A Content Secondary Science Newsletter from the
Southern Nevada Regional Professional Development Program

Science Dissected

Nonrenewable Resources: Oil
Model-Evidence Link Diagram (MEL)

Nonrenewable resources are natural resources which cannot be produced, grown, or generated in a relatively short period of time. Therefore, they are unable to sustain their consumption rate, and once depleted, there are no more available for future needs.

The term Nonrenewable Resource refers to the resources that are consumed much faster than nature can create them . This issue of Science Dissected provides an instructional resource for teachers to present students with the opportunity to examine several pieces of evidence compiled about oil production/creation and critically evaluate two competing models of oil as a resource;

Model A: **Oil is a renewable energy resource because it can be replenished, or re-made, at a scale comparable to its rate of consumption, over time.**	*Model B:* **Oil is a nonrenewable energy resource because it cannot be replenished, or re-made, at a scale comparable to its rate of consumption, over time.**

Evidence #1: Oil was created from diatoms, or small sea creatures, that died and were buried under rock millions of years ago.

Evidence #2: All living things are made of complex molecules of long strings of carbon atoms. Connected to these carbon atoms are others such as hydrogen and oxygen.

Evidence #3: Oil is called nonrenewable because its supplies are limited.

Evidence #4: New evidence has been found that states oil is being created from other underground sources.

Evidence #5: Oil contains fossilized chlorophyll.

The following is a suggestion for using this MEL with students:

1. Hand out the Nonrenewable Resource Model Evidence Link Diagram (page 1). Instruct students to read the directions, descriptions of Model A and Model B, and the four evidence texts presented.
2. Handout the five evidence text pages (pages 3-12).
3. Instruct students to carefully review the Evidence #1 text page (page 3), then construct two lines from Evidence #1; one to Model A and one to Model B. Remind students that the shape of the arrow they draw indicates their plausibility judgment (potential truthfulness) connection to the model.
4. Repeat for Evidence #2-5 (pages 4-12).
5. Handout page 2 for the students to critically evaluate their links and construct understanding.

Once students have completed page 2, they can then engage in collaborative argumentation as they compare their links and explanations with that of their peers. Students should be given the opportunity to revise the link weighting during the collaborative argumentation exercise. If time permits, have students reflect on their understanding of oil production/creation and create questions that they might explore in the future.

Archived Issues of Science Dissected, http://www.rpdp.net/link.news.php?type=sciencedis. Instructional Resource resulting from Plausibility, It's All About Connecting the Models Workshop co-sponsored by CPDD and SNRPDP Science March 6, 2012

Written by: Kelley Sherman

Name:_____ _____ **Period:**_____

Directions: draw two arrows from each evidence box. One to each model. You will draw a total of 10 arrows.

Key:

→	The evidence **supports** the model
⇝	The evidence **STRONGLY supports** the model
⊸	The evidence **contradicts** the model (shows its wrong)
⇢	The evidence has **nothing to do with** the model

Standard: P.8.C.4

Evidence #1
Oil was created from diatoms, or small sea creatures, that died and were buried under rock millions of years ago.

Evidence #2
All living things are made of complex molecules of long strings of carbon atoms. Connected to these carbon atoms are others such as hydrogen and oxygen.

Model A
Oil is a renewable energy resource because it can be replenished, or re-made, at a scale comparable to its rate of consumption, over time.

Model B
Oil is a nonrenewable energy resource because it cannot be replenished, or re-made, at a scale comparable to its rate of consumption, over time.

Evidence #3
Oil is called nonrenewable because its supplies are limited.

Evidence #4
New evidence has been found that states oil is being created from other underground sources.

Evidence #5
Oil contains fossilized chlorophyll.

Provide a reason for three of the arrows you have drawn. **Write your reasons for the three most interesting or important arrows.**

A. Write the number of the evidence you are writing about.
B. Circle the appropriate descriptor (**strongly supports | supports | contradicts | has nothing to do with**).
C. Write the letter of the model you are writing about.
D. Then write your reason.

1. Evidence # ____ strongly supports | supports | contradicts | has nothing to do with Model _____ because:

2. Evidence # ____ strongly supports | supports | contradicts | has nothing to do with Model _____ because:

3. Evidence # ____ strongly supports | supports | contradicts | has nothing to do with Model _____ because:

4. Circle the plausibility of each model. [Make two circles. One for each model.]

	Greatly implausible (or even impossible)									Highly Plausible
Model A	1	2	3	4	5	6	7	8	9	10
Model B	1	2	3	4	5	6	7	8	9	10

5. Circle the model which you think is correct. [Only circle one choice below.]

Very certain that Model A is correct	Somewhat certain that Model A is correct	Uncertain if Model A or B is correct	Somewhat certain that Model B is correct	Very certain that Model B is correct

Evidence #1: Oil was created from diatoms, or small sea creatures, that died and were buried under rock millions of years ago.

There are three major forms of fossil fuels: coal, oil and natural gas. All three were formed many hundreds of millions of years ago before the time of the dinosaurs – hence the name fossil fuels. The age they were formed is called the Carboniferous Period. It was part of the Paleozoic Era. "Carboniferous" gets its name from carbon, the basic element in coal and other fossil fuels.

The Carboniferous Period occurred from about 360 to 286 million years ago. At the time, the land was covered with swamps filled with huge trees, ferns and other large leafy plants, similar to the picture above. The water and seas were filled with algae – the green stuff that forms on a stagnant pool of water. Algae is actually millions of very small plants.

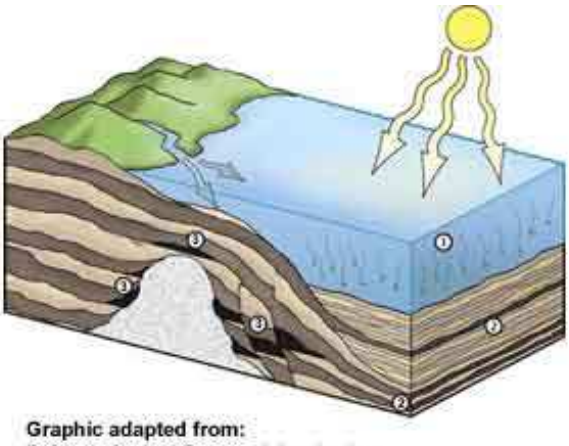
Some deposits of coal can be found during the time of the dinosaurs. For example, thin carbon layers can be found during the late Cretaceous Period (65 million years ago) – the time of Tyrannosaurus Rex. But the main deposits of fossil fuels are from the Carboniferous Period. For more about the various geologic eras, go to **www.ucmp.berkeley.edu/help/timeform.html**

As the trees and plants died, they sank to the bottom of the swamps of oceans. They formed layers of a spongy material called peat. Over many hundreds of years, the peat was covered by sand and clay and other minerals, which turned into a type of rock called sedimentary.

More and more rock piled on top of more rock, and it weighed more and more. It began to press down on the peat. The peat was squeezed and squeezed until the water came out of it and it eventually, over millions of years, it turned into coal, oil or petroleum, and natural gas.

Oil is another fossil fuel. It was also formed more than 300 million years ago. Some

scientists say that tiny diatoms are the source of oil. Diatoms are sea creatures the size of a pin head. They do one thing just like plants; they can convert sunlight directly into stored energy.



Graphic adapted from:
Paleontological Research Institution

In the graphic on the left, as the diatoms died they fell to the sea floor (1). Here they were buried under sediment and other rock (2). The rock squeezed the diatoms and the energy in their bodies could not escape. The carbon eventually turned into oil under great pressure and heat. As the earth changed and moved and folded, pockets where oil and natural gas can be found were formed (3).

(EnergyQuest: California Energy Commission, 1994 – 2012)

Evidence #2: All living things are made of complex molecules of long strings of carbon atoms. Connected to these carbon atoms are others such as hydrogen and oxygen.

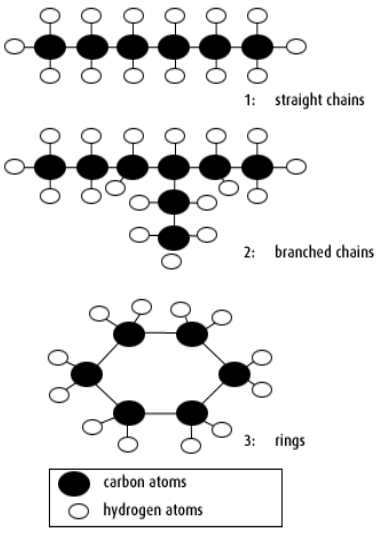
Worldwide there is a range of energy resources available to us. These energy resources fall into two main categories, often called **renewable** and **non-renewable** energy resources. Each of these resources can be used to generate electricity, which is a very useful way of transferring energy from one place to another such as to the home or to industry.

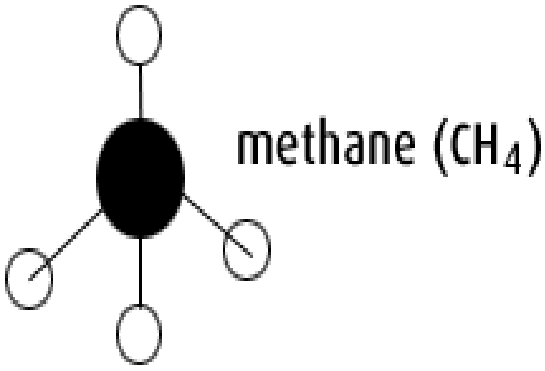
Non-renewable sources of energy can be divided into two types: **fossil fuels** and **nuclear fuel**.

Fossil fuels are found within the rocks of the Earth's surface. They are called fossil fuels because they are thought to have been formed many millions of years ago by geological processes acting on dead animals and plants, just like fossils. Coal, oil and natural gas are fossil fuels. Because they took millions of years to form, once they are used up they cannot be replaced.

Oil and natural gas: **What are they?** Oil and gas are chemicals made from molecules containing just carbon and hydrogen. All living things are made of complex molecules of long strings of carbon atoms. Connected to these carbon atoms are others such as hydrogen and oxygen. A simple molecule, called methane (CH_4), is the main component of natural gas.

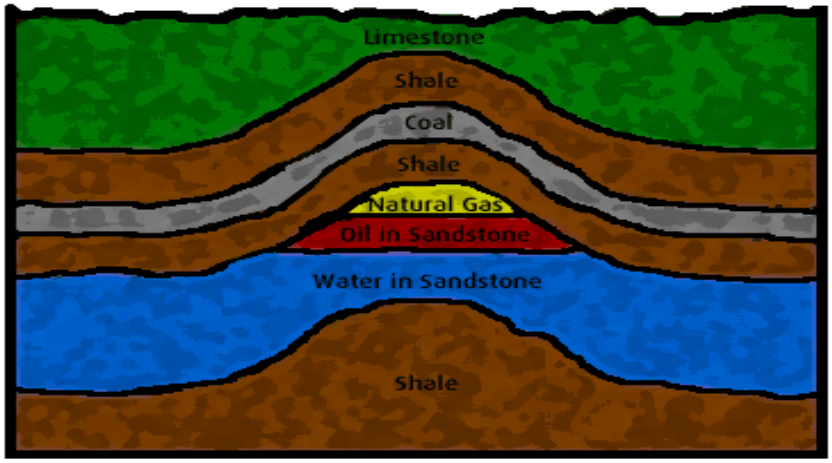
Crude oil (oil obtained from the ground) is a sticky, gooey black stuff. It contains many different molecules, but all are made of carbon and hydrogen atoms.





Organic materials are formed from chains of carbon atoms. Methane is the main component of natural gas

How were they formed? Gas and oil were formed from the remains of small sea creatures and plants that died and fell to the bottom of seas. Over many millions of years, layers of mud or other sediments built up on top of these dead animals and plants. The pressure from these layers and heat from below the Earth's crust gradually changed the once-living material into oil and natural gas. Over time, the layers of rocks in the Earth's crust move and may become squashed and folded. Gas and oil may move through porous rocks and may even come to the surface. In some places, pockets of oil and gas can be found, because non-porous rocks have trapped them.



Pockets of oil and natural gas may become trapped between layers of non-porous rocks.

Where are they found? Natural gas and crude oil can be found in many places around the world, such as the Middle East (about 70 per cent of the world's known resources of oil), the USA and under the North Sea off the coast of the UK.

How long will they last? Oil and gas are non-renewable: they will not last forever. New sources of oil and gas are constantly being sought. It is thought that the current resources under the North Sea will last about another 20 years and the world resources will last for about 70 years. Estimates vary, however, because we do not know where all the resources are and we do know how quickly we will use them. It is thought that with new discoveries these fossil fuels will last well into the next century.

Evidence #3: Oil is called nonrenewable because its supplies are limited.

What is Energy?
Energy makes change; it does things for us. It moves cars along the road and boats over the water. It bakes a cake in the oven and keeps ice frozen in the freezer. It plays our favorite songs on the radio and lights our homes. Energy makes our bodies grow and allows our minds to think. Scientists define energy as the ability to do work.

Sources of Energy
We use many different energy sources to do work for us. They are classified into two groups—renewable and nonrenewable.
In the United States, most of our energy comes from nonrenewable energy sources. Coal, petroleum, natural gas, propane, and uranium are nonrenewable energy sources. They are used to make electricity, heat our homes, move our cars, and manufacture all kinds of products. These energy sources are called nonrenewable because their supplies are limited. Petroleum, for example, was formed millions of years ago from the remains of ancient sea plants and animals. We can't make more crude oil deposits in a short time.
Renewable energy sources include biomass, geothermal energy, hydropower, solar energy, and wind energy. They are called renewable because they are replenished in a short time. Day after day, the sun shines, the wind blows, and the rivers flow. We use renewable energy sources mainly to make electricity.

Renewable Energy Sources
Hydropower is used to generate electricity. Today, most hydropower sources make use of falling water through a dam. New technology is utilizing energy from waves and tides.
Wind is created from the uneven heating of Earth's surface. Wind energy is used to generate electricity.
Solar energy comes directly from the sun. Solar energy can be used for heating buildings and water, and to electricity.
Geothermal energy comes from within the earth. Geothermal energy can be used for heating buildings and to generate electricity.
Biomass is any organic matter that can be used as an energy source. Biomass is used for heating, generating electricity, and as a transportation fuel.

What is Electricity?
Electricity is different from energy sources because it is a secondary source of energy. We must use an energy source to produce electricity. In the U.S., coal is the number one energy source used for generating electricity.
Electricity is called an energy carrier because it is an efficient and safe way to move energy from one place to another, and it can be used for so many tasks. As we use more technology, the demand for electricity grows. Learning how to conserve energy and use it efficiently are important goals for everyone.

Efficiency and Conservation

Energy is more than numbers on a utility bill; it is the foundation of everything we do. All of us use energy every day—for transportation, cooking, heating and cooling rooms, manufacturing, lighting, and entertainment. We rely on energy to make our lives comfortable, productive, and enjoyable.

There are many things we can do to use less energy and use it more wisely. These things involve energy conservation and energy efficiency. Energy conservation is any behavior that results in the use of less energy. Energy efficiency is the use of technology that requires less energy to perform the same function. Use the *Home Energy Survey* on the back page to find out how you can use energy more efficiently.

The Electric Grid

To get electricity to consumers, there are more than 300,000 miles of high-voltage electric transmission lines across the U.S. They take the electricity produced at power plants to transformers that step up the voltage to reduce energy loss while it travels along the grid to where it is going to be used. Before coming into your home, another transformer steps down the power down to 120 volts so it can operate your lights, appliances, and other electrical needs. And most remarkably of all, this entire process—from generation at the power plant to the trip along the lines to its availability for use in your home— takes just a fraction of a second!

These transmission lines—whether they are located on poles above ground or buried underground—make up the most visible part of what is called the "electric grid." The grid consists of the power generators, the power lines that transmit electricity to your home, the needed components that make it all work, and the other homes and businesses in your community that use electricity.

The process starts at the power plant that serves your community, and ends with wires running from the lines into your home. Outside your home is a meter with a digital read-out or a series of dials that measure the flow of energy to determine how much electricity you're using. Of course, there are many more parts to this process, ranging from substations and wires for different phases of current to safety devices and redundant lines along the grid to ensure that power is available at all times. You can see why the U.S. National Academy of Engineering has called America's electric grid "the greatest engineering achievement of the 20th century."

The Smart Grid

The current electric grid is aging and plans are underway to update it and create a "smart grid." The existing electric grid has worked well for many years, but developing a new, more efficient grid will help meet growing electricity demand. Updating the current grid and transmission lines would not only improve current operations, but would also open new markets for electricity generated by renewable energy sources.

The smart grid system will include two-way interaction between the utility company and utilities. During peak demand when power generation is reaching its limit, the utility company can contact consumers to alert them of the need to reduce energy until the demand decreases. The smart grid would alert the power producer

to an outage or power interruption long before the homeowner has to call the producer to let them know the power is out.
Developing the smart grid would offer a variety of technologies that will help consumers lower their power usage during peak periods, allow power producers to expand their use of photovoltaics, wind and other renewable energy technologies, provide system back-up to eliminate power outages during peak times, and save money while reducing carbon dioxide emissions.

www.need.org

Evidence #4: New evidence has been found that states oil is being created from other underground sources.

Oil is a Renewable Resource
by Russ McGlenn russmcglenn@juno.com

Oil wells in the Gulf of Mexico are being refilled with oil coming up from below the current oil fields. Russia has drilled over 300 eight mile deep wells into the Earth's granite crust. This has worked so well that they worked in Vietnam and found oil off its coast where everyone said there was no oil. Oil used to be found in sedimentary rock at 2-3 miles deep, but the Russians found a new source.

What is happening? The Russians found that new oil was being made from hot molten rock called magma heating the basement rocks of the Earth's crust. As the rocks are heated methane gas is distilled. This combines with carbonates and carbon 14 that occur naturally in rock, when these are mixed together, they form oil. It's called Abiotc (non biological) because it does not come from vegetable matter. The original theory of how oil was formed is that swamps filled with vegetation, (biomass) were covered with mud (called sedimentary rock once it hardened) and decayed over millions of years into coal or crude oil. This is called the Biotic Theory. Oil is a renewable resource because it is being made today deep in the earth's crust. We do not have an energy crisis we have a leadership crisis. One group says we are running out of energy so we have to cut back all that we do and will not allow us to drill for the new oil. This new group says we have plenty of oil, let us drill for it and use it. Write or call you congressmen and tell them your views. They are already feeling the heat from voters, keep the pressure on.

Evidence #5: Oil contains fossilized chlorophyll.

Based on the NY Times article "*Tracing Oil Reserves to Their Tiny Origins*"

By WILLIAM J. BROAD

In 1913, as the automobile zoomed into American life, The Outing Magazine gave its readers a bit of background on what fueled the new motorcars in "The Story of Gasoline." After a brief vignette describing the death of "old Colonel Stegosaurus Ungulatus," the article explained that "yesterday you poured the remains of the dinosaur from a measuring-can — which, let us hope, held five gallons, full measure — into your gasoline tank."

The idea that oil came from the terrible lizards that children love to learn about endured for many decades. The Sinclair Oil Company featured a dinosaur in its logo and in its advertisements, and outfitted its gas stations with giant replicas that bore long necks and tails. The publicity gave the term "fossil fuels" new resonance.

But the emphasis turned out to be wrong.

Today, a principal tenet of geology is that a vast majority of the world's oil arose not from lumbering beasts on land but tiny organisms at sea. It holds that blizzards of microscopic life fell into the sunless depths over the ages, producing thick sediments that the planet's inner heat eventually cooked into oil. It is estimated that 95 percent or more of global oil traces its genesis to the sea.

"It's the dominant theory," said David A. Ross, scientist emeritus at the Woods Hole Oceanographic Institution on Cape Cod. The idea, he added, has been verified as geologists have roamed the globe over the decades and repeatedly found that beds of marine sediments are "a good predictor" of where to discover oil.

Some of the ancestral waters that made the planet's oil still exist, like the Gulf of Mexico, while others have long vanished, like the ocean that produced the massive oil fields of the Middle East. The bodies come and go because the earth's crust, through seemingly rigid, actually moves a great deal over geologic time, tearing apart continents and ocean basins and rearranging them like pieces of a giant jigsaw puzzle.

The secret of the oil story turned out to be understanding how the bygone oceans, ancient seas and smaller bodies of water produced complex environmental conditions that raised the prevalence of microscopic life and ensured its deep burial, producing what eventually became the earth's main oil reservoirs.

The clues accumulated over more than a century and included discoveries from geology, chemistry and paleontology. An early indication was that petroleum discoveries were always associated with ancient beds of sedimentary rock — the kind that forms when debris rains down through water for ages and slowly grows into thick seabed layers.

A breakthrough came in the 1930s. Alfred E. Treibs, a German chemist, discovered that oil harbored the fossil remains of chlorophyll, the compound in plants that helps convert sunlight into chemical energy. The source appeared to be the tiny plants of ancient seas.

By the 1960s and 1970s, oil samples were producing many fossil molecules. One class, the hopanoids, were seen as representing the remains of ancient microbes that fed on seabed detritus. A 2009 book,

"Echoes of Life: What Fossil Molecules Reveal About Earth History" (Oxford University Press), says geologists found so many fossil molecules, and in such variety, that they began using them as fingerprints to identify the family relationships among pockets of deep oil.

A separate breakthrough came as paleontologists peering at oil came to recognize a host of microfossils. Often smaller than grains of sand, the fossils nonetheless spoke volumes. Many were foraminifera, minuscule sea creatures with a bewildering array of shells. Oil geologists began using the foraminifera's shifting appearance as a reliable guide to geologic dating.

Oil production begins when surface waters become so rich in microscopic life that the rain of debris outpaces decay on the seabed. The result is thickening accumulations of biologic sludge.

Scott W. Tinker, the state geologist of Texas, said the abundant flows of mud and sediment not only fed microscopic life but also formed rocky barriers that sealed off the organic remains from the outer world. A main barrier was shale, a sedimentary rock made of clay and silt.

"The organics got buried quickly because of the heavy sediment flow," Dr. Tinker said. "So they didn't get biodegraded as quickly. You preserved the organic richness."

He said the flow was so heavy that the growing accumulations keep pressing the lower sediment layers deeper into the earth, forcing them into hot zones where the organic material got transformed into oil. The process involves a long series of chemical reactions that slowly turn life molecules into inanimate crude.

The standard temperature for oil formation is between 120 and 210 degrees Fahrenheit. The earth gets increasingly warm with increasing depth, the temperature eventually rising so high that rocks melt (and occasionally remerge at the surface in volcanic eruptions).

Restrictions on watery flows turn out to have played starring roles in determining where oil formed, scientists say. The Tethys Sea — an ancient ocean that girded the equator in the Cretaceous period, some 100 million years ago, in the heyday of the dinosaurs — became a sprawling factory.

Its most productive regions centered on shorelines, coastal regions and shallow seas, said Dr. Stow of Heriot-Watt University, whose new book describes the secret life of the Tethys. He identified "broad shelf areas" as some of the best "factories for biogenic proliferation." When the Tethys mostly closed up (its remnants include the Aral, Black, Caspian and Mediterranean Seas), its fertile southern shores formed the dozen or so nations of the Middle East that produce two-thirds of the world's oil.

Dr. Stow called their wealth "an accident of geology."

"It's not about dinosaurs," said Kenneth E. Peters, a petroleum geochemist at Stanford University. "Any kind of organic material can contribute, yes. But if you look at the food chain, they're way at the top. It's the little guys that matter."

This article has been revised to reflect the following correction:

Correction: August 10, 2010

An article last Tuesday about the microscopic origins of oil, in quoting a 1913 magazine article based on the premise that oil came from dinosaurs, misspelled the name of a species of stegosaurus. It is ungulatus, not ugulatus.