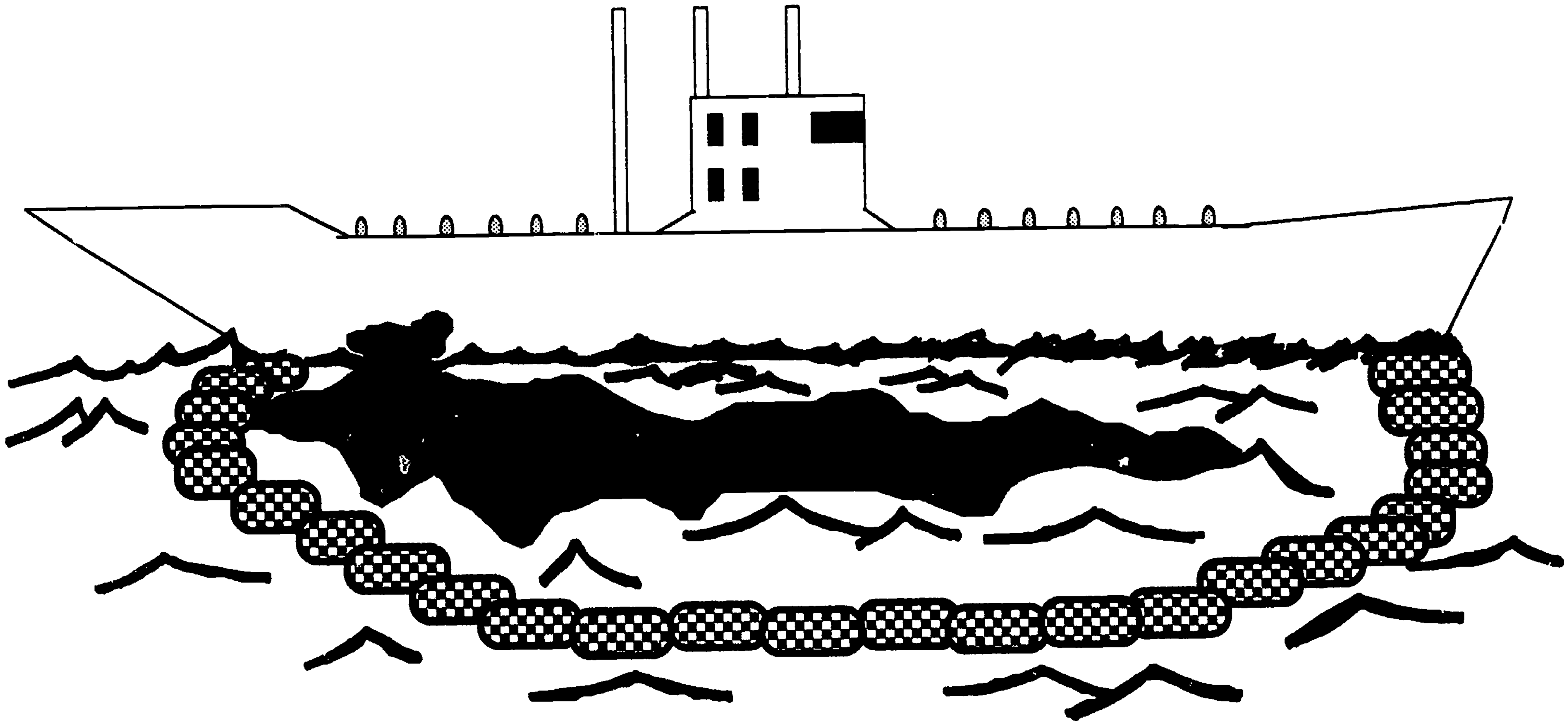
Air Pollution

Can Be Reduced By Regularly Performing Proper Maintenance Procedures On Your Vehicle



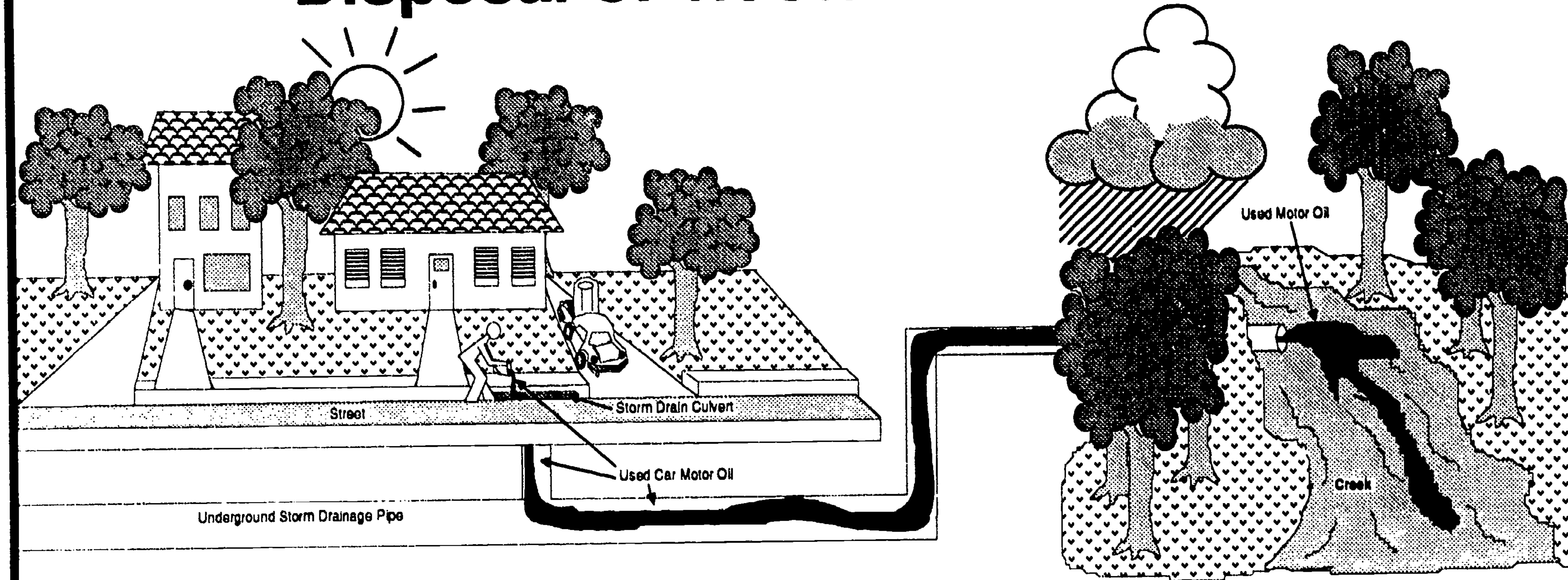
Oil Spills On Waterways And Oceans Can Be Harmful To Wildlife, Such As Otters and Fish

Oil Spill Containment

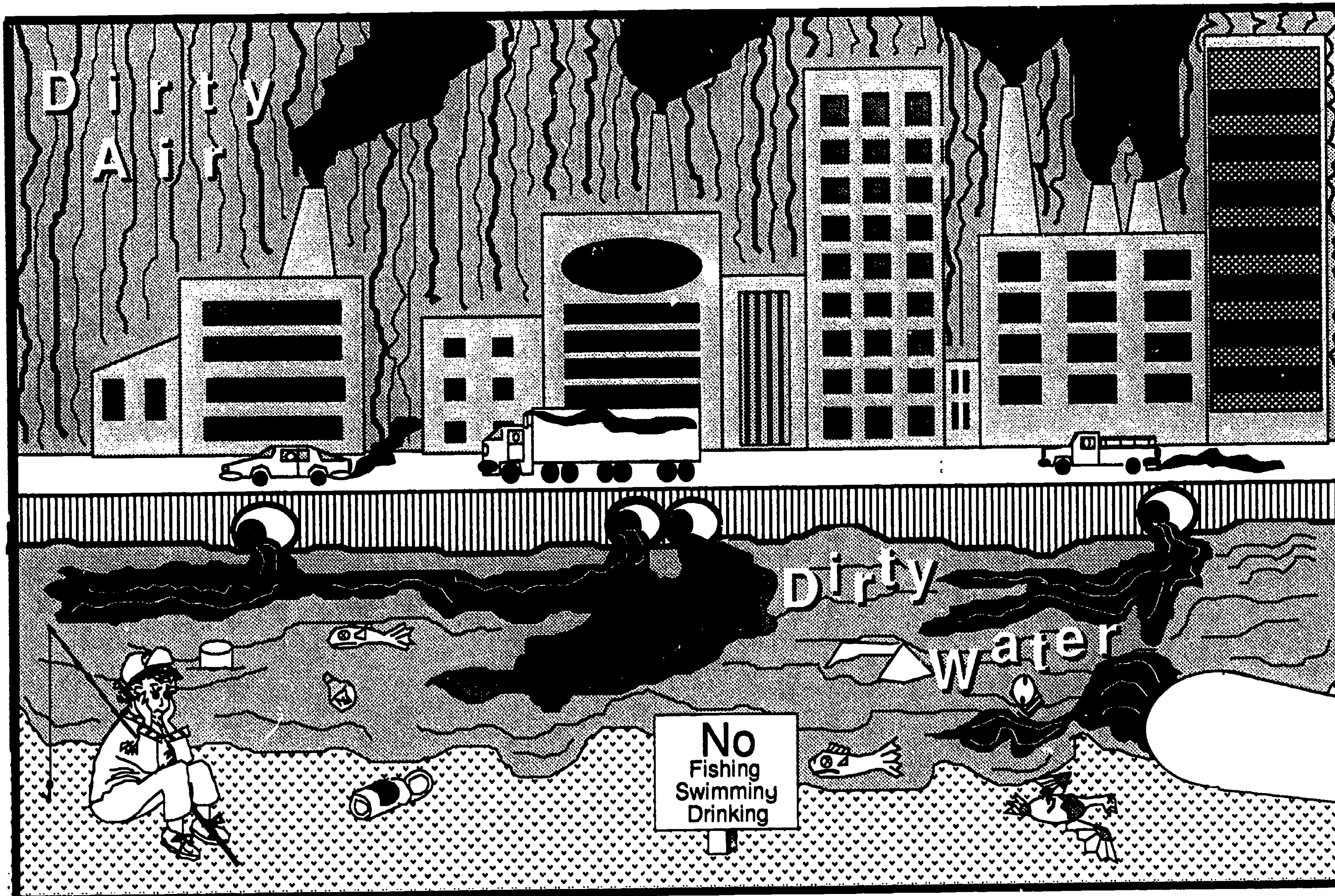


When An Oil Spill Occurs A Fence Of "Booms" Is Placed Around The Oil To Keep It From Spreading

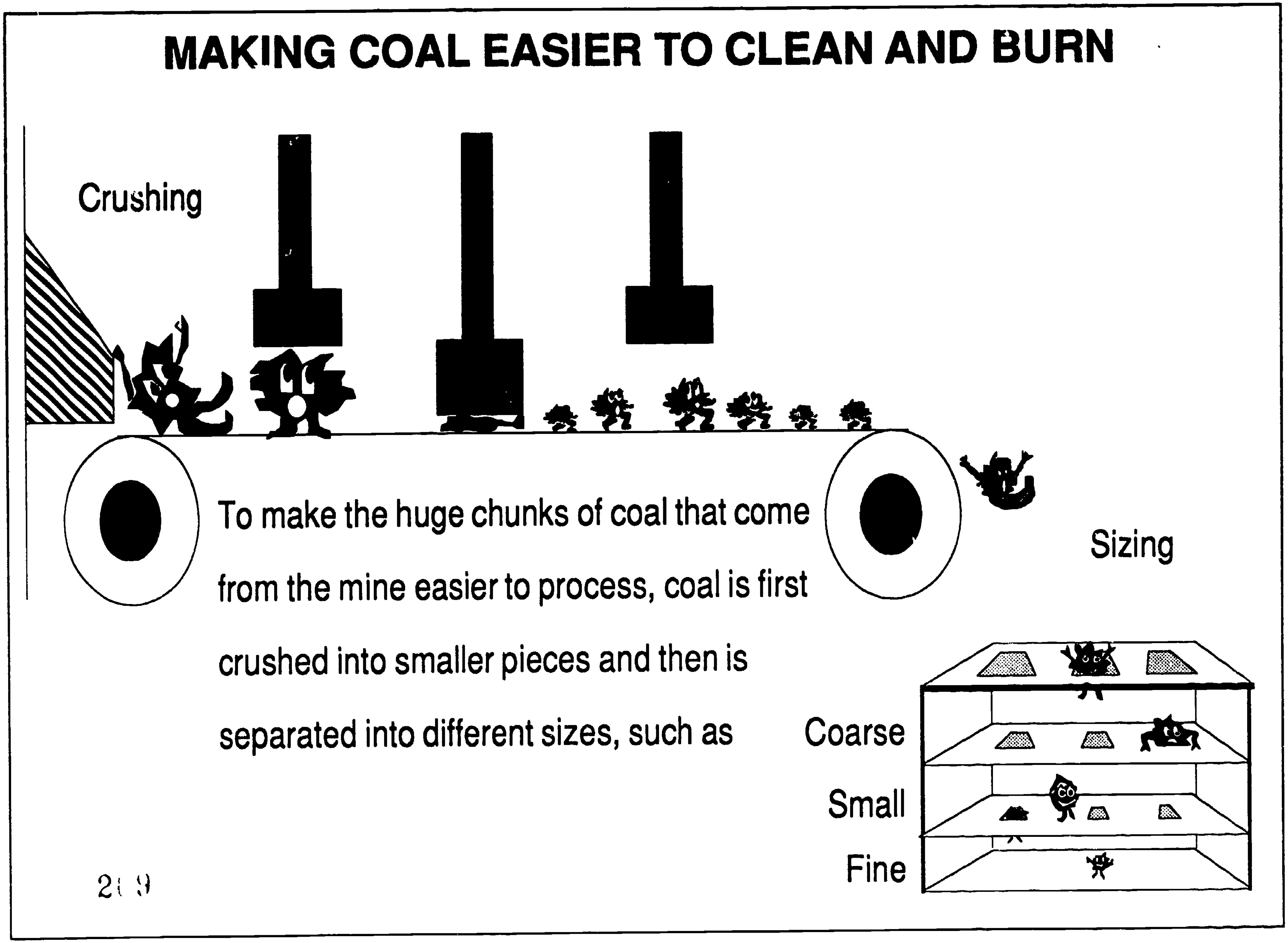
Disposal of Waste Oil Products



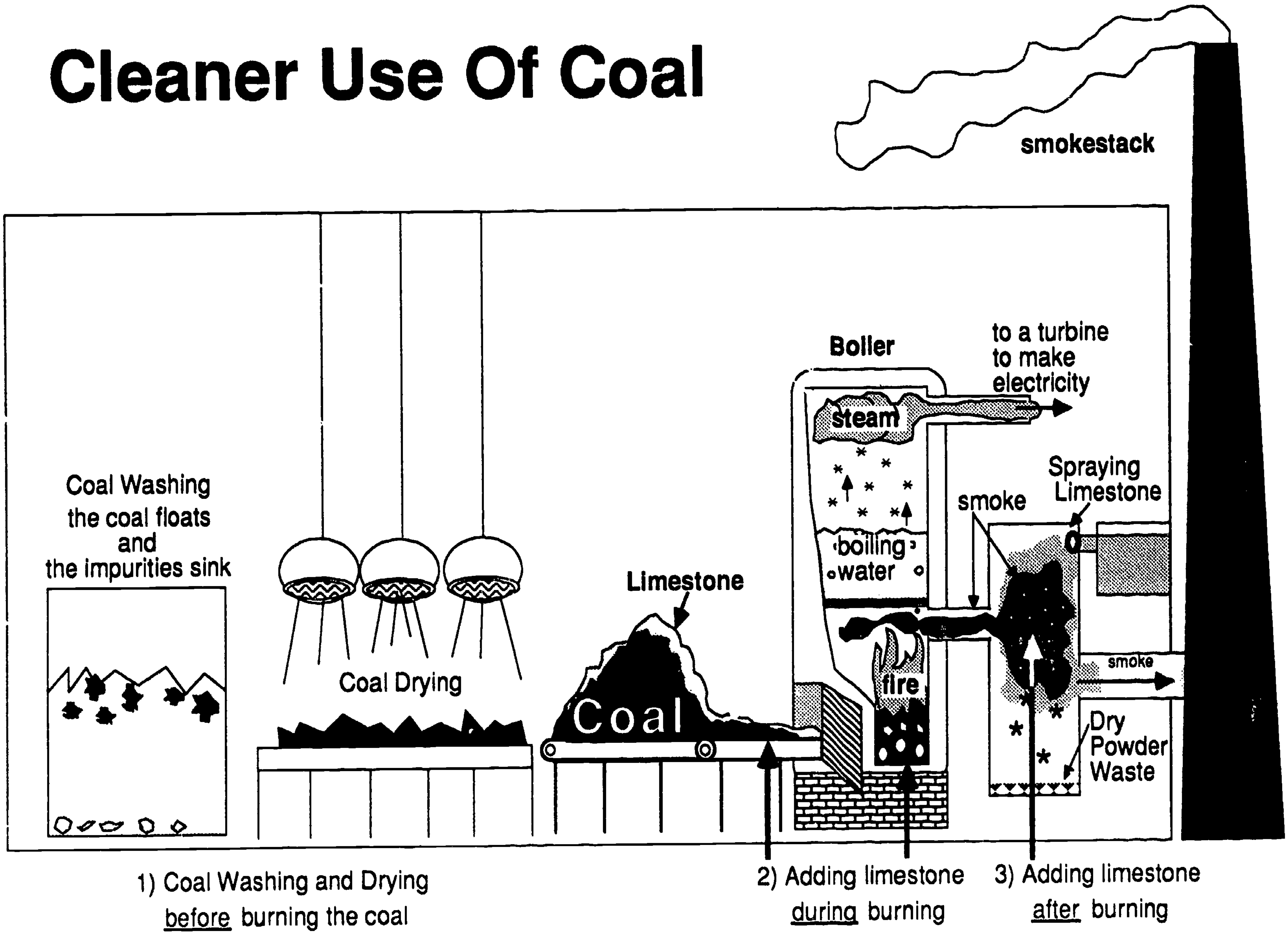
Improper Disposal Of Used Car Motor Oil, Grease, Kerosene, Paint, etc. By Pouring Them Down The Drains In Your House Or Down The Storm Drain On The Street Curb Can Pollute Streams Or Cause Problems At The Local Water Treatment Plant. Call The City Or County Before Disposing Of These Items.



Preventing Pollution Is Everyone's Responsibility


MAKING COAL EASIER TO CLEAN AND BURN
Crushing
To make the huge chunks of coal that come from the mine easier to process, coal is first crushed into smaller pieces and then is separated into different sizes, such as
Sizing
Coarse
Small
Fine

Cleaner Use Of Coal



Cleaner Use Of Coal

1. Cleaning Before Burning

Washing and Drying Coal
to Remove Pollutants
(coal floats / impurities sink)
Before Coal is Burned

2. Cleaning During Buring

Adding Limestone
During Burning to Soak Up
Pollutants While Coal Burns

3. Cleaning After Burning

Adding Limestone to Clean
Pollutants from Smoke
before releasing the exhaust
to the smokestack and to our air

Cleaning Coal

Pyritic sulfur that is

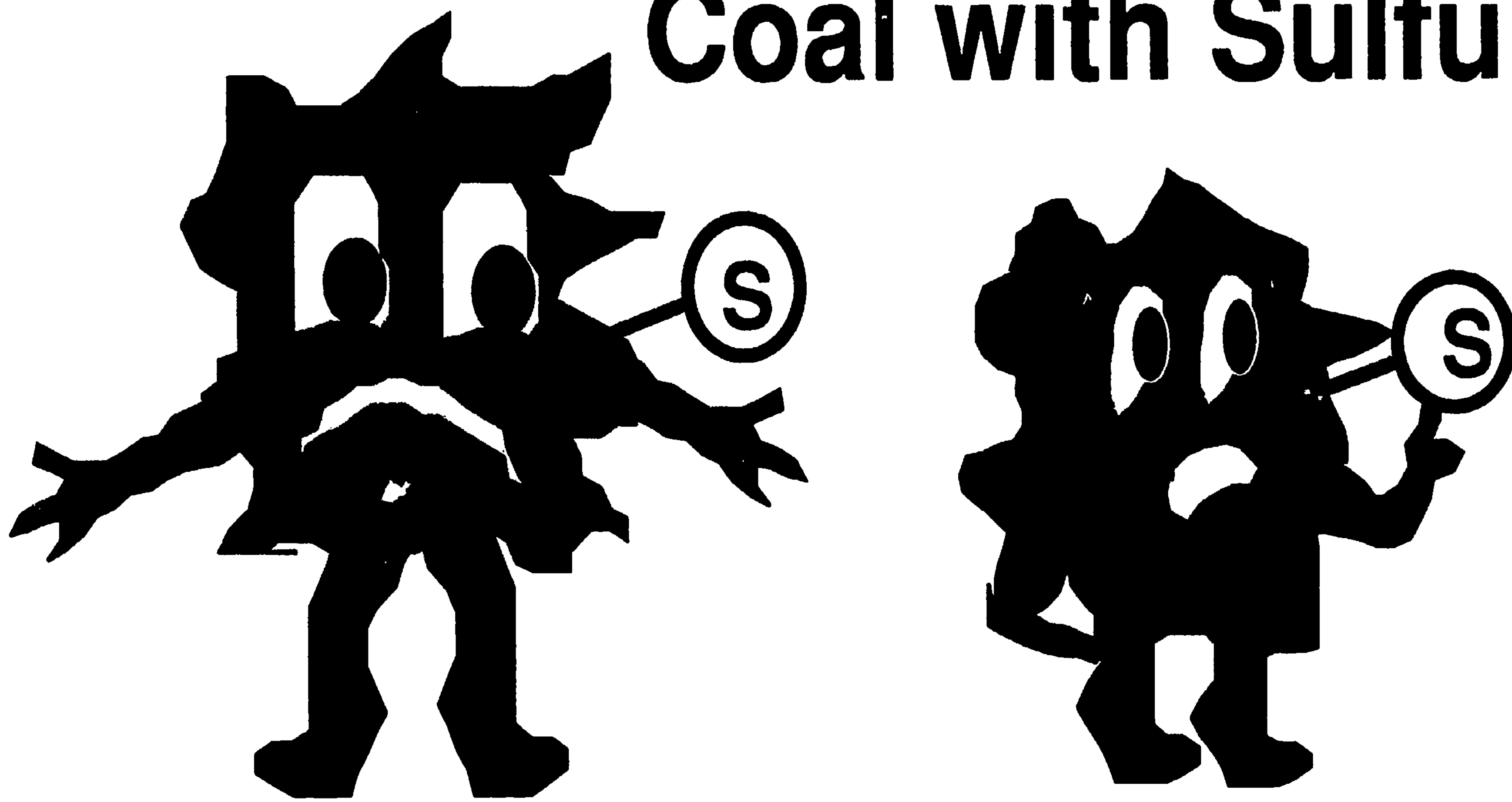
glued to the iron

in coal can be

removed by washing

coal before it is burned.

Coal with Sulfur

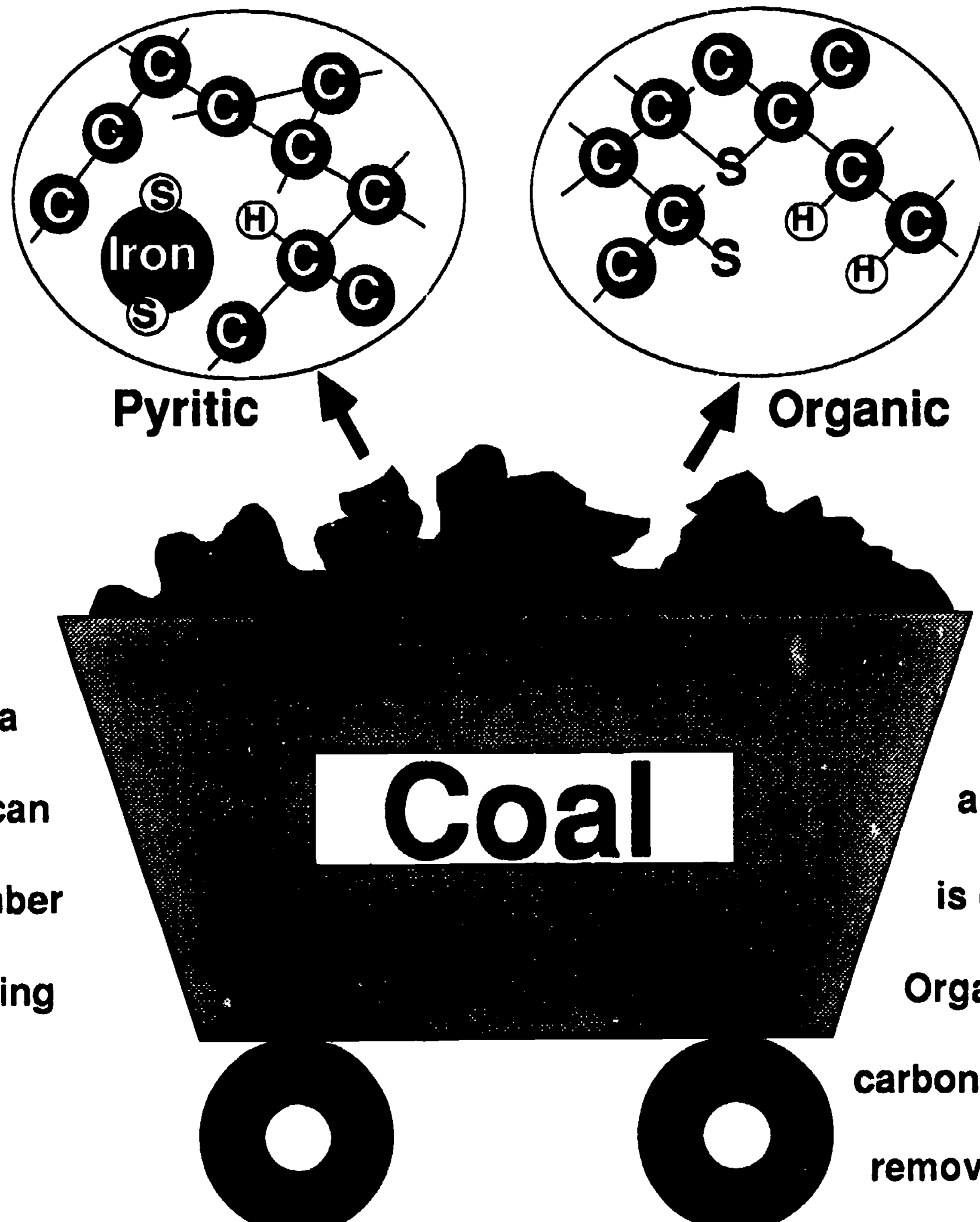


Coal contains sulfur that is released

when coal is burned and can pollute

our air if it is not removed.

Sulfur in Coal



If you look at the composition of coal as a group of marbles, you can see that coal has a number of elements in it, including carbon (c), sulfur (s), hydrogen (h), and iron.

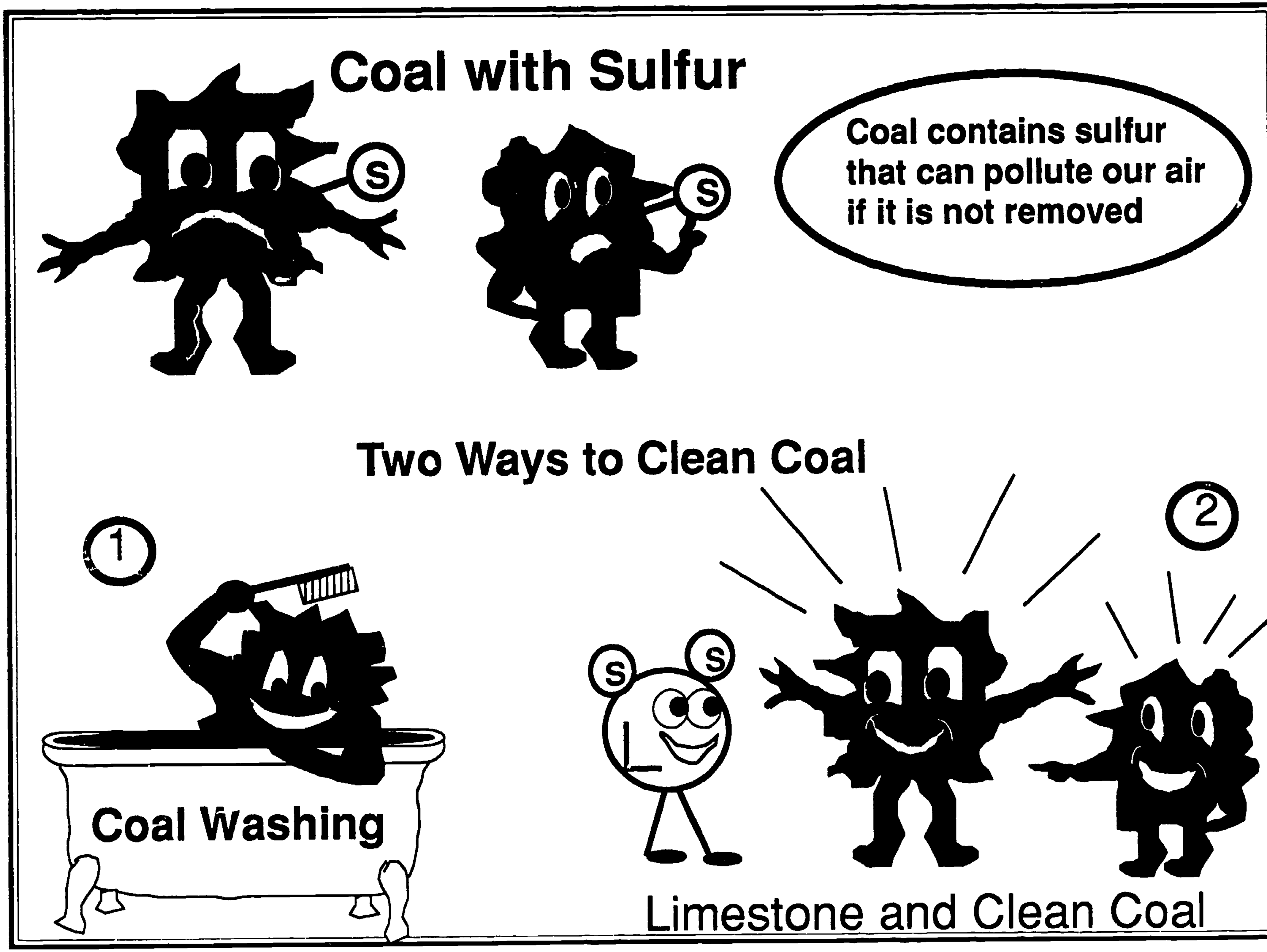
There are two types of sulfur in coal: pyritic and organic. Pyritic sulfur is connected to iron. Organic sulfur is bound to carbon. Both types must be removed to prevent pollution.

Sulfur In Coal

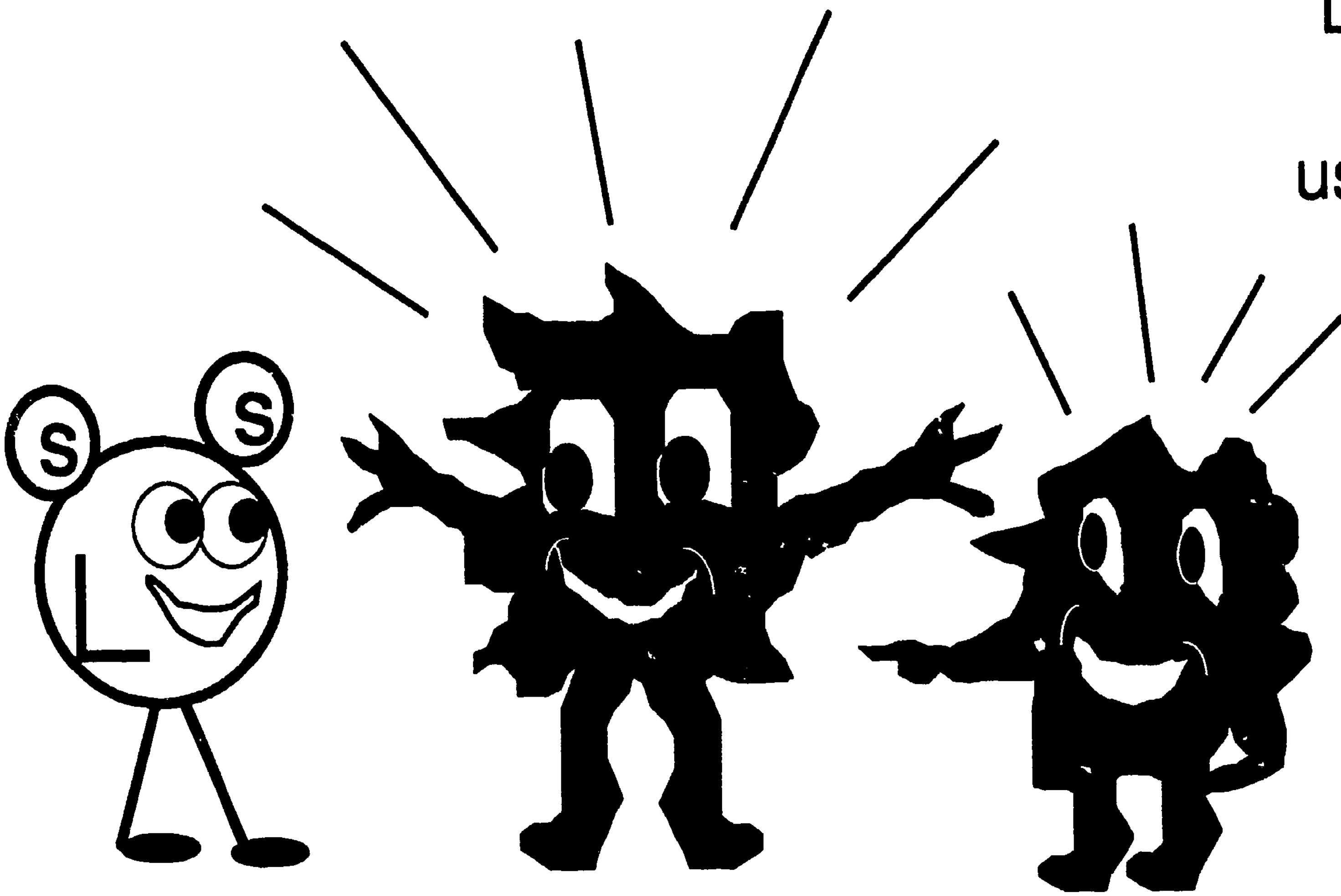
Locked within coal are impurities such as sulfur. When coal burns to produce energy, these impurities are released. Unless they can be removed before they escape into our air, the impurities can cause pollution.

If you look at the composition of coal as a group of marbles, you can see that coal has a number of elements, including carbon (c), sulfur (s), hydrogen (h), and iron.

There are two types of sulfur in coal: pyritic and organic. Pyritic sulfur is connected to iron. This type of sulfur can be removed by washing the coal. Organic sulfur is harder to remove because the sulfur is bound to the carbon in the coal. It takes advanced cleaning methods, such as Clean Coal Technolgies, to remove organic sulfur.


Coal with Sulfur
S
S
Coal contains sulfur that can pollute our air if it is not removed
Two Ways to Clean Coal
1
Coal Washing
2
S
S
L
Limestone and Clean Coal

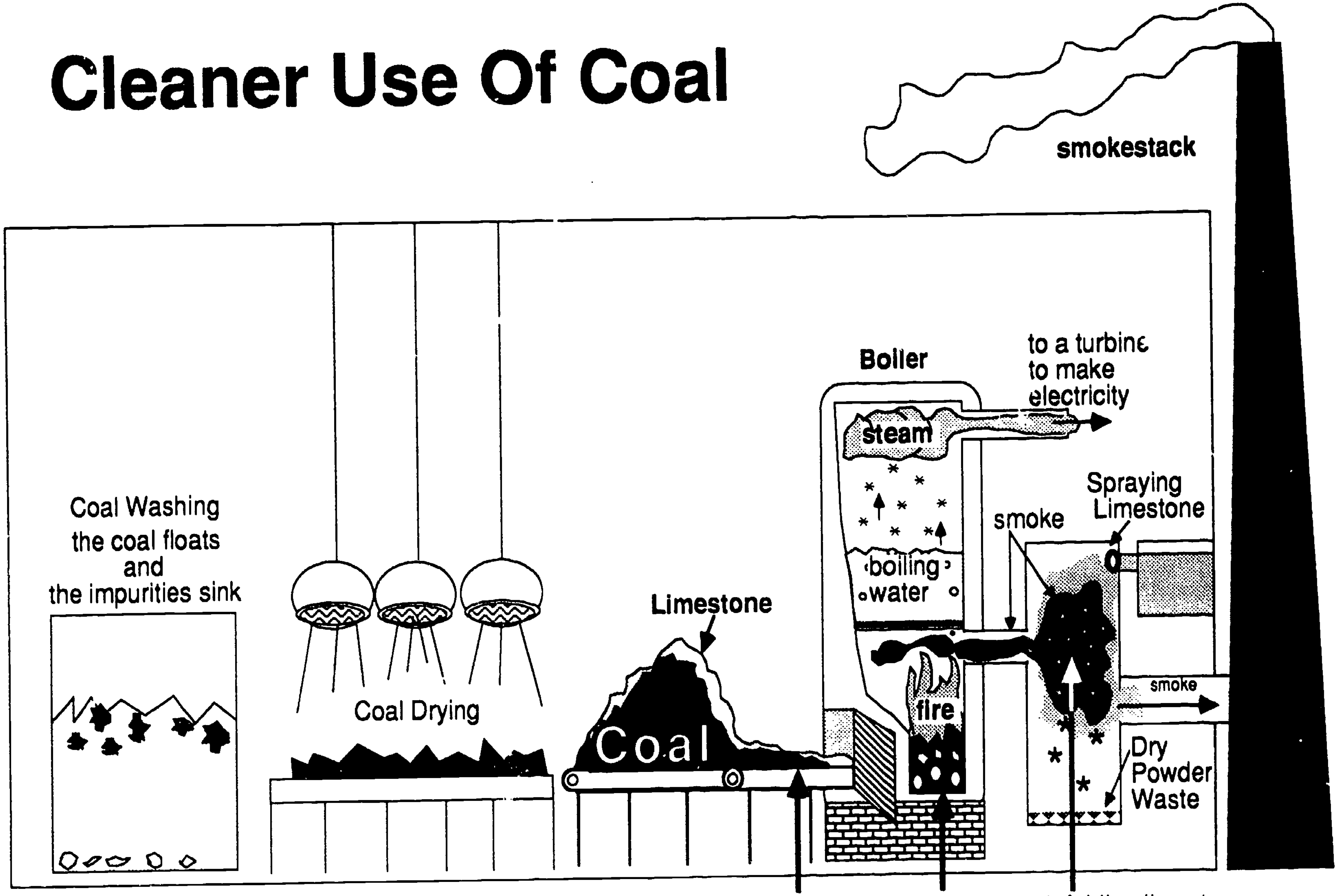
Cleaning Coal



Limestone and Clean Coal

Limestone can be used during or after coal burning to remove both pyritic and organic sulfur.

Cleaner Use Of Coal



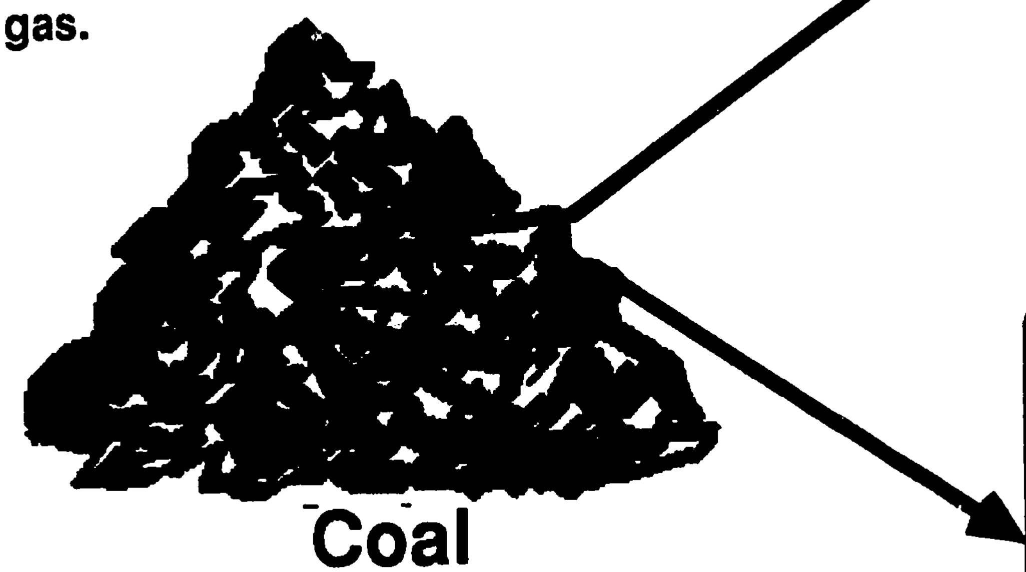
1) Coal Washing and Drying
before burning the coal

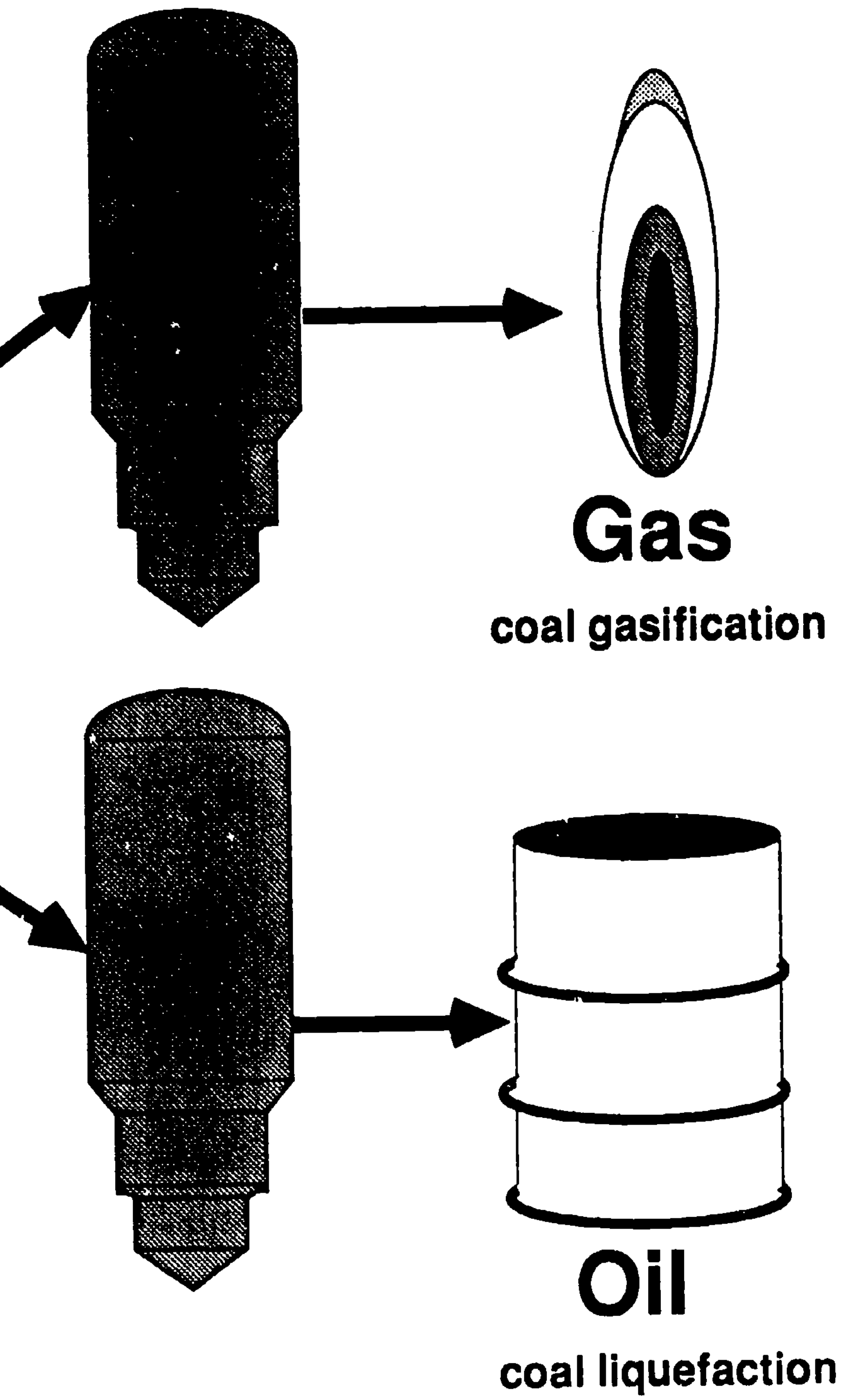
2) Adding limestone
during burning

3) Adding limestone
after burning

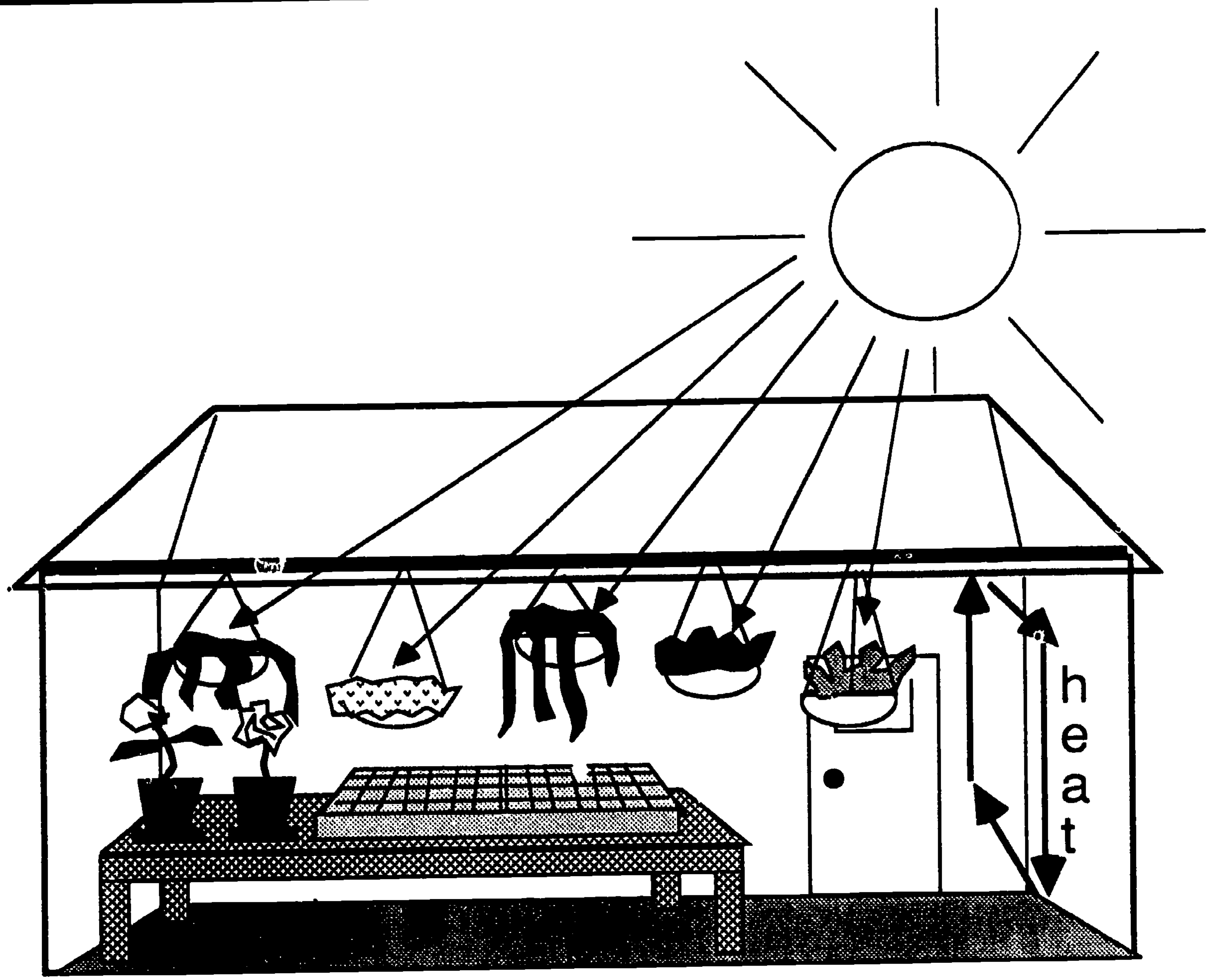
Coal Conversion

Coal can be changed into a clean burning liquid or gas fuel. The coal is heated and then squeezed under great pressure until it converts into a liquid or a gas.





The methods of changing coal are called "coal liquefaction" (to a liquid) or "coal gasification" (to a gas).

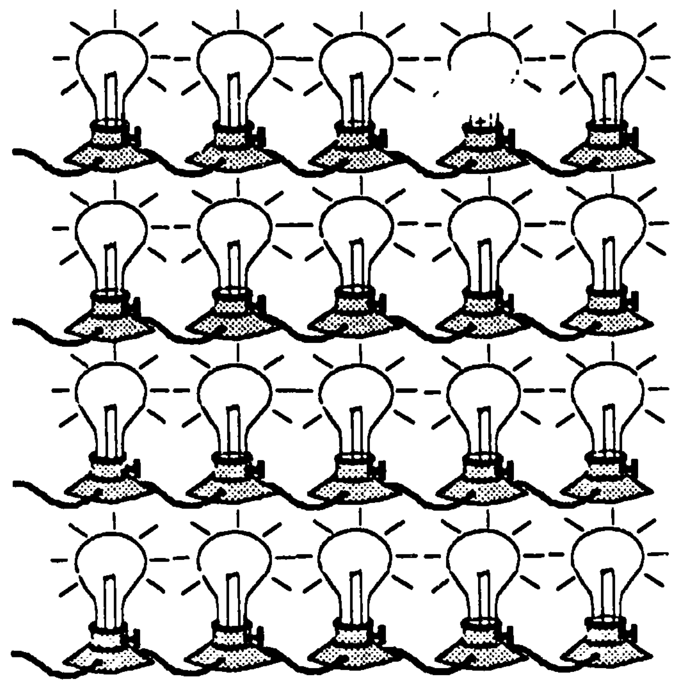


The Greenhouse Effect

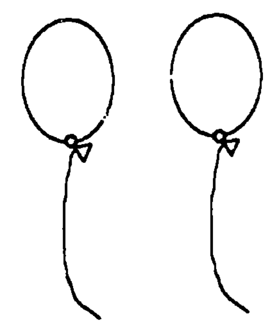
The roof and walls of a greenhouse allow the rays of the Sun to penetrate but do not let any heat escape. The climate in a greenhouse stays very warm and humid. Carbon dioxide and other gases in our atmosphere could have the same effect on Earth and cause the temperature to rise worldwide.

With Today's Coal Technologies

Produces



Energy for
100 Light Bulbs*

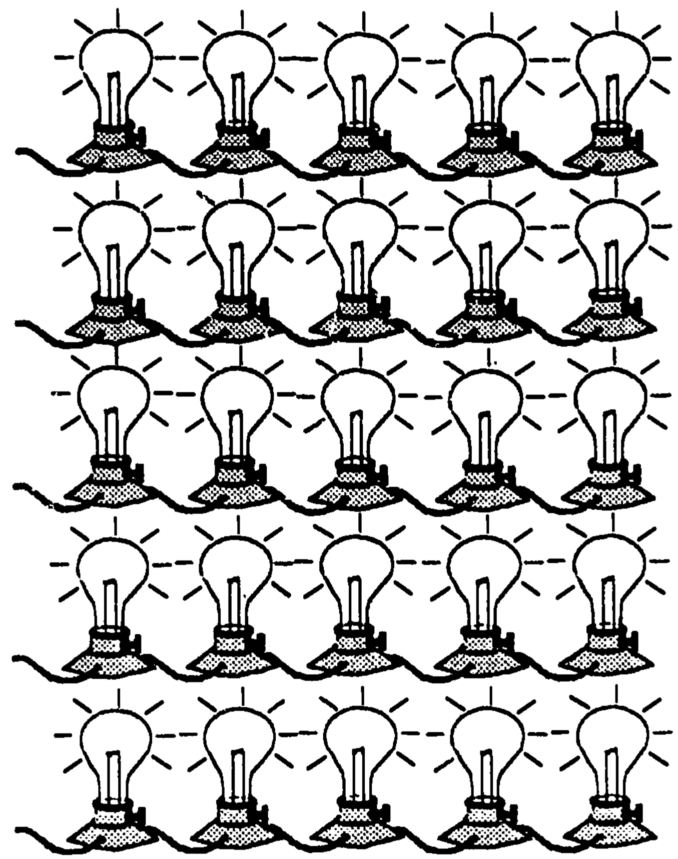


10 Balloons*
of Carbon Dioxide

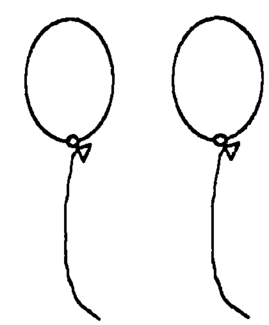
*Each large bulb or balloon represents 5 and each small one = 2 1/2

A) With Clean Coal Technologies

Produces



Energy for
125 Light Bulbs*

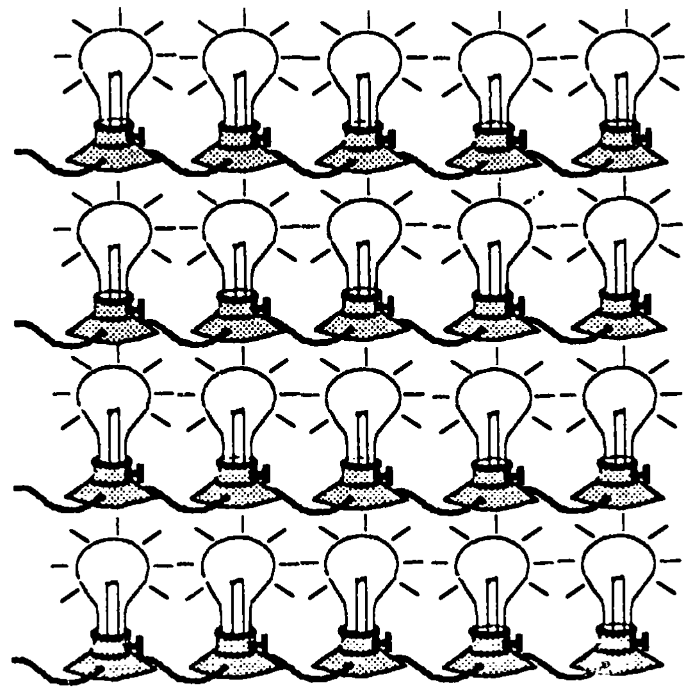


10 Balloons*
of Carbon Dioxide

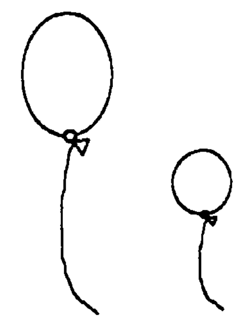
*Each large bulb or balloon represents 5 and each small one = 2 1/2

B) With <u>Clean Coal</u> Technologies

Produces



Energy for
100 Light Bulbs*

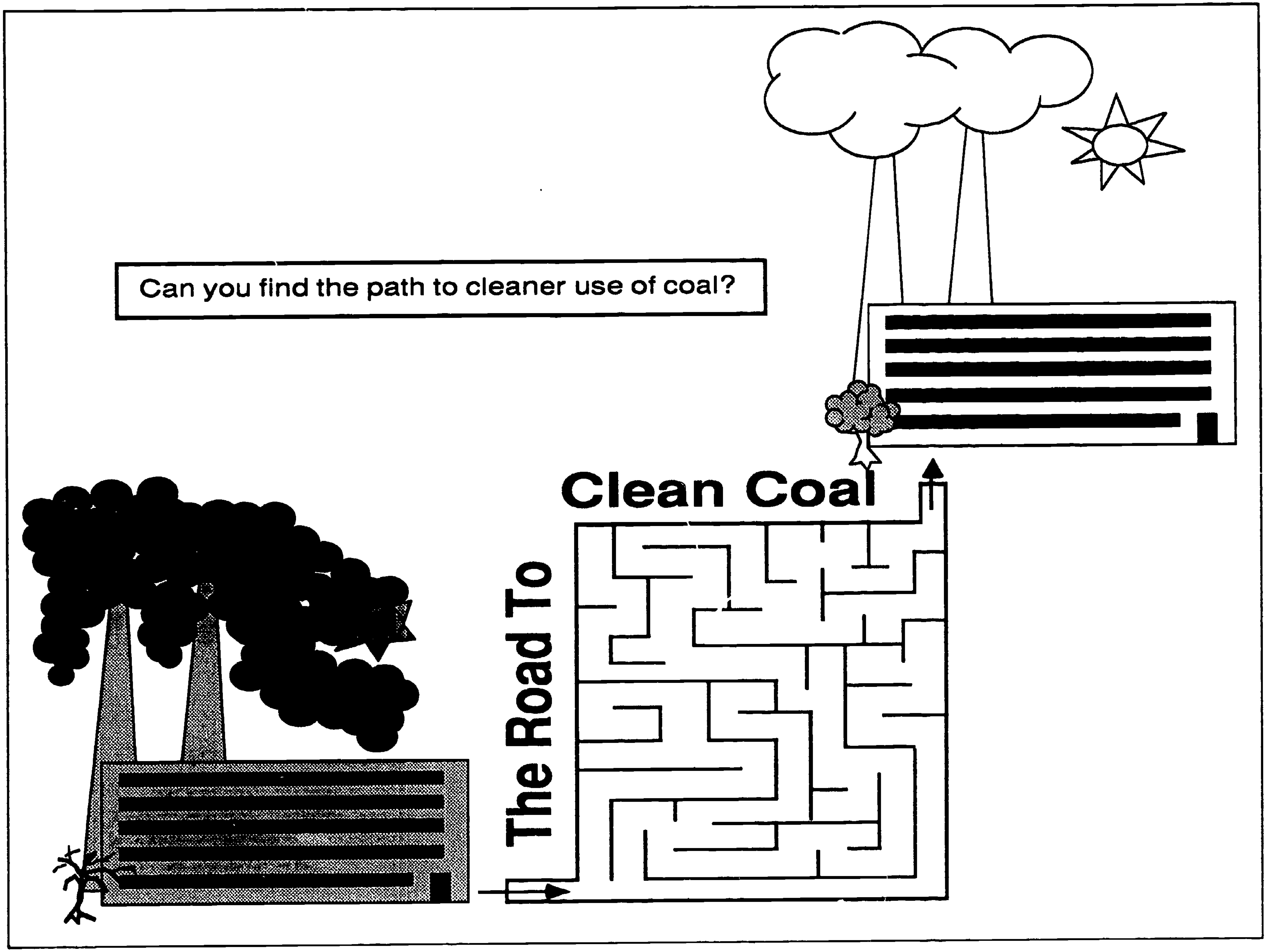


<u>7 1/2</u> Balloons*
of Carbon Dioxide

237

238

*Each large bulb or balloon represents 5 and each small one = 2 1/2


Can you find the path to cleaner use of coal?
The Road To
Clean Coal

F	O	S	S	I	L	E	N	E	R	G	Y
R	U	F	L	U	S	D	E	G	I	S	T
S	T	E	A	M	I	R	O	N	O	C	I
A	E	W	L	E	I	C	T	Y	V	R	C
E	N	A	I	F	A	N	S	A	R	U	I
C	O	S	M	R	K	R	E	I	E	B	R
L	O	U	E	L	C	S	T	R	S	B	T
E	S	A	G	I	O	A	S	H	E	E	C
M	U	E	L	O	R	T	E	P	R	R	E
S	L	U	D	G	E	T	O	O	S	S	L
N	I	A	R	D	I	C	A	L	R	Y	E

Fossil Energy Puzzle

Can you find the following words in the puzzle on the left? They may be up, down, backwards, across, or diagonal. "Fossil Energy" has been marked for you. (The answers are on page 7 of *Dinosaurs and Power Plants*)

air	coal	earth
gas	oil	soot
fire	electricity	rock
car	scrubbers	USA
seam	acid rain	sludge
mine	petroleum	sulfur
rye	reservoir	test
ore	steam	sea
lime	fuel	EOR
ash	fans	iron

Lesson 4 Word List

Do you know what these words mean?

Can you spell the words without looking at the list?

Can you find where the words are used on these pages in *Dinosaurs & Power Plants*?

PAGE 8

environment
research program
odorless
unpleasant
sole users
flares
pipeline system
petroleum
unleaded gasoline
detrimental
cleanup technology
skimming
chemical dispersal
microscopic
convert

releases gases
natural gas
chemical
customers
sophisticated
reduced
distribution
derivatives
catalytic converters
wildlife
contained
absorption
droplets
microbes
lubricants

pollution
air pollution
mercaptan
gas leak
drilling techniques
resume
factories
environmentally safe
vehicles
equipment
potential
slick (oil slick)
microorganisms
pose

PAGE 9

(From the "Cleaner Uses of Coal" graphic)
crushing
smokestack
boiler

separated
limestone
dry powder

sizing
turbine

(From the text)
coal
reclaim the land
unsightly
sulfur
escape
industrial
scientists
clean coal technologies
smoke
temperatures

plentiful
erosion
beneficial
released
pollution
power plants
pollutants
government
atmosphere
undesirable

surface mining
usable
impurities
captured
machinery
soot
processes
nitrogen
harmless
degrees F

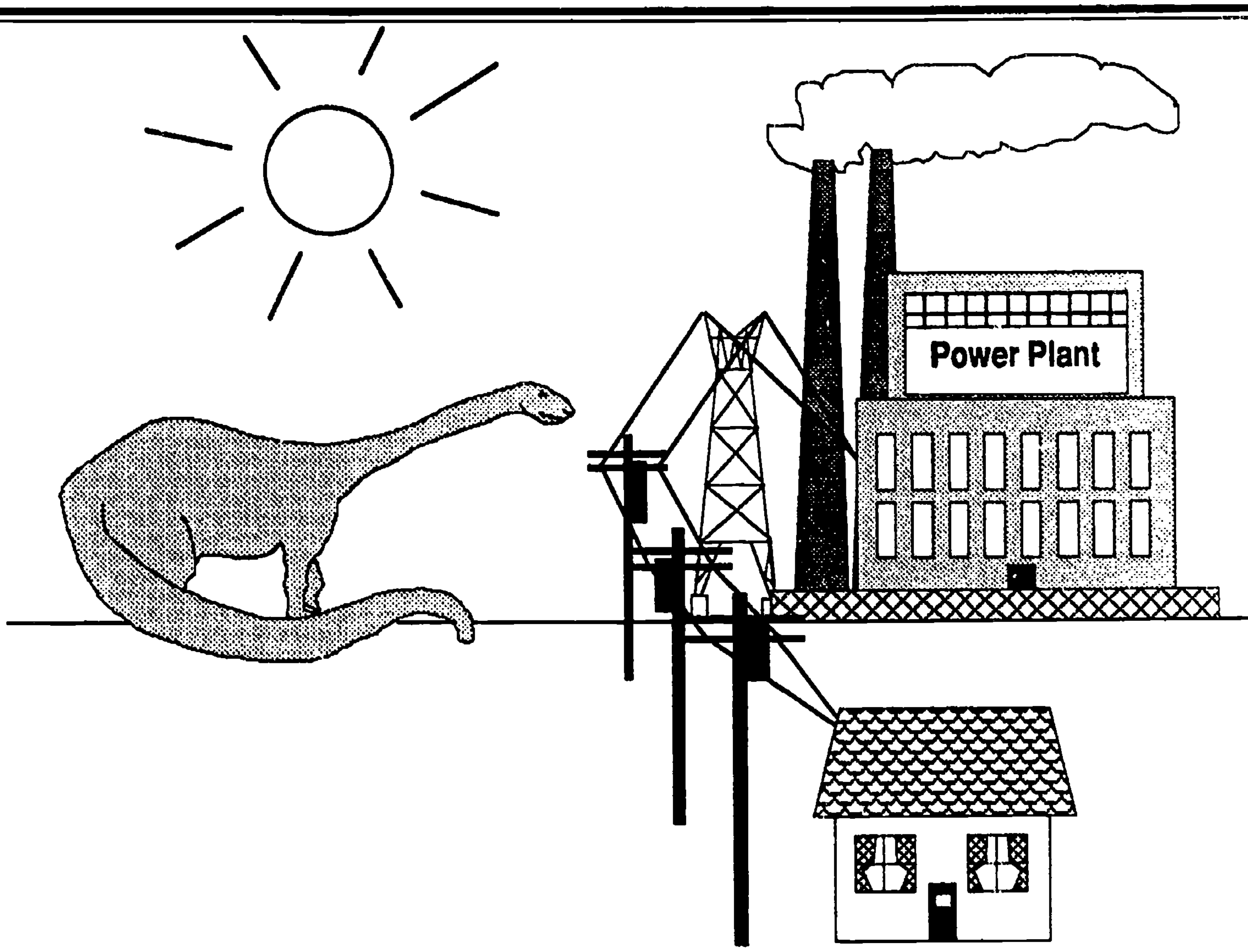
LESSON 4 WORD LIST

PAGE 10

structure
element
sulfur
water vapor
moisture
connected
clean coal technologies
advanced coal burner
fluidized bed combustor
scrubbers
coal gasification
effectively

marbles
reasonable
chemical
visible
acid rain
iron
expensive
sponge
limestone
sludge
coal liquefaction
designed

carbon
substances
prescribed
particles
organic sulfur
pyritic sulfur
devices
formation
ducts
conversion
advantages
eventually



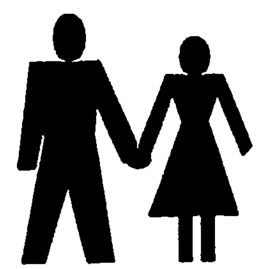
Teacher's Guide Supplement

Lesson Five Supporting Materials

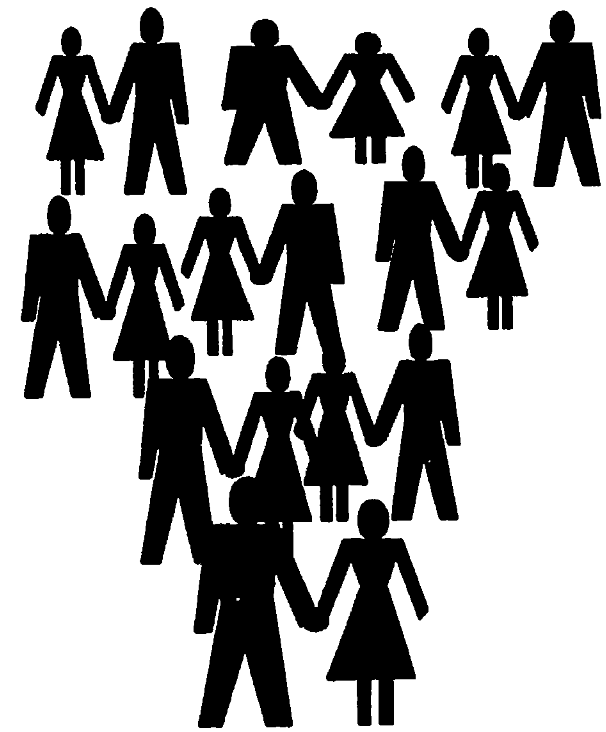
YOU Are Part Of Tthe

Increasing Population

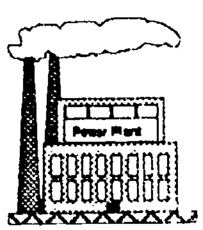
That Will Create More Jobs,
Cause More Homes And Schools
To Be Built, And More Equipment
To Be Used. These Future Jobs,
Homes, Schools, And Equipment
Will Require Electricity.



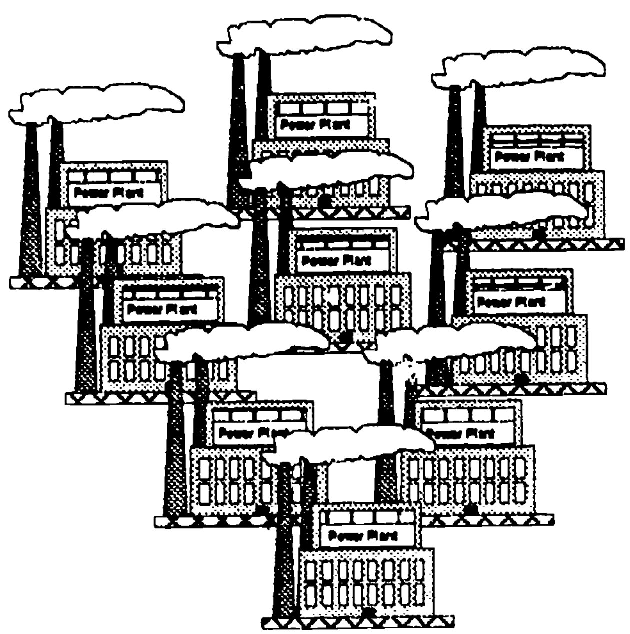
Today



The Future



Today



The Future

More Power Plants

Will Have To Be Built To
Provide The Electricity For
YOU To Use In YOUR Homes,
Offices, And Factories In Future Years.
Will YOU Be Ready To Make The Right
Energy Decisions For YOUR State?
Knowing The Basics Of Science
Will Prepare You For These Decisions.

Four Ways To Assure A Secure Energy Future

Conserve Resources

Think Ahead.
Do NOT Waste!

Develop Better Resource Recovery Methods

"Enhanced Oil Recovery"

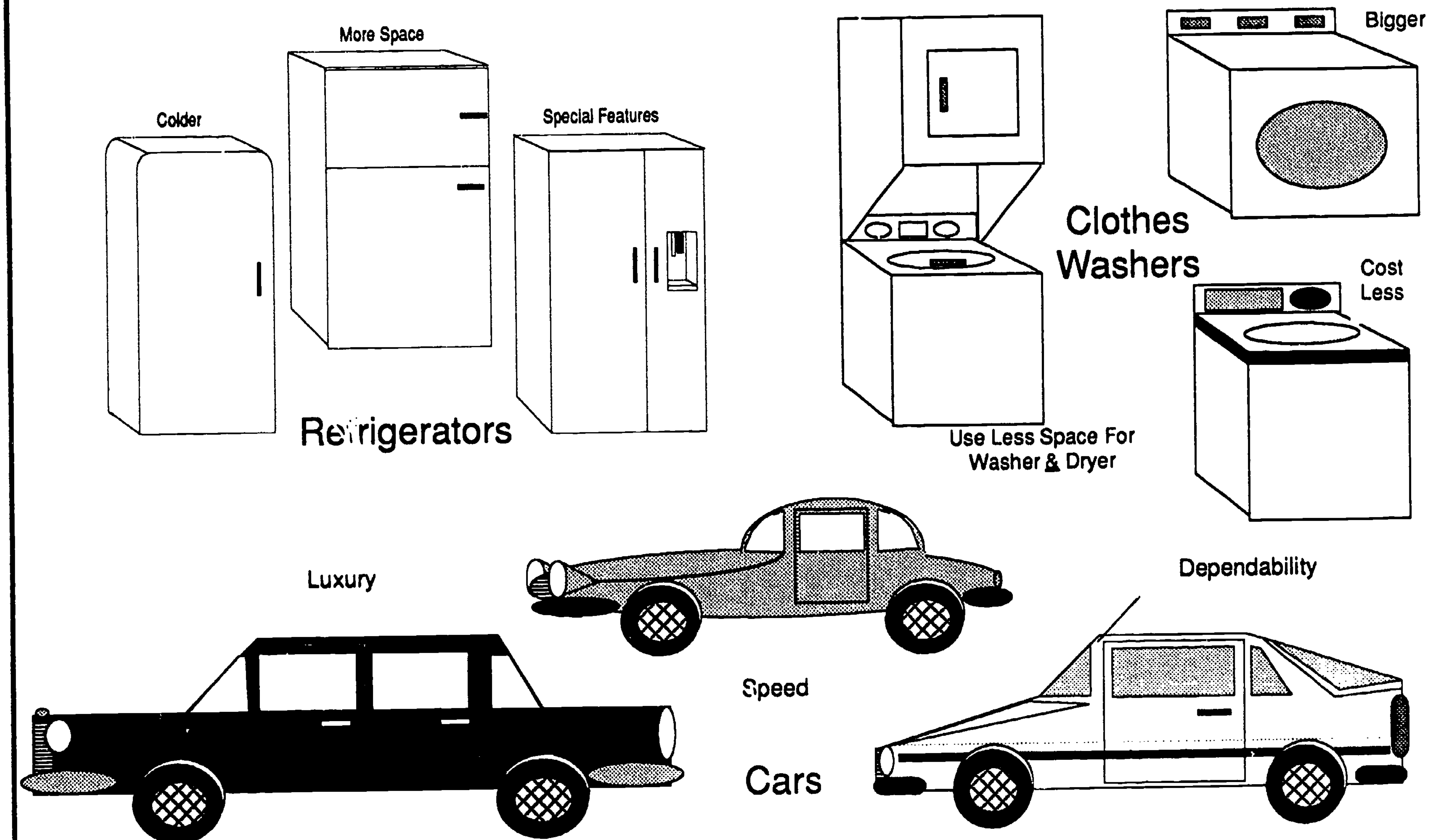
Develop Cleaner Resource Use Methods

"Clean Coal Technologies"

Recycle And Reuse Resource Products

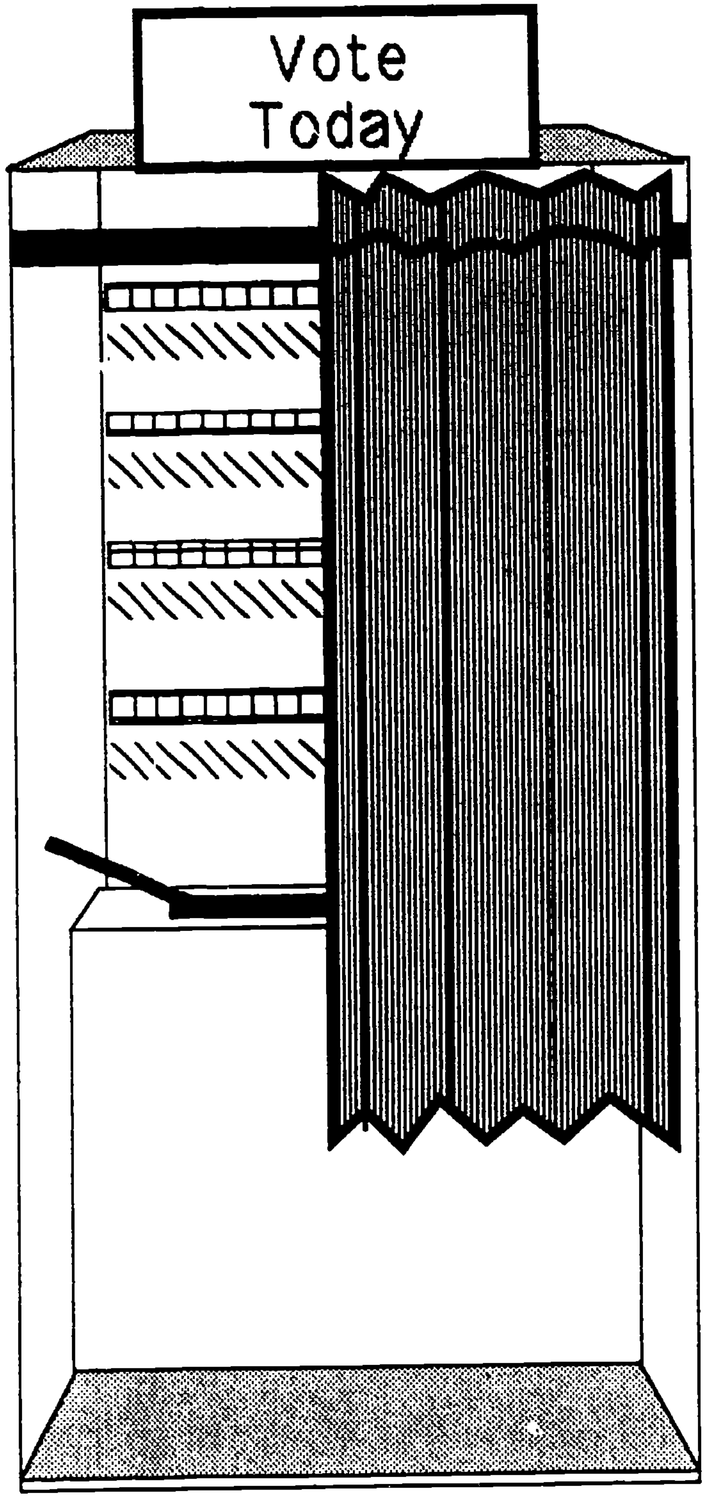
Be A Discoverer

Explore Your World



Be An Intelligent Consumer

Studying Science Can Help You Understand How Things Work. This Knowledge Will Make You An Intelligent Shopper, Who Recognizes A True Value, And A Wise Energy Consumer, Who Knows How To Save Money By Not Wasting Energy.



Running For An Elected Office

Or

Voting For Elected Officials

Requires That You Are Able To Understand

The Problems And Potential Solutions

In Order To Make A Decision That Will

Keep The United States Strong.

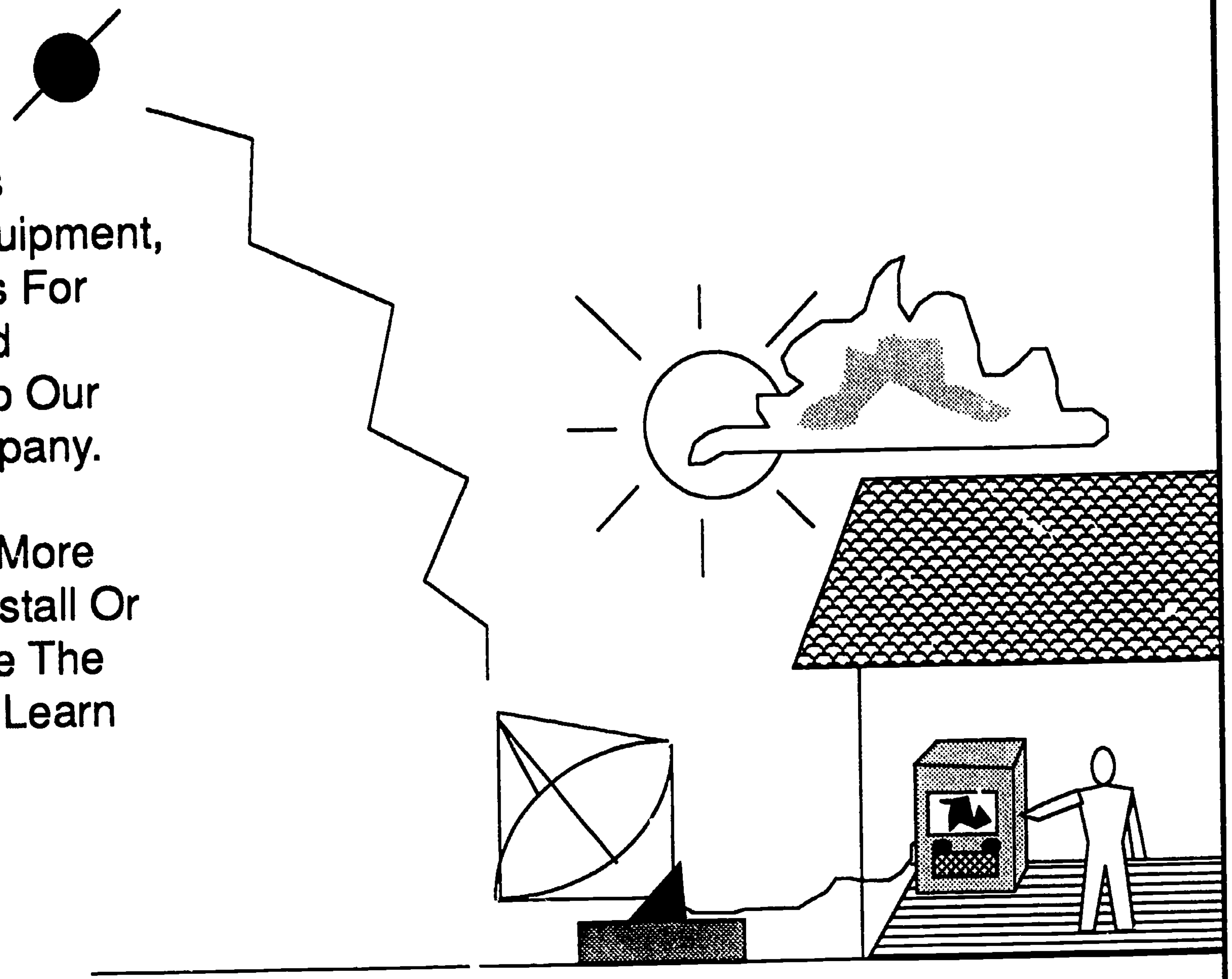
Many of Our Complex Issues Require

At Least A Basic Understanding of Science.

Will **YOU** Be Ready When It Is Your Turn

To Step Into The Voting Booth?

Our World Depends On Complex Technology



Even Our Everyday Lives Depend On Technical Equipment, Such As Satellites Dishes For Transmitting National And International Programs To Our Television Or Cable Company.

As Equipment Becomes More Complex, The Jobs To Install Or Repair Them Will Require The Ability To Understand Or Learn NewTechnology.

Learn Your Science Basics Now In School To Be Prepared For Tomorrow's Jobs!

Lesson 5 Word List

Do you know what these words mean?

Can you spell the words without looking at the list?

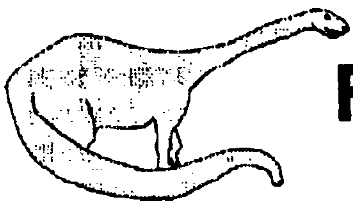
Can you find where the words are used on this page in *Dinosaurs & Power Plants*?

Can you find the countries on a map?

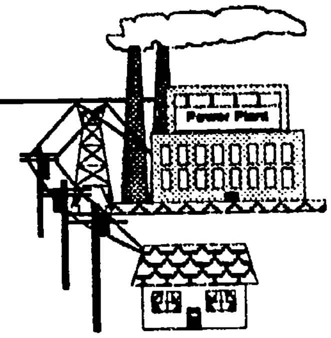
PAGE 12

fossil fuels	burden	shrinking
Germany	Japan	solar power
nuclear power	abundant	affordable
oil fields	resources	research
effective	feasible	clean coal technologies
oil & gas recovery	options	secure

Dinosaurs and Power Plants



Fossil Energy Summary Quiz



Lesson 1-Importance and Formation

1. List at least three things that people and animals do that uses energy.

2. Name three fossil fuels.

3. Describe how fossil fuels were formed.

4. Tell how much plant debris it took to form one foot of coal.

5. List at least three things that run on energy products produced from fossil energy sources.

Lesson 2-Discoveries and Uses

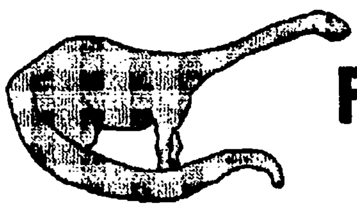
1. List at l[illegible] two people from the past who either used or reported sighting Fossil Fuels outs[illegible] United States.

2. [illegible] ates and places that coal, natural gas, and petroleum were first used commercially in the United States.

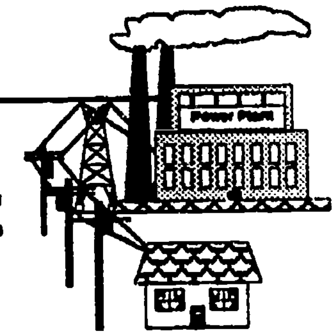
3. Name the reason why Americans needed both the natural gas and petroleum that came from the first commercial wells.

4. List at least 10 things that are made from or run on Fossil Fuels or Fossil Fuel products.

5. List three simple conservation methods that can be used to save energy.



Fossil Energy Summary Quiz



Lesson 3-Detection, Extraction, & Transporation

1. Name, describe, and give a general mining location for each of the four kinds of coal.

2. Name two types of coal mining.

3. Name at least two places "unconventional" gas deposits may be found.

4. Tell why we need Enhanced Oil Recovery (EOR) and describe one EOR technique.

5. List one way each to transport coal, natural gas, and petroleum.

Lesson 4-Potential Environmental Problems & Solutions

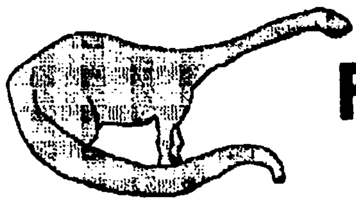
1. Name one way to clean up an oil spill.

2. Name one way to control air pollution from cars.

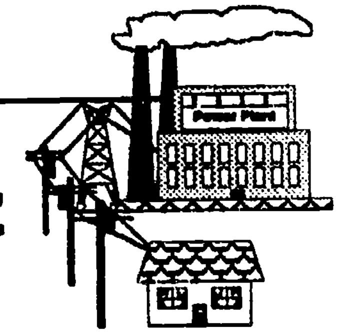
3. Name at least one pollutant in coal.

4. Name two types of sulfur.

5. List four ways to make cleaner use of coal.



Fossil Energy Summary Quiz



Lesson 5-Energy for the Future

1. Complete this sentence. "As Fossil Energy resources are ____________, population and industrial needs are ____________ in the U.S. and the world."

2. Name two things that the U.S. will need as a result of population growth.

3. Name the Fossil Fuel resource used to produce electricity that is most abundant in the U.S.

4. Name two ways we can save Fossil Fuel resources.

5. Name the programs funded by the federal govern-ment that are developing methods

1) to use coal in cleaner ways

and 2) to improve recovery of crude oil.

Bonus Questions:

Are Fossil Fuels important in YOUR Life now? Why?

Will Fossil Energy be important to YOU when you become an adult? Why?

Fossil Energy Feud/Super Feud

Preparation By The Teacher—Before Class

1. Make a copy (if possible) of the original game boards, solution sheets, and money block sheets to use now in case the games need repair or replacement in the future.

2. Prepare the game boards for "Fossil Energy Feud" and "Fossil Energy Super Feud" either as paper graphics or as transparencies.

o Preparation Of Paper Game Boards:

Hand Held Use—

If the games will be presented to the class in their original paper formats, glue cardboard to the back of each game board to make it more sturdy. The game boards can then be tilted so the students can see them better when they are held by hand in front of the class.

Separate the money blocks with scissors. Use one money block of the appropriate dollar amount to cover each answer on the game boards. Lightly apply a small piece of scotch tape to attach each block to the game board. Do not tape the blocks firmly because they must be removed during the game so students can see which categories have already been chosen. Also, be sure no block is taped to another block. It may be easier to start taping on the bottom row and work upward.

Money values: The solutions under each column topic get increasingly difficult as you progress toward the bottom so the money also increases. The solutions to FE Super Feud are intended tobe harder than those for FE Feud. Therefore, the money value for solutions in FE Super Feud are double those found in FE Feud.

Examples: In FE Feud, place a $100 money block on "It has been used for heating since the cave man" and a $500 one on "Two of the four ranks of coal." In FE Super Feud, place $200 on "Under ground pockets of petroleum" and $1000 on "An advanced coal burner."

Fossil Energy Feud/Super Feud

Preparation By The Teacher—Before Class

2. Prepare Game Boards (cont'd).

o Preparation of Paper Game Boards (cont'd):

Hand Held Use (cont'd)—

Copies of the solution sheets for both games can be used as paper only or they may also be backed with cardboard.

Opaque Projector Use—

To allow enlargement of game board text by use of an opaque projector, prepare as above but do not back game boards with cardboard.

o Preparation Of Transparency Game Boards:

Overhead Projector Use—

The text on the game boards can be enlarged for easier class use by projecting it on a screen or wall with an overhead projector. However, a transparency will have to be made from a copy of each game board.

The paper money blocks can be used in their original paper form to hide the answers on the transparency game boards when they are projected on the wall.

The dollar amounts for each row will show on the transparency to the left of the game board. (For more information on dollar values of answers on each game board, see the discussion under "Preparation of Paper Game Boards—Money Blocks.") Students should remember to look at the dollar amounts on the left when requesting a category.

The solution sheets can also be used in the original paper form as they should not be seen by the whole class.

Fossil Energy Feud/Super Feud

Preparation During Class

(Teacher May Choose To Partcipate In One of the Game Jobs)

1. Choose a Master of Ceremonies (MC). Duties:

   Recognizes the Team Leader who is FIRST to raise a hand after an answer is read from the game board.

   Verifies (along with Teacher) the accuracy of the question (solution) given in response to the answer that was read. (Keeps the solution sheets.)

   Prompts Team Leaders when they give solutions in an incorrect format (not a question).

   Tells the Team Leaders when it is their turn to select another category.

2. Choose a Game Board Coordinator. Duties:

   Repeats the category and dollar amount selected to the Team Leader to verify the correct item to uncover.

   Uncovers an answer category as it is selected by a Team Leader.

   Reads the answer from the selected category.

3. Choose a Timekeeper/Chief Accountant. Duties:

   Keeps track of time left in each Team Leader's turn for a category selection (5 seconds) or solution announcment (5 seconds).

   Distributes to the Team Accountants all money slips won by teams for giving correct solutions.

4. Divide the rest of the class into three teams.

   Each team should select a Team Leader and a Team Accountant.

Fossil Energy Feud/Super Feud

Preparation During Class (cont'd)

4. Divide the rest of the class into three teams (cont'd).

o Team Leader—Duties:

Solicits ideas from team for category selections and solutions.

Raises hand quickly when team members have decided they have the solution for the selected category answer.

Announces to the MC the solution or category the team has selected. (Only the Team Leaders are allowed to respond. This procedure teaches the students to work as teams, to respect their spokesmen, and to play the game in a less noisy manner. The Teacher might want to stress the quieter a team is, the less likely it is that another team may hear a solution being developed.)

o Team Accountant—Duties:

Collects money slips won by the team from the Chief Accountant.

Keeps track of the total money won by the team on the chalkboard so the teams see where each group stands. (The teams should be discouraged from using calculators in this activity. Each Team Accountant should manually add to the old money total each time. The Teacher might want to emphasize the importance of math in everyday life even in playing games and managing your allowance. As the team with the most money at the end of the game WINS, it is very important to each team to keep an accurate account of the its money!)

The teams should choose which team name they want to use (See "Playing the Games—Starting the Games" to determine which team gets to choose first, second, and third.).

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Fossil Energy Feud/Super Feud

<u>Playing The Games</u> **(Games Are Similar To "Jeopardy" On Television)**

1. Starting the games:

   To find out which team will be first in Fossil Energy Feud, the Teacher secretly chooses a number between 1 and 100. The three team leaders consult their teams, select a number, and write the number and the Team Leader's name on a piece of paper that is given to the Teacher. The team submitting the number closest to the Teacher's number will select a category and dollar amount first. (The team that starts first in FE Feud also is first to choose a team name. The team with the second closest number chooses a name second.) The team with the <u>least money</u> at the end of FE Feud is the <u>first to play</u> in Fossil Energy <u>Super</u> Feud.

2. Play Procedures.

   - The Team Leader whose turn it is has 5 seconds to consult her/his team about the category to choose. He/she requests the category and dollar amount selected by the team.

   - The Game Board Coordinator repeats the selection to the Team Leader, uncovers that category block, and reads the answer.

   - All teams consult rapidly and choose a solution.

   - As the team finds a solution, each Team Leader quickly raises his/her hand (the Team Leader <u>must</u> have been given a solution before raising her/his hand).

   - The Team Leader who was first to raise her/his hand is asked for a solution.

   - After being called upon by the MC, the Team Leader has 5 seconds (the Timekeeper should tell the MC if the player exceeds his/her time) to announce the solution in the form of a question (i.e., beginning the sentence with who, what, where, etc.) such as "What is coal?"

     The MC should warn Team Leaders if their solutions are not in the form of a question or if they exceed their time. However, no money should be deducted from the team.

Fossil Energy Feud/Super Feud

Playing The Games (cont'd)

2. Play procedures (cont'd).

If the question/solution was accurate, the team wins a slip for the money amount for that category block. The money slip for that amount is given by the Timekeeper/Chief Accountant to the Team Accountant.

The Team Accountant records the new money on the chalkboard by adding it to the old money total.

If the solution was incorrect (no money deducted), the MC responds, "No, I'm sorry. Does someone else want to try?" If no one can answer, the MC reveals the solution in the form of an answer.

- The team providing the correct solution selects the next category and dollar amount. Each time, the category selection is made by the team that last gave the correct solution until the end of the game (Exception: the beginning of both FE Feud and FE Super Feud. Check sections on starting and ending games.)

3. Ending the games.

Fossil Energy Feud and Fossil Energy Super Feud are each played until all the category blocks are uncovered or a time limit set by the Teacher is reached.

If Fossil Energy Super Feud is not to be played, the team with the most money at the end of FE Feud WINS!

If Super Feud will be played, the team that has won the least money FE Feud starts FE Super Feud.

At the end of FE Super Feud, the team with the most money WINS!!

The winning team members are given Energy Award Certificates of Superior Merit. All other students receive Meritorious Energy Award Certificates.

Fossil Energy Feud/Super Feud

<u>Playing The Games</u> (cont'd)

4. Scoring.

   Teams win money when they accurately give a solution/question to a category answer.

   No money is deducted for incorrect attempts (to encourage participation).

   The team with the most money when the game(s) is/are declared to be over is the WINNER.

   The winning team members are given Energy Award Certificates of <u>Superior</u> Merit. All other students receive Meritorious Energy Award Certificates.

FOSSIL ENERGY FEUD

Game Board

	COAL	HISTORY	NATURAL GAS	USES	PETROLEUM
$100	The country with 1/4 of all the coal in the world	Materials from which fossil fuels began forming millions of years ago	It is found many times along with natural gas	It has been used for heating since the cave man	Petroleum in an underground reservoir may be as thick ___ or as thin as ___
$200	10 feet of prehistoric plant debris formed this amount of coal	The state in which the first commercial coal mine started operating in the 1740s	The substance added to give an odor to natural gas	He used burning petroleum to scare away the war elephants of his enemies	Where petroleum goes to be separated into its components or "products"
$300	The type of coal mining performed above ground	It created a massive worldwide market for coal	These are bounced through underground formations to detect pockets of natural gas and petroleum	The product that powers most of today's cars and the fossil fuel from which it is refined	The U.S. oil stockpile that is our "insurance policy" in case of an oil disruption emergency
$400	The holes cut into the ground to provide ventilation & transportation to underground mining sites	In 1542, he reported discovering petroleum near what is now Santa Barbara, California	A tiny cage of ice in which molecules of natural gas are trapped	It was used by ancient Egyptians in the process that preserved the mummies seen in museums today	Two rock formations where petroleum may be found
$500	Two of the four ranks of coal	The year the first commercial natural gas well was drilled	Two types of underground formations where unconventional gas deposits may be found	They used coal for cooking & heating in the 1300s in what later became the Southwest of the United States	Plastics and adhesives are formed from this category of petroleum products

FOSSIL ENERGY FEUD (Questions or Solutions)

COAL	HISTORY	NATURAL GAS	USES	PETROLEUM
What is the United States $100	What are Dead Plants and Animals $100	What is Petroleum $100	What is Coal $100	What are Tar & Kerosene $100
What is 1 Foot $200	Where is Virginia $200	What is Mercaptan $200	Who was Alexander the Great $200	Where is a Refinery $200
What is Surface Mining $300	What was the Industrial Revolution $300	What are Sound Waves $300	What are Gasoline and Petroleum $300	What is the Strategic Petroleum Reserve $300
What are Shafts $400	Who was Juan Rodriquez $400	What is Methane Hydrate $400	What is Asphalt $400	What are Sandstone and Limestone $400
What is Anthracite, Bituminous, Subbituminous, and Lignite $500	When was 1821 $500	What are Shale Formations, Sandstone Beds, Coal Seams, and Salt Water Aquifers $500	Who are the Hopi Indians $500	What is Petrochemical $500

Money for Fossil Energy Feud

(Separate money blocks with scissors. Use each block to cover one answer for that amount of money.)

$ 100	$ 100	$ 100	$ 100	$ 100
$ 200	$ 200	$ 200	$ 200	$ 200
$ 300	$ 300	$ 300	$ 300	$ 300
$ 400	$ 400	$ 400	$ 400	$ 400
$ 500	$ 500	$ 500	$ 500	$ 500

FOSSIL ENERGY SUPER FEUD

Game Board

	ENVIRONMENT	OIL RECOVERY	ELECTRICITY	CLEAN COAL	TRANSPORTATION
$200 →	The fossil fuel that releases the smallest amount of pollution when burned	Underground pockets of petroleum	It carries electricity into your home	Two impurities released if coal is burned without cleaning techniques	One way coal can be moved out of the mine
$400 →	Two innovations that reduced the amount of pollution from cars	It causes some petroleum to be expelled as a reservoir is first tapped	Turns the blades of a steam turbine	A material added to burning coal to absorb sulfur	Three ways that petroleum can be shipped
$600 →	Two of the ways to clean up an oil spill on water	Advanced techniques of extracting petroleum from underground reservoirs	Where electricity is generated	The type of sulfur removed by coal washing	The transportation system that, if connected end to end, could stretch to the moon and back twice
$800 →	Sulfur gases and water vapor combined into a weak acid that falls to Earth	A man-made island designed to support drilling for oil in water	It is responsible for producing over 1/2 of all electricity available at the flip of a light switch in the U.S.	The method used to change coal to a cleaner burning liquid	A coal and water mixture that can be shipped by pipeline
$1000 →	Actions that restore [illegible] area to other uses after coal mining is completed	Enhanced oil recovery method that uses living bacteria	It collects the electricity produced in the generator	An advanced coal burner	A temporary above ground storage facility for millions of barrels of crude oil

FOSSIL ENERGY SUPER FEUD (Questions or Solutions)

ENVIRONMENT	OIL RECOVERY	ELECTRICITY	CLEAN COAL	TRANSPORTATION
What is Natural Gas $200	What are Reservoirs $200	What is on a Wire (or Power Line) $200	What are Sulfur & Nitrogen $200	What is by Conveyor Belt or Rail Car $200
What are Catalytic Converters and Unleaded Gasoline $400	What is Natural Pressure $400	What is Steam $400	What is Limestone $400	What are by Supertanker, Tank Truck, Railroad Tank Car, Pipeline, and River Barge $400
What are Skimming, Absorption, Dispersal, and Burning $600	What are Enhanced Oil Recovery Methods (EOR) $600	Where is a Power Plant $600	What is Pyritic Sulfur $600	What is the Natural Gas Pipeline System $600
What is Acid Rain $800	What is a Offshore Oil Drilling Platform $800	What is Coal $800	Wtat is Coal Liquefaction $800	What is a Coal & Water Slurry $800
What is Land Reclamation ("Reclaiming the Land") $1000	What is Microbial Enhanced Oil Recovery (MEOR) $1000	What is a Wire coil $1000	What is a Fluidized Bed Combustor $1000	What is a Tanker Farm $1000

Money for Fossil Energy Super Feud

(Separate money blocks with scissors. Use each block to cover one answer for that amount of money.)

$ 200	$ 200	$ 200	$ 200	$ 200
$ 400	$ 400	$ 400	$ 400	$ 400
$ 600	$ 600	$ 600	$ 600	$ 600
$ 800	$ 800	$ 800	$ 800	$ 800
$ 1000	$ 1000	$ 1000	$ 1000	$ 1000

JOB NAME TAGS—Copy, Cut Out, & Attach To Clothes With Doubled Over Scotchtape

TIMEKEEPER & CHIEF ACCOUNTANT	CHIEF ACCOUNTANT
GROUP ACCOUNTANT	TEAM ACCOUNTANT
TEAM LEADER	LETTER KEEPER
TIMEKEEPER	LETTER KEEPER ASSISTANT
MASTER OF CEREMONIES	GAME BOARD COORDINATOR

FOSSIL ENERGY FEUD / FOSSIL ENERGY <u>SUPER</u> FEUD / ENERGY SPIN

TEAM NAMES-Copy & Cut Out Use Large Names Over MoneyTotals On Chalkboard. Use "Team Leaders" As Job Name Tags.

THE COAL LUMPS

THE COAL LUMPS TEAM LEADER	THE OIL DROPS TEAM LEADER

THE OIL DROPS

THE NATURAL GAS FLAMES
TEAM LEADER

THE NATURAL GAS FLAMES

Energy Spin

Preparation By The Teacher—Before Class

1. Choose words or phrases from *Dinosaurs and Power Plants* (see word lists in the *Teacher's Supplement*) that will be appropriate for your class to use in this game.

2. If possible, make a copy of the Energy Spin sheet (circle and "up" arrow) in case a "wheel" replacement is needed in the future.

3. Cut out the circle and arrow with scissors.

4. Glue both to cardboard backing (to make them more sturdy) and then trim each again.

5. Push a 3/4" long nail (or long thumbtack) through the center (If you do not hit the center, the wheel will favor numbers on one side) of the circle. Then attach the circle to a cork bulletin board (or other wall surface in which the nail can be pushed). The circle then becomes a "money wheel." It should be a height easily reached by students.
   Make sure the nail is long enough to allow the wheel to be loose enough to spin.

6. Then pin the arrow on the bulletin board to one side of the wheel where it can point at (but not touch) the numbers as the wheel spins.
   Make sure the arrow cannot move.

7. (Optional) Obtain sheets of colored paper and cut them into small slips to be used as "money" during the game. The amounts will have to be written as the Energy Spin is played since the dollar amounts may vary greatly.

Preparation—During Class

[The Teacher May Choose To Participate In One Of The Game Jobs.]

1. Select a Master of Ceremonies (MC)(not a member of a team). Duties:

   At the beginning of each round, tells the topic of the mystery word/phrase (person, place, phrase, or thing). (The MC is given word/phrase at beginning of each round so he/she can encourage efforts of participants.)

   Tells each student when it is their turn to spin.

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Energy Spin

Preparation—During Class (cont'd)

2. Select a Timekeeper/Chief Accountant. Duties:

    Keeps track of time left in each student's turn for an answer (requires a watch with a second hand—either the wall clock, a stopwatch, or a wristwatch).

    (Optional) Writes dollar amounts accrued for letter discovery on colored slips of paper and distributes them to Group Accountants.

3. Select a Letter Keeper (may need an Assistant!). Duties:

    Keeps the list of mystery words/phrases to be used in the game.

    Places the correct blank underlines for letters and spaces for word breaks in the mystery word/phrase on the chalkboard at beginning of each round. (_ _ _ _   _ _ _ ="cave man")

    Tells MC the mystery word and topic at the beginning of each round.

    Writes in the letters on the blanks as they are discovered in the mystery word or phrase during the game. (C _ V E   M _ N)

    Writes the alphabet on the chalkboard and marks off each letter as it is chosen during the game (all letters chosen not only the ones found in the mystery word—so students can see which ones have already been tried). (AB~~C~~...)

4. Divide the rest of the class into three groups or teams.

    A Group Accountant should be selected by each group. Duties:

    Keeps track of the money slips accrued.

    The Group Accountant holds the money slips accrued by the group from discovery of letters while a round is in progress.

    If his/her group solves the mystery word, the Group Accountant adds the money from the slips to the total money the group has won so far.

Energy Spin

Preparation—During Class (cont'd)

4. Divide the rest of the class into three groups or teams (cont'd).

A Group Accountant should be selected by each group. Duties: (cont'd)

The new money is added to the previous total of money on the chalkboard for that group. A separate total of the money being accrued in a particular round may be kept on the chalkboard also, but it should not be added to the group's total of winnings until the group has its turn and announces the solution.

The game can be played either of two ways:

The members of each group can be rotated so that each student gets to spin the wheel, discover letters, and interpret the mystery word or phrase.

The group can work as a team. The elected team leader spins for the team and gives the letter/answer that the team has developed by pooling ideas.

Playing the Game (Rules are similar to "Wheel of Fortune" on television.)

1. The Teacher secretly chooses a number between 1 and 100. The first participant of each of the three groups/teams writes a number in that same range on a piece of paper with her/his name. The student submitting the number closest to the Teacher's number will spin first in the initial round. The second closest spins second. In the next round, the first spin will shift to the group that was second to spin in the first round. The first spin will continue to rotate each round.

2. After spinning, each student has 5 seconds to choose a letter. If the letter chosen was actually discovered in the mystery word(s), he/she then will have 15 seconds to discover and announce to the game partcicipants the mystery word or phrase before the next student spins.

Energy Spin

Playing the Game (cont'd)

3. At the time of his/her turn to spin, a participant may spin, choose one letter, and if successful at discovering a letter may (optional) announce the solution to the mystery word/phrase.

   Or the student may choose to announce the solution before spinning.

   If the announced solution is incorrect, the student loses that turn to spin.

   However, if the student is successful, the group wins the money they have accrued so far in that round for discovering letters in the mystery word.

   Only the student whose turn it is should announce a solution.

   If Energy Spin is being played as a team game, the team members should decide on a solution (as quietly as possible—do not give away your ideas to other teams!) and the team leader whose turn it is should give the solution. This is to prevent the game from becoming too noisy and to help the students to learn to share ideas and work together rather than only performing as individuals.

4. Ending the game.

   Energy Spin is played until a group/team 1) wins an amount of money set by the Teacher, 2) each group participant has a chance to spin, or 3) a time limit set by the Teacher is reached. At the end of the game the group with the most money wins. The winning group members are given Energy Award Certificates of Superior Merit. All other students receive Meritorious Energy Award Certificates.

5. Scoring:

   As each letter (consonents and vowels) is discovered, the student choosing the letter accrues the amount of money the wheel stopped on multiplied by the number of times the letter was found in the mystery word/phrase (For "cave man" and $200 on the wheel, the student would accrue $400 for discovering "a.")

   [The Teacher may want to point out to the students that MATH is important even in playing games. Students will want to be sure that they are awarded the correct amount of money they have won!]

Energy Spin

Playing the Game (cont'd)

5. Scoring: (cont'd)

To prevent confusion later in totaling each group's money, the Teacher may (before class) want to acquire some colored paper and cut it into small pieces on which the Timekeeper/Chief Accountant can write the amount of money each time a student discovers a letter. The money slips will be given to the student's Group Accountant. The Group Accountant will keep these slips for each round until someone finds the solution to the mystery. The group whose member announces the solution will keep the slips of "money" and add them to its previous winnings. The other two groups must return theirs for that round to the Timekeeper. When the next new mystery word/phrase blanks are posted all groups start with $0 (the money won in previous rounds is kept separate by the Group Accountants).

No money is accrued when a letter is chosen and is not found in the mystery word.

However, no money is deducted for incorrect selection of letters or announcement of incorrect solutions.

If the wheel stops on "Lose Turn," the group does not get to choose a letter or announce a solution for that turn.

"Lose All $" means that all "money" accrued for that round has to be returned to the Timekeeeper/Chief Accountant and the group starts accruing money again on its next turn.

"Double $" on the wheel allows the group to take the amount accrued so far in the round and multiply it by 2 (more math!).

The group with the largest amount of money at game end WINS!

The winning group members are given Energy Award Certificates of Superior Merit. All other students receive Meritorious Energy Award Certificates.

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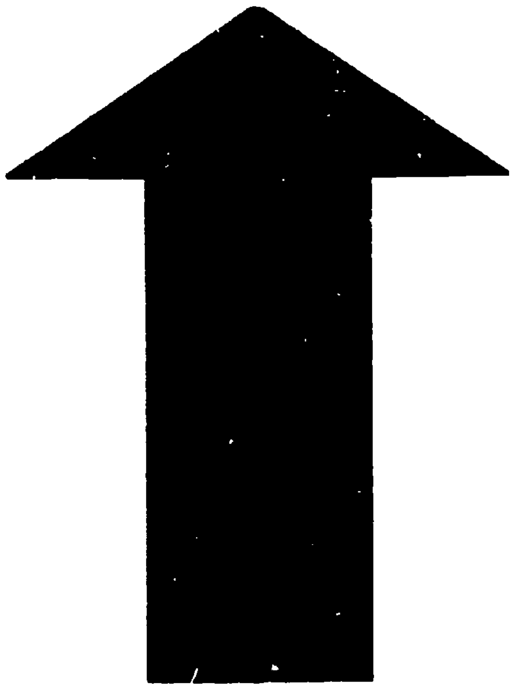
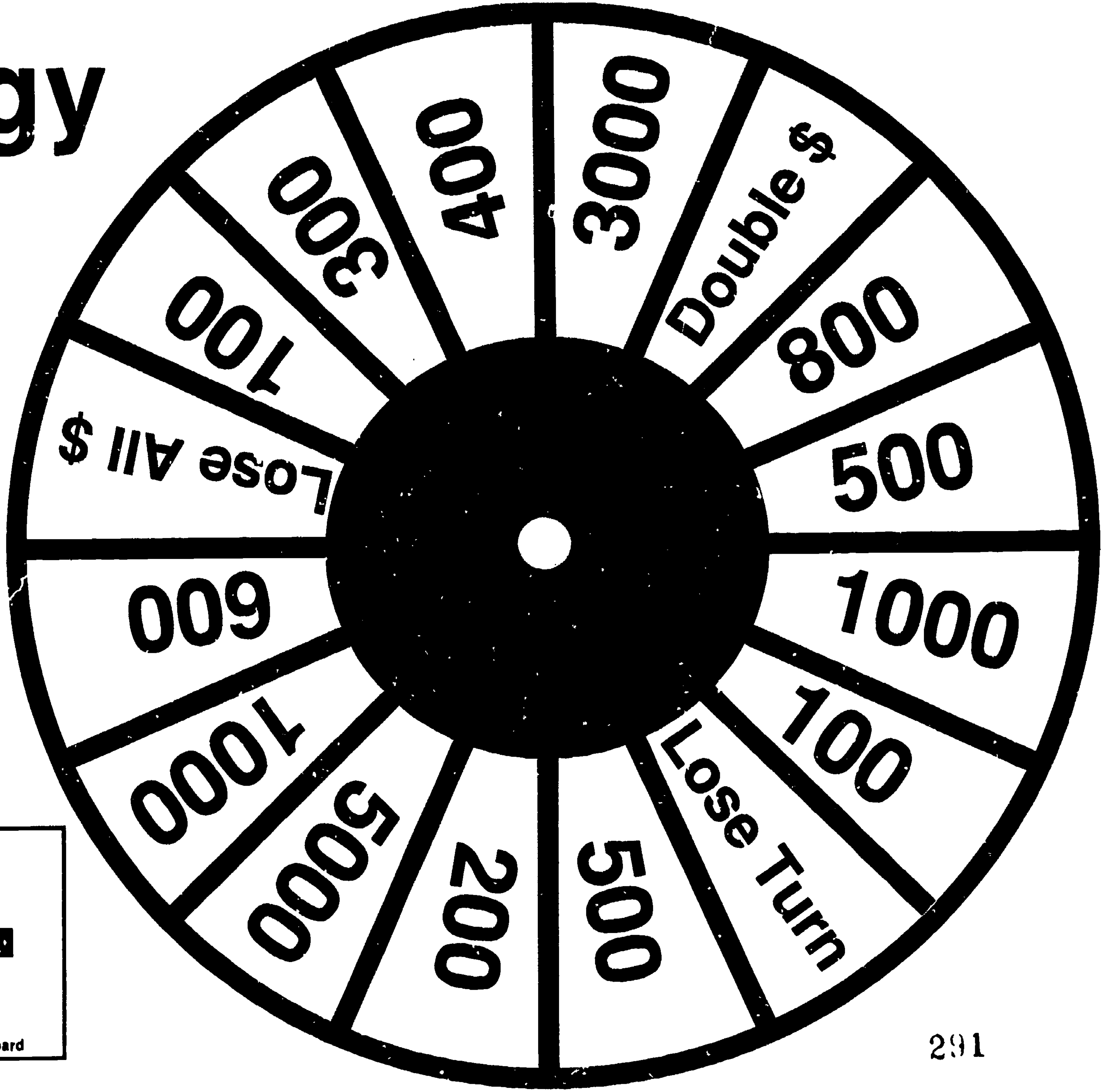
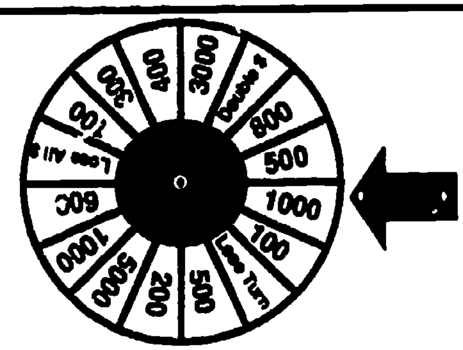
Energy Spin

(Separate Parts With Scissors)







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This is to certify that

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name

has shown Superior Achievement in completion of a course on

____
course subject

held at ____________________ on ____________________

school — date

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Meritorious Achievement Energy Award

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